International Telecommunication Union

THE ITU NEW INITIATIVES PROGRAMME

UBIQUITOUS NETWORK SOCIETIES

ITU International Telecommunication Union

FOREWORD AND ACKNOWLEDGEMENTS

Ubiquitous Network Societies is one of the themes covered in the 2005 series of the ITU New Initiatives Programme. This publication was prepared by a team of authors, led by Lara Srivastava of the ITU Strategy and Policy Unit (SPU). The cover design is by Jean-Jacques Mendez.

For the convenience of the ITU membership and interested members of the public, this publication presents the Chairman's Report, an extended meeting summary, and a selection of papers and case studies prepared for the ITU Workshop on Ubiquitous Network Societies held in Geneva from 6-8 April 2005. The contributions and papers were made by ITU staff and individual experts with a wide spectrum of backgrounds and views on the topic, including from ITU Member States and Sector Members.

Further information on the workshop and on the New Initiatives Programme is available at: http://www.itu.int/ni/. The following titles in the series can be ordered from the ITU Sales Service (15% reduction applicable for ITU Member States and Sector Members; 80% for administrations from least developed countries):

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The ITU New Initiatives Programme:

Ubiquitous Network Societies

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UBIQUITOUS NETWORK SOCIETIES:
CHAIR'S REPORT

UBIQUITOUS NETWORK SOCIETIES: CHAIR'S REPORT

INTRODUCTION

1. At the invitation of the ITU Secretary-General, a workshop on "Ubiquitous Network Societies" was held in Geneva, Switzerland, from 6-8 April 2005. The workshop was organized as part of the Secretary-General's "New Initiatives" programme.[1] Some 40 experts participated in the workshop, representing a range of regulatory and policy-making agencies, mobile operators, service providers, academic institutions, futurologists, private firms, and others. Those present at the meeting participated in an individual capacity. Professor Robin Mansell, who holds the Dixons Chair in New Media and the Internet at the London School of Economics and Political Science, chaired the meeting.

2. Three background papers were prepared for discussion at the workshop: "*Ubiquitous Network Societies: Their impact on the telecommunication industry*" (presented by Professor Elgar Fleisch, University of St. Gallen, Switzerland), "*Ubiquitous Network Societies: The case of RFID*" (presented by Lara Srivastava, SPU, ITU), and "*Ubiquitous Network Societies: Privacy Implications*" (presented by Dr Gordon Gow, London School of Economics and Political Science). In addition, a number of case studies were prepared covering country experiences in Italy, Japan, Korea, and Singapore.[2] The experiences of other economies were also presented, including India, Hong Kong SAR, China, France, Spain, Russia and the United Kingdom.

CASE STUDIES ON UBIQUITOUS NETWORK SOCIETIES

3. The four countries selected for the case studies each represented early adopters of mobile and ubiquitous technologies in their regions:

- The case of **Italy**, together with the results of a survey of opinion-shapers in Italy, was presented by Maria Cristina Bueti. The Italian government is committed to making Italy a leader of the digital age and, to this end, has committed to making consumer subsidies available for the adoption of broadband (EUR 75 per household) and set-top boxes for digital TV (initially EUR 150 per household, but subsequently reduced to EUR 75). In particular, the use of interactive TV has been identified as a way of extending access to government services ("T-government" or "television-government", which enables local television companies to transmit content for third parties as part of their public service mission), beyond those reached by other new media.
- The case of **Japan** was presented by Lara Srivastava. Japan defines the Ubiquitous Network Society (UNS) as one in which there is "anywhere and anytime access for anyone and anything". Since 2003, the Ministry of Internal Affairs and Communication (MIC) has been working with industry and academia to stimulate the development of ubiquitous networks, namely in three areas: next generation networks, universal communication, and safety and security. A Charter of the Ubiquitous Network Society has been proposed to balance technology and societal interests.
- The case of the **Republic of Korea** was presented by Tim Kelly. Korea can be seen as a laboratory of the future, as it holds a leadership position in both broadband and 3G mobile. This has resulted, *inter alia*, from a unique public/private consensus-making process, which has shaped government policy for promoting Korea's position in the Information Society. One recent element of this has been the IT839 strategy, which targets 8 services, 3 infrastructures and 9 new growth engines for a ubiquitous ICT environment.
- The case of **Singapore** was presented by Eric Lie. Singapore has long been a leader in the field of e-government and has pioneered the use of ubiquitous technologies in fields such as traffic management and library automation. Singapore's current strategy is built around its aim to become the "Next Generation I-Hub", with the vision of creating a secure, ultra high-speed network to drive next generation connectivity.

- In addition to the formal case studies, the experiences of a number of other countries were presented. The case of **India**, and other developing countries, was presented by Rakesh Kumar (Cognizant Technology Solutions), who noted, in particular, two applications of RFIDs in India: for delegate management (at NASSCOM 2005) and livestock management (Chitale Dairy Farms).

UBIQUITOUS NETWORK SOCIETIES

4. The term "ubiquitous computing" was coined in 1991 by the computer scientist, Marc Weiser. He described a new era in which computer devices will be embedded in everyday objects invisibly at work d the environment around us; in which intelligent, intuitive interfaces will make computer devices simple to use and unobtrusive; and in which communication networks will connect these devices together to facilitate anywhere, anytime, always-on communications. Now, almost fifteen years later, technological change and the diffusion of mobile communications and the Internet are making this vision a reality. The term "Ubiquitous Network Societies" (UNS) captures the convergence between a number of technological fields as well as their implications for the economic, political and social aspects of society. Key trigger points in making this possible might include radio frequency identification (RFID) chips available at less than USD 0.05, USD 20 mobile phones and USD 200 computers.

5. However, the business case for implementing longer-term visions of UNS remains unproven. In addition to the difficulties of reaching the price points at which widespread hardware diffusion becomes possible, there is the problem of keeping usage or subscription charges at a sufficiently high level to maintain incentives for investment without deterring usage. Other difficult challenges include simplifying the inherent complexity of ubiquitous networks; interpreting issues of liability and ensuring interconnection; and countering any tendency towards monopoly provision by fostering competition between networks that offer multi-purpose functionality.

6. Different visions of UNS were presented at the workshop, some focusing on the use of sensor technology, and others more broadly encompassing a range of new technologies. A major characteristic of UNS is the mapping of activities in the "virtual" and "real" worlds. For some, the migration path to UNS is incremental, with capabilities such as self-adaptive or context-aware operation of devices being added slowly to today's products and services. For others, the migration path is longer-term, disruptive and potentially requiring huge investment in infrastructure and applications. For instance, some argue that using RFIDs effectively in inventory management will require a complete rethink of existing management systems rather than an incremental adoption of the technology within existing supply chains. Others stress the importance of differentiating between today's RFID applications and future nano-scale or sensor-enabled radio technologies.

TECHNOLOGIES AND THEIR APPLICATIONS

7. There are likely to be multiple platforms for the delivery of ubiquitous networks and computing applications based upon interworking and the interoperability of systems, as well as convergence at the network, device and services levels. Broad definitions of UNS encompass a wide variety of information and communication technologies, while more narrower definitions focus more directly on developments in RFID and sensor technologies. Although, by no means the only technology development of concern to UNS, at present the best developed is RFID (both passive and active), the subject of one of the background papers prepared for the workshop. Many other technologies, such as Near Field Communications (NFC), sensors, and Zigbee are coming to market and will likely play a major role in future developments. Key considerations in this area are the usability, utility and ubiquity of new applications. A number of presentations provided examples of early adoption of UNS applications. For instance:

- Sensor networks have been established to provide flood-warning systems through a network of sensors in a river bed near Nice in France;
- In Japan, RFID chips have been used to improve food traceability, for instance to track the origin of meat, or the freshness of fish;
- RFID chips are being used to distinguish legitimate pharmaceuticals from counterfeit ones. It is estimated that 30 per cent of drugs in the developing world and 6-10 per cent in the developed world are counterfeit;

- RFID chips in ID cards and passports have been proposed as a way of improving security and streamlining procedures at airports. However, this may have the undesired effect of enabling citizens to be more easily tracked and making particular nationalities more recognizable to terrorists and other criminals;
- In the Republic of Korea, self-adaptive ICT devices (like KT's "One-Phone" or "Nespot Swing"), automatically recognize which network is being accessed and which one is the cheapest or fastest available;
- In Switzerland, RFID is widely used in ski-passes to provide access control and an easy mechanism for payment;
- In Singapore, RFID chips have been used in road pricing since 1998 and there is 100 per cent penetration of vehicles in the country;
- RFIDs are widely used in inventory management and in maritime transport and logistics, with Wal-Mart and Gillette being among the early adopters and bulk purchasers of chips and readers, a process which is essential to reducing unit prices;
- Bio-medical applications include RFIDs that contain identity information or medical records and which can be implanted in dental prosthetics or injected into the body. The latter are also used, for instance, in the Baja Beach Club, Barcelona, for controlling access to certain parts of the club, and to facilitate purchases of drinks and food.

RFID AND SENSORS AS ENABLERS OF THE UBIQUITOUS COMMUNICATION ENVIRONMENT

8. "Ubiquitous Network Societies: The case of RFID", one of the background papers prepared for this Workshop, was presented by Lara Srivastava (ITU). Though there are early examples of ubiquitous technologies and their applications, such as the mobile phone, access "anytime, anywhere, by anyone and anything" is currently limited by our inability to collect raw data about where things are located and changes in their status. RFID promises a shift in the computing paradigm such that in the future not only people and their communication devices will be connected to global networks, but also a large number of inanimate objects from tires to razorblades. RFID applications will enable the automatic and autonomous collection of data about all the things we see and use in our environment, thereby creating truly intelligent and ambient network spaces.

9. RFID applications are quickly gaining momentum in public transport, toll collection and contactless payment cards. Though not a new concept, RFID is being seen as an enabler of the "Internet of things", the next and crucial step beyond person-to-person person-to-machine communication. In the future, "things" will communicate with each other in the interest of (and on behalf of) people. However, the tremendous potential of RFID-based applications is currently being hindered by the absence of new international standards to ensure interoperability. Continuing fragmentation in standard-setting in this area may mean that organizations will incur higher costs to ensure compatibility with multiple types of systeMs Workshop participants called for concerted efforts to encourage global harmonization of RFID standards and their interoperability, so as to stimulate smooth and rapid technological advance in the field. This holds particularly true for the harmonization of frequency use and communication protocols which vary across regions. Data formats for RFID tags, or electronic product codes, on the other hand, have benefited from international collaboration through organizations such as Auto-ID Center, now EPCGlobal, and Ubiquitous ID Centre.

10. The potential benefits of RFID applications range from better and more efficient medical care to increased convenience at points of sale, improved fraud prevention, and streamlined business processes (in particular, in supply-chain management applications). It was suggested that near-term growth in RFID use will continue to be driven by business applications with consumer applications growing in the mid- to long-term. Given its potential for tracking the location of individual items and people (using wearable or implantable RFID tags), consumer advocates remain concerned about the potential risks RFID poses to individual freedoms and privacy protection.

THE CHALLENGES OF UBIQUITOUS NETWORKS FOR THE TRADITIONAL TELECOMMUNICATION INDUSTRY

11. The background paper on "Ubiquitous Network Societies: Their impact on the telecommunication industry" was presented by Professor Elgar Fleisch (Univ. of St. Gallen, Switzerland). The hope for the telecommunication vendors and service providers is that ubiquitous communication will create new revenue streams, in particular, from machine-to-machine communications (the "Internet of Things"). Operators are expecting greater revenue growth from data services than from voice services, on both fixed and mobile networks.

12. Ubiquitous technologies promise to be engines for economic growth, which is one reason that so many operators and firms are targeting this area. However, for traditional operators there is also the threat of cannibalization of existing revenue streaMs There are continuing tensions between the economics of Internet Protocol and Time Division Multiplexing (TDM) networks that will need to be addressed, together with issues of billing, quality of service, and network security. For instance, self-adaptive telephones will tend to reduce the price paid for calls without necessarily increasing their duration or number. Advanced wireless technologies (such as WiMAX, Wi-Fi or Korea's WiBro standard) were also seen to complement and build on current third-generation mobile technologies. The introduction of "always-on" pricing models will provide a significant improvement over traditional per-minute charging schemes. In Korea, two out of the three licensees for WiBro are fixed-line operators (KT and Hanaro) that see WiBro as a way of winning back traffic that has shifted to their mobile competitors.

IMPLICATIONS FOR GOVERNMENT POLICY AND REGULATION

13. The different types of service underlying UNS each have difficult spectrum requirements that are difficult to foresee, but certainly substantial. There also are issues around who should bear the risk and costs associated with changes in spectrum management approaches and allocation decisions. Within ITU, the ITU-R Working Group 8F is working on the spectrum requirements of services beyond IMT-2000 (3G), with a typical radio interface of 100-1'000 Mbit/s (depending on the level of mobility), as well as enhancements to today's 3G systeMs A market analysis of future service requirements is being undertaken in order to develop recommendations for the next World Radio Conference. For RFID applications, various spectrum allocations and power limitations have been agreed in different regions (for instance, 902-928 MHz, 2.4 W ERP (Effective Radiated Power) in United States but 868-870 MHz, 0.5 W ERP in Europe). This is hindering the further development of global RFID applications and future decisions will have an impact on the structure and competitiveness of emerging markets.

14. New spectrum requirements for UNS are also posing challenges for traditional command and control or administrative spectrum allocation techniques. Some countries have already adopted market-based mechanisms for spectrum allocation (including spectrum trading in some countries) while license-exempt services like Wi-Fi are also being deployed in a growing number of countries, creating demand for a larger spectrum "commons". Some services (for instance, public protection disaster relief) still require global harmonization. Different mechanisms for spectrum management will most likely coexist in ubiquitous network societies, and it will be important to consider whether allocation should be done on a application-specific basis on a technology neutral one.

15. Government policy and regulatory issues are important considerations as UNS emerge. In some economies, there is a shift in focus from 'e' to 'u'-strategies, to reconsidering the treatment of universal service and the ubiquity of access for potentially excluded groups, including the elderly, and, potentially, to discussing new codes of social conduct. In addition, the roles of the public and private sectors in encouraging the spread of the new technologies will continue to need to be reviewed to ensure an appropriate balance in their respective contributions.

DATA PROTECTION, PRIVACY, SECURITY AND CONSUMER PROTECTION

16. The third background paper commissioned for this workshop was on the topic of "Privacy Implications", presented by Dr Gordon Gow of the London School of Economics and Political Science. Notions of privacy and related concepts also were raised by other speakers in the context of increasing technological pervasiveness. The "privacy paradox" associated with ubiquitous network societies involves three co-dependent domains: the technical domain (e.g. encryption and spyware), the regulatory domain (e.g.

rules on disclosure and retention of personal data) and the sociological domain (e.g. blurring boundaries between public and private spaces). In the sociological domain privacy issues are evaluated as they relate to social systems and norms and, in this respect, education and awareness about the concept of privacy are important starting points.

17. Specific challenges related to privacy in UNS were raised such as authentication mechanisms (e.g. forgotten passwords or stolen identities), individual profiling (i.e. prediction or categorization of human behaviour), and unsolicited and fraudulent communication (e.g. spam, spim and phishing). Other concerns included surveillance, retention of data, and security.

18. Although PETs (privacy enhancing technologies) have emerged on the market for the protection of individual privacy and identity, serious problems remain in terms of their usability. In addition, if sensor networks should "announce" their presence rather than remaining undetected, there are issues as to whether this capability should be mandatory. It was suggested that mechanisms for protecting privacy should not be provided at a premium and businesses should not charge more for services or products that free users from tracking or profiling. The question was raised as to whether privacy is to become a commodity available only to those with the necessary financial means?

19. Privacy is widely recognised as a shared set of common values (cf. OECD Guidelines, 1990) and in many countries it is recognised as a human right. Privacy is also an important business consideration, especially as consumer demand and the building of consumer confidence are pivotal to any business case for ubiquitous network applications. In this respect, fears related to the social impact of new technological developments are important considerations for the mass take-up of ubiquitous network technologies and applications. Privacy issues need to be considered along with other consumer issues such as affordability, health, and environmental concerns. Although there are considerable concerns about privacy protection, it was suggested that the notion of individual privacy is not absolute and that protections must be balanced against collective interests in economic growth, business and social development, and the public interest. The resolution of issues in this area will have a fundamental impact on the trust and confidence that consumers and citizens place in UNS.

20. In the specific context of data protection it will be necessary to elaborate solutions based on shared principles in response to new challenges presented by ubiquitous networks and the use of sensors that otherwise might result in surveillance. Solutions are likely to entail the use of technology, regulatory, administrative and financial mechanisms and will need to cover data collection, retention and security issues.

THE INTERPLAY BETWEEN TECHNOLOGICAL UBIQUITY, HUMAN BEHAVIOUR AND SOCIALIZATION

21. No technology can develop without an effect upon society and *vice versa*. The mobile phone, as an early example of a ubiquitous technology, provides an interesting case study. Mobile communication, in particular, among young people, has been accompanied by changes in social values and norMs For young people, mobile phones are regarded more as personal gadgets than as communication devices: they serve as fashion statements, as a link to their peer groups and often as a means of gaining independence from parental control. The mobile phone of the future may change radically, perhaps by being integrated into users' glasses or clothes ("invisible mobile"), accompanied by further changes in social practices. There is a need to manage increasing complexity, to ensure that functionality for users is transparent, and to develop ways of fostering trust and minimizing risk.

22. It was suggested that the extensive use of ubiquitous technologies may lead to a reduction in face-to-face contacts and to greater individuality or isolation. It also was argued that any form of mediation is an essential aspect of human communication. Human beings have always communicated using some kind of "utility", be it a language or a technology. The emergence of ubiquitous or ambient spaces is likely to affect the "form" or "type" of mediation, but will not be the first instance of mediated communication environments. Technological mediation of human relationships is likely to become more intense and frequent, however, thereby influencing social behaviour and human identity formation. The real (or perceived) social consequences that may result from the global and pervasive use of ubiquitous technologies (such as RFID) will need to be considered along with the economic, organizational and political considerations, possibly in the context of multi-disciplinary global foruMs

23. An important consideration in any assessment of these technological developments and their policy and regulatory implications (as well as the likelihood of compliance with legislative measures) is the extent to which people will remain a systemic weakness in UNS. Decisions with respect to the liability assigned to various human actors within these societies will play an important role in whether policy and regulatory goals can be met. A further consideration is the development of a better understanding of the user motivations that shape demand for new applications and services and of the socio-economic factors that influence them. In particular, there is a need for ongoing discussion of the distinctive social, cultural and other values that will become embedded in the architecture of UNS and whether these are consistent with agreed values and ethical norMs

Shaping ubiquity in the developing world

24. For most developing countries, achieving universality of information and communication technologies is more important than achieving ubiquitous networks. Priorities suggest that access to basic telecommunication services must come before access to more advanced ones. Nevertheless, developing countries will certainly benefit from advanced technologies that achieve economies of scale in production in the industrialized countries as this will reduce their unit prices. Equally, certain RFID applications – such as those in the field of agriculture or emergency warning systems – are of potentially greater benefit in developing countries than in the industrialized countries.

25. One of the major factors influencing developing economy firms to adopt ubiquitous technologies is the need to meet requirements for participation in global supply chains including the requirements of their clients in the industrialized countries. For instance, the retailer Wal-Mart, which sources many of its products from China, is progressively requiring the use of RFID tags throughout its supply chain. Although the benefits of supply-chain automation for labour-saving may not be as significant in developing economies, the potential gains in terms of reduction of inventory losses, traceability of origin and improvements in timeliness of delivery will provide benefits. As in the case of the industrialized economies, there are issues of security, spam and privacy intrusion which may be more severe in developing economies and need to be taken into consideration, together with issues of public and private sector sources of investment.

Opportunities for international collaboration and further work

26. The development of ubiquitous, next generation networks will require international coordination in many different areas including standardization, both of technical interfaces and product codes, frequency allocation, allocation of IPv6 addresses, etc. As one participant in the workshop observed, "it is difficult to speak about the future, especially during a technological revolution". However, it is clear that consideration must be given to what a standards development organization in the 21st Century would be like and to the priorities that should be given to global harmonization in certain areas. This will require continuous institutional evolution and, perhaps new types of mechanisms, with broader membership that could handle the many different coordination requirements, while remaining flexible, responsive and cost-effective.

27. Further inter-disciplinary research is required in many of these areas including the crucial question of the level of ubiquity that may be considered appropriate by users in different countries and regions in the world. In addition, it will be important in some cases to consider alternative approaches to "marketing" the importance of privacy protection in ubiquitous network societies, for instance by placing more emphasis on the commercial benefits to business enterprises, rather than on human rights considerations.

Endnotes

1 For more information on the ITU New Initiatives Programme, see www.itu.int/spu/ni

2 All of the meeting documents are available on the ITU website at: www.itu.int/ubiquitous and will be published later as part of the ITU New Initiatives series of publications. Workshop presentations can be downloaded at www.itu.int/osg/spu/ni/ubiquitous/presentations/

CHAPTER II

UBIQUITOUS NETWORK SOCIETIES:
EXTENDED MEETING SUMMARY

UBIQUITOUS NETWORK SOCIETIES: EXTENDED MEETING SUMMARY*

1 INTRODUCTION

In line with technological progress, falling prices and effective policies, all societies are becoming gradually more dependent on information and communication technologies (ICTs). As it is generally recognized that the use of ICTs creates social, as well as economic advantages, bringing people onto the net should help build the new backbone of each economy. Indeed, this is reflected in many national and international policies and strategies for the development of the information society. Moreover, the tangible effects of this common understanding can be observed not only amongst the industrialized countries that have already been reaping the ICT-related benefits for many years, but also in the developing and least developed countries, as well as those in transition, all of which are gradually catching up and becoming beneficiaries of the ICTs in a real sense.

The vision of the information society is evolving over time; together with many technological innovations, the futuristic vision of the Ubiquitous Network Societies (UNS) created in the last decade is becoming an increasing reality. The creation of an environment that enables us to communicate anywhere, anytime, with anyone and with anything extends the vision of information society development, in particular focusing our attention on mobility, ubiquity, convergence and the communication of things.

The UNS concept has already been recognized by some advanced economies, which, for many years, have been demonstrating their broad experience and great potential in moving towards the modern ICT environment. Consequently, some of these economies have incorporated the UNS concept into their new policies and strategies. However, for many other countries, even some of the advanced economies, UNS will remain a future vision for some years to come. There is a need for open discussion between the ICT sector stakeholders at the international level to identify the fields in which cooperation might foster the development of the UNS. The initial experiences of the pioneering countries, including Italy, Japan, the Republic of Korea and Singapore are proving extremely valuable in this respect.

Given this, within the framework of the "New Initiatives" programme,[1] the ITU workshop on "Ubiquitous Network Societies" was held in Geneva, Switzerland, from 6 to 8 April 2005.[2] Some 40 experts participated in the workshop, representing a range of regulatory and policy-making agencies, mobile operators, service providers, academic institutions, futurologists, private companies and others.

The purpose of this workshop was to identify and examine the cornerstones of the Ubiquitous Network Society vision that many countries might incorporate into their national policies and strategies in the near future. One key aim was to identify the possible trends in the ICT sector, including regulation, technology, and social and economic progress. The creation of a common understanding on the UNS concept between all ICT sector stakeholders may determine the future development of UNS at the global level.

Three background papers[3] were prepared, along with a number of case studies covering Italy, Japan, Republic of Korea, and Singapore.[4] All of these documents have been included in this publication. During the workshop, the experiences of several other economies were presented: these included France, India, Russia, Spain, the United Kingdom and Hong Kong, China.

This extended summary is divided into four parts and aims to highlight the most important issues and concerns raised during the presentations and open discussions. The first part focuses on the viewpoints of various ICT sector stakeholders on the UNS raising consequences for ICT sector developments. The second concentrates on the technologies that foster the development of the Internet of things. The third addresses the challenges related to data protection, privacy, security and consumer protection. The final part discusses different national approaches on UNS development, as well as the threats to the developing countries from the UNS and the opportunities presented by it.

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* Geneva, 6-8 April 2005. See www.itu.int/ubiquitous/workshop.html for more information, e.g. agenda and presentations.

2 THE UBIQUITOUS NETWORK SOCIETY FROM THE PERSPECTIVE OF ICT SECTOR STAKEHOLDERS

This section will demonstrate the different approaches of the ICT sector stakeholders to UNS development. It is important to note that all presentations expressed an optimistic attitude concerning new business opportunities, whilst identifying some potential threats.

Elgar Fleisch[5] discussed the impact on the traditional telecommunication industry of emerging ubiquitous networks. Besides technological trends, the author focused on the existing business drivers that would determinate the development of the ubiquitous network societies. He stressed the special role of the particular technologies, such as Radio Frequency Identification (RFID), that transform the Internet of things from a futuristic vision into a reality.

Demonstrating various application opportunities, the author drew our attention to the possible advantages to be reaped by the public and private sector stakeholders (see Box 1). He admitted that, with technological advances, there has been a tendency towards the miniaturization of all communication devices, followed by a significant decrease in their production costs. This has created a wide range of opportunities for new, real-life applications, thus further closing the existing gap between the virtual and real worlds. At the same time, this confronts both the particular business entities and the traditional telecommunication sector with new challenges.

Assuming the Ubiquitous Network Society does indeed become a reality, the value of the information, as well as the speed of its diffusion and processing will gradually change. The socio-economic implications could be similar to or even broader than those already partially observed during the Internet expansion a few years ago.

As regards the traditional telecommunication sector, Professor Fleisch expects the new ubiquitous technologies, such as the Internet of things, to increase the demand for data transmission; however, at this stage of development, it is not easy to obtain a clear vision of this tendency. For instance, some participants expressed doubts about this term, arguing that, within the extended capacity of the networks, it may have a minor impact on the revenues of the fixed infrastructure. In particular, the expected positive impact refers to the wireless communication infrastructure and service providers that can play very important role in the future development of the UNS market. Nevertheless, their position depends on how fast they are able to identify latent economic potential as being behind the new ubiquitous technologies and applications.

It should be borne in mind that ubiquitous solutions can attract many newcomers and that using the first mover advantage might be rewarded with a significant role in the future market structure.

Box 1: Integrating the real and virtual worlds

There is no doubt that UNS applications can become a source of significant operational cost savings for particular business entities. The following examples of inefficiencies that exist in the real world demonstrate the potential fields, in which the implementation of the UNS technologies might be very successful in determining the further expansion of the UNS.

- **Out of Stock** (OOS) level in retail industry is 8.3%: the average OOS level in direct store delivery product categories in US is 7.4%.
- **Shrinkage**: the average shrinkage rate for supermarkets/groceries in the US is 1.5% of sales.
- **Invoice inaccuracy**: the average deduction level is 9.9% of annual invoiced sales in the US.
- **Unsaleable products**: the cost of unsaleable food and grocery products in the US is 1% of sales.
- **Counterfeiting**: product counterfeiting is estimated to account for between 5% and 7% of world trade, with a value of USD 280 billion and 30% of pharmaceuticals in the developing world and 6-10% in the developed world are counterfeits.
- **Data inaccuracy**: the mean difference between physical and book inventory in a single case study is 6.8 units per SKU, or, on average, 35% of target inventory.

Source: Presentation by Elgar Fleisch: "Ubiquitous Network Societies: Their impact on the telecommunication industry", adapted from C. Tellkamp, E. Fleisch, Auto-ID Lab, St. Gallen.

For Rob Borthwick[6] (Vodafone, UK), the concept of ubiquitous network societies goes beyond current fixed and 3G networks, but should, nevertheless, be built on these technologies. This would imply that in the discussion on UNS development, the role of mobile communication operators should not be diminished. In most countries today, mobile telecommunications infrastructure provides the opportunity to be connected anywhere and at any time, and it is important to stress that this kind of ubiquity has been developed without any regulatory interventions.

Nevertheless, these days, mobile telecommunication operators face many challenges in terms of regulation (e.g. competition-oriented regulatory policy), technological innovations (e.g. 2G to 3G, intelligent phones) and competition (e.g. WLAN). To be able to defend their present role as the ubiquitous infrastructure provider, they are being forced to adjust their business models continuously; very often this involves expansion to other wireless communication technologies (WLAN, Wi-Fi, WiMAX). A more intensive involvement of the mobile operators in UNS development should be seen as a natural step forward.

Moreover, in line with development of the UNS, the strategies of mobile operators will gradually change; customer power will be more exposed. Even now, mobile telecoms tend to deliver the "best connection for the job". Thus, we should expect more connection possibilities within a single operator portfolio, either from heterogeneous operator alliances, or on the basis of resale between non-aligned operators. In addition, Mr Borthwick drew our attention to the fact that although the UNS concept provides the user with many advantages, we should be prepared for extended attempts to exploit anything that can be connected to "free of charge", as this can distort the positive image of the UNS.

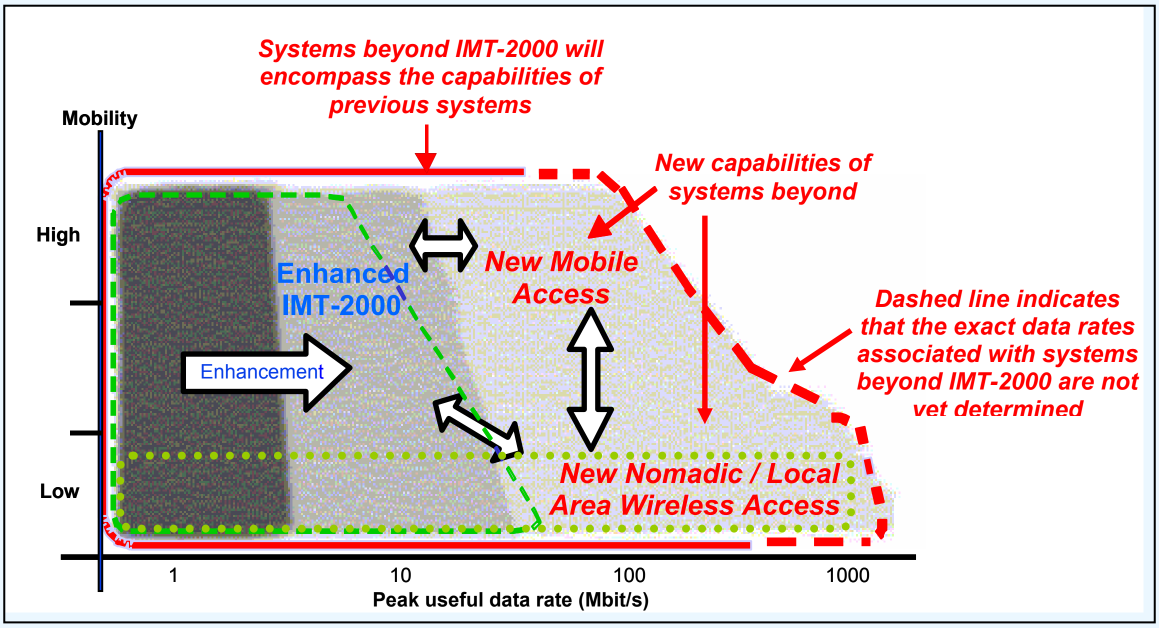
Antongiulio Lombardi[7] (H3G, Italy) believes that the UNS concept ought to be more associated with the process of convergence, in its three dimensions, i.e. convergence of means, services and rules. To create more a more UNS-friendly legal environment, fostering the convergence process requires state involvement. The Italian experiences demonstrate that in particular the interrelation between electronic communications, broadcasting and m-commerce should motivate the stakeholders to make access to the services and applications easier, safer and more credible for the customers. Moreover, the customers still need to be educated in the use of the new services. If it is to succeed with the UNS, the ICT sector itself needs a better common understanding of the changing character of the converging ICT sector, as well as the more intensive cooperation of its stakeholders.

Leslie J. Martinkovics[8] (Verizon Communications, USA) underlined that the UNS concept is very closely related to the convergence process and stressed the particular link between ubiquity and the role of the actual devices that will be on the net anywhere and at anytime, and how this may change the paradigm of user behaviour. The UNS concept opens new perspectives for the creation of various highly reliable, flexible, new-generation services in the infrastructure. In Mr Martinkovics' opinion, this will have vast implications for both the digital content creators and the ubiquitous electronics suppliers and will also lead to the more effective utilization of the frequency spectrum and policies, and may well trigger R&D in both public and private sectors. Nevertheless, he stressed that behind the UNS there remain many issues for discussion, such as security, authentication, billing and privacy. Finally, he pointed out that ubiquitous networks involve not only changes in technology, but also changes in the entire social system, including legal frameworks, as well as in usage and value judgments. Similar concerns were expressed by Santiago Lorente[9] (Universidad Politécnica de Madrid, Spain), who focused mainly on the social implications of the UNS technologies and the way in which they change the behaviour of society. He concentrated on its social impact on young people in Spain.

Christoph Legutko[10] (Siemens, Germany) associates the UNS with the process of convergence that may create new business opportunities for telecommunication sector stakeholders, provided they are able to adjust to the continuously changing environment. Considering that the ICT sector is driven by high innovation dynamics, it is a natural development that, over time, the behaviour and preferences of customers will evolve to influence the structure of demand. To stay competitive, telecom stakeholders must also evolve; they must look for new sources of revenue, simultaneously optimizing their utilization of the networks and harmonizing and standardizing their infrastructure. Nevertheless, the success of UNS solutions may depend on many opposing forces, for instance the market, technical challenges, enhancements, regulation and spectrum; some of these are not easy to influence. For fixed-mobile convergence, Mr Legutko recognizes the potential advantages that might be expressed in higher average per user revenues of the telecommunication companies in the future. One of the most important UNS development issues should be spectrum management; the way in which it is reallocated and used could have significant implications for the performance of the entire telecommunications sector.

Consequently, Colin Langtry[11] (ITU, ITU Study Group 8) drew particular attention to the ITU work on spectrum management, focusing on the ITU-R Working Group 8F activities, which investigate the adjustments beyond IMT-2000. In accordance with the ITU Recommendation (ITU-R M.1645), systems beyond IMT-2000 will be realized by the functional fusion of existing, enhanced and newly developed elements of IMT-2000, nomadic wireless access systems and other wireless systems, with high commonality and seamless inter-working. More work is required to identify future spectrum requirements, in order to develop recommendations for the next World Radio Conference in 2007, although the necessary market analysis and technical investigations have already been launched. The graph below (Figure 1) demonstrates the capabilities of the systems beyond IMT-2000, depending on mobility. The IMT-2000 system and its enhancement have been standardized and will evolve considerably over the next 10-15 years, with an open and market-led process. The relationship with other radio systems will take place on a market-led basis. There is still a need for intensified efforts towards international standardization, which can have crucial implications for the diffusion of emerging UNS technologies.

Figure 1: Capabilities of systems



Nomadic / Local Area Access Systems Digital Broadcast Systems Interconnection

Source: Presentation by Colin Langtry on "*IMT-2000 and systems beyond*".

A similar view was expressed by Peter Scheele[12] (RegTP, Germany), who focused on the spectrum management issues, discussing opportunities for the creation of the "new" spectrum management approach that would allow the most optimal use of frequency channels, corresponding to the UNS developments. He pointed out that the need for the allocation of more common spectrum is under consideration. In fact, reservation of two bands, namely 2.4 GHz and 5 GHz, had previously had significant implications on the diffusion of the wireless technologies, including Wi-Fi. Consequently, some UNS technologies, for example short-range devices like RFID, may need globally harmonized spectrum. Moreover, Mr Scheele favoured more sharing of the spectrum management, demonstrating a few advantages that might have implications for accelerated UNS development.

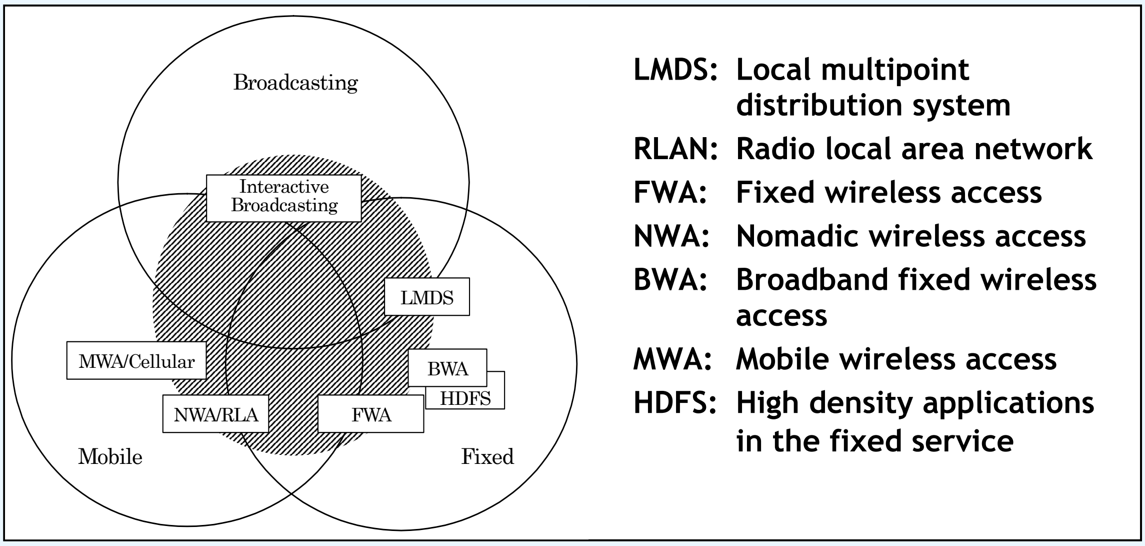
Gérard Pogorel[13] (ENST, France) also focused on the spectrum issues, arguing that efficient management should facilitate UNS development. Although many argue that the spectrum is scarce, in reality, this is relative and in many cases the spectrum is not being used to its full capacity. Given this, he advocated greater flexibility in its use. In particular when countries start to promote ubiquity, a more flexible approach, taking into consideration dynamic market developments, may be desirable.

Regarding the scarcity of the spectrum, Simon Forge[14] (SCF Associates, UK) presented the socio-economic approach in assessing spectrum requirements for future mobile communications markets and services. Using this tool, spectrum management policy may take into account factors other than the technical ones.

Yan Xu (HKUST, Hong Kong)[15] raised the problem of convergence in the context of Ubiquitous Network Societies. In respect of the licensing procedure for broad wireless access, he discussed the issue of the existing legal framework that has to be adjusted, in order to foster the development of UNS. Current licensing and regulatory frameworks for mobile and fixed carriers are different and separated; this could have implications for the licensing policy. Moreover, Professor Xu draws attention to the digital terrestrial TV (DTT) that is on the eve of implementation, pointing out that there is still a need for legal adjustments in order to trigger the process of convergence. He opted for the migration from the technology-oriented regulation to the application-oriented regulation.

Alexander Kalin[16] (RTRN, Russia) drew attention to the significance of TV broadcasting in the process of UNS development and pointed out that TV is currently undergoing a period of transition. Digital TV is expected to become an important player in terms of creating ubiquity platform, so assuring the customers mobility, portability, interactivity and personalization. The implementation of digital TV is creating new business opportunities, as it gradually becomes a competitor for the traditional telecom operators. and TV can become the new platform on which the new applications, such as t-government in Italy or mobile TV, will be developed. From the UNS development perspective, the fostering of terrestrial wireless interactive multimedia systems (TWIM) represents one of the most important issues. Convergence between broadcasting, mobile and fixed operator would be easy and would enable a wider range of services and applications to be made available on the ubiquitous base with the sharing a frequency resources. The graph below (Figure 2) demonstrates the concept of TWIM, where a precondition for the provision of these convergence services should be that all the stakeholders provide the user with a set of services with identical or very similar structure.

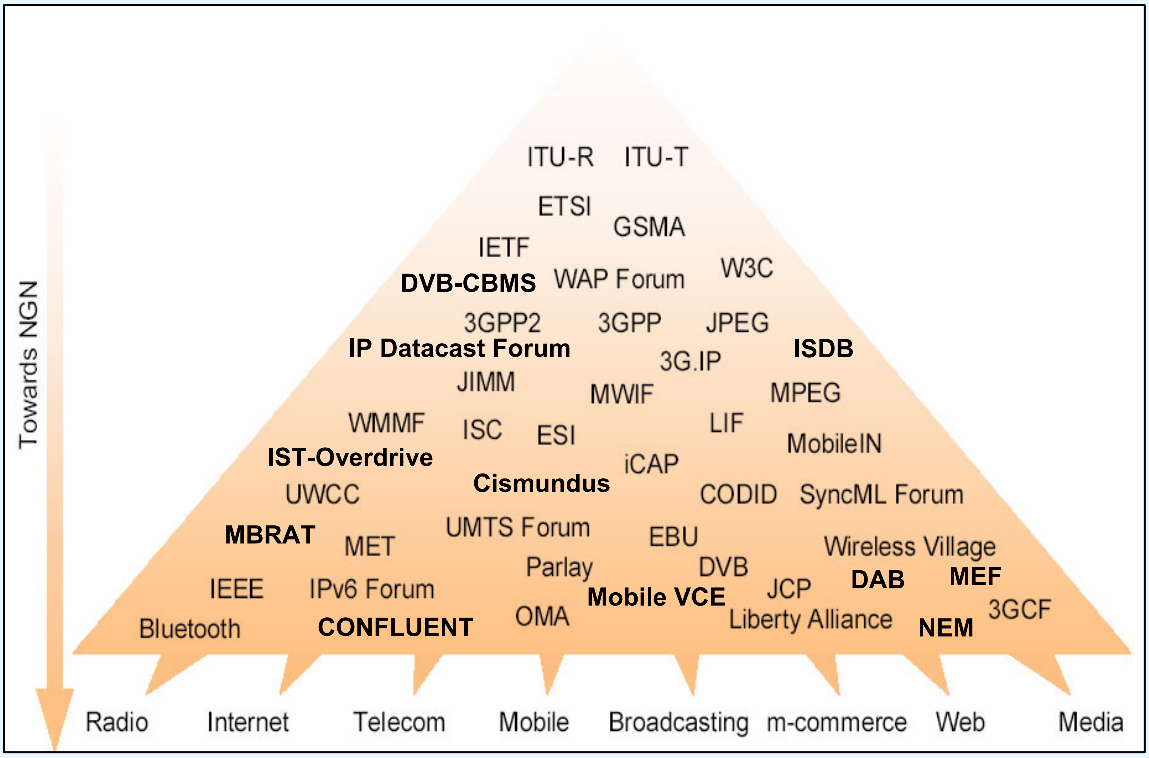
Figure 2: Terrestrial wireless interactive multimedia systems (TWIM)



Source: Presentation by Alexander Kalin: “The future of television broadcasting in ubiquitous network societies”.

Monique Morrow[17] (Cisco Systems, USA) focused on the significance of next-generation networks for the development of the UNS. She underlined the importance of fostering NGNs to create a converged communication infrastructure, bringing all networks together and letting them operate together. Nevertheless, there are still issues to be ruled out, for instance the quality of service, interconnection, billing, settlements, and agreements. ITU has a crucial role to play in this process; however, it is clear that that many other international bodies are involved in the very lively discussion on the future developments that could revolutionize the whole telecommunication industry. Figure 3 (below) illustrates the stream of forums involved in the discussion.

Figure 3: Forum stream towards NGN



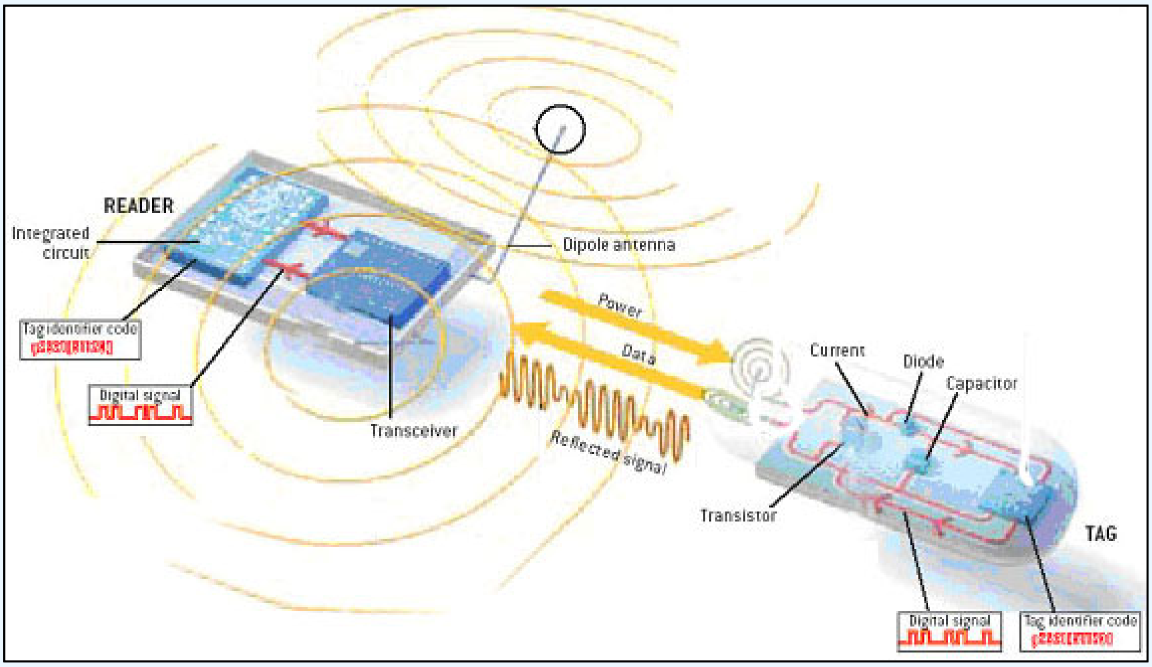
Source: Presentation by Alexander Kalin: "The future of television broadcasting in ubiquitous network societies".

Dario Calogero[18] (Ubiquity, Italy) focused on the opportunities for the development of the applications in the UNS world. In his opinion, content is becoming increasingly digital and multimedia networks are increasingly likely to favour broadband. As devices are becoming pervasively digital, smaller and ubiquitous, so convergence is becoming the real challenge. For the application providers in particular it is becoming more complex to offer ease of use and availability in volume, at the right price. Nevertheless, Mr Calogero confirmed the existing economic potential of UNS that may be exploited by following the rule of the three "*U*'s", i.e. Usability, Utility and Ubiquity.

3 THE INTERNET OF THINGS: WHAT MAKES IT WORK?

The concept of UNS, i.e. connecting "anytime, anywhere, with anybody and anything", encourages the investigation of the most popular technologies and the extension of the traditional view of networked societies, in particular those technologies that enable communication. Consequently, Lara Srivastava[19] focused on Radio Frequency Identification (RFID), which has been recognized as one of the main innovations triggering the development of the Internet of things. Although the technology was invented more than 60 years ago, extensive R&D has led to improved RFID performance and the creation of new application opportunities. Thanks to swift miniaturization, falling prices and gradually increased interoperability, RFID has become a global technology that requires the increasing involvement of international bodies to foster harmonization and so accelerate its global diffusion. Figure 4 is a schematic demonstration of the workings of a basic RFID system, consisting of reader and TAG.

Figure 4: How an RFID system works

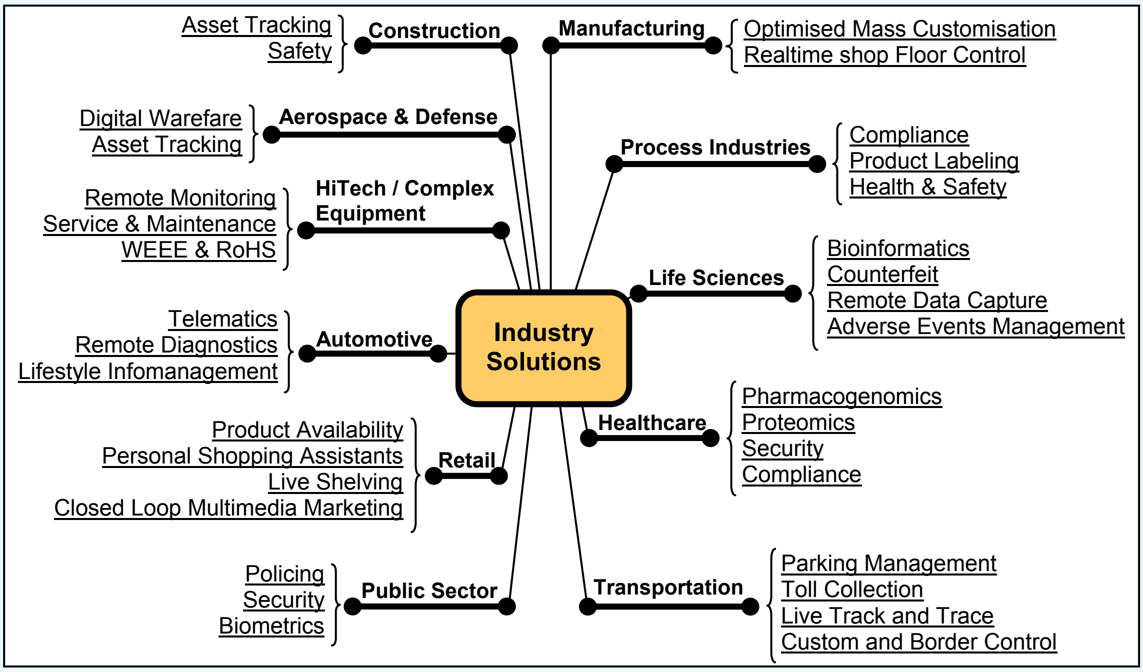


Source: Presentation by Lara Srivastava: "Ubiquitous Network Societies: the case of radio frequency identification (RFID)" adapted from *Scientific American*, 2004.

Today RFID market values do not seem very significant; according to the estimates of some consulting companies, in 2003 the market value of RFID systems did not exceeded USD 2 billion. Nevertheless, very high growth is expected during the coming years, particularly with regard to the development of new, profitable applications to foster further innovation in this field. It has been broadly recognized that even at this stage of its development, RFID systems make business processes more efficient and that this will gradually trigger growth in both the public and private sectors. Figure 4 (below) demonstrates the variety of possible industrial applications that RFID can provide.

Luigi Battezzati[20] (Polytechnic of Milan, Italy) stressed that the implications of RFID are very broad and that not only is it a technology that will enable data to be collected, but also a new system that will lead to fundamental changes in traditional business models and human life in general. RFID is still in an experimental phase and the search for the most advantageous and lucrative applications of this technology continue. The adoption of each innovation is not automatic and RFID systems can still face many problems, for instance a lack of standardization, high investment costs, critical mass of adoption, perceived privacy, health problems, legal issues, lack of sponsorship, skill shortage, possible technology failure, partners unwilling to share data and possible sabotage.

Figure 5: Ubiquitous Network Societies: examples of industry solutions



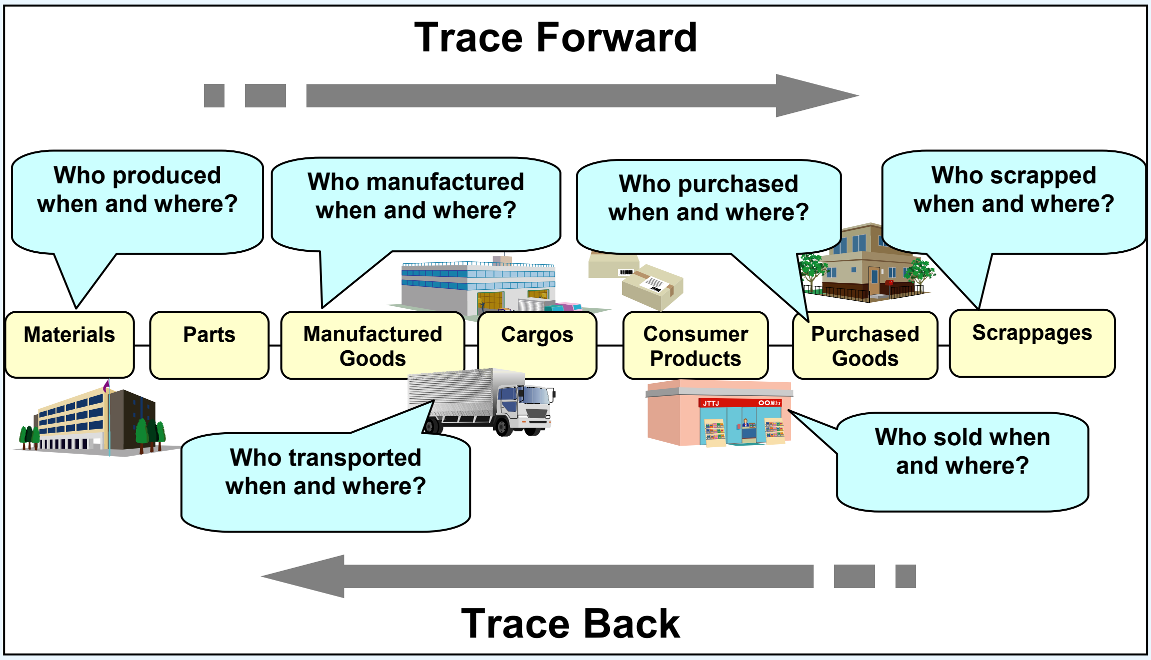
Source: Presentation by Vasu Briquez: "Ubiquitous networks and ubiquitous computing".

It has often been stressed that the speed of RFID diffusion, as well as its applications may depend on the ICT environment. Referring to the Republic of Korea, Sewon Oh[21] (ETRI, Republic of Korea) underlined the importance of identifying the potential behind the innovation, and the consequent development of RFID-friendly "infrastructure", consisting of four elements, namely overall policy, R&D, testing and demand.

Poon Hong Yuen[22] (IDA, Singapore) related Singapore's experiences in promoting RFID and underlined the significance of RFID for human life, shedding light on few examples of initial applications in e-health, transport and health security: the SARS case being a good example. He stated that Singapore recognized RFID as an important innovation and had intensified its efforts to promote this technology. In 2004, Infocomm Development Authority even announced that was going to invest SGD 10 million to develop Singapore into an Asian RFID hub. Consequently Singapore has become the first Asian country to be formally allocated UHF spectrum with a suitable power limit for RFID applications.

Tetsuo Tanaka[23] (Hitachi, Japan) raised the interesting issue using RFID for traceability, a function that is becoming increasingly real. Demand for this innovation could increase in the near future, aided by the further miniaturization of devices and falling prices. Figure 5 (below) demonstrates an exemplary RFID-based system to streamline the business process. On the one hand, the enterprise can optimize the supply chain to achieve tangible economic advantages and on the other, it may be used for compliance. Over time we can expect a very broad spectrum of traceability systems applications. Tests carried out in Japan over the last year have demonstrated the great optimism of the entrepreneurs in this field.

Figure 6: Streamlined Business Process



Note: Trace forward – operation for more effective supply chain management; Trace back – operation for compliance.
Source: Presentation by Tetsuo Tanaka: "RFID & Traceability Related Activities in Hitachi".

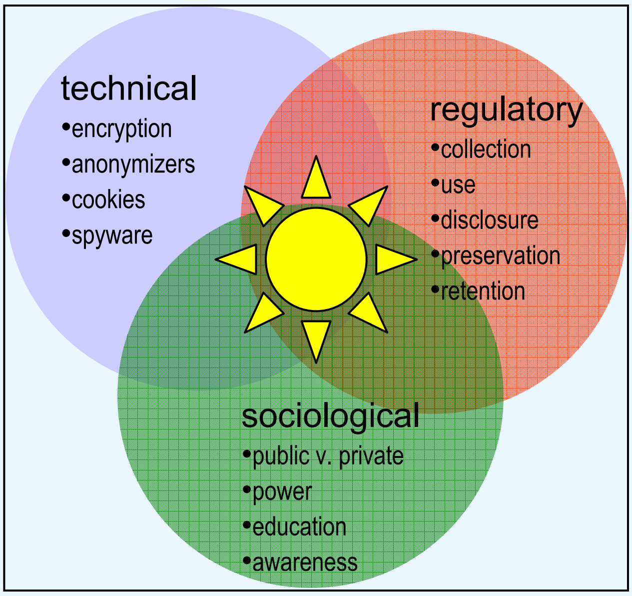
Gilles Privat[24] focused on the intelligent systems creating the future vision of the UNS, in particular on the role of the new smart devices gradually being integrated into real life. Thanks to these, many processes can be carried out automatically without human interference; at the same time, human awareness on many interactions will decrease, so changing the demand preferences. Reality is going to be augmented with new interactions and this has to be taken into account when designing new UNS technologies.

4 DATA PROTECTION, PRIVACY, SECURITY AND CONSUMER PROTECTION

Along with the rapid expansion of the ubiquitous networks, the public are becoming increasing concerned with privacy and security concerns. Although UNS technologies certainly have many advantages for accelerated socio-economic development, it should always be borne in mind that they may lead to significant costs that will ultimately be imposed on the end user. Should the issues regarding data protection, privacy, security and consumer protection not be managed properly, the development of the UNS might be slowed down. As the nature of the UNS is essentially borderless, intensified cooperation amongst the international forums may be necessary to avoid, or at least minimize, the existing threats and risks.

Gordon Gow[25] (London School of Economics and Political Science, UK) discussed the privacy issues related to UNS development. Over time, more and more applications have been gathering data on user behaviour, even without their knowledge; this raises many privacy concerns. Professor Gow drew attention to the existing UNS-related privacy paradox that consists of three domains: the technical domain (encryption, cookies, spyware, etc.), the regulatory domain (collection, use, disclosure, preservation, retention of private data, etc.) and the sociological domain (education and awareness, etc.). This is clarified in Figure 7. Professor Gow drew attention to the emerging privacy enhancing technologies (PETs) that will enable greater control over the unauthorized collection of person information, although it remains to be seen how far this solution can assure privacy in a real sense. From this point of view, the question remains as to whether or not privacy will become the commodity in the future and the UNS citizens will be charged for it.

Figure 7: Domains and sub-domains of the privacy paradox



Source: Adapted from presentation by Gordon Gow: "Privacy Implications".

Ewan Sutherland[26] (INTUG, Belgium) focused on consumer protection; although he sees UNS as a source of economic growth, he does identify many ubiquity threats and risks, for example spam, spim, viruses, hacking and identity theft. He pleaded for horizontal legislation that includes privacy and data protection, health and consumer protection, competition and contract law. He also believes that the involvement of the international forums in the creation of a new legal framework could be crucial, pointing out that OECD and EU had already carried out some of these activities.

Marie Georges[27] (CNIL, France) focused on the influence of the technological progress on data protection requirements. Data protection is the new field, expanding very fast, in line with the development of UNS. She admitted that there is a need for a broader involvement of the international forums in the discussion on data privacy. In addition, an international declaration on data protection might be very advantageous for all stakeholders.

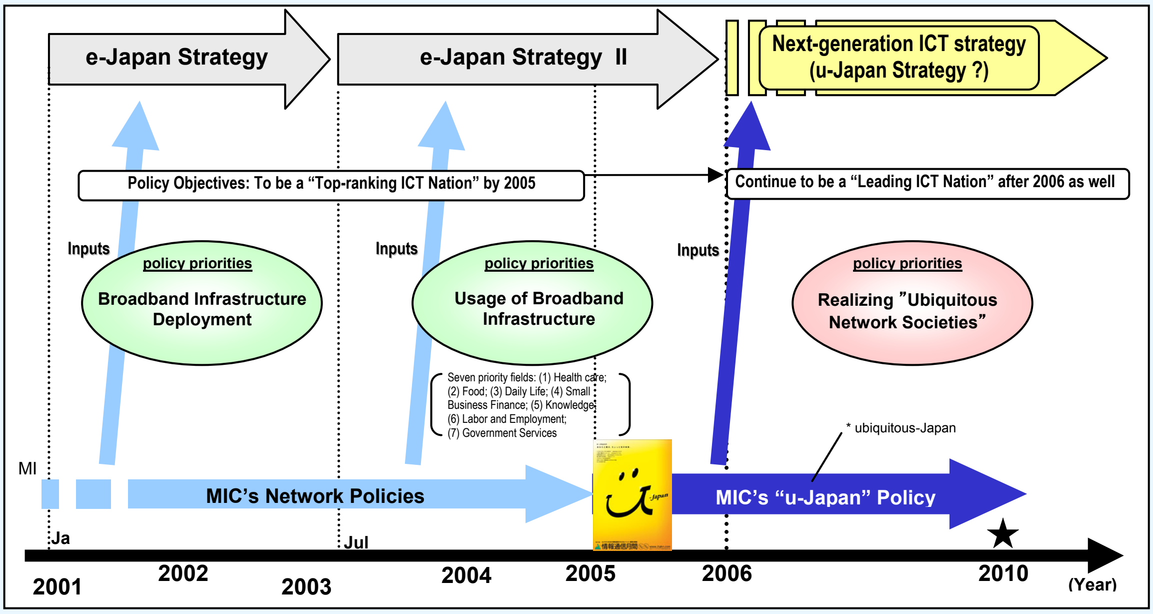
Tony Lam[28] (Office of the Privacy Commissioner for Personal Data, Hong Kong, China) presented the experiences of Hong Kong, China, mentioning that whilst the exact content and priorities for privacy protection can differ from one country to another, and can vary between different cultures, the core value remains the same. Some governments may interpret the privacy issues in a different way, taking into consideration that very conservative privacy legislation can make the business environment less efficient. Nevertheless, the customer is gradually becoming more aware of the control over, and use of their personal data and may call for remedies. Mr Lam demonstrated the successful strategy that Hong Kong, China has developed over the previous decade, which has been elaborated through an approach based on consultations, co-working arrangements between business, industry and professional bodies, the development of codes of practice, e-management books and guidance materials. In addition, Hong Kong, China has developed the "Privacy Impact Analysis Tool Early Warning System", that allows the assessment of the privacy risks associated with project or public policy initiatives that involve the processing of personal data.

5 DIFFERENT APPROACHES ON UBIQUITOUS NETWORK SOCIETIES IN DEVELOPED AND DEVELOPING COUNTRIES

During the workshop, different national approaches to UNS development were presented, with some countries seeing the UNS concept as a great opportunity for acceleration of social and economic progress. For instance, according to the presentation by Takuo Imagawa[29] (Ministry of Internal Affairs and Communications, MIC, Japan), u-Japan will have a significant economic impact. MIC forecasts that in promoting the u-Japan policy, the ubiquitous network society-related market will achieve a value of 87.6 trillion yen (USD 814.7 billion), meaning that since 2003, the market value will have been trebled. However, we can expect that, together with extensive subvention programmes, market growth will be driven up significantly by public spending, although some level of sustainability will be achieved.

Lara Srivastava[30] (ITU) demonstrated the determination of Japan to carry out the vision of the Ubiquitous Network Society; in cooperation with other ICT stakeholders, the government has developed its Charter of the Ubiquitous Networked Society, which could become the foundation of the new u-Japan strategy, fostering anywhere and anytime access for anyone and anything. The new u-Japan should promote and facilitate development of ubiquity in terms of access to the network, universality in terms of friendly communication, user-orientation in terms of user's viewpoints incorporation and uniqueness in terms of creativity and vigour. The Japanese case demonstrates the possible future scenario for other countries to migrate from "e" strategies to "u" strategies. Figure 6 (below) shows the predicted evolution of the Japanese strategy until the year 2010.

Figure 8: U-Japan's policies progressing from "e" to "u"



Source: Presentation by Takuo Imagawa: "Japan's Policy Initiatives toward Ubiquitous Network Societies", adapted from MIC.

Another example of a country demonstrating its ambition to develop a UNS is Singapore. Eric Lie[31] (ITU) showed that Singapore had already developed a national strategy, the so-called "Next-generation I-Hub" with its vision of creating "a secured, ultra-high speed and ubiquitous network to drive next-generation connectivity".

Tim Kelly[32] (ITU) presented the developments from the Republic of Korea, drawing particular attention to Plan 839, which has been developed by the government to build the Korean ubiquitous network society. Plan 839 consists of three layers intended to promote eight services, three infrastructures and nine growth engines. Dr Kelly demonstrated the existence of a few coexisting ubiquitous networks.

Maria-Cristina Bueti[33] (ITU) presented the Italian approach on the promotion of the UNS, where, to encourage its achievement, the Italian Government has made it a priority to transform Italy into a leader of the digital age. Consequently, the government subsidises the diffusion of two communication platforms among private customers, i.e. Internet broadband access (a subsidy of EUR 75 per household) and digital TV (a subsidy of EUR 75 per household). A rushed expansion of interactive TV has contributed to the development of additional services, for example t-government. In addition, broadband, mobile computing, digital TV and wireless technologies have been promoted.

The case studies created a generally optimistic vision of the UNS, which should encourage other economies to follow, although some participants also highlighted impending problems and challenges. Most of the concerns focused on the developing countries, although the general voice of scepticism was also in the air. For instance, Makoto Yokozawa[34] (NRI, Japan) pointed out that the provision of unlimited connectivity could take many years, even in the advanced countries; he believes that UNS remains more of a future vision, with its achievement lying somewhere towards the year 2010.

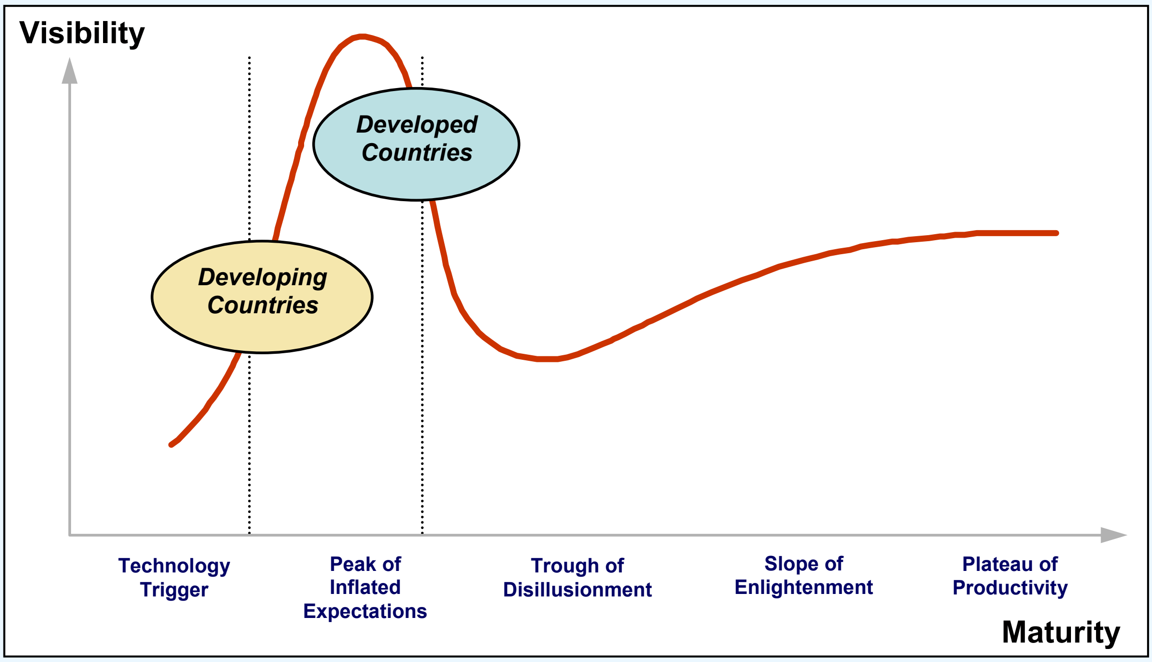
Mr Yokozawa pointed out that the creation of the UNS requires a very complex process that cannot easily be accelerated and that the UNS should be analyzed in three dimensions: connectivity that is responsible for the potential communications demand; reality that resolves problems in the real world; intelligence that changes society in ways that have not yet been seen.

As the developing countries still face the problem of basic connection to the net, the UNS concept should be considered more as a middle or long-term goal. Nevertheless, it should be recognized that in line with high innovation dynamics in the ICT sector, additionally accelerated by UNS development, the ubiquitous communication technologies, e.g. WiMax and NGN, will gradually become more cost efficient in terms of capital expenditure (CAPEX) and operational expenditure (OPEX); this has significant implications for the accelerated infrastructure roll-out.

In the opinion of Rakesh Kumar[35] (Cognizant Technology Solutions, USA), unless developing countries do not want to join the system of international economic interdependencies, they will gradually be forced to assimilate the ubiquitous technologies. Examples have shown that the use of ubiquitous technologies could become a global standard requirement of foreign enterprises meaning that if they wish to be included in the international production chains, the developing countries will have to adjust to these global requirements. Figure 8 (below) demonstrates the state of RFID adoption in developing countries, highlighting the fact that they have remained far behind developed economies.

At this stage in the development of ubiquitous infrastructure, the benefits of ubiquitous technologies for the developing countries cannot be stated clearly. Nevertheless, despite existing lags in the diffusion of ubiquitous technologies, some applications can, indeed, be identified. Emerging UNS will become the source of many risks, in particular those concerning location privacy, information privacy, misuse of data, etc.

Figure 8: State of RFID adoption in developing countries



Source: Presentation by Rakesh Kamar: “Shaping Ubiquity for the Developing World”, adapted from Gartner Hype Cycle.

6 CONCLUSION

In line with technological progress, the vision of the Ubiquitous Network Society is gradually becoming a reality. Innovations are making it possible for anything and anybody to communicate anywhere and anytime. New business opportunities are being created for the traditional telecommunication sector stakeholders, as well as for newcomers seeking the new type of ubiquity applications. In this way, the UNS can become a source of many new social and economic advantages that, in the medium and long-term, will make a valuable contribution to global socio-economic development. Nevertheless, the UNS brings with it new “ubiquitous threats and risks” that could affect its expansion significantly. In particular, certain security issues, such as data protection and privacy, have been the subject of increasing concern voiced by the general public and this has gradually forced governments to create appropriate remedies. Some developed countries have already started to promote UNS development in their policies and strategies; for some others, UNS remains a distant vision. Nevertheless, even those developing countries facing challenging infrastructure problems can derive benefits from the emergent UNS technology. Ultimately, real UNS success depends upon the efforts of each individual country, but international cooperation and the involvement of international organizations will be crucial for the creation of the appropriate, “ubiquity friendly” environment.

Endnotes

1 For more information on the ITU New Initiatives Programme, see www.itu.int/spu/ni. This extended summary was written by Jaroslaw Ponder, and edited by Neil Livingstone, of the ITU Strategy and Policy Unit.

2 All workshop materials are available on the particular Webpage dedicated to the Ubiquitous Network Societies, see www.itu.int/ubiquitous

3 Thematic papers: "Ubiquitous Network Societies: Their impact on the telecommunication industry" presented by Professor Elgar Fleisch, University of St. Gallen, Switzerland, "Ubiquitous Network Societies: the case of RFID" presented by Lara Srivastava, SPU, ITU, and "Privacy and Ubiquitous Network Societies" presented by Dr Gordon Gow, London School of Economics and Political Science.

4 All of the meeting documents are available on the ITU website at: www.itu.int/ubiquitous/. Workshop presentations can be downloaded at www.itu.int/osg/spu/ni/ubiquitous/presentations/

5 University of St. Gallen, Switzerland; author of the background paper and presentation: "Ubiquitous networks and their impact on the traditional telecommunication industry", available under www.itu.int/ubiquitous

6 Author of the presentation: "From mobility to ubiquity".

7 Author of the presentation: "From mobility to ubiquity – the Italian experience".

8 Author of the presentation: "Embracing change: the advent of ubiquitous networks".

9 Author of the presentation: "Mobile phones as a platform for ubiquitous societies: the case of youths"

10 Author of the presentation: "Convergence towards ubiquitous network societies".

11 Author of the presentation: "IMT-2000 and systems beyond".

12 Author of the presentation "Government policy and strategy for ubiquitous communications"

13 Author of the presentation: "Radio spectrum management and ubiquitous networks societies"

14 Author of the presentation: "Ubiquitous networks and radio aspects"

15 Author of the presentation: "Towards a converged regulatory framework in the age of the ubiquitous network society"

16 Author of the presentation: "The future of television broadcasting in ubiquitous network societies".

17 Author of the presentation: "IP NGN – Foundation for ubiquitous networking".

18 Author of the presentation: "Ubiquitous Network Societies".

19 ITU Strategy and Policy Unit; author of the background paper and presentation: "The case of RFID", available under www.itu.int/ubiquitous

20 Author of the presentation: "RFID as enabler of the ubiquitous".

21 Author of the presentation: "RFID and USN technology in Korea"

22 Author of the presentation: "Singapore's RFID journey".

23 Author of the presentation: "RFID & traceability related activities in Hitachi".

24 Author of the presentation: "Ubiquitous network & smart devices: new telecom services & evolution of human interfaces".

25 London School of Economics, UK; author of the presentation and background paper: "Privacy and ubiquitous network societies" available under www.itu.int/ubiquitous

26 Author of the presentation: "Consumer protection: The ubiquitous network".

27 Author of the presentation: "Ubiquitous network societies: From a data protection experience".

28 Author of the presentation: "Technological ubiquity: Consumer privacy protection".

29 Author of the presentation: "Japan's Policy Initiatives toward Ubiquitous Network Societies"

30 Author of the presentation: "Ubiquitous network societies – the case of Japan".

31 Author of the presentation: "Ubiquitous network societies – the case of Singapore".

32 Author of the presentation: "Ubiquitous network societies – the case of Korea".

33 Author of the presentation: "Ubiquitous network societies – the case of Italy".

34 Author of the presentation: "Towards a ubiquitous future limited only by our imagination".

35 Author of the presentation: "Shaping ubiquity for the developing world".

CHAPTER III

UBIQUITOUS NETWORK SOCIETIES:
THEIR IMPACT ON THE TELECOMMUNICATION INDUSTRY

BACKGROUND PAPER

ACKNOWLEDGEMENTS

This paper was prepared by: Thorsten Staake, Research Associate, Institute of Technology Management, University of St. Gallen; Dr Enrico Senger, Project Manager, Institute of Information Management, University of St. Gallen; Dr Frederic Thiesse, Project Manager, Institute of Technology Management, University of St. Gallen, Associate Director Auto-ID Lab St. Gallen; and M-Lab Prof. Dr Elgar Fleisch, Institute of Technology Management, University of St. Gallen Department Management, Technology and Economics, ETH Zurich, Co-Chair of the Auto-ID Lab Network and the M-Lab.

The New Initiatives Project on “Ubiquitous Network Societies” is managed by Lara Srivastava <lara.srivastava@itu.int> under the direction of Tim Kelly <tim.kelly@itu.int>. Country case studies (Italy, Singapore, Japan and Korea) on ubiquitous network societies, as well as three background papers, can be found at www.itu.int/ubiquitous.

Ubiquitous Network Societies: Their Impact on the Telecommunication Industry

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UBIQUITOUS NETWORK SOCIETIES: THEIR IMPACT ON THE TELECOMMUNICATION INDUSTRY

1 INTRODUCTION[1]

Over the last 30 years, we have seen the power of microprocessors double about every 18 months, and an equally rapid increase has characterized other technological parameters, such as communications bandwidth. This continuing trend means that computers will become considerably smaller, cheaper and more abundant; indeed, they are becoming ubiquitous and are even finding their way into everyday objects, resulting in the creation of "smart things".

In the long term, "ubiquitous information and communication technologies" (or ubiquitous ICTs) will take on great economic significance. Industrial products will become smart because of their integrated information processing capacity, or take on an electronic identity that can be queried remotely, or be equipped with sensors for detecting their environment, enabling the development of innovative products and totally new services.

This paper is one of three thematic papers presented during the New Initiatives Workshop on Ubiquitous Network Societies, hosted by the International Telecommunications Union from 6-8 April 2005, in Geneva, Switzerland. In addition to the other thematic papers on RFID and network traffic management, there were presentations of country case studies from Italy, Japan, the Republic of Korea and Singapore.

1.1 Definition of ubiquitous technologies

The term "ubiquitous computing" was coined more than ten years ago by Mark Weiser,[2] who, at that time, was the chief scientist at the XEROX Palo Alto Research Center. Weiser defined ubiquitous computing as: "The method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user". Recently, some members of the ubiquitous computing community tried to sharpen this definition and agreed on the following most important elements:[3]

- First of all, ubiquitous computing always deals with non-traditional computing devices, such as very small, or even invisible computers, which blend seamlessly into the physical environment. These new computing devices are sometimes hard to distinguish from real world items and so are referred to as "hybrid things", "smart things" or "digital artifacts".
- Secondly, ubiquitous computing applications always involve a very high number of these non-traditional computers.
- Thirdly, the new computing devices are usually equipped with a selection of different sensors to collect data from their environment. Here, the goal is to create context awareness, which allows intelligent things to decide and act on a decentralized basis.
- Fourthly, most of the new computing devices are mobile and the tasks they are programmed to perform depend on the geographical location and neighborhood of other devices. Since most of the mobile devices cannot form a fixed part of a ubiquitous computing application, ubiquitous computing systems need to support spontaneous networking, i.e. the ad hoc detection and linking of mobile devices into a temporary network.

The expressions "ubiquitous networks" or "ambient networks" focus on the communication aspects of ubiquitous technologies. Ubiquitous computing refers to a single device, as well as to a network of such devices. A number of similar, or at least not clearly differentiated, terms exist in the realm of ubiquitous technologies; for example, "pervasive computing" and "ambient intelligence," are often used as synonyms for ubiquitous computing.

In this paper, the term "ubiquitous information and communication technology" (or "ubiquitous ICT") is used to emphasize the importance of the networking and communication aspects within the ubiquitous technology framework.[4] The paper focuses on "new, network-independent" technologies and functionalities and does not, therefore, discuss 3G or 4G networks in greater detail.

1.2 Towards ubiquity in technology

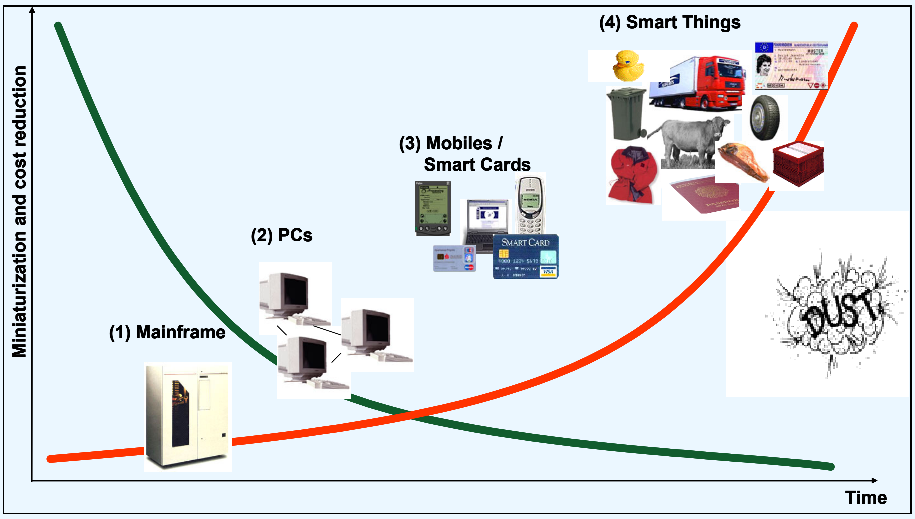
Given the continued rate of technical progress in computing and communication, it seems that we are heading towards an all-encompassing use of networks and computing power. According to Mark Weiser,[5] the computer as a dedicated device should disappear, while at the same time making its information processing capabilities available throughout our surroundings: "*As technology becomes more embedded and invisible, it calms our lives by removing the annoyances… The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.*"

While Weiser saw ubiquitous ICTs in a more academic and idealistic sense, as an unobtrusive, human-centric technology vision that will not be realized for many years, industry has coined the term "pervasive computing" with a slightly different slant. Although this also relates to pervasive and omnipresent information processing, its primary goal is to use this information processing in the near future in the fields of electronic commerce and Web-based business processes. In this pragmatic variation – in which wireless communication plays an important role alongside various mobile devices, such as smart phones and PDAs – ubiquitous ICTs are already gaining a foothold in practice.

The vision of ubiquitous ICTs is grounded in the firm belief amongst the scientific community that Moore's Law, stated in the mid-1960s by Gordon Moore, will hold true for at least another 10 to 15 years.[6] This means that in the next few years, microprocessors will become so small and inexpensive that they will be able to be embedded in almost everything; not only electrical devices, cars, household appliances, toys, and tools, but also in such mundane things as pencils (e.g. to digitize everything we draw) and clothes.

Figure 1.1 tracks the history of this development: With the ongoing miniaturization and price decline it has become both technologically possible and economically feasible to make everyday objects "smart" and to "tag the world". Tagging, i.e. attaching a transponder to everyday objects, lays the foundation for ubiquitous ICTs.

Figure 1.1: Miniaturization and price decline of RFID-tags widen the field of application



Source: Fleisch et al. 2003.[7]

What can we expect, in this regard, from this rapidly advancing technical progress? It is becoming ever more clear that we are standing on the brink of a new era of computer applications that will influence our lives radically. In recent years, PCs, the Internet, the Web and mobile phones have already brought about many changes and have transformed our daily lives. Today, we are seeing indicators everywhere of a major convergence of entire industries in the fields of media, consumer electronics, telecommunications and information technology. But the approaching wave of the technological revolution will affect us more directly, in all aspects of our lives; it is becoming apparent that our future will soon be filled with tiny processors, all communicating spontaneously with each other, and, given their small size and low price, these will be integrated into the vast majority of everyday objects.

The results of micro-technology[8] are also becoming more and more important; for example, the development of tiny integral sensors that can record a wide variety of different environmental parameters. One interesting development in this regard are radio sensors that can report their measured data within a radius of a few meters without an explicit energy source; such sensors obtain the necessary energy from the environment (e.g. by being irradiated with microwaves) or directly from the measuring process itself (e.g. temperature change, pressure, acceleration).

Electronic labels, the so-called passive Radio Frequency Identification (RFID) tags, also operate without a built-in source of power; they collect the energy they require to operate from the magnetic or electro-magnetic field emitted by a reader device. Depending on their construction, these labels can be less than a square millimeter in area and thinner than a sheet of paper.[9] What is interesting about such remote-inquiry electronic markers is that they enable objects to be identified clearly and recognized, and can, therefore, be linked in real time to an associated data record held on the Internet or in a remote database. Ultimately, this ultimately means that specific data and information processing methods can be related to any kind of object.

Enabling everyday objects to be identified uniquely from a distance and furnished with information opens up application possibilities that go far beyond the original task of automated warehousing or supermarkets without cashiers. For example, packaged food could communicate with the microwave, enabling the microwave to follow the preparation instructions automatically.

Significant technical advances have also been made in the field of wireless communications. With the emerging Near Field Communication (NFC) standard, mobile phones and other handheld electronic devices will be able to read RFID labels at short distances. The goal is to enable users to access content and services in an intuitive way, simply by touching an object that has a smart label. Of particular interest are the recent NFC communications technologies (such as Zigbee) that need less energy and make smaller and cheaper products possible.

Researchers are also working intensively on improved ways of determining the position of mobile objects. As well as increased accuracy, the aim is also to make the receiver smaller and reduce its energy requirements. Many of these technological developments can be used together, or even integrated. For example, fully functioning computers that include sensors and wireless networking functionality will be developed on a single chip that can be built into any device or everyday object for control purposes. High processor speed is not as important as producing chips that are small, cheap and save energy.

If we summarize these technology trends and developments – tiny, cheap processors with integrated sensors and wireless communications ability, attaching information to everyday objects, the remote identification of objects, the precise localization of objects, flexible displays and semiconductors based on polymers – it becomes clear that the technological basis for a new era has been created everyday objects that communicate and are, in some respects, "smart" will constitute the "Internet of Things"

1.3 Structure of the paper

To help evaluate the impact of ubiquitous ICTs on the telecommunications industry, this paper starts out by discussing the business and technological basics of ubiquitous ICTs (Sections 2 and 3), evaluates application scenarios, potential benefits and current obstacles in different industries (Section 4) and applies these results to the telecommunications industry, in order to help determine the impact of such technologies on the current industry landscape (Section 5). The paper concludes with a summary of the findings and discusses future developments.

2 On the economics of the Internet of Things

The Internet is the foundation of what we today refer to as "electronic business" or "electronic commerce". It connects computers all over the world and provides a network in which any participant can collect or exchange information or buy and sell products and services, etc. Ubiquitous ICTs not only enable computers to be connected to one another, but also to link "smart things" to computer systems or interconnect "smart things", which will have a strong effect on the economy.

The Internet hype of the late 1990s proved that a poor understanding of the underlying economic rules of new technologies sooner or later eliminates many companies, which are unable to build proper business models from a technology. A thorough understanding of the economic implications is important and the following section will explore the business rules for applications based on ubiquitous ICTs. It helps to determine which problems can be solved with ubiquitous ICTs, which benefits can be derived, how the technologies could help to create customer value and which barriers must be overcome.

2.1 Drivers within the private and corporate world

During the last four decades, managerial information processing has made a significant contribution to the speed, efficiency and precision of internal and inter-corporate processes. For this reason, the integration scope has been increased by connecting information systems initially through single departments, then through divisions, and now across multiple, globally spread enterprises.

However, the fact that physical objects are not yet linked directly to information systems has given rise to a number of issues with which firms have been struggling over recent years and which may provide ripe areas for the application of ubiquitous technologies, e.g.:

- At retail, 5-10 per cent of the requested products are not available[10] and 15 per cent of advertised products are out of stock.[11] Retailers and manufacturers thereby lose 3-4 per cent of their sales volume and lose their customers to their better-organized competitors.[12]
- Theft by employees, suppliers, and customers, as well as fraud and administrative failures lead to unplanned stock reduction (shrinkage), which costs US-American retailers USD 33 billion per year (1.8 per cent of the sales volume).
- Commerce with forged products accounts for between 5 per cent and 7 per cent of the world trade volume.[13] The value of forged goods mounts up to over EUR 500 billion per year,[14] partly because of the lack or inefficiency of the tracking of individual goods in the supply chain. Next to the primary damages through lost sales of the original trademark, the use of qualitative inferior counterfeits in the field of drugs, or spare parts for aircraft involves high risks. For example, surveys of the World Health Organization (WHO) assume that up to 10 per cent of worldwide medication is forged, unlicensed, or of poor quality.[15]
- From 2005, numerous sectors will be obliged to organize the recycling of their products professionally and transparently. Car manufacturers in the EU must take back used cars and recycle 85 per cent of their original weight.[16] The scrap metal regulation forces retailers of electronic devices to cover the expenses of the scrapping.[17] The allocation of parts and responsible companies is the key to the billing systeMs

The common factor in all these problems has been the insufficient integration of the real, physical world with the digital world of the information systeMs Yet in many cases, human beings still have to bridge the gap between the virtual world (of information systems) and the real world by translating observations made at the point where data emerges into digital information (e.g. typing-in data extracted from observations or by scanning barcodes), or by condensing digital information into decisions at the location of data application and initiating their implementation in reality. For instance, if a retailer knew exactly which products were on the shelves and which were in stock, it could raise product availability substantially.[18] So why don't retailers simply collect this data, or derive it from the cash register systems based on bar codes?

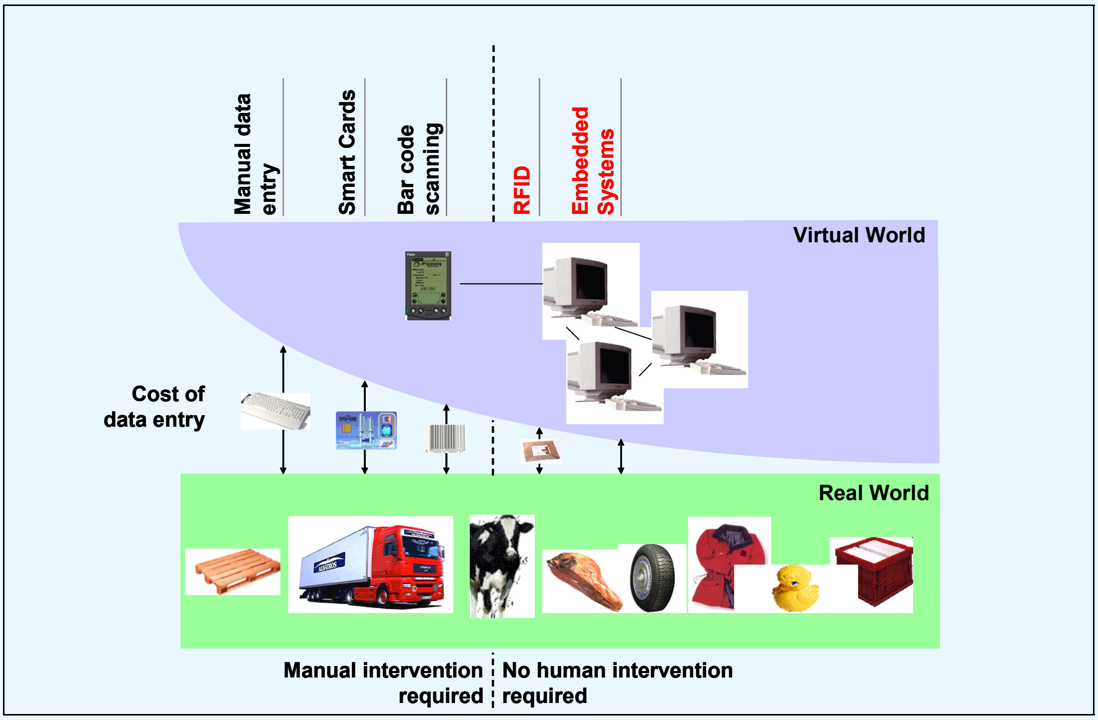
On the basis of today's technologies, the complete collection of data in the real world is often too expensive, which leads firms to develop methods of gathering and processing data through random sampling. This inevitably results in decisions based on low-quality data at the point of action. Deciders, who rely heavily on statistics at the point of action, gain their information by processing historical data. Since the treatment of this data usually costs extra time, companies often make decisions, e.g. about the lot size on the basis of total order quantity up to a specific date in the past. Ubiquitous ICTs can help to obtain precise, real-time data, thus leading to more secure decisions.

2.2 Linking the real to the virtual

Ubiquitous ICTs have the potential to prevent media discontinuities between physical processes and their information processing. They allow a fully automated, machine-to-machine relationship between real objects and information systems by adding "mini computers" with communication capabilities to the former. These help to reduce the cost of mapping real resources to information systeMs They adopt the role of mediator between the real and virtual worlds. Physical resources are enabled to communicate without human intervention.

The increasing miniaturization of information processing and communication devices is leading to a new era of networking, in which the physical reality corresponds automatically with the information system of an individual or a company. Objects like consumer goods (medicaments, textiles) and means of production and transportation (e.g. machine tools, containers, palettes, boxes) equipped with ubiquitous ICTs establish new perspectives in the innovation of products and services for the end-user and processes in the corporate world. Figure 2.1 shows how this linking of the real and virtual worlds reduces the time and costs of data entry, so laying the foundation for efficiency gains; for example, within a retailer's supply chain or for end-users, who, if their "smart products" automatically communicate the price to a cash point, can be billed automatically when leaving the supermarket.

Figure 2.1: Linking the real and the virtual through ubiquitous ICTs



Source: Fleisch et al. 2003.[19]

Ubiquitous ICT is able to reduce the costs of reality integration. At the point of creation (POC) sensors absorb data on their environment automatically, for example RFID scanners read the identification numbers of all objects within reading distance (for details about the technology, see 3.1). At the point of action (POA) actuators automatically translate the data of diverse POC into useful actions, such as sending an "out-of-stock" message to another information system or to an employee. Such systems can be implemented on a supermarket shelf or in the fridge of the end-user, so triggering a new order. Therefore the next level of development towards information society is an interlinking of the virtual world with reality through sensors and actuators (also known as actors). Like a fill-level gage in a silo tank, sensors transform real-world events into digital information; conversely, actors, such as traffic regulators or robots, convert electromagnetic signals into physical reality (see Table 2.1).[20] Simple applications are already in use in many private households; these include e.g. roller blinds that lower automatically when the sun is too intense.

Table 2.1: Application areas for linking the real to the virtual

Application area	Short description
Identification	Technologies like RFID enable the automatic identification of objects. Identification technologies are multi-functional and can be used, among other things, for supervision of logistic chains, or the prevention of medical forgeries (see FDA 2004],[21] Strassner & Fleisch 2002.[22]) The organizers of the soccer World Cup 2006 in Germany plan to use RFID tags on the tickets, both to prevent forgeries and as a protection system against violent spectators. Together with game and seating numbers, the RFID chips will contain a reference to the customer data of the ticketing system [see Quack 2004].[23]
Drive-by-Wire	The term "Drive-by-Wire" denotes steering mechanisms in which the mechanical and hydraulic components have been replaced by electromechanical ones, sensors and steering gadgets. This enables more flexible vehicle steering, for example through computer-aided interventions of driving dynamics (see [Bünte 2004],[24] [Branquart 2003][25]).
Smart Automation	"Smart Automation" describes the development of mechatronics precision systems that enable the automatic handling of objects at the micro- and nanoscale, for instance by gripping systems in the production of semiconductor parts [see CTR 2002, 34f].[26]
Optical Measuring Systems	Optical measuring systems enable contactless examination of textiles and surfaces; this allows the inspection of the chemical composure of powder mixtures, the quality control of textiles and the identification of skin cancer [see CTR 2002, 32f].[27]

Source: stated within table.

2.3 Potentials of ubiquitous ICTs

The benefits of real-world interconnection can be described from two perspectives: the internal perspective describes how the company can improve its processes by implementing ubiquitous ICTs; the external perspective describes what profit the customer or end-user may gain.

Internal perspective: reduction of insecurity, and efficiency of information handling in processes

The internal perspective of a company or value chain focuses on the search for efficient processes. The successive and extensive enquiry of real-time information reduces the insecurity under which the actors make their decisions. At the same time, the automatic transformation into decisions, e.g. the generation of an order from the information system, is more cost-efficient because of the elimination of routine, manual jobs. An example is given in Box 2.1.

Box 2.1: Vendor managed inventory between Röhm and BASF Coatings

Röhm produces special plastics, for example for the varnish industry. Together with BASF Coatings, Röhm developed an expanded, vendor-managed inventory. The business area of Röhm Methacrylate takes on the filling of the tanks and the supply, with goods shipped in barrels on the basis of the actual inventory, planned requirements, and planned extractions transferred by BASF Coatings. The chemicals are paid for by credit ("self billing") at the moment of extraction by BASF Coatings. In future, the partners will exchange accompanying documents, such as analysis certificates, electronically. "Consignment" is one of the four sub-processes of the new collaborative process between BASF Coatings and Röhm: The actual inventory of the silo tanks (liquidities and granulates) is transferred daily to Röhm through telemetry measurement. Short-term extractions, on the basis of released production orders from BASF Coatings, are also notified. Therefore, Röhm makes sure that there are always enough stocks available in the consignment stocks. The quantities for piece goods are reconstructed from the SAP R/3-stocks of BASF Coatings. For cost reasons the partners still rejected an automatic consumption measurement for these products, for instance with the help of tags fixed on pallets, at the moment of realization in 2002.

The realization of a consignment-scenario leads to a closer collaboration between the business area Röhm Methacrylate and BASF Coating with an automated data exchange and tailored processes. The partners achieved savings in process costs with the new business solution totaling EUR 500'000.

Source: Senger 2004, 195-206.[28]

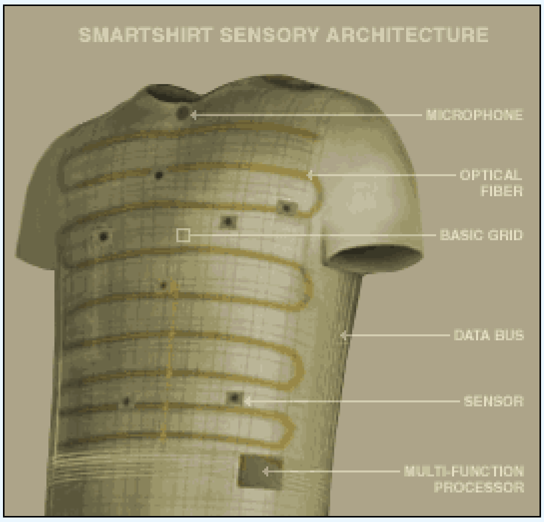
External perspective: existing services at a lower price and the creation of new services with additional value to the customer

More efficient processes enable the company to provide new customer benefits. Services like parcel tracking are of value for the end-user, but can only be offered profitably to a wide customer basis because of the ability to automate the services. Cash and atomic waste transportation can be tracked by maintaining continuous radio contact with the driver and escort. But this kind of tracking is expensive and could not be justified for a package of books. If the parcel can be located automatically with the help of RFID tags, a compatible cost-efficient service can be provided using negligibly small and cheap RFID tags, making available to private consumers services that were previously only offered to large companies.

At the same time, ubiquitous ICTs are upgrading "simple objects" to "smart objects," which can provide customers with new services that could not have been imagined before, because of the missing connection between the real-world objects and the intelligence of information systeMs An example of another end-user application is given in Box 2.2.

Box 2.2: Intelligent T-shirt

With "Smartshirt", Sensatex corporation presents a garment that enhances the clothing function with new and additional services. The shirt is equipped with sensors to measure body functions like temperature, breathing rate, pulse and cardiogram and transmit the data through the mobile network to base stations. The information can also be transferred to other devices like a watch or PDA and be read out.SPU_Box_Enum



Smartshirt for Remote Patient Monitoring

Application opportunities for this product include the supervision of training squads in serious sport, or in the military, as well as the monitoring of chronic patients (e.g. heart patients). The intelligent T-shirt thereby lessens the constraint on the patient's quality of life. Added values include expanded mobility without sacrificing timely help in an emergency. The automatic survey of the body's functions also reduces the number of consultations and hospitalizations.

Source: www.sensatex.com

Ubiquitous ICTs will replace conventional data input and output methods, where cost-advantage is given (in the corporate world) or where solutions become more convenient (for end-users). The drivers of the growing diffusion of ubiquitous ICTs by substituting existing technologies are the sinking costs of sensors and actuators, as well as the conquest of additional fields of application through the increasing miniaturization and robustness of the components. In addition to the substitution effect, the so-called elasticity effect applies: where they add a value exceeding the supplementary costs, companies insert additional sensors and actuators.

2.4 Barriers of ubiquitous ICTs

In a business sense, the main hindrance to distribution is the absence of sustainable business models in many potential fields of application. One of the reasons for this is the lack of generally accepted standards and this leads to high investment costs, as well as a high risk to the sustainability of the solution for both companies and end-users.

One of the main challenges for the acceptance of ubiquitous ICT solutions by the customer is to reconcile the potentials of ubiquitous ICTs with the needs of privacy and trust. The vision of ubiquitous computers expands the existing Internet problem of "online history", e.g. click behaviour and websites visited. In a world of smart objects, which can communicate seamlessly with each other, this ubiquitous data becomes both more valuable and more vulnerable, because it allows a very comprehensive picture of a person and their behavior to be complied. Some actions aimed at addressing this issue are outlined in Section 5.3.

Another challenge is the potential risk of an infrastructure breakdown. If, for instance, many objects can only function properly when connected, a breakdown of communications infrastructure, for whatever reason (e.g. design errors, material defects and malfunctions, sabotage, overload, or natural disasters), can have significant consequences to the businesses involved.

It is important question to discuss how we allow ubiquitous ICTs to change our society: with ubiquitous ICTs increasingly prevalent in our daily lives, people who cannot participate are excluded from the benefits. Moreover, with smart things invading our daily lives and becoming more and more autonomous, we must address the question of who is responsible for the incorrect decisions of the smart things and the damage they may cause.

3 UBIQUITOUS ICTS: A TECHNICAL OVERVIEW

The following Section will describe ubiquitous ICTs from two perspectives. The Section entitled "Building block of ubiquitous ICTs" describes which components are needed to make "smart things" and the vision of ubiquity possible. Current ubiquitous ICT solutions use these building blocks selectively, depending on the application area. The section entitled "Key functionalities" examines the technology in terms of the requirements for a ubiquitous ICT solution, and describes what ubiquitous ICTs must be capable of, in order to make ubiquity a reality; from the identification and localization of objects and the tracking of their status through time, as far as the implementation of fully automated processes. The section concludes with an examination of current technical barriers to the realization of ubiquitous ICTs.

3.1 Building blocks of ubiquitous ICTs

The building blocks of an individual "smart thing" can be derived from those of a classic computer, namely memory and processing logic (3.1.1), as well as input and output devices, in this case sensors and actuators (3.1.2). If single "smart things" should be capable of interacting with each other, additional building blocks appear: Mobile communication technologies allow individual sensors and actuators to communicate with each other and thus to build a network of "smart things" (3.1.3). Ubiquitous ICT system architectures and middleware are the requirements for a connection of ubiquitous ICTs among each other and with regular information systems (3.1.4). The interaction of a person with these networks of smart things requires novel human-computer-interfaces, i.e., special input and output devices, which enable a natural, almost unconscious interaction (3.1.5). Many of these building blocks can be used together in integrated solutions; for example, fully functioning computers, including sensors and wireless network functionality, will be developed on a single chip that can be built into any commodity for control purposes.

3.1.1 Storage and Processing

A commodity becomes a "smart thing" when it is able to store information about itself and its environment and makes this available on request. In the simplest case, this means a readout memory, which contains information about the object, e.g. a unique number combination on the basis of which it can be identified with certainty.

RFID tags are examples of such memories. In the form of flexible self-adhesive labels, they cost between EUR 0.1 and EUR 1 each, and could potentially replace traditional barcodes for the identification of goods in certain areas. Their big advantages are that, unlike the laser scanners currently used in supermarkets, they do not have to be placed within line of sight of the "reading device," that individual products, rather than whole product groups, can be differentiated because of their long identification number, and that, by recording different information on it, some versions of electronic labels can be used several times. If an object is also to be capable of acting autonomously and not merely delivering information to a central processing unit, it must be equipped with the processing capacity of a computer. This central processing unit (CPU) allows the evaluation of data streams directly onto the device and their translation into actions.

3.1.2 Sensors and actuators

Each computer has an input-output unit to communicate with its environment. Traditional input devices are the mouse or keyboard; traditional output devices are the printer or screen. When thinking about "smart objects" we have to consider special input and output devices, since the keyboard or printer are obviously not feasible for applications such as "intelligent" T-shirts as described in Box 2.2. In the world of ubiquitous ICTs, sensors serve as the input unit, whereas actuators serve as the output unit to bring the decisions of the information systems into action.

Sensors – taking reality to information systems

Traditionally, sensors are connected directly to a computer and are used to measure the physical values of certain phenomena in the environment. Sensor types include seismic, magnetic, thermal, visual, infrared, acoustic, or radar to monitor conditions like temperature, humidity, vehicular movement, lighting conditions, pressure, soil composition, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, or current characteristics such as the speed, direction, and size of an object. The results of microsystems technology and, increasingly, nanotechnology (for details see Box 3.1) are becoming more important. For example, they allow for tiny integral sensors that can record a wide variety of different environmental parameters. One interesting development in this regard have been radio sensors that can report their measured data to within a couple of meters, without an explicit energy source.

Box 3.1: Nanotechnology

While many definitions for nanotechnology exist, a dominant definition requires the following three properties:

- Research and technology development has to be at the atomic, molecular, or macromolecular level in the length scale of approximately 1 – 100 nanometer range.
- Devices and systems must create and have novel properties and functions because of their small size.
- The ability to control or manipulate on the atomic scale

Although the use of nanotechnology is limited today, nanoparticles are used in a number of industries. Nanoscale materials are employed in electronic, magnetic, optoelectronic, biomedical, pharmaceutical, catalytic, and materials applications. Areas reportedly producing the greatest revenue for nanoparticles are chemical-mechanical polishing, magnetic recording tapes, sunscreens, automotive catalyst supports, biolabelling, electroconductive coatings, and optical fibers. Some applications already in the marketplace include catalytic converters on cars, burn and wound dressings, water filtration, protective and glare-reducing coatings for eyeglasses and cars, sunscreens and cosmetics, and ink.

The latest display-technology for laptops, cell phones, digital cameras, and other uses is made out of nanostructured polymer filMs OLEDs, or organic light emitting diodes will provide brighter images, be lighter in weight, use less power and secure wider viewing angles than conventional devices. It is difficult to predict when products will move from the laboratory to the marketplace, but it is believed that high-performance nanotechnology materials will facilitate the production of ever-smaller computers that store vastly greater amounts of information and process data much more quickly than those available today. Computing elements are expected to be so inexpensive that they can be in fabrics – e.g. for smoke detection – and other materials. For ubiquitous ICTs, the impact of nanotechnology on new sensor technology is of great importance. Nanomix Inc., a US-based startup, develops innovative new sensor technology that combines silicon architecture with nanoscale sensing elements. Nanomix's aim is to design sensors that are smaller, more sensitive, and consume less power; these can be applied in leak detection, medical and environmental hazard monitoring, industrial control, and biochemical diagnostics. NanoMarkets LC predicts that the overall nanotechnology sensor market will generate global revenues of USD 2.8 billion in 2008 and will reach USD 17.2 billion by 2012.

Sources: www.nano.com, www.eetimes.com/at/news/showArticle.jhtml?articleID=55300380

Wireless sensor networks extend sensors with wireless networking capabilities. As sensors in a wireless network are not connected directly to a central controlling computer wireless sensor networks may be used in remote and unknown regions and benefit from being autonomous and from synergy effects through collaboration.

Efficient sensor networks require the sensor nodes to be cheap, to consume little energy, to be multifunctional, to be small and to have the ability to communicate both amongst themselves and with other networks. Compared to mobile ad-hoc networks, wireless sensor networks differ in various ways, including the larger number of nodes, the dense deployment, the attribution of fault-proneness, the frequent topology changes, the main use of broadcast communication instead of point-to-point communication, the limitations in power, storage and processing units, and often not possessing a global identity. Nevertheless, the demarcation of wireless sensor networks and mobile ad-hoc networks is often vague in literature. In contrast to other ubiquitous ICT areas, the field of wireless sensor networks is a new discipline.

Actuators – bringing decisions of information systems into action

Whilst sensors, as the “eyes” of the information system transform real-world occurrences like temperature, pressure or the incidence of light into bits and bytes, the actuators serve as “hands” that transpose the results of the information processing into reality.

A robot is the prototype of an actuator. These machines are controlled by the “intelligence” of an information system. Robots assemble, bolt, and fuse components, supervise oil drillings, disarm mines, or mow grass. Because of their size, most robots do not fall under the definition of ubiquitous ICTs. However, the technical advances of nanotechnology suggest that actuators and sensors will become smaller and may more easily be connected to common objects.

Although scarcely seen to date, the connection of actuators in mobile networks is possible in sensor networks. The vision is a sensor-actuator-network, in which singular objects are already able to (re-)act autonomously with the inherent actuators and sensors or connect with other objects for problem solving, if required. In this case an intelligent t-shirt, for example, can not only monitor body functions but also identify muscle tension in the neck area and instantly cure it with small stimulation currents.

3.1.3 Communication between “smart things”

Wireless communication technologies are required to connect “smart things” with each other regardless of where they are located. Typically, a broadcast medium is used as a basic communication scheme in sensor and actuator fields. Two nodes may establish a communication link if they are within communication range. A special node acts as gateway between the sensor and actuator field and other networks like the Internet. The task performed by the sensor field is managed and controlled by an instance that resides in one of these networks connected to the sensor field.

The biggest part of realized ubiquitous ICT applications nowadays is based on Radio Frequency Identification (RFID) technologies. However, it is expected that for the coalescence of some applications to ubiquitous ICTs, the existing mobile communication standards will be used and combined according to their adequacy, and that new technologies will be developed which expand the limits of present standards.

In the field of wireless communication, second generation mobile phone technology (such as GSM) is slowly giving way to so-called third generation systems (IMT-2000[29]) with higher bandwidth and better possibilities for data communication. Especially interesting for ubiquitous ICT solutions are recent short-range communications technologies, often referred to Near Field Communication (NFC) such as Bluetooth or Zigbee that need much less energy and make smaller and cheaper products possible. Currently such communications modules are the size of about half a matchbox and cost only a few euros (for a detailed discussion of mobile technologies see ITU report “The Portable Internet”). Another exciting development in progress is “Body Area Networks,” where the human body itself is used as a transmission medium for electrical signals of very low current.

3.1.4 System architecture and middleware

With the increasing maturity and standardization of the ubiquitous ICTs and the corresponding size of the systems to be implemented, they continue to lose their prototype-character and the focus is shifting from the properties of the hardware itself to the construction of complex systeMs These complete systems create operational benefits, because of the interaction of many highly specialized ubiquitous ICT applications with one another and with traditional information systems like inventory management. For end-users, systems lead to time savings when dealing with standards information systems, e.g. by autonomously replicating data on a mobile device or by automatically adjusting car seats after the drivers have identified themselves with their electronic car keys. As a result, there is an increasing need for reusable solution modules, which are fast and reliable.

Therefore, ubiquitous ICT solutions require a common infrastructure (middleware), through which the individual applications can communicate with each other and with standard information systems, as well as a system architecture, which defines what share the different components have in the whole system [Kubach 2003].[30] A challenge during their implementation is the embedding of technology and systems in an already existing infrastructure. Both system architecture and middleware are described in more detail below.

System architecture

We refer to system architecture as the documented design decisions that describe structure and behaviour of an information system, be it a system within a company or a system owned by a private person. Elements include hardware and software components and the interfaces between them, as well as system usage, functionality, performance, resilience, and constraints.

The main challenges of ubiquitous ICT system architectures can be summarized as follows:

- *Integration*. Ubiquitous ICT systems are rarely isolated applications; instead they serve as gateways between physical occurrences in the real world and the information systeMs Therefore, the possibilities for a flexible integration into an existing system environment are crucial to the value of ubiquitous ICT systeMs
- *Performance*. As ubiquitous ICT systems are used not only for offline analysis but also for real-time interaction, high performance requirements can emerge, which the system has to be able to process reliably, even under a full load. This means the ability to process large amounts of incoming data, as well as the speed with which that happens.
- *Scalability*. Scalability is also important; this is the possibility of expanding the system by spreading it over several computers or locations, to meet increasing performance requirements. The extent to which the system performance benefits from the additional computing capacity and is influenced negatively through potentially redundant data storage is crucial, as is the need to transfer data between multiple installations.
- *Robustness*. The supervision and control of physical events is open to a multitude of sources of error, depending on the extent to which the processes are guided or chaotic. Because the user cannot usually intervene immediately, the ubiquitous ICT system must be able to treat errors as they occur and pass them on to super-ordinate systems without derogating the functioning of the entire system. Moreover, the behavior of inexperienced users must be taken into account when applications are being designed.
- *Security*. Last but not least, as with other information systems, the security aspects of ubiquitous ICT applications must be addressed; this means protecting individual system components against external manipulation and safeguarding the data transferred during communication procedures.
- *Privacy*. Systems used by private end-users must protect the privacy of the individual. Since certain ubiquitous ICT devices are capable of recording user behavior (if they are to offer personalized services, they must do this), it must be ensured that these data remain private. See Section 5.3.3 for a more thorough discussion.

Middleware

Middleware for ubiquitous ICTs plays an important role in providing basic services for complex and highly distributed applications. Middleware supplies protocols and languages that define how different participants communicate with one another in a network, as well as basic services that are used by many applications (e.g. authentication).

The particular challenges faced by ubiquitous ICT middleware include efficient algorithms for data evaluation, the use and definition of software components and system management:

- *Algorithms for data evaluation*. Given the amount of data generated by sensors, the main duty of middleware is to derive information from processes instead of merely forwarding gross data to super-ordinate systeMs A typical example is the motion detection by which sequence data from various RFID readers is combined with a direction statement such as “Object 123 has left area X”.
- *Software components.* Sections of a ubiquitous ICT system architecture may be re-used as a software part, which again simplifies the development of ubiquitous networks and would make the result more trustworthy. Examples of this include special interfaces to hardware (sensors and actuators) and other information systeMs
- *System management.* As in traditional information system management, the operation of ubiquitous ICT systems requires tools on a technical and organizational level, e.g. a performance measurement system that helps to evaluate the quality of the physical-world image generated by the sensors. Other examples are best practices for operation and maintenance, as well as software tools, which enable updates or monitoring the status of the hardware.

3.1.5 Human-computer-interfaces

Even though a multitude of input devices exist alongside the keyboard and mouse, so far we have been almost exclusively used to receiving audio-visual system replies through monitors or speakers. These traditional interfaces generally lead to processing through the cerebral cortex, which requires a conscious preoccupation with the input of the information system. At the same time, certain application contexts, such as wearable computing, are not suited for conventional interfaces.

This being so, the emergence of ubiquitous ICTs also requires a multitude of new connections between individuals and information systeMs The mastermind of innovative networking possibilities is the game industry. Information systems artificially excite the sense organs and nerves to trigger the illusion of real sensations in cyber worlds. Whilst virtual reality (VR) describes and exhibits a completely computer animated world, as in a computer game, augmented reality (AR) applications combine the real world with context-sensual additional information from the information system.[31]

Therefore, we can expect that future human computer interfaces (as applications of augmented reality) will increasingly address senses other than sight and hearing, such as smell, taste, balance or touch. Force feedback, for instance, conveys information to the user by simulating affecting forces. That way, in aircraft with fly-by-wire steering, the resistance of the pilot’s gearshift lever is varied depending on the forces acting on the aircraft’s rudder, so transmitting the information that certain flight movements should be carried out slowly. Human computer interfaces addressing the human senses must be designed to constrain the users as little as possible and should be integrated into their clothing invisibly (wearable computing).

Wearable computing intends to shatter the myth of how a computer should be used. A person’s computer should be worn much as a jacket is worn and it should interact with the user according to the context. With head-up displays, unobtrusive input devices, personal wireless local area networks, and a host of other context-sensing and communication tools, the wearable computer can act as an intelligent assistant, whether this is through a *remembrance agent*, augmented reality, or intellectual collectives. The key differences between a wearable computer and the existing palmtops or laptop computers are that wearables tend to have access to sensors in their environment and are also active without direct user interaction. This opens the door to a whole range of augmented memory applications.

Several important aspects and performances of wearable computing are:[32]

- *Photographic memory*. Perfect recall of previously collected information.
- *Shared memory*. In a collective sense, two or more individuals may share in their collective consciousness, so that one may recall information that has not necessarily been experienced personally.
- *Synergy*. Rather than attempting to emulate human intelligence in the computer, which is a common goal of research into Artificial Intelligence (AI), the goal of wearable computing is to produce a synergistic combination of human and machine, in which the humans perform tasks they are better

at, whilst the computers perform tasks they are better at. Over an extended period of time, the wearable computer begins to function as a true extension of mind and body and no longer feels as if it were a separate entity.

There are also ethically justifiable fields of application for the direct connection of ubiquitous ICT with the nerve tract of the human being, for instance in the steering of artificial limbs (see Box 3.2).

Box 3.2: C-Leg from Otto Bock

The C-Leg® (the name stands for "computerized leg") is the only fully micro-processor steered artificial leg in the world, developed and manufactured by Otto Bock HealthCare GmbH (Duderstadt).

The knee joint is controlled in real-time by computer during the entire walking cycle – both the sweep phase and the stand assurance. Sensors check in which phase of the step the artificial limb is 50 times a second. The micro-processor regulates the knee function with the help of hydraulics according to the sensor data.

The micro-processor is programmed with the elementary common data of the human walking process. The orthopedic technician adjusts the C-Leg® to the individual safety requirements and activities with a computer and software.

Source: www.ottobock.de

3.2 Key functionalities

After having outlined the building blocks for ubiquitous technologies, it is useful to explore the key functionalities that such technologies should exhibit, i.e. identification, localization, monitoring. These result from three questions that could be asked of "smart things":

- Who are you? (identification, 3.2.1)
- Where are you? (localization, 3.2.2)
- What are you doing? (monitoring, 3.2.3)

If smart things can pose these core questions to each other, a basis will be provided for the automation of whole processes through the interaction of smart things (3.2.4).

The condition for answering these core questions is the interaction of the individual building blocks of ubiquitous ICTs, as presented in 3.1. For example, a smart thing requires a memory, wearing a unique identification number, to answer the question "Who are you?" In addition, the "questioner" needs to be able to transmit the question to the object with mobile technology and to decode the answer.

3.2.1 Identification – "Tagging the world"

The goal of automatic identification (Auto-ID) is to determine the identity of an entity, which can be either a person or an object. Auto-ID comprises two tasks, i.e. capturing an external stimulus or signal and recognizing that signal by a computer analysis, and is the key to the development of ubiquitous ICT solutions.

In many cases identification is achieved by using a unique number, which acts as a pointer to attributive datasets in an information system, or documents the affiliation to an object class (e.g. barcode system). Alternatively, objects can be identified by optical or acoustic techniques (e.g. the authentication of users with iris test or vocal identification).

Box 3.3: Approach of the Auto-ID Center

The identification approach of the Auto-ID Center consists of three basic components: The Electronic Product Code (EPC), the Object Name Service (ONS) and the Physical Markup Language (PML).

Electronic Product Code (EPC)

The Electronic Product Code is a numbering scheme to identify unique product instances. It looks broadly very similar to the existing barcode system, the main difference, or extension, being the possibility of enumerating each single product instead of just the product types. Since the existing barcode systems are a subset of the new ePC, all the GTIN (Global Trade Item Number) standards, including UPC (Universal Product Code) in North America, and EAN (European Article Number) in the rest of the world. Numbering schemes can be embedded into the ePC and the PML. The ePC consists of four fields, the first of which is called Header and is used as version number of the code; t can also be used to distinguish different naming schemes and is intended for future extensions that might prove necessary. The second field is called EPC Manager and identifies the company or organization that wants to number its products. Product groups are identified by the third field, called the Object Class. The last field, which is an extension of the already existing barcode system, is the Serial Number field that identifies each product uniquely.

Field name	Header	EPC Manager	Object Class	Serial Number
Bit Position	0..7	8..35	36..59	60..95

The EPC has a length of 96 bits, according to the specification of the Auto-ID-center and these numbers can be stored e.g. on RFID tags. These transponders have an integrated antenna, do not require their own source of energy (in the simplest case) and can be read out by an external reading device that establishes the connection to the information system.

Object Name Service (ONS)

Similar to the Domain Name Service in the Internet the Object Name Service is a service that interlinks physical resources with their virtual representation. In the Internet, the DNS connects an IP-address and an URL (Uniform Resource Locator). In the Auto-ID-approach, the ONS handles the allocation between EPC and an URL.

Physical Markup Language (PML)

The information about physical resources can be kept in different data formats and system environments. For example, a corporation may require order data, product information, as well as details of the origin and history of the goods ordered. As the information is usually stored in various systems and formats, companies use description standards of product data, customer information etc. that simplify the exchange of data within the company, as well as between the organization units. In order to extract information from the heterogeneous systems and translate them into a uniform structure, the Auto-ID-center uses the so-called Physical Markup Language. This description language for physical resources should select and integrate the diverse information from the underlying systeMs

Source: Auto-ID 2005, Brock 2001.[33]

In various contexts, many different schemes have been developed to assign unique identifiers to identify entities. One challenge is to prevent the same identifier from being assigned twice. Denominating hierarchies are used to assign identifiers in an ordered and concurrent way, as well as to retrieve data that are more efficiently associated with an entity (Box 3.3 explains the identification approach of Auto-ID Center). Besides proprietary solutions, some standards and coding schemes are important for ubiquitous ICT applications: the Universal Product Code (UPC), the European Article Numbering Code (EAN), and the electronic Product Code (ePC).

For example, barcode systems describe an object or class of objects by means of black and white bars, which are based on a standardized numbering system. The information about objects can be determined by barcode-scanners and transferred automatically to the information system (e.g. to identify price and origin). Barcodes are cheap, but have certain disadvantages: they require a line-of-sight connection when read and can only store a limited amount of data; because of this they are mostly used to identify product groups, but not individual iteMs

Radio Frequency Identification (RFID) tags address the shortcoming of barcodes: They can store a larger amount of data, so making it possible to identify individual objects and they can be read without a line-of-sight connection between tag and reader.

One criterion to distinguish RFID solutions is the power mode: an active tag has an integrated power supply, which enables it to transmit data to a reader up to 100 meters away. Passive tags are powered by an electromagnetic field generated by the reader and can usually transmit their information up to two meters. The readers are connected to a host system, which runs the applications. RFID solutions are currently being used by large retailers, such as Wal-Mart and Tesco. The cost for the tags and readers is decreasing; currently the minimum prices for readers are USD 200 for active tags USD 5 to USD 10, and for passive tags between USD 0.10 and USD 0.20.

3.2.2 Localization

Localization refers to the process of identifying the location where an entity resides. This information is needed by applications that provide location-based services. This issue is closely related to automatic identification. In most cases, location information is only requested with the identity of the entity that is to be localized.

The localization of objects can be realized technically through various methods. One widespread technology is the Global Positioning System (GPS), which can determine the exact position of an object anywhere in the world. The GPS provides location information based on signals from a network of satellites. Originally developed for military use, a number of non-military applications exist, for example, navigation systems for cars or vehicle tracking solutions, which use GPS in conjunction with cellular mobiles. A specific example of the complementary use of GPS and embedded mobile is the case of Fleetmanager, set out in Box 3.4.

Box 3.4: Case of Fleetmanager

The company Fleetfinder features an online information system called Fleetmanager for the localization and status display of vehicles, buildings, yachts, etc. The monitored objects are equipped with on-board computers, GPS systems, and an integrated mobile phone. The current position of the mobile objects can be determined via satellite. The position information, together with other information about the object, for example cooling temperature or battery charge, is transferred to the Fleetfinder headquarters via the cellular phone network. Through previously defined scenarios, actions can be specified that are initiated when reaching critical values (e.g. when the object leaves a defined area or when the doors of a house are opened). Fleetfinder offers a service for shipping companies, which provides the position and status information about the goods shipped and makes it available to the customers through a web-based information system.

Source: www.fleetfinder.com/

GPS-systems are satellite-supported radio positioning systems, which provide three-dimensional positioning, as well as speed and time information via standardized devices. Two different public GPS systems are presently available: the NAVSTAR system of the US and the Russian GLONASS System. The European Union is building its own global navigation satellite system called Galileo, currently projected to be operational by 2008. Galileo is slated to be a civil system that will be operated by a commercial Galileo Concessionaire. The European Union intends to launch a full constellation of satellites that will be independent from existing GPS solutions.

Cellular mobile technologies can be used for localization purposes by measuring the field strength of more than two base stations. If the network topology is known, the position of cell phones can be estimated. The drawback of this approach is its limited precision. A few network operators (e.g. Genion or Swisscom) offer services based on the localization within the GSM-system. Through approximation methods the position of a user or a device can be determined inside a radio cell.

Near Field Communication (NFC) technologies, such as RFID, Bluetooth or Zigbee may, under special conditions, also be used for localization. The position of objects that are equipped with NFC devices can be determined as long as they are within reach of as RFID reader, a Bluetooth or Zigbee base station. Given the limited range of the readers, this is possible as long as their position is known. However, for area-wide coverage, a large number of readers would be required, which renders the solution inefficient.

Typical applications based on positioning technologies are navigation systems in cars, location-based services (Where is the nearest automated teller machine?) and track and trace-systems (e.g. for efficient transportation).[34]

3.2.3 Monitoring

Monitoring displays information about the past or present state of physical goods or people and their environment. Technically, this information can be derived from sensors (see paragraph 3.1.2) and can then be processed and stored (see paragraph 3.1.1) for future use. Typical fields of application for this function are the monitoring the temperature of critical goods (cold chain monitoring), verification systems for the proper storage of goods (e.g. monitoring of humidity, pressure, incidence of light) and diagnosis systems in medical applications (e.g. monitoring of the glucose level of diabetics or contaminated food identification systems).

3.3 Technological challenges of ubiquitous ICTs

Ubiquitous ICTs should provide the right information to the right person at the right place and time. Moreover, the system has to be aware of the user's context so it can respond in an appropriate manner, with respect to the cognitive and social state, and the need of the user.[35]

At the technology level, there are several unresolved issues concerning the design and implementation of ubiquitous ICTs (for ongoing research on ubiquitous ICTs see Table 3.1). In its ultimate form, ubiquitous computing means any computing device that, while moving with us, can build dynamic models of its various environments incrementally and configure its services accordingly.

Furthermore, the devices will be able to "remember" past environments in which they were operating, thus helping us to work when we re-enter, or proactively build up services in new environments whenever we enter them.[36] This context-awareness requires the availability of powerful ontology and domain models, which are not yet in place.

Another challenge is the device heterogeneity. Multiple devices from multiple vendors with different technological capabilities, equipped with varying communication technologies must cooperate in an ever-changing environment. Moreover, the available resources are restricted. Many devices will be battery-driven and particularly for applications where low costs are important, the computing power will be limited.

A severe challenge is the desired scalability of the infrastructure. A large number of devices and applications must be supported and the high availability of the infrastructure is required as the users rely on the systeMs

Table 3.1: Ongoing research on ubiquitous ICTs

Project	Goal	Challenges
Auto-ID Lab Network (MIT, Univ. of Cambridge, Univ. St. Gallen)	Develop an open standard architecture for creating a seamless global network of physical objects.	Infrastructure, passive and active tags and sensors, addressing uncertainty in RFID, smart products and services, business impact.
Aware home (Georgia Tech.)	Develop the requisite technologies to create a home environment that can both perceive and assist its occupants.	User experience enhancement and validation.
Oxygen (MIT)	Bringing an abundance of computation and communication to users through natural spoken and visual interfaces, making it easy for them to collaborate, access knowledge, and automate repetitive tasks.	User experience enhancement and validation.
PIMA (IBM Research)	Developing an application model in a platform-independent manner and for adapting them to multiple heterogeneous device platforMs	Application development and deployment; Context-based adaptation.
Portolano (University of Washington)	Investigating ubiquitous task-specific computing devices, which are so highly optimized to particular tasks they blend into the world and require little technical knowledge on the part of their users.	Software infrastructure; Service construction and composition; user experience enhancement and validation.
SmartIts Project (Swiss Federal Institute of Technology Zurich)	Development of small, embedded devices that can be attached to everyday objects to augment them with sensing, perception, computation, and communication capabilities.	Building and testing ubiquitous computing scenarios; Studying emerging functionality and collective context-awareness of information artifacts.

Source: www.autoidlabs.org; www.cc.gatech.edu/fce/ahri; www.oxygen.lcs.mit.edu; www.research.ibm.com/PIMA; www.portolano.cs.washington.edu; www.smart-its.org

4 AN INDUSTRY-BY-INDUSTRY LOOK AT UBIQUITOUS TECHNOLOGIES

The following section discusses the use of ubiquitous ICTs in the retail, logistics, automotive, aerospace and pharmaceutical industries, all of which are highly end-user driven; the discussion also identifies the implications for the non-corporate impact of the emerging technologies. Applications, potential benefits and existing barriers of these industries lay the foundation for the discussion of ICTs impact on telecommunication industry in section 5.

The selected industries have extensive experience in using ubiquitous ICTs because they face strong challenges that drive them to change their business and application areas where the use of ubiquitous ICTs might be helpful.

Each subsection describes the vision of using ubiquitous ICTs in the selected industries, followed by the drivers for change. Subsequently, solutions that are now in the labs, or exist as prototypes, are exemplified, and the benefits and existing barriers for a broad use in the industry are discussed.

4.1 Retail industry

Retail industry serves as a good example of ubiquitous ICT solutions for two reasons. First, this industry deals with (relatively small) consumer goods in high quantities that are subject to regulations (e.g. observance of origin and food cool chain). Second, the retail industry is confronted with a high level of competition and cost pressure which forces companies to seek more efficient processes and provide better customer service.

Normally, large retail chains only achieve returns on sales in the lower single-digit percentage range. At the same time, sales volume is largely stagnating. Retail sales were actually in decline in Germany in the year 2002. In Switzerland, the market environment is difficult, too. Retailers are faced with the challenge of differing from their competitors and reducing costs further. What happens if they do not succeed can be seen in the German food sectors, where discounters now occupy a 40 per cent share of the market and the return on sales is just 0.5 per cent

4.1.1 Vision

In the retail store of the future, each article will be equipped with sensors, such as a RFID tag, which makes it possible to automate many processes completely. Automatic replenishment and production based on daily sales figure updates mean that it is always possible to find out which sizes and colors of an item of clothing have already been sold and which are still available. At the beginning of the season the number, sizes, and colors of items to be produced to satisfy demand and avoid overproduction can be extrapolated from the initial sales figures.

Box 4.1: METRO Future Store

METRO Group Future Store Initiative is a cooperation of METRO Group with SAP, Intel, T-Systems, and IBM, as well as other partner companies from the information technology and consumer goods industry. Its purpose is to push the national and international modernization process in trade and he initiative is to be understood as a platform for technological and process-related development and innovation in trade. Technologies and technological systems have already been tested and further developed in practice, within the METRO Group Initiative. Standards which are worldwide uniformly realizable for trade are to be developed in the long term.

The METRO Group has tested new technologies in trade at its Future Store in Rheinberg, near Duisburg (Germany) together with its Future Store Initiative partners since April 2003. Technological innovations, which promise high benefits not only to the customers, but also to trade, are for the aim. One of these technologies is radio frequency identification (RFID), which enables a contactless transmission of product information. RFID is mainly employed in the value chain and in the stock of the Future Store and also gives the user certain advantages: the innovative technology supports trade in satisfying the needs of the customers at the best possible rate, such that shopping becomes faster, more comfortable, and more secure in future. It becomes possible, that, if a product is sold out and the shelf has to be replenished, it is reported automatically. Beyond that, RFID helps trade companies to optimize process flows and to cut costs.

At the moment, METRO Group is testing the implementation of RFID technology mainly in stock management of the Future Store. RFID has been implemented in the following areas:

- Goods delivery in the market: RFID helps to check that the incoming delivery corresponds with the order.
- Stock management: in the goods flow system, the exact products which are in stock are recorded.
- Transportation of goods in the sales area: the goods flow system identifies the products as “placed in the market” thanks to RFID.
- Intelligent shelves in the market: some products in the Future Store are already equipped with smart chips. Readers located in the shelves of “Philadelphia” cream cheese, “Pantene” Shampoo, and “Mach 3 Turbo” razor blades, notify the employees if goods have to be sorted.
- Tags on CDs, DVDs and videos: RFID makes it possible to watch the trailers to some movies, as well as to listen to music CDs.
- De-activator: the customer can overwrite the information stored on the Smart Chip and thus deactivate the chip after payment.

Source: www.future-store.org

With the help of ubiquitous ICTs, each article turns into a “smart thing”. For this reason, a piece of cheese is capable of verifying compliance with the storage conditions (e.g. temperature, humidity) or autonomously offering itself with a price reduction three days before its expiration date. Razor blades or high value goods can set off an alarm in case of theft.

Based on ubiquitous ICTs, shopping carts recognize the user and present offers on the basis of the profile data. One scenario could be as follows: customers enter a supermarket, where they are recognized by means of their customer card and on a display on the shopping cart they receive a list of special offers tailored to their individual interests. The products in the supermarket are augmented with RFID tags, so that it is always possible to identify which products the customers place in their shopping cart. Information on each product, e.g. product origin, can be called up and shown on the display and the customer can save the data on a PDA. With this device the Internet can be accessed and further information on the product obtained from independent suppliers or alternative offers in other stores can be assessed. At the check out the customers do not have to wait, but push their shopping cart through the exit provided for this purpose and the amount is debited directly from their credit card. Companies like Metro are bringing this vision to life (see Box 4.1).

4.1.2 Drivers for change

The retail industry is seeking to improve its inventory management, lower its process costs, increase customer confidence in their products and improve customer retention and service. The rivers are "out of stock" and "dead stock" scenarios, shrinkage, inaccurate inventory information, high human resource (HR) costs, low consumer confidence and inconvenient waiting time at cash desks and for advice. These drivers are illustrated below.

- *Out of stock.* The percentage of products that are not available in the retail trade is estimated at between three and seven percent.
- *Dead stock*. In the food sector the percentage of dead stock (stock that is damaged or has passed its expiry date) is roughly one percent of sales according to industry figures. Dead stock is also a problem in other segments; for example, the clothing sector has to aim to minimize the percentage of unsaleable seasonal articles.
- *Shrinkage.* Surveys show that shrinkage in retail is on average 1.8 per cent of sales, in some segments even as much as 3 per cent because of theft by staff and customers, and fraud by suppliers.
- *Inaccurate inventory information*. Case studies show that information on inventory levels is rarely accurate. Inventory levels in the information system varied from the actual level for 65 per cent of all products. This reduces profits by over 10 per cent. Inadequate data quality may explain why, in one survey, only 9 per cent of retail managers reported that they used their information systems to check shelf life.
- *High HR costs.* HR costs arise when providing customers with advice and at the cash desk, as well as when manually checking goods receipts and inventory levels or marking prices, e.g. on the shelf or on the product itself.
- *Consumer confidence.* A succession of food scares, such as the one involving BSE-infected beef, have rocked consumer confidence. The same applies for other animal diseases, which are, or are perceived as being, infectious to humans; there was also the case of avian flu. There have been calls to document the origin of products much more carefully.
- *Waiting time at cash desks and for advice.* Long queues form regularly in front of cash desks, particularly at peak times, at weekends and before public holidays. The customer frequently has to put up with long waiting times and the quality of advice is not always very good.

4.1.3 Early applications

First and foremost, ubiquitous ICT applications in the retail industry focus on single articles by providing information about what it is, where it comes from, where it is located and to which environmental influences it has been exposed since its manufacture. Essential knowledge is linked directly to the physical object.

The combination of the information about all articles lays the foundation for the complete reorganization of the trading processes; from the purchase and presentation of the products, all the way through to the actual sale. Ubiquitous ICTs enable the automation of tasks and processes: in the order process, through the automatic repeat order of goods on the basis of forecast and sales numbers, and in the selling process through the automated product presentation with the help of small shopping carts, or through automated paying processes with self-service cash desks or electronic payment systeMs Together with customer identification, i.e. through a customer card with an RFID tag, the retailer may even collect data on customer behaviour and thereby draw conclusions on individualized offers or the correct composition of the whole range of products.

Table 4.1. summarizes exemplary deployment scenarios of ubiquitous ICTs in the retail industry and assigns each to a functionality of ubiquitous ICTs as laid out in paragraph 3.2. For a detailed example, see Box 4.2.

Table 4.1: Ubiquitous ICT functionalities and deployment scenarios in the retail industry

Ubiquitous ICT functionality	Deployment scenarios
ID	• Place of origin • Product presentation
Localization	• Theft protection • Shell and inventory management
Monitoring	• Cool chain monitoring • Expiration date monitoring • Automatic replenishment • Analysis of customer behavior
Process Automation	• Electronic Payment Systems • Smart shopping carts

Source: Tellkamp & Haller 2005.[37]

Box 4.2: Implementation of RFID in the clothing industry – a pilot project at Kaufhof and Gerry Weber

The implementation of RFID in the clothing industry is one of the most discussed applications of RFID in the retail business. In contrast to food retailing, where, as a first step, retailers primarily push the use of RFID at the cardboard and pallet level, in clothing the implementation of RFID is considered at the product level. RFID offers a wide range of potential benefits in the supply chain as far as the place sale and beyond. However, at the moment most applications are in the pilot stage.

Kaufhof Warenhaus AG carried out a RFID pilot project in collaboration with the clothing producer Gerry Weber International AG. The experiences of the pilot showed that a multiple-way solution is worthwhile, profitable, and achievable. This approach is supported by the CCG, which elaborates a concept for the "multiple-way-tagging-process," together with the retail, textile industry and the manufacturers of security systems for goods. A first pilot realization along the whole supply chain is expected for the second half of the year 2005.

Expected advantages are: thorough control at issuing of goods, avoiding errors by reducing manual activities, fewer incorrect deliveries, improved communication facilities between all involved parties along the supply chain and information opportunities about the customer's product acceptance. The acceptance of the technology depends *inter alia* on the ability of the companies to convey the advantages of RFID to their customers. Another important subject is data security, although the concerns about data security can, to a large extent, be dispelled by a multiple-way solution, because the RFID tag is removed at the cash desk.

Source: Kaufhof 2003.[38]

4.1.4 Benefits observed

Retailers who focus on ubiquitous ICTs expect great increases in efficiency and improved customer care of their application in the business processes. Ubiquitous ICTs allow the automation of laborious routine activities, such as stock inventory, repeat orders, cash transactions, or the work of a store detective. More efficient processes allow higher margins and lower sales prices.

The reduction of stock means that its management requires less effort and also decreases the capital commitment to embedded products and infrastructure. A precondition for preventing theft and shrinkage of stock in trade efficiently and effectively is to equip all articles with identification.

Moreover, ubiquitous ICTs allow the complete documentation of a product's "history" from producer to end-consumer, and also the constant inspection of the compliance against important parameters, such as storage temperature, humidity and expiry date.

If the retailer uses this customer knowledge to prepare individual offers and promotions (e.g. a special discount on the customer's birthday), he may increase customer loyalty through according special attention and extensive covering of customer needs.

4.1.5 Barriers to take-up

Many of these scenarios have already been under discussion for some time now but, except in isolated cases or pilot applications, have not been implemented. Some of the reasons for this are given below:

- *Availability and reliability.* Although the required technologies often exist, in some cases there are still problems with availability and reliability. With RFID applications, where a large number of tags have to be read, the reading rate is generally less than 100 per cent. This limits suitability, e.g. for checking receipts. In addition, reading the tag can be hindered, by shielding the tag with metal, etc.
- *Absence of industry standards.* The absence of industry standards is another major point, e.g. when tracking products in the supply chain; as far as possible, all the companies in the supply chain should be able to use the relevant data. This is where standards, e.g. for data exchange protocols, describing products and finding the data are necessary. Isolated solutions, which can only access limited data bring only limited added value.
- *Collaboration and trust.* Alongside standards, the will to collaborate with other businesses is important; this is where mutual trust is necessary. Collaboration has to be beneficial for everyone involved.
- *Data security and protection.* Data protection is a major issue in applications involving consumer data. Consumer interest groups are expressing their resistance to the introduction of RFID solutions in the retail sector. Various applications have already foundered as a result of the negative attitude of consumer protection groups, e.g. the planned introduction of customer cards with RFID tags at METRO Future Store (see Box 4.3). Consumers should be given the opportunity to destroy the tag once they have purchased the product, in order to prevent further tracking. In the context of data protection for consumers, but also in the interests of protecting company and product data, the issue of data security is relevant, especially as potentially different players must be able to access the data, e.g. via the Internet or cellular networks.
- *Consumer habits.* With the exception of a small number of innovators, most consumers tend to hesitate to adopt new technologies. A study has shown that electronic shelf labels and mobile shopping assistants were accepted by three quarters of those surveyed, whereas self-service cash desks, where customers have to read in their products manually, will only be accepted by users slowly.
- *Costs of ubiquitous ICT systeMs* With some applications, it is still unclear to what extent they constitute an added value for the customer (e.g. customer-specific offers) and how businesses can profit from them financially when the costs of using them are taken into consideration. In supply chain management the costs of the RFID tags are a critical factor. In order to be able to fit RFID tags to the majority of products in the retail sector, the prices of tags have to come down. Ideally, a passive RFID tag should cost 5 US cents; at present, certain tags are priced at around 10 US cents in large volumes. The investment costs can also be considerable, for example, the estimated cost of equip a large supermarket with an RFID infrastructure are currently USD 300,000-400,000.

Box 4.3: Big brother award for METRO Future Store

The wholesale and retail chain METRO felt impelled to partially abandon its experiments with ubiquitous ICTs in the Future Store; one example of this is the retraction of customer cards with RFID tags after massive protests by consumer protection and civil rights groups. Even before, the company had already received the “Big Brother Award”, through which the initiators criticize with the perceived abuse of personal data according [see Tangens/Frank 2003].

The METRO Group insists that they implemented RFID in a way that is consistent with the data protection regulations. In order to deflect possible reservations towards the smart chips, the Future Store Initiative no longer employs these tags in the Extra Future Cards. Already released customer cards already released could be exchanged with conventional cards without tags. METRO regards this gesture as a significant part of their contribution to meeting the emotionally justified concerns and to taking the emotional element out of the discussion about RFID, independent of any legal valuations.

Sources: www.future-store.org; www.big-brother-award.de

4.2 Logistics industry

The logistics sector of ubiquitous ICTs represents a cross-sectional branch offering smart services as an outsourcing partner. In the automotive and consumer goods industry, as well as in the retail trade, efficient logistics constitutes a decisive competitive advantage. Here, logistics costs account for between 8 per cent and 28 per cent of total costs, with external organizations providing up to 50 per cent of the logistics services.

4.2.1 Vision

The successful implementation of ubiquitous ICTs in the field of logistics achieves complete transparency and the control of all material, information, and cash flows along the entire value chain. The vehicles, warehouses and production sites, as well as the goods to be transported are all endowed with intelligence. This means they can communicate clearly with their surroundings; who they are (identification and anti-forgery), where they come from (product traceability) and where they are heading to (route planning).

Whilst in transit, they save data on transport conditions; this is particularly important in the case of hazardous and perishable goods. The warehouse is equipped with sensors, which can determine the exact location of an object; this elimination of search operations drastically reduces physical access time. Goods left in the warehouse for a longer period of time will automatically make themselves known to personnel. Likewise if they are loaded onto the wrong vehicles; incorrect deliveries are thus excluded even after the goods have been re-palletized several times.

Intelligent vehicles automatically calculate the transport route according to the traffic situation. At any moment customers know the location and exact arrival time of their goods. Waiting times at customs and during unloading can be minimized, as all the goods are automatically and simultaneously registered during these operations. The laborious, time-consuming job of checking the delivery can be dispensed with. And finally, the intelligence is also useful when it comes to disposing of the goods. Having stored details of the materials of which their components are made they thus facilitate recycling whilst supplying the manufacturer and the logistics provider with valuable data on use and service.

4.2.2 Drivers for change

At present, a wide range of opportunities for expanding service portfolios is provided in the logistics sector. Whilst the traditional physical tasks, such as transportation and transshipment continue to play a major role, higher-value tasks in coordination, organization, consulting, as well as information and communication technologies, are now being added. This development has been triggered by changes in the general business environment, with the internationalization of the economy and global networking increasing the competition between individual players. A reduction of the value creation depth can be observed, with a consequent increase in the interfaces between players. In this environment companies react by concentrating on their core competencies and by outsourcing logistics services to external providers. Current outsourcing topics with a focus on ubiquitous ICTs range from product traceability, through intelligent container systems, to fleet management.

As a result of food scandals in recent years, traceability has gained importance in the food sector. It is against this background that the EU Commission is calling for a monitoring system encompassing both producers and retailers all along the line "From farm to fork". Under EC Directive 178/2002, which will become effective in all EU states from 2005, all companies involved in producing or distributing food will be required to establish systems and procedures which guarantee complete traceability. In a ubiquitous ICT scenario all goods will be identified by means of an RFID tag that ensures efficient traceability in spite of cross-docking and re-palletization.

4.2.3 Early applications

The implementation of ubiquitous ICTs in the logistics industry brings about transparency in the goods streams down to the aggregation level of a single product. This facilitates the coordination of the logistics streams for the company, since it knows at any given time, where the specific goods are and whether the transport and storage parameters, such as temperature and humidity are adhered to. Table 4.1 summarizes exemplary deployment scenarios of ubiquitous ICTs in the retail industry and assigns each to a functionality of ubiquitous ICTs, as derived in paragraph 3.2. For a detailed example, see Box 4.4.

Table 4.1: Ubiquitous ICT functionalities and deployment scenarios in the logistics industry

Ubiquitous ICT functionality	Deployment scenarios
ID	Prevention of incorrect loading
Localization	Anti-theft device Fleet management Three dimensional localization of goods on stock
Monitoring	Tracking and tracing Monitoring of transport and storage parameters
Process Automation	Automatic entry for goods receipt and goods issue

Source: M-Lab Working Paper.

Box 4.4: Tracking of carriers in the logistics industry – pilot installation at a goods loading terminal

A pilot installation at a goods terminal in Graz shows the potential of integrating physical resources with systems for data processing. The findings gained through the pilot systems apply to the 26 trailers included in this test, which are not necessarily representative of the total portfolio. A pre-condition for effective fleet management would be the surveillance of the total portfolio of trailers. Isolated deviations, which occurred during the measurements, for example the lifetimes of the contents of certain trailers being significantly above the average, require an additional analysis of the measurement data and the additional information respectively, e.g. about of the length of time the trailers were in garages. An analysis and interpretation of the data thus collected is, therefore, necessary to derive concrete recommended procedures. However, the weaknesses discovered through using the prototype, for example irregular utilization, lack of availability and inefficient circulation times, are typical for the use of transport containers in logistics.

In pilot installations in different areas, the corporation Identec Solutions achieved a reduction potential of between 5% and 20% with the stock of transportation containers.

Source: Internal M-Lab Working Paper.

4.2.4 Benefits observed

The logistics industry is already benefiting from the use of ubiquitous ICTs and, under certain conditions, the investments can pay off within a short period of time. Moreover, companies stand to gain early experience with the new technology, which is set to change logistics significantly.

The constant examination of transport and stock conditions is not only a legal necessity for many products, it also reduces the loss of goods through improper treatment. Moreover, ubiquitous ICTs enable real-time information about the condition and disposition of goods, whereas previous logistics concepts required the periodical and manual collection and processing of information about the logistics chain. For this reason, the coordination of the supply chain and the individual partners has been clearly simplified and the elimination of unproductive waiting and idle time enables faster reaction to new customer needs or disturbances in the operating procedure.

The elimination of manual data collection reduces errors (e.g. through transposed digits) and thereby helps to reduce incorrect and delayed deliveries; the automatic identification and localization of goods offer efficient protection against theft.

4.2.5 Barriers to take-up

Obstacles to the implementation of ubiquitous ICTs in the logistics industry are primarily organizational. Suppliers and customers must agree on how they are going to handle this new transparency and technology standards must be defined.

As a rule, supply chain solutions for inter-organizational chains are handled from a central point, which coordinates the chain for all the companies involved. These solutions only work if suppliers and customers trust each other, particularly if an external agent is coordinating the supply chain. This external coordinator, who might perhaps be a logistics provider, gains a deep insight into the processes and data of the individual partners in the chain. This transparency does carry the inherent risk that competitors get hold of such data and possibly misuse the information for their own ends.

The costs and benefits of inter-organizational supply chain solutions are never distributed symmetrically. Consequently, the participants in the supply chain must clarify who has to bear the initial outlay and how the resulting profits can be distributed equally among them.

Finally, recognized standards must be available if RFID tags are to establish themselves on a wide scale; there are parallels with the introduction of the bar code in the 1970s. It was not until the international standards EAN and UCC were created that the bar code made its mark. The International Standards Organization (ISO) and the American National Standards Institute (ANSI) are currently working on standards applicable to the RFID.

4.3 Automotive and aviation industry

The automotive industry is one of the leading sectors in the use of innovative technologies, which also include mobile and ubiquitous technologies. Given the similarity of the automotive and aviation industries in most deployment areas, potential applications are discussed together.

4.3.1 Vision

The automotive and aviation industries use ubiquitous ICT solutions to automate their processes, starting with the delivery of individual components, continuing through production and sales to maintenance and recycling. Potentials exist both at the intra- and inter-organizational level, as well as in the customer relationship.

Increases in efficiency can be achieved by virtue of the fact that real-world operations such as goods receipt, storage, shipment, etc. are depicted automatically in the information system. It is here that automatic identification using RFID could play a vital role. One possibility is that in future, each individual part be equipped with a smart label, so providing complete transparency all along the supply chain. A ubiquitous infrastructure, which provides the relevant information on each individual part at an inter-organizational level, paves the way for a range of applications. For example, it is possible to ensure that deliveries reach the correct destination automatically. The smart load carrier recognizes the destination of the parts it is transporting and monitors on-time delivery. Prior to storage, goods are automatically checked for completeness and the data in the inventory system is updated. Production planning can then be carried out on the basis of current inventory levels and take into account the goods which are to be found in the supply chain. In production, the automatic identification of individual components can raise the level of automation and facilitate integrated quality control. The information (about the individual components used to manufacture a vehicle) could be used later date for a recall operation, where it is necessary to identify the vehicles with parts from a specific lot. Data on vehicle configurations are also required when the software versions of electronic components have to be updated to avoid incompatibility probleMs Identification by means of a chip provides reliable protection against product piracy when it comes to selling spare parts. The automatic checking of serial numbers means that gray markets can rapidly be identified and combated. Original spares can be unequivocally identified in the event of a legal dispute.

There are an increasing number of new services which can provided in a car; for example, mobile communication technologies make it possible to provide Internet access in every car. With GPS the car can then communicate its position at any time via the Internet. This means, for example, that the car can take on the role of a traffic jam reporter or automatically notify police and ambulance services in the event of an accident. Systems that constantly monitor the attentiveness of the driver and warn him or her of overtiredness, for example, are also possible.

4.3.2 Drivers for change

Drivers in the automotive and aviation industry are increasing customer requirement, efficient design of the supply chain, product piracy, and recycling, which are detailed below.

- *Increasing customer requirements.* Nowadays, a car is of greater significance to customers than just a means of transportation. Alongside safety and comfort, customers expect additional services such as those related to navigation, communication and entertainment. Compiling features of this kind to suit the customer represents a key challenge, although most car manufacturers, particularly those who attach a high level of importance to telemetrics, have recognized this trend.
- *Efficient design of the supply chain.* According to A.T. Kearney, up to 25 per cent of the operating costs in manufacturing relate to supply chain management. Compared to other sectors, the supply chain in the automotive industry is considered to be exemplary and this is not just because in recent years, some 60 per cent of the entire IT budget has been invested in improving supply chain management systeMs Nonetheless, even in the automotive sector, complete transparency in the supply chain still remains wishful thinking. Delayed or misdirected deliveries, as well as incorrect information on inventory levels lead to avoidable search times, delays in production, machine downtimes, and expensive express orders.
- *Product piracy.* Where sales of spare parts are concerned, proof of origin plays an important role. Corporations like DaimlerChrysler or Volkswagen estimate that some 10 per cent of all parts sold as "original spares" have, in fact, been declared as such without the permission of the car manufacturer.
- *Recycling.* In Europe, from 2006, new statutory requirements will in force for the disposal of vehicles. Manufacturers will be required to take back old cars and become responsible for their recycling. At the same time, the costs of recycling can be reduced considerably through the use of modern identification technologies in production.

4.3.3 Early applications

The automotive industry already uses ubiquitous ICTs for a variety of applications. Sokymat, which is the market leader in transponder sales, sold around 30 million RFID transponders (50 per cent of their total sales) to the automotive industry in 2001.[39] A variety of applications are possible and financially justified for certain product and market requirements (see Table 4.2).

Table 4.2: Ubiquitous ICT functionalities and deployment scenarios in automotive and aviation industry

Ubiquitous ICT functionality	Deployment scenarios
ID	• Vehicle identification • Smart ignition keys • Tools management • Identification of original spare parts
Localization	• Parts supply
Monitoring	• Engine Tracking
Process Automation	• Throughout Production

Source: Strassner & Fleisch 2003.[40]

Today, ubiquitous ICTs are already used widely in the automotive industry and various examples of the use of RFID for tracking components or transport containers can be quoted. The use of mobile devices for capturing data, as well as sensors and mobile data storage in production are commonplace. Examples of new systems offered with cars include automatic security, navigation, and entertainment (for examples, see Boxes 4.5 and 4.6).

Box 4.5: Tools management in aircraft maintenance

Unscheduled delays in aircraft maintenance cause high follow-up costs and inefficient tools management is a possible reason for such delays. High safety regulations require periodic checks on the tools inventory, so as to prevent mechanics from accidentally leaving tools in the machine. The tools requirements in terms of operability are also high.

One solution, which contributes to the automation of tools management is the smart tool box. It identifies which tools it contains, records their condition and alerts the mechanic if incomplete or if tools have been included incorrectly. When tools are borrowed, it is always known which mechanic borrowed which tools. In addition, the system records how frequently the tools are used and uses these data to provide information about their attrition. These solutions employ RFID technology to identify tools automatically.

Source: www.vs.inf.ethz.ch/publ/papers/MKWI_Flugzeugwartung.pdf

4.3.4 Benefits observed

Ubiquitous ICTs offer a broad range of potentials to the automotive and aviation industries. This includes gains in production efficiency, protection from counterfeiting and fraud, and individualized service offerings to the customer. Some key benefits are summarized below:

- *Individualization.* User identification by the vehicle makes it possible to adjust its pre-configured settings of the seat and control elements before every journey.
- *Reduction of cycle times.* Elimination of search times through automatic identification and localization has the potential for significant cycle time reduction.
- *Monitoring of process parameters.* The automatic documentation of tasks in the production process of a car or aircraft increases the efficiency of the process control.
- *Failure reduction.* Ubiquitous ICTs reduce the influence of human error in the production and maintenance processes in the automotive and aviation industry through automatic data collection, but also, as in the case of the intelligent toolbox, through plausibility and completeness control.
- *Counterfeit protection.* High-quality aircraft and vehicle spare parts are often counterfeited and circulated in the form of low-grade copies. Ubiquitous ICTs support the recognition of such counterfeits and increase the security of the customers, as well as the protection of the corporation against unfair competition.

- *Fraud protection.* At the same time, ubiquitous ICTs provide basic technologies for an efficient theft protection that ranges from electronic immobilizer to the localization of stolen vehicles via GPS.

Box 4.6: RFID in the automotive industry

Smart ignition keys from BMW

A RFID tag is built into the ignition key of all new vehicles. The engine only starts if the correct code is read (automatic immobilizer). Even more functionality is offered by a key from BMW that stores the chassis number, customer number, seat settings, and mileage, etc. If several people use the same vehicle, personal settings are activated rapidly, thanks to individual keys. All BMW customer service centers are equipped with a reader, which means that the relevant customer and vehicle data are available immediately.

Container management for Golf-sheet metal components at Volkswagen

Special containers are employed in the process of providing sheet metal components, which are to reduce the damage of the transported sheet metal components to a minimum. These special containers are capital intensive and, furthermore, own a part specific characteristic. In the case being considered here, special containers have to pass through three production locations in Europe. In a pilot project, special containers for Golf-sheet metal components were equipped with active transponders and tracked on all three locations.

Vehicle identification at Volkswagen

Volkswagen offers its customers the opportunity to collect their finished vehicles from the factory in Wolfsburg. On average, around 35'000 cars stand ready for collection and before a car is released, various operations (e.g. quality controls, cleaning) have to be performed. Each of these operations is stored on an RFID transponder, which is located behind the vehicle windshield. The range of the transponder, which is approximately 100m, permits each car to be identified for collection when only its approximate location is known.

Engine tracking at Ford

Ford stores all the data relating to each engine on the assembly frame during engine assembly. The data are then transferred to the production planning system in real-time. Optimization can then be performed on a central server, which makes it easier to create variants on the main assembly line, thus leading to a reduction in production bottlenecks and also permitting the documentation to appear without gaps. It also provides a means of ensuring that all quality controls have been performed and that the engines cannot be mixed up.

Source: Strassner & Fleisch 2003.[41]

4.3.5 Barriers to take-up

Despite the many benefits, some hurdles stand in the way of the broader use of existing laboratory solutions and prototypes from a business, as well as a technical perspective.

One of the major obstacles to the use of smart labels in the automotive supply chain is the lack of an industrial (and retail) standard. As long as everyone has to attach tags for their own purposes, the costs will outweigh the benefits for many applications. However, if suppliers were to begin to source-tag their products and data sharing were made practical, the cost per user could be minimized. This challenge is addressed by the approach of the Auto-ID Center to RFID (see Box 3.3)

The issue of technical integration into existing systems has not yet been adequately resolved. Inter-organizational IT infrastructures (e.g. EDI-based or using SAP) already exist in the automotive industry. How ubiquitous ICT technologies can complement and improve these infrastructures has yet to be clarified.

Investments in information technology are currently being subjected to particularly tight scrutiny. In many applications bar codes seem to be sufficient, especially with industry efforts to improve bar code technologies (e.g. the 2D bar code). For many applications the price of RFID tags must be reduced.

Moreover, the drawback of RFID technologies, which are currently the dominant technology to achieve ubiquitous ICT solutions, is that RFID interferes with metallic objects; in automotive applications, many parts are made of metal. Current techniques for reading passive smart labels on metal are relatively expensive and cumbersome. However, there are some solutions based on active transponders and novel passive tag designs, which are showing promise.

Finally, the benefits and costs are distributed unequally between the members of the value chain. For most applications, source tagging will be the optimum, but the source will not usually be the main recipient of the benefits the tags hold. This issue will require the beneficiaries to find some way to compensate others in the supply chain for any additional costs that are incurred.

4.4 Pharmaceutical industry

Pharmaceuticals are followers of the retail initiative towards ubiquitous ICT. In addition to the goal of improving efficiency, pharmaceuticals are extremely safety-related products such that consumerism becomes a major driver.

4.4.1 Vision

Unit-of-use and unit-dose marking of pharmaceuticals is gaining momentum. The Bollini legislation in Italy, for example, aims to ensure unit-of-dose marking of every drug. The use of innovative technologies helps to improve visibility and traceability in the supply chain. The consumer packaged goods companies, which are now adopting ubiquitous ICTs, are setting an example for a more secure pharmaceutical supply chain. Wireless data-capture technology, to monitor the transportation of sensitive goods, is becoming popular as pharmaceuticals realize the business potential of such technologies.

Ubiquitous ICT-enabled electronic data capturing (EDC) methods improve data gathering and analysis, reduce time and costs and create real-time and accurate data trails. Electronic patient diary (EPD) applications further enhance patient compliance. The clinical trial process can turn into a commercialization platform for the development of a new generation of personalized health services for the broader medical and consumer markets. Ubiquitous ICT data gathering methods, such as innovative compliance monitors, can lead to innovations for managing and monitoring care in patient-centric environments.

4.4.2 Drivers for change

In 2002, the pharmaceutical industry generated worldwide sales of more than USD 300 billion and the pharmaceutical producers remain the most profitable of all industries among the Fortune 500 companies. However, the industry will face some major challenges in the years to come.

More than ever, it will have to cut costs and become more efficient. From the 1970s to the 1990s, the capitalized costs of the drug development process increased by 481 per cent. Nevertheless, in the years to come, drug companies face the loss of patent protection on dozens of leading drugs and will have to conduct more and more expensive clinical trials for new drugs. Ubiquitous ICTs may help them achieve the necessary savings, for example by recording and documenting results from clinical trials, or by helping to set up more efficient manufacturing processes.

Other drivers are influential organizations, such as the American Food and Drug Administrations (FDA), which is urging the industry to use RFID to fight counterfeiting; diversion and counterfeiting are growing concerns in the US market. Diversion, as a parallel trade, is widespread in Europe and can be a significant cause of lost revenues to pharmaceutical companies.

Moreover, pharmaceutical manufacturing is a highly regulated and documentation-intensive process. In the USA, the FDA publishes Good Manufacturing Practices (GMP), which define the standards by which pharmaceuticals must be manufactured. Currently, the FDA sees ubiquitous ICTs, especially RFID, as the technology of choice for making pharmaceuticals more secure.

4.4.3 Early applications

Many of the existing issues in the pharmaceutical industry relate to the collecting of data about discrete product units, be they barrels of active ingredients, pharmaceutical product inventories, finished goods, or the distribution and administration of pharmaceuticals to patients (see Table 4.3). Solutions addressing this data capturing issue have been proposed and should defuse the mounting frustration with existing processes and help to create the substantial opportunities that a breakthrough solution would present.

Two-dimensional barcodes can also address the space issue; however, as one-dimensional readers and software have not readily been converted to read two-dimensional barcodes, in many cases hardware upgrades will be required (at the manufacturer, the distributor and the hospital). The application of EPC and RFID allows automated capture of data using a method that relies much less on people to ensure its successful execution.

Table 4.3: Ubiquitous ICT functionalities and deployment scenarios in the pharmaceutical industry

Ubiquitous ICT functionality	Deployment scenarios
ID	• Counterfeit detection • Detection of mix-up medication
Localization	• Inventory management
Monitoring	• Inventory and transport chain of drugs (temperature, incidence of light, sell-by date, etc.)
Process Automation	• Throughout production and distribution

Tracking, tracing and effective checking for authenticity all become possible with modern RFID technology, supported by suitable information systems structures.

A holistic solution requires all producers, express agents, wholesalers and traders to be equipped with systems to read the RFID tags and that these are able to communicate with external data bases over the Internet. These requirements have not yet been met. However, the deficiencies of the existing approach, which is based on barcodes and traditional labeling, favour the implementation of RFID technology. The guidelines of the legislator and the recommendations of influential organizations like the FDA further accelerate the development.

Beyond that, tracking and tracing can serve as the basis for further applications in future. One noteworthy example is the continuously growing number of medicaments, which are produced in very small quantities on a "make-to-order-basis" and whose efficient distribution poses a great challenge. RFID technology also lays down the foundations for efficient and secure design of the supply chain in the pharmaceutical industry.

Source: Koh & Staake 2004.[42]

4.4.4 Benefits observed

In addition to the reasons for implementing ubiquitous ICT solution in retail, the pharmaceutical industry sees benefits connected with strict monitoring of production, discovery of counterfeits and avoiding the wrong medication being prescribed. Some key benefits are listed below:

- *Efficient store keeping.* Localization and identification functions enable more efficient inventory management, e.g. through ongoing, automated stocktaking and control of stock parameters, such as temperature, light, expiry dates or quarantine times for substances purchased or produced.
- *Storage parameters tracking (e.g. temperature, humidity, incidence of light).* Because the durability of medicaments requires their storage parameters to be observed continuously, manufacturers usually destroy goods returned after being delivered incorrectly; this is because it is no longer possible to verify the observation of all the storage parameters of these medicaments without gaps. The use of ubiquitous ICTs allows the packaging of the medicaments to be endowed with information technology that enables the complete observation and autonomous documentation of their storage parameters.
- *Facilitated evidence of proper production.* Registration authorities, in particular the US FDA, demand from pharmaceutical companies evidence that the entire production process is being carried out with state-of-the-art technology. The record of these parameters can be simplified significantly, for example through sensor networks.
- *Counterfeit discovery.* As ubiquitous ICTs to identify medicaments provide an efficient instrument in the fight against the counterfeiting of medicaments, the FDA will require all producers to implement RFID for the counterfeit protection in the years to come.

- *Customer retention.* Ubiquitous ICTs allow extended benefits, such as long-term monitoring of the chronically sick.
- *Preventing the wrong medication being administered and reducing side effects.* If medicines can be identified through ubiquitous ICTs, the danger of administering the wrong one can be reduced. Applications like the “smart pillboxes” are of particular help to patients who need to take several medicaments at the same time and according to their doctor’s instructions. Moreover, intelligent packaging can include information about the content of the medicament and the way it interacts with other medicaments. Balancing it with an electronic patient card helps to minimize the medicament’s undesirable side effects and ineffectiveness.

4.4.5 Barriers to take-up

Like the retail industries, most ubiquitous ICT solutions still exist only as lab solutions or prototypes. Powerful authorities like the FDA may enforce standardization and roll-out of these solutions. However, there remains the important hurdle of data security, as the unauthorized combination of the medicine and the patient’s data may constitute a serious violation of the patient’s privacy.

5 Impact on the telecommunication industry

Ubiquitous ICTs will have a tremendous impact on both society and business, with some of the most momentous developments already outlined in the previous chapters. This will bring about transformations in numerous sectors of the corporate world and in the telecommunication industry, this transformation is likely to be radical, since this industry is affected by changes in technology, society and business processes. This will also challenge the existing structures within established companies and constitute the basis for new opportunities and business models.

The following section provides a vision of the impact of ubiquitous ICTs on the telecommunications industry (section 5.1). Section 5.2 illustrates the convergence of ubiquitous ICTs with existing technologies, standards and enterprises. Section 5.3 provides recommendations and options for actions for established companies in the telecommunication sector.

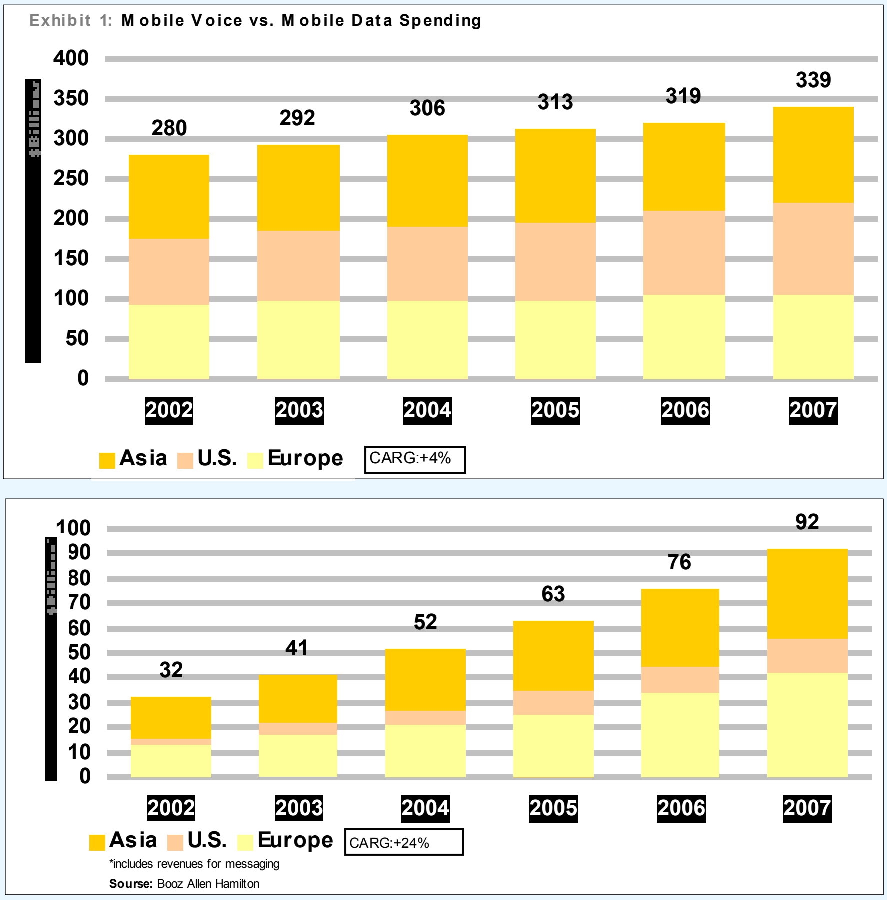
5.1 Vision

In the long term, ubiquitous ICTs will take on great economic significance. Industrial products will become “smart” because of their integrated information processing capacity, or they will take on an electronic identity that can be queried remotely, or they will be equipped with sensors for detecting their environment, so enabling innovative products and totally new services to be developed. However, ubiquitous ICTs do not only affect the industry by optimizing or reshaping production or logistics processes. Combining everyday objects with identification, localization and communication technologies will also have a significant impact on the private life of millions of people. With the decreasing costs of ubiquitous ICTs, the penetration of the technology will become more and more widespread and no doubt a large number of business opportunities will emerge within this sector.

The telecommunications industry can profit from ubiquitous ICTs by using their potential internally, i.e. by optimizing internal processes; they can also become active players by providing communication infrastructure and developing new products and services. The vision formulated here focuses clearly on the telecommunication industry as an active player in the emerging business.

With millions of smart objects communicating with each other, the income generated by data traffic will easily overtake the customer spending for voice traffic. Figure 5.1 shows a projection of both sources of income. The development has numerous implications for infrastructure providers, which are discussed in Section 5.3.1

Figure 5.1: Mobile voice vs. mobile data spending



Source: Booz Allen Hamilton.

Even more important than the increasing demand for data transfer is the use of ubiquitous ICTs as an enabling technology for new products and services. The telecommunication industry can play a prominent role in developing and offering these services. By building on existing solutions and utilizing available know-how from acquainted technologies, they can use their advantages to compete with emerging competitors. Table 5.1 shows possible applications within the retail, logistics, automotive and pharmaceutical sectors and states the possible impact on the telecommunication industry. Table 5.2 outlines the potential advantages of ubiquitous ICTs within these sectors.

Table 5.1: The impact on the telecommunications industry of hurdles existing in other industries

Hurdle	Industry				Impact on Telecommunications Industry
	Retail	Logistics	Autom.	Pharma.	
Insufficient availability and reliability	X				Provide highly available mobile networks, which support different communication standards Provide standardized services
Lack of standards	X	X	X		
High costs and uncertain ROI	X		X		
Collaboration, trust and win-win	X	X	X		
Data security	X			X	Develop mechanisms for data security in mobile networks
Technical drawbacks			X		Advise other industries how to deal with technical drawbacks Support alternative communication technologies, if necessary (e.g. Infrared)
Consumer habits	X				Provide feasible devices

Source: M-Lab.

Table 5.2: Potential for the industrial sectors examined through ubiquitous ICTs

Potential	Industry			
	Retail	Logistics	Autom.	Pharma.
Reduction of process costs	X	X	X	X
Reduction of inventory	X			X
Reduction of cycle times		X	X	
Coordination of supply chain		X	X	
Reduction of error		X	X	X
Monitoring process parameters	X	X	X	X
Fraud protection	X	X	X	
Counterfeit protection			X	X
Individualization of product and service offerings	X		X	X
Data of customers use behaviour	X			X

Source: M-Lab.

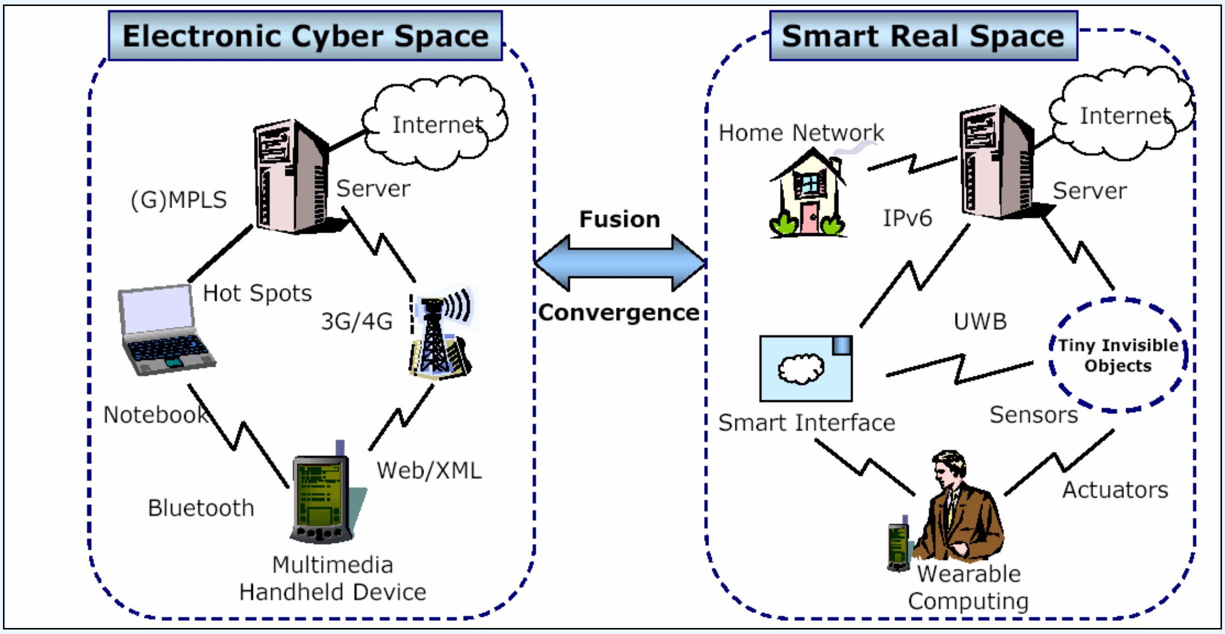
5.2 From e-everything to u-everything: fusion, convergence or resistance?

The idea behind ubiquitous ICTs is the convergence, or even fusion of real-world objects with information systeMs Figure 5.2 illustrates the interconnection of objects and systems, dividing the world in the *Electronic Cyber Space,* e.g. server, notebooks, multimedia handheld devices or base stations, and the *Smart Real Space,* e.g. wearable computing jackets, home networks and "smart" objects augmented with sensors and actuators.

Certain companies offer specialized solutions for both worlds. If the two worlds converge, some of the specialized enterprises from the *Electronic Cyber Space* will start to compete with enterprises from the *Smart Real Space* and vice versa, and companies may start to offer products that combine technologies from both realMs As an example, a company specialized on near-field sensor networks may foster an alliance with a mobile operator to augment its product portfolio with solutions capable of covering larger geographical areas.

It is a strategic decision of the established telecommunication enterprises to determine the extent to which individual organizations should enter the new markets. Companies may try to align their organization to reflect the convergence of markets and technologies, or they may resist the changes and concentrate on traditional business. As it is generally difficult to predict which tactic will prove to be the more successful, companies should, on a case by case basis, decide which solutions match their portfolio, which applications or standards should be supported and which research projects will be funded. The requirements on ubiquitous ICT solutions are as manifold as the technologies being used, and it is hard to evaluate their future market penetration. It is, therefore, particularly important to build up know-how on the emerging technologies, in order to reach reliable, substantiated decisions. Though difficult, some elementary recommendations and options for actions are summarized in Section 5.3.

Figure 5.2: Convergence of ubiquitous ICTs and the networking environment



Source: Park 2003.

5.3 Recommendations and options for action

As mentioned above, general recommendations concerning the way established companies should deal with the emerging ubiquitous ICTs cannot be made. However, to the best of our knowledge, the most promising approach is to support the fusion and convergence of the *Smart Real Space* and the *Electronic Cyber Space*, rather than to resist the change. The telecommunication industry has a good starting position in the emerging markets and can profit not only from its know-how in acquainted technologies and by providing the network infrastructure, but also by offering services, such as payment solutions. The telecommunication industry already has an established relationship with a large number of customers in similar markets and can take advantage of this. Moreover, the telecommunication industry should proactively develop applications with an added value for their customers (e.g. by combining mobile phones with Near Field Communication functionalities to request product information for items which are equipped with RFID tags), or offer consultancy services for business customers applying the new technology. The recommendations within the following subsections deal with infrastructure development and standardization, application and service development, and user equipment.

5.3.1 Infrastructure development and standardization

For the mobile communication market, analysts forecast at best moderate growth rates of language-based human-to-human-communication, but expect a high growth in mobile data transfer, as indicated in Figure 5.2. Beyond the mobile human-to-machine-communication, e.g. between a mobile phone owner and a website on the Internet, the examination of potentials and implementation scenarios of ubiquitous ICTs (see Section 4) suggests that data transfer between "smart objects" will increase dramatically. This implies that an even more extensive rise of data traffic within mobile communication networks is to be expected.

Since many ubiquitous ICT devices will be cheap, low power computers, which only transfer relatively simple information, such as position or temperature, a huge number of additional low-bandwidth channels will be utilized. Network providers should address this when designing their infrastructure.

It is likely that mobile service providers will profit more from a convergence of the *Smart Real Space* and the *Electronic Cyber Space* (see Figure 5.3) than fixed network providers, simply because many ubiquitous ICT applications will be portable or mobile and because the added value offered by interconnecting most objects will not justify the installation costs of fixed lines. For the same reason, Internet service providers may tend to find themselves in a stronger position to offer mobile services.

An example of a ubiquitous ICT application that uses existing mobile communication infrastructure is the toll collection system, Toll Collect, which is illustrated in Box 5.1.

Box 5.1: Toll Collect

Toll Collect Ltd, a joint subsidiary of DaimlerChrysler Services AG (45%), Deutsche Telekom AG (45%) and the French Cofiroute SA (10%), operates a satellite-based toll collection system for lorries on motorways, by order of the Federal Republic of Germany.

Toll Collect On-board Unit (OBU)

The system enables the automatic registration of the number of kilometers driven by combining the mobile telephone system technology (GSM) with the GPS (Global Positioning System). The core piece of the automatic recording is a vehicle-mounted device (on-board unit), which determines the position of lorries, recognizes road sections, calculates the height of the toll automatically and sends the data to the toll-collect data centre at intervals, with the help of satellite signals and other locating sensors. An alternative is manual recording through terminals or the Internet.

Toll Collect showed significant higher investment costs than toll collection systems in many other states and, because of "technical challenges" could only be put into operation after a 16-month delay. Apart from toll collection in Germany, the German Federal Government and the operator syndicate both expect further potentials of satellite-based infrastructure, e.g. through roll-out in other countries or location based services.

Sources: www.toll-collect.de; www.heise.de/tp/r4/artikel/16/16699/1.html

The decision for or against a certain communication protocol for the realization of ubiquitous ICT solutions in an economic sense will not have to be made, but for coverage, data information flow-rate, and communication costs. Customers demand coverage, not the specific service standards. For example, it does not matter to the customers whether they have access to e-mails via IMT-2000, GRPS or WLAN; the important things are reliability, speed and price. If an infrastructure provider succeeds in invisibly combining the advantages of these mobile communication standards, ranging from RFID, GPRS and IMT-2000 and WLAN, it will be able to offer its customers new services through the extended coverage. An example for services based on various communication standards is the Swisscom Unlimited Data Manger, as described in Box 5.2. Similar services can be envisaged for combinations of other standards.

Box 5.2: Swisscom Unlimited Data Manager

Swisscom Mobile provides a service called “Mobile Unlimited Data Manager”. Software and the Unlimited PC Card automatically ensure that the user always uses the fastest available network. Customers can prioritize automatic network selection, configure cooperation with e-mail clients and web browsers, set up a VPN connection to their company network and have full control over the current data volumes used; in this way they can keep track of costs at all times. The system automatically switches between Swisscom Mobile’s IMT-2000, GPRS, and Public Wireless LAN networks when the quality of the reception changes (so-called "seamless handover")

Info	• Information on connection technologies, use, updates, etc.
E-mail	• Starts the required e-mail client and connects as required.
WWW	• Starts the required web browser and connects as required.
VPN Company network	• Starts a secure connection to the company network.
Settings	• Configures Unlimited Data Manager to customer requirements.
Disconnect	• Disconnects an existing connection or sets up a connection.
UMTS WLAN	• Shows the connection strength of the available networks.

Source: www.swisscom-mobile.ch

A customer’s buying decision depends not only on the coverage and the performance of a ubiquitous ICT solution, but also – and no less importantly – on the ability of the communication infrastructure to integrate all the ubiquitous ICT applications the customer needs. This integration ability requires standardized interfaces to the applications. In a global environment, ubiquitous networks demand global standards. If the telecommunications industry succeeds in setting and supporting global standards, it simplifies and makes cheaper the use of ubiquitous networks, by offering high scale (i.e. network) effects. This is due to the cost structure of electronic services: for the most part, costs are fixed, e.g. it is not important how often a document is viewed on the Internet compared to the cost of generating the content. The costs that do arise with the attendance of an additional customer and the provision of an extra activity unit can be neglected, so that the more customers demand electronic services, the cheaper they can be supplied.[43] A set of basic services is necessary for ubiquitous ICTs, which enable the interaction of different applications in the ubiquitous ICT systems (see also paragraph 3.1.5). Telecommunication companies, as potential infrastructure providers of ubiquitous ICT solutions, are predestined to offer their customers those basic services, which almost all subscribers require.

Besides providing the infrastructure, companies can win customers through individualized, value added services, there is great potential in providing personalized information. A good example of this would include location-based services, which deliver messages about traffic jams, or recommendations for restaurants to the users depending on their location. In cases of theft, the missing vehicle, painting, or diamond can be located; the storage conditions of perishable or dangerous goods can also be kept under surveillance. To provide such services efficiently, standard services must be put in place in the rear and these must not be assembled as a personalized service package until the user receives them; for instance by processing the contents independently of the layout and then adapting the display to the user's specific device.

Another example would be billing operations, which may be made available by the telecommunication service providers. Within billing operations, the efficient charging of trifling amounts for digital services (micro payments) is a critical factor for the success of a sustainable business model. Therefore, it may prove worthwhile for telecommunications companies, as infrastructure providers, to offer third parties to take over the charging of customer for their services.

5.3.2 Handheld devices

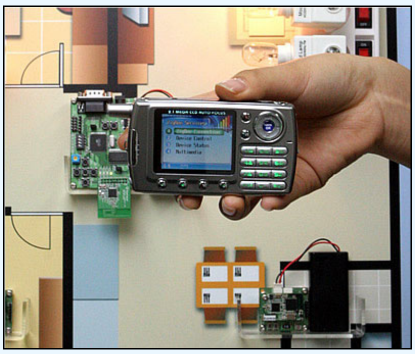
Users of ubiquitous ICTs require comfortable devices to connect to ubiquitous ICT applications and mobile phones are likely to be the device of choice for most users. Not only do mobile phones provide long-range communication capabilities, which complement near field protocols such as Bluetooth, most potential users posses a mobile phone and are already familiar with the device. What consequences can be drawn from this fact? First of all, that mobile phones, when augmented with Bluetooth, Zigbee or RFID communication features, can become extremely important for the rapid spread of ubiquitous ICTs. If the telecommunication industry wants to foster the proliferation of these technologies, it should support the development of such devices. By doing so, the telecommunications industry can create the opportunity to achieve a large share of the ubiquitous ICT market. Mobile phones are forerunners in the field of new human computer interfaces; just a few years ago, they were big, expensive, and their function limited to voice transmission. Within a relatively short period of time, all this changed and today a mobile phone offers short message services, computer games, MP3 players, digital camera and Internet access.

Moreover, in the future, the number of functions will increase. One option is to add localization features, for example by integrating GSM modules. Another is to provide mobile phones with additional short-range radio interface (e.g. Near Field Communication [NFC], such as Bluetooth, Zigbee, RFID tag and reader functionality), so that the phone becomes a personal base station or control center for various devices and "smart things". The mobile phone of the future may not even look like the present-day devices, but might be integrated into a jacket or the users' glasses, following the paradigm of the invisible, "disappearing" computer (see Section 1.2).

In the telecommunications industry, the combination of mobile phones and Near Field Communication standards offers providers the potential to position themselves – alone or with partners – as infrastructure providers of ubiquitous ICT solutions. The mobile phone becomes the enabling technology, and the development of user-friendly devices will be crucial fostering the convergence of the *Smart Real Space* and the *Electronic Cyber Space.* Some handset manufacturers have realized the potential of NFC solutions and already developed phones with integrated NFC functionality (see Box 5.3).

Box 5.3: Zigbee phone

Pantech & Curitel, the leading Korean handset manufacturer, developed the world's first Zigbee phone, although this ubiquitous device was not available for sale during its testing phase. In simple terms, the mobile phone meets cost-effective ubiquitous technology.



Zigbee technology makes it possible to control upcoming home networks, for example, which allows home/building networking services, such as controlling electrical appliances, alarming mail receiving, checking temperature and humidity and sending mobile messages to alarm in cases of trespass.

Source: www.3g.co.uk/PR/December2004/8787.htm

5.3.3 Selected public policy recommendations

The application of ubiquitous ICTs is currently the subject of enormous interest, not only from researchers and industry, but also from the media and society in general. The implementation of Radio Frequency Identification (RFID) solutions is of particular interest, as companies such as Wal-Mart and Tesco have started to use this technology, with the hope of increasing their internal operational efficiency. However, over the past few months, concerns have been raised about the possible risks of this technology, such as the impact of electromagnetic radiation on users' health and the misuse of data generated by ubiquitous ICT applications. Concerned consumers can perceive this misuse of personal data as an undesirable intrusion into the privacy of the individual. The public is extremely wary of the analysis and evaluation of individual consumer behavior and the debate has become even more heated through the actions of pressure groups such as the American Association: "Consumers Against Supermarket Privacy Invasion and Numbering" (CASPIAN).

Against the background of consumers' attitude to ubiquitous ICTs, businesses are facing questions about which means they have at their disposal to swing risk perception back in their favor. The aim must always be to explain the technology or, where this is not possible, to develop and maintain a relationship of trust, which will also help to solve the problem. The creation of trust, initiatives for information sharing and best practice, as well as the importance of international collaboration for the development of the ubiquitous vision is discussed in this section.

Creating trust

In recent years, information technology has had a significant impact on everyday life in most countries and most cultures around the world. The importance of privacy and trust concerns has also grown with the increasing use of electronic media.[44]

These concerns will grow when ubiquitous ICTs begin to reach every aspect of our daily lives. The acceptance of ubiquitous ICT solutions must be linked to trusted mechanisms that ensure privacy. In this context, privacy refers not only to consumers but also the protection of company secrets. Aimed primarily at electronic data recording and storage, the U.S. Department of Health, Education and Welfare has formulated the Code of Fair Information Practices, which defines five basic principles, each summarized in Table 5.3. These principles recommend procedures for telecommunications companies as providers of ubiquitous ICT solutions. Examples of this include the development and supply of secure ubiquitous networks through the transfer of encoded data, or the use of pseudonyms to qualify user data as soon as it is no longer necessary to allocate names to individual customers or objects.

Table 5.3: Fair information principles

Principle	Explanation
notice/awareness	Customers should be informed about the practices of a corporation before data is collected.
choice/consent	Customers should have a choice as to whether private data is collected, and if so, how it is collected.
access/participation	Customers need to have access to their data and be able to check and update them.
integrity/security	Data need to be protected against malpractices and loss.
enforcement/redress	Customers need to be able to enforce their rights.

Source: U.S. Department. of Health/Welfare 1973.[45]

Several individual composition objectives and goals can be identified at the level of immediate action:

- *Technology:* at the technological level, the aim is to expand ubiquitous ICT systems and functions to make it impossible to misuse data, or at least to make misuse extremely difficult.
- *Dialogue:* the dialogue on risk, both in the public forum and with individual customers, aims to accord credibility.

- *Rules and regulations:* these must apply to all parties, in order to determine which applications or actions are permissible in the context of the technology.

Initiatives for information sharing and best practice

The aim and purpose of marketing is not only to win, but also to retain customers. Nevertheless, in the past, the emphasis lay more on acquiring new customers rather than maintaining existing relationships. As an example, providers of financial services have moved relatively far along the path from transactions to relationship marketing. When it comes to occupying emerging ubiquitous ICT markets, trust, and with it customer relations, becomes increasingly important. Financial service providers can serve as best practice partners in establishing trust.

Against this background, initiatives for sharing information, i.e. maintaining an open dialogue with customers, plays an important role in generating and increasing confidence and credibility. Infrastructure providers for ubiquitous ICT solutions should neither indoctrinate the public nor just refuse to communicate. What is needed is constructive dialogue, stressing the advantages of ubiquitous ICTs and explaining how the risks are addressed, for example by including improved network security features or conducting audits of the data management with externally acknowledged agencies. As soon as the added value of the emerging technologies becomes apparent to the customers, their scepticism will abate.

The importance of international collaboration for the development of the ubiquitous vision

International collaboration for the development of the ubiquitous vision is important for two reasons: firstly, to ensure the interoperability of ubiquitous ICTs through international standards; and secondly by establishing rules to guarantee the privacy of the consumers. Both international standards and rules can proceed through conventional regulations and laws, or in the form of self-commitment.

As regards consumer privacy, the integration of a neutral institution carries a certain trust "bonus" when constituting and overseeing regulations. Regarding standardization, for example of communication procedures between of ubiquitous ICT devices, internationally acknowledged institutions are vital to achieving widespread, international cooperation.

6 CONCLUSIONS

Ubiquitous ICTs subsume several existing and emerging technologies. These technology trends and developments include tiny, cheap processors with integrated sensors and wireless communications ability, attaching information to everyday objects, the remote identification of objects, and the precise localization of objects. It has become clear that the technological basis for a new era has already been created: everyday objects that communicate and are in some respects "smart" will constitute the "Internet of Things". The established telecommunication industry can foster this development and profit from the emerging technologies.

With ubiquitous ICTs, which aim to integrate applications and databases with the real operational environment, information processing will now become "grounded". Sensor and actuator technology enable ubiquitous ICT-based systems to make their decisions according to fact-based, real-time data. This results in the introduction of new processes, so leading to cost savings, improvements in quality, new business models and new applications for the end users.

The successive and extensive enquiry of real-time information reduces the insecurity under which the decisions are taken. At the same time, the automatic transformation into decisions, e.g. the generation of an order out of the information system, allows more cost-efficient processes, because of the omission of routine, manual jobs. More efficient processes enable the company to provide new customer benefits and, therefore, to distinguish themselves from competitors. Because the services can be largely automated, existing services, such as parcel-tracking, can be offered profitably only to a wide customer basis. Moreover, ubiquitous ICTs upgrade "simple objects" into "smart objects," which can provide the customers with new services that, because of the missing connection between objects and information systems, could not previously have been imagined.

Applications in the retail, logistics, pharmaceutical, automotive and aviation industries show that ubiquitous ICTs have a lot of potential for businesses. These include a reduction in process costs, inventory, errors, and cycle times; the improved coordination of the supply chain; and monitoring of critical process parameters. Wherever high value goods are transshipped, counterfeit and fraud protection will play a major role.

Ubiquitous ICTs will have a tremendous impact on both society and business, with some of the most momentous developments outlined in the previous chapters. A consequence of this will be the transformation, in numerous sectors, of the corporate world. In the telecommunication industry, the transformation is likely to be radical, as this sector is always affected by changes in technology, society and business processes. This will challenge existing structures within established companies, but also constitute the basis for new opportunities and business models.

The telecommunication industry can profit from the emergence of ubiquitous ICTs: with millions of smart objects communicating with each other, the income generated by data traffic will increase. By providing a large part of the necessary infrastructure, the industry will profit from the growing demand for mobile data transfer. However, even more important is the use of ubiquitous ICTs as an enabling technology for new products and services. Similar to websites in the World Wide Web, added value for customers is generated not simply by connecting objects to the Internet, but rather by providing information and services linked to an object. The telecommunication industry can play a prominent role in developing and offering these services. Established companies can build on the existing solutions and use the available knowledge from acquainted technologies to their advantage to help them succeed in the emerging market.

And so, through its expertise in mobile communication, the telecommunications industry has the potential to become the infrastructure and service provider of ubiquitous ICT solutions. Possible options include providing access to the emerging services, providing standardized services (access to e-mail, appointments calendar, etc.), ensuring high data security through the provision of mechanisms for data security as a network provider, and advising and supporting other industries with the implementation of ubiquitous technologies.

Endnotes

1 Except for Sections 1.1 and 1.3, the introduction is based on a shortened and adapted translation of the following paper: Mattern F., (2004), "Ubiquitous Computing: Scenarios for an informatized world" (Original German title: "Ubiquitous Computing: Szenarien einer informatisierten Welt"), in Axel Zerdick, Arnold Picot, Klaus Schrape, Jean-Claude Burgelman, Roger Silverstone, Valerie Feldmann, Dominik K. Heger, Carolin Wolff (Eds.): E-Merging Media – *Kommunikation und Medienwirtschaft der Zukunft*, Springer-Verlag, pp. 155-174, 2004.

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CHAPTER IV

UBIQUITOUS NETWORK SOCIETIES:
THE CASE OF RADIO FREQUENCY IDENTIFICATION

BACKGROUND PAPER

ACKNOWLEDGEMENTS

This paper was prepared by Lara Srivastava <lara.srivastava@itu.int>, Telecom Policy Analyst, International Telecommunication Union (ITU).

The New Initiatives Project on "Ubiquitous Network Societies" is managed by Lara Srivastava <lara.srivastava@itu.int> under the direction of Tim Kelly <tim.kelly@itu.int>. Country case studies (Italy, Singapore, Japan and Korea) on ubiquitous network societies, as well as three background papers, can be found at www.itu.int/ubiquitous.

The opinions expressed in this study are those of the author and do not necessarily reflect the views of the International Telecommunication Union or its membership.

Ubiquitous Network Societies:
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UBIQUITOUS NETWORK SOCIETIES: THE CASE OF RADIO FREQUENCY IDENTIFICATION

1 INTRODUCTION

It was over a decade ago that the late Mark Weiser outlined his vision of a world in which technologies "weave themselves into the fabric of everyday life until they are indistinguishable from it".[1] Declaring that the most profound technologies are those that disappear, he heralded the dawn of the era of "ubiquitous computing".

There are examples of ubiquitous information and communication technologies (ICTs) on the market, the mobile phone being an early but important one. Technology today is becoming an afterthought in our daily activities, an integral part of them, rather than a tool that must be actively "used". Communication via email or short message service (SMS) is now taken for granted in many parts of the world. At the same time, the power of microprocessors has doubled about every eighteen months over the last three decades. The trend continues as devices with computing power become smaller, faster, and more pervasive, and communication tools more personalized and indispensable (e.g. the mobile phone or the personal digital assistant).

For information and communication access to be truly and seamlessly embedded in the environment surrounding us, however, the exponential growth of networked devices is required together with a paradigm shift in computing. This paradigm shift will mean that smart computers will become as common as the written word. Already, human beings are more often connected to a network than not, through personal computers and handheld devices, at work and at home.

But what if not only people, but also things were connected and contactable? Far from science fiction, the day is fast approaching when every consumer product (from cars to toothbrushes) will be tracked using tiny radio transmitters, or tagged with embedded hyperlinks. Such labels will ultimately transform the way that products are distributed, sold and purchased, and perhaps eventually how people are identified and how they communicate. That is the vision of technological ubiquity that technology developers, service providers, futurologists, and economists alike are positing on today. Building on "anytime and anywhere" information and communication technology, developers are now looking to enhance access in space and time, providing access for all persons and all things. Ubiquitous ICTs may thus promise ICTs "anytime, anywhere, for anyone and anything".

Delivering on this promise is currently limited by the ability to collect raw data about where things (or people) are located and about ongoing changes in their status. Radio-frequency identification (RFID) provides just such a capacity. RFID is at the core of the aptly-named "Internet of things" and is a key enabler of the ubiquitous network society. RFID refers to those technologies that use radio waves to automatically identify and track individual iteMs It may be seen to fall into the family of short-range wireless technologies, such as ZigBee and Bluetooth,[2] but with a higher capacity for tracking and computing. The present paper examines this important development. It includes a discussion of the underlying technology, its current applications, human implications, and future directions. It is one of three thematic papers presented at the New Initiatives Workshop on "Ubiquitous Network Societies" from 6-8 April 2005[3] hosted by the International Telecommunication Union in Geneva, Switzerland. Papers on "Ubiquitous network societies: Their impact on the telecommunication industry" and "Privacy implications" were also commissioned. Country-specific case studies on Italy, Singapore, Japan, and Korea were also prepared for the Workshop. All documents are available for downloading at www.itu.int/ubiquitous

2 THE TECHNOLOGY BEHIND RFID

This chapter provides a technical overview of radio frequency identification (RFID), including a discussion of standards behind the technology.

2.1 Origins of RFID

Radio frequency identification is not based upon a new idea. One can trace the origins of radio back to the discovery of electromagnetic energy, and its early understanding by Michael Faraday in the 1840s[4]. During the same century, James Clerk Maxwell formulated a theory for the propagation of electromagnetic radiation. In the early 20th century, human beings were first able to use radio waves. Soon thereafter, the 1920s saw the birth of radar. This technology detects and locates objects (position and speed) through the reflection of radio waves.

RFID is the combination of radio technology and radar. An early application of RFID emerged during World War II: the "identification of friend or foe" (IFF) programme saw the first generation of identification tags into military aircraft. But perhaps one of the first studies exploring RFID is the landmark work by Harry Stockman entitled "Communication by Means of Reflected Power"[5] in 1948.

Following the development of radio and radar, RFID techniques were explored further in the 1950s. In the late 1960s, radio frequency began to be used for the identification and monitoring of nuclear and other hazardous materials.

Work on RFID began to blossom in the 1970s and 80s when developers, inventors, companies, universities, and governments actively developed RFID applications in their laboratories. The technology underwent enhancements aimed at reducing cost and size, as well as power requirements and communication range. This set the stage for mass market RFID. In the 1999s, millions of RFID tags made their way into applications including toll roads, entry access cards and container tracking. The first mass-market deployment of RFID was in electronic toll collection (e.g. Oklahoma, United States, 1991). Since then, technical standards have emerged, together with new applications (such as RFID in athletics), and the technology is slowly becoming part of everyday life. RFID is being used as a generic term that can be used to designate the identification at a distance by radio frequencies. It has the key advantage of suffering very little from obstruction or interference.[6] Table 2.1 sets out some of the key events in RFID development.

Table 2.1: RFID development
RFID through the decades

Time period	Event
1940-1950	Radar defined and used. Major World War II development efforts. RFID invented in about 1948.
1950-1960	Early explorations of RFID technology. Laboratory experiments.
1960-1970	Development of the theory of RFID. Early field trials.
197-1980	Explosion of RFID development. Tests of RFID accelerate. Early adopter implementation of RFID.
1980-1990	Commercial RFID applications enter the mainstream.
1990-2000	Emergence of standards. RFID more widely deployed.
2000-2010	Innovative applications emerge. Combination of RFID with personal mobile services. Subcutaneous RFID emerges for animals, humans. RFID becomes part of daily life.

Source: Adapted from *Shrouds of Time: History of RFID,* AIM Publications, 2001.

2.2 How RFID works

Simply put, RFID technology may be seen as a means of identifying a person or object using electromagnetic radiation. Frequencies currently used are typically 125 kHz (low frequency), 13.56 MHz (high frequency), or 800-960 MHz (ultra high frequency). RFID enables the automated collection of product, time, place, and transaction information.

An RFID system consists of two main components:

1. A transponder to carry data (e.g. a tag), which is located on the object to be identified. This normally consists of a coupling element (such as a coil, or microwave antenna) and an electronic microchip;
2. An interrogator (or reader) to read the transmitted data (e.g. on a device that is handheld or embedded in a wall). Regardless of whether this interrogator is a read only or read/write device, it is always referred to as a "reader".

Many readers are fitted with an additional interface (i.e. middleware[7]) to enable them to forward the data received to another system, such as a personal computer or robot control system.[8] Most tags are no bigger than a grain of sand (i.e. less than 1/3 mm wide), and are typically encapsulated inside a glass or plastic module (Figure 2.1). Compared with tags, readers are larger, more expensive and power-hungry. In the most common type of system, the reader transmits a low-power radio signal to power the tag (which, like the reader, has its own antenna). The tag then selectively reflects energy/data back to the reader (which now acts are a receiver), communicating its identity and any other relevant information (Figure 2.2). Most tags are only activated when they are within the interrogation zone of the interrogator. When outside that zone, they are dormant. Information on the tag can be received and read by readers. These latter can be attached to a computer containing the relevant database. This database can in turn be connected to a company's Intranet, and/or the global Internet.

Figure 2.1: The Look of RFID
An RFID tag in the palm of your hand

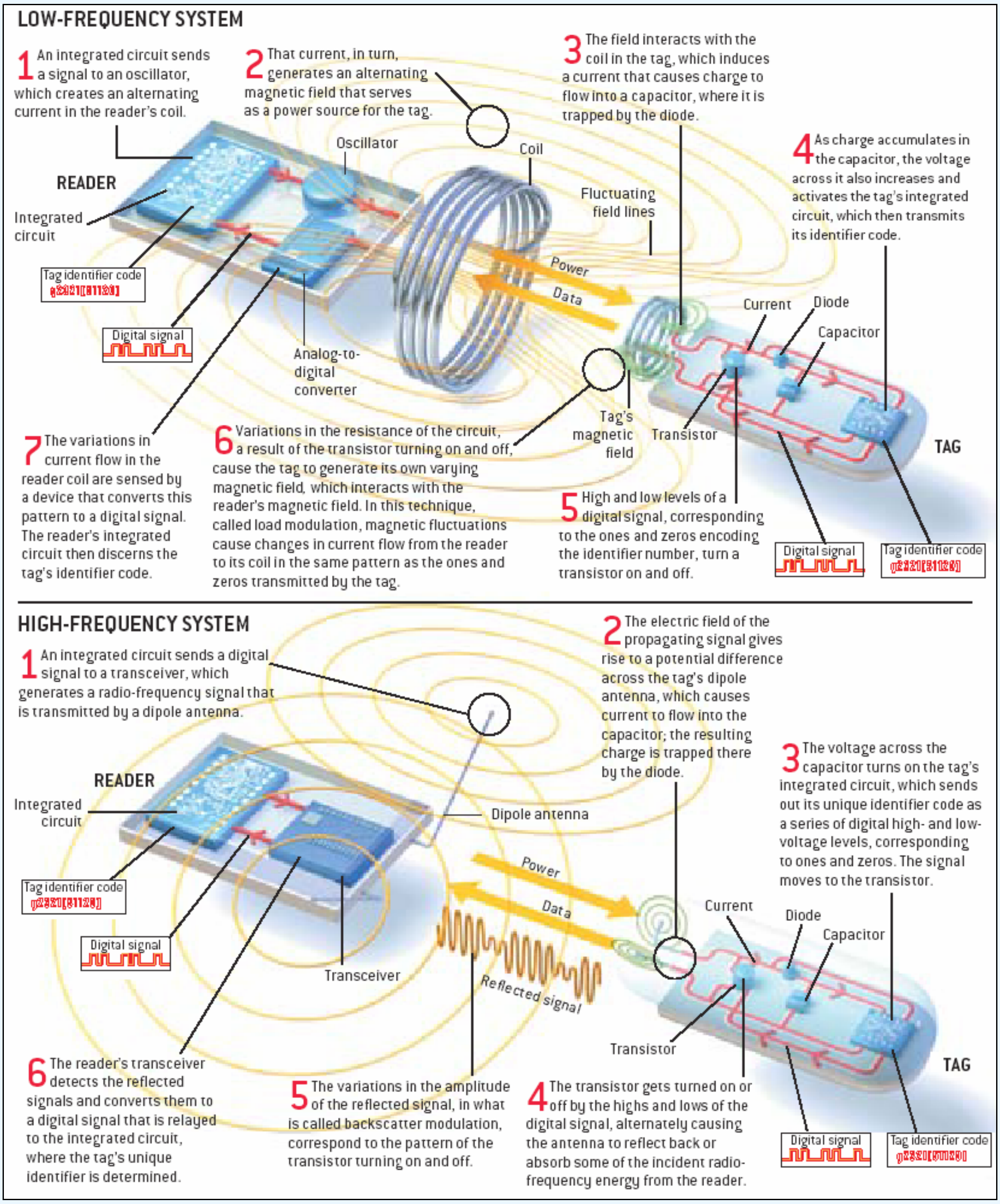
Source: ITU

Much of the recent media attention surrounding RFID use refers to the use of smart tags in consumer sales, i.e. automatic identification and data capture. This type of RFID tag has been considered by many to be the next generation of the Universal Product Code (UPC) or the traditional bar code.

RFID and the traditional bar code have some very important and fundamental differences. Firstly, traditional bar codes identify only a category of products. For instance, all Gillette Mach 3 razor blades have the same bar code. However, with RFID tags, each packet of these blades would have its own unique identifier that can be transmitted to suitably located readers for monitoring. At the moment, the Electronic Product Code (EPC) is the dominant standard for the data contained RFID tags for item-level tracking. The EPC can hold more data than a bar code, and becomes in some sense a mini database embedded in the item. Secondly, RFID allows data capture without the need for a line of sight, another significant advance over the bar code.[9] This means that the need for physical manipulation or access to individual items (often stacked or piled) is virtually eliminated for purposes of identification and tracking. This is not the case with the bar code, which must be "seen" at close range by scanners in order to be identified. Some applications limit the read range of RFID tags to between 0.15 to 0.20 metres, but the majority have a range of around a metre. Newer tags in the UHF frequency bands could even have a range of 6 to 7.5 metres.[10]

Figure 2.2: Getting underneath RFID

Schematic representation of RFID at low frequency (LF) and high frequency (HF)



Source: "RFID: A key to automating everything", *Scientific American*, January 2004.

RFID is indeed more than the next generation of bar codes. It creates a variety of interfaces that can connect computers directly to individual physical items, and even to people. One of the larger RFID networks in the world is the Joint Total Asset Visibility (JTAV) network built by the US military over the last ten years: the network uses active RFID tags and GPS locators to globally track military supplies.[11] RFID tags have the potential of containing anything from item location and pricing information to washing instructions, banking details and medical records.[12] RFID is also being embedded under the human skin for purposes of authentication, location and transaction,[13] and is under consideration as a mechanism for tracking bank notes[14] and passports.[15] These and other RFID applications are discussed in more detail in Chapter 3.

2.3 Types of RFID

RFID systems are typically classified according to the functionality of their data carrier (transponder or tag). For the most part, transponders are either active or passive. As such, they are categorized according to the power source used by the tag:[16]

1. *Passive tags*. Such tags require no power source or battery within the tag. The tag uses the energy of the radio wave to power its operation. This is the least expensive tag. Passive tag RFID systems are the prevalent types.
2. *Semi-passive tags*. Such tags rely on a battery built into the tag to achieve better performance, notably in terms of communication range. These batteries power the internal circuits of tags during communication. They are not used to generate radio waves.
3. *Active tags*. These systems use batteries for the entire operation, and can therefore generate radio waves even in the absence of an RFID reader.

Active and passive tags can be further classified according to how their data is encoded.[17] Tags can possess read-only, read/write or read/write/re-write capabilities. Tags that have read/write capability can contain additional data such as time of receipt, associated sales order (in the case of retail applications), quality control data, etc. On the other hand, read-only tags are only meant to transmit the unique identification data initially written to the tag, like a product code or serial number. Read-only tags are naturally less costly than writable tags.

2.4 International RFID

The widespread use of any technology requires technical harmonization at the international level, notably in the form of standards. The setting of standards facilitates compatibility and interoperability between technological features, data structures and specific applications.

The tremendous global potential of RFID-based applications is being hindered by the lack of established international standards. With the exception of electronic product codes, there has been a fragmented approach to the setting of standards. Eventually, the lack of standards means that organizations will be forced to incur high costs to ensure compatibility with multiple readers and tags.

There are two main types of RFID standards being developed. The first is RFID frequency and protocols for the communication of readers as well as tags and labels, which is typically being dealt with by international standard-setting bodies, such as the European Telecommunication Standards Institute. The second is the standardization of data formats placed on these tags and labels (e.g. electronic product codes).

In North America, currently the biggest regional player in RFID, there are standards such as Global Tag (GTAG), American National Standard Institute's NCITS-T6 256-1999 and some ISO standards. In the Asia-Pacific region, China has announced that it will develop its own national standard for RFID, in the 900 MHz band. If it works in collaboration with international organizations, this bodes well for the take-up of RFID in the country.[18] The European case is rather more complex, because there is less uniform use of frequencies.

In addition, as mentioned above, RFID data carriers (tags or transponders) and other associated components share spectrum with other short-range systems such as telemetry and alarMs Given this radio component, RFID needs to be in line with any applicable spectrum regulation, such as the use of licensed or unlicensed spectrum, electromagnetic compatibility, interference immunity and safety.

2.4.1 RFID and the Radio Spectrum

RFID systems can be classified on the basis of the spectrum they operate in. Although spectrum use varies depending on national regulation, governments around the world have been trying to harmonize frequency allocation for RFID. In most regions of the world, RFID systems can be used in the low frequency (LF), high frequency (HF) and ultra high frequency (UHF) parts of the spectrum.

Typical LF applications include access control, animal tracking, vehicle immobilization, healthcare applications, authentication, and point-of-sale applications. Typical HF applications include smart cards and shelves for item-level tracking, library tracking, patient monitoring, product authentication, and the tracking of airline baggage. UHF is the recommended frequency range for RFID applications related to distribution and logistics, such as the Electronic Product Code (EPC) standard mentioned earlier in this chapter. UHF bands are highly suited to supply chain RFID applications due to the greater range for transmission of data. The range bands is also widely used for toll collection systems on highways, manufacturing applications, and parking lot access control.[19]

The use of RFID in the LF (125-134 MHz) and HF (13.56 MHz) bands is harmonized across regions, whereas RFID operation in the UHF band is not. The differences in UHF operations stem from the allowance of power levels, communication speed, and shared frequency bands. The United States and Canada typically use 915 MHz, whereas Europe uses 868 MHz. Fortunately, though, most UHF RFID tags can function in both bands, with a slight hit on performance.

In the United States, RFID devices operating in the UHF bands are allowed to operate in the ISM bands (Industrial, Scientific and Medical) under conditions defined in Federal Communications Commission Part 15 rules (section 15.247). These rules define operation within the bands 902-928 MHz, 2.4-2.48 GHz, and 5.72-5.85 GHz (Super High Frequency Band). The 902-928 MHz band offers optimum range of operation and is usually preferred for supply chain applications. Part 15 compliant RFID systems typically utilize a frequency-hopping spread spectrum modulation technique in order to maximize power allowances. Part 15 compliant UHF readers can operate at a maximum transmitted power of 1 watt. This maximum can be further raised to 4 watts using a directional antenna, when the system hops across a minimum of 50 channels.[20]

Table 2.2: RFID in the Ultra High Frequency (UHF) bands
Main UHF bands used for RFID

Frequency band	Details
433.5-434.5 MHz	ISM (Industrial, Scientific and Medical) band implemented in Europe, and under consideration, by Japan and Korea. In April 2004, FCC released rules increasing the maximum signal level permitted for RFID systems operating in the 433.5-434.5 MHz band, following pressure from shipping companies.
865-868 MHz	ETSI 302-208 regulations provides additional frequency range, increasing spectrum bank from 250 kHz to 3MHz. Under old regulations, the readers were restricted to half a watt of effective radiated power (ERP), but the new regulations allow them to emit up to 2 watts ERP between 865.6 and 867.6 MHz.
869.4-869.65 MHz	There is a very small 250 kHz unlicensed spectrum allocation in Europe that could be used for RFID and other applications, at up to 0.5 watts ERP. This has been used, per performance is limited.
902-928 MHz	This is an unlicensed band available for use in North America by systems deploying spread spectrum transmission. This band would be shared with other non-RFID applications, such as some wireless LAN systeMs
918-926 MHz	This is the Australian spectrum allocation for RFID, up to 1 watt ERP.
950-956 MHz	Japan has set aside this band for RFID applications (regulations not yet finalised).
2.4 GHz (Microwave)	Unlicensed ISM band that is available in most regions in the world, by systems deploying spread spectrum transmission. This band is also used by Bluetooth systems and Wireless LAN systems (e.g. IEEE 8092.11b and 802.11g)

Source: Adapted from Auto-ID Center, 2004. RFID Journal (9 November 2004).

In Japan, RFID tracking using UHF tags was resisted for a number of years, as relevant parts of the spectrum had been allocated for mobile phones, taxi and truck communications systems, and a public wireless network for disaster prevention. Since then, however, the MIC (Ministry of Information and Communications) has opened up the 950 – 956 MHz band for RFID trials. The Standardization Administration of China (SAC) announced in 2004 that it has set up an RFID Tag Standards Working Group to develop China's national standards.

UHF is critical to the widespread adoption of RFID because it is in this frequency band that the extended read range needed to track goods in a supply chain setting is possible. The current status of UHF bands is set out in Table 2.2. With the growing importance of RFID, governments and international organizations are aiming to minimize differences between regions, and to ensure that sufficient spectrum is available for RFID applications.

2.4.2 Key international organizations for RFID development

Some of the key international organizations involved in RFID standardization and spectrum allocation are briefly presented below.

EAN.UCC

In 2000, the Global Tag (GTAG) initiative was launched by EAN International and the Uniform Code Council (UCC). GTAG is mostly deployed in the United States, and covers both UHF RFID technology (including air interface) and data formats. The air interface aspects of GTAG have now been merged with ISO 18000 Part 6.

International Organization for Standardization (ISO)

Standards for RFID have typically been adopted for specific applications, e.g. animal tracking. In May 2000, the International Organization for Standardization (ISO)[21] ratified the "Smart Label" standard. The new ISO/IEC 15693-2 specifies how data is to be passed between tags and readers and covers only the 13.56 MHz frequency. More recently, the organization is working on standards for tracking goods in the supply chain using high-frequency tags (ISO 18000-3) and ultra high-frequency tags (ISO 18000-6). For animal tracking, the ISO has adopted international standards ISO 11784 and 11785.

The three main ISO standardization areas relative to RFID are the following: identification cards and related devices, automatic identification and data capture techniques, and conformance.

Table 2.3 provides an overview of the various ISO standards in these three areas.

Table 2.3: ISO standards
Overview of ISO standards related to RFID

Identification Cards and Related Devices (JTC1/SC17)

Standard	Area	Details
ISO/IEC 10536	Identification Cards: Contactless Integrated Circuit(s) Cards	Typical range of 7-15 cm. RFID at 13.56 MHz
ISO/IEC 14443	Identification cards: Proximity Integrated Circuit(s) Cards	Typical range of 7-15 cm. RFID at 13.56 MHz
ISO/IEC 15693	Contactless Integrated Circuit(s) Cards: Vicinity Cards	Typical range of up to 1 metre. RFID at 13.56 MHz

Automatic Identification and Data Capture Technologies

Standard	Area	Details
ISO/IEC 15961	RFID for Item Management – Data Protocol: Application Interface	Defines Common functional commands and syntax features (RFID tag types, data storage formats, compression schemes), independent of transmission media and air interface protocols. Companion standard to ISO/IEC/15962

Table 2.3: ISO standards (cont'd)

ISO/IEC 15962	RFID for Item Management – Protocol: Data encoding rules and logical memory functions	Specifies interface procedures used to exchange information in an RFID system for item management. Protocols ensure correct data formatting, structure of commands, and processing of errors in the system.

Automatic Identification and Data Capture Technologies

ISO/IEC 15963	RFID for Item Management – Unique Identification of RF Tag	Specifies numbering system, registration procedure and the use of uniquely identifiable RFID tags.
ISO/IEC 18000	RFID Air Interface Standards	This series of standards provides a framework to define common communications protocols for international use of RFID, and where possible, to determine use of same protocols for different frequencies. This series deals with only air interface protocol and not concerned with data content of physical implementation of tags or readers.
ISO/IEC 18001	RFID for Item Management – Application Requirements Profiles	

Conformance

Standard	Area
ISO/IEC 18046	RF Tag and Interrogator Performance Test Methods
ISO/IEC 18047	RFID Device Conformance Test Methods

Source: Auto-ID Center, January 2004.

European Telecommunications Standards Institute (ETSI)

The European Telecommunications Standards Institute (ETSI) produces consensus-based telecommunications standards with 55 member countries. ETSI standards relevant to RFID operation in the UHF bands are defined in ETSI EN 300-220.[22] Until 2004, compared with the United States, UHF bands in Europe were limited in power, bandwidth and duty cycle. In September of that year, the ETSI Technical Committee – Electromagnetic Compatibility and Radio Spectrum Matters (ERM), delivered a two part Standard (EN-302-208) giving the industry new tools to make the best use of the available frequencies for RFID. As indicated above, the new standard expands bandwidth available for RFID applications and extends power limits[23] (Table 2.3). This will allow European RFID readers in the UHF band to perform nearly as well as UHF readers operating under the Federal Communication Commission (FCC). The data rate between the reader and the tag, however, has been reduced in the new standard. This is due to the fact that only 3 MHz of spectrum is available in Europe for RFID (compared with 26 MHz available in the United States). In order to maximize efficient spectrum use, the regulation divides this relatively narrow bandwidth into 15 channels of 200 KHz each (Figure 2.4).

The new standard was written by Task Group 34 within ETSI. In November 2004, the Group will begin its work on a code of practice for RFID applications in the UHF bands. In so doing, it will also assess the extent to which this lower data rate will pose a problem for users, and whether modifications to the standard are necessary.

Table 2.4: ETSI regulations for RFID: Then and Now
ETSI 200-220 vs. ETSI 302-208

	ETSI 300-220	ETSI 302-208
Frequency	869.4-869.65 MHz	865-868 MHz
Bandwidth	0.25 MHz	3.0 MHz
Maximum Power	0.5 watts ERP	2.0 Watts ERP
Channels	1	15
Duty Cycle	10% (6 mins/hour)	97.5% or more
Data Rate	Similar to data rate in United States	30% the data rate in the United States

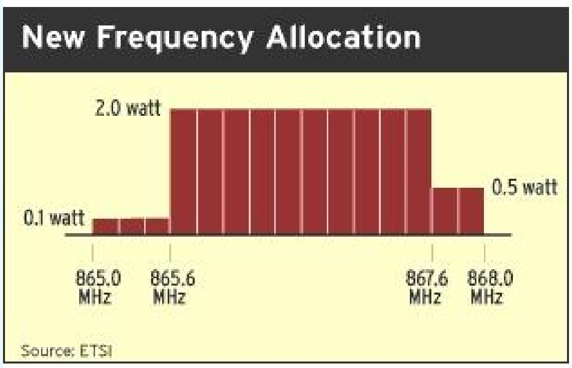
Source: RFID Journal, ETSI.

The European Radiocommunication Office (ERO)

The European Radiocommunication Office (ERO) is the permanent office that supports the Electronic Communications Committee (ECC).[24] The ECC is the telecommunications regulation committee for the European Conference of Postal and Telecommunications Administrations (CEPT), and represents 46 countries across Europe.

The main tasks of the ECC are to develop radio-communications policies and coordinate frequency allocation, in particular the 9 kHz to 275 GHz frequency range. Recommendations related to the use of short range devices (SRDs) are found in ERC Recommendation 70-03. The ERC Decision ERC/DEC(01)04 on March 12, 2001 addresses non-specific Short Range Devices, such as RFID, operating in 868.0-868.6 MHz, 868.7-869.2 MHz, 869.4-869.65 MHz, and 869.7-870.0 MHz.

Figure 2.3: ETSI's new frequency allocation for European RFID
ETSI Rules under 302-208



Source: RFID Journal, ETSI.

EPCglobal

A joint venture between the EAN International in Europe and the Uniform Code Council in the US resulted in the creation of EPCGlobal, formerly known as the Auto-ID Center. The Auto-ID Center was founded in 1999 and was headquartered at the Massachusetts Institute of Technology (MIT). Its original mandate was to define standards for UHF RFID. On 26 October 2003, the Centre was closed and its technology transferred to EPCglobal. This organization's main focus is the standardization of the data format embedded in the RFID tag or label.

EPC, or electronic product code, is simply a number, typically from 64 to 256 bits long, for the identification (and tracking) of individual iteMs This is now an internationally accepted item-level code, and replaces the traditional bar code. RFID is the favoured medium to transmit and read that number remotely, and thus EPC and RFID are complementary. The Auto-ID Center chose not to select a specific type of RFID system to be used for EPCs in order the allow maximum flexibility in the choice of frequencies. EPC has helped to significantly increase the adoption of RFID products across Europe and North America.

3 RFID IN APPLICATION

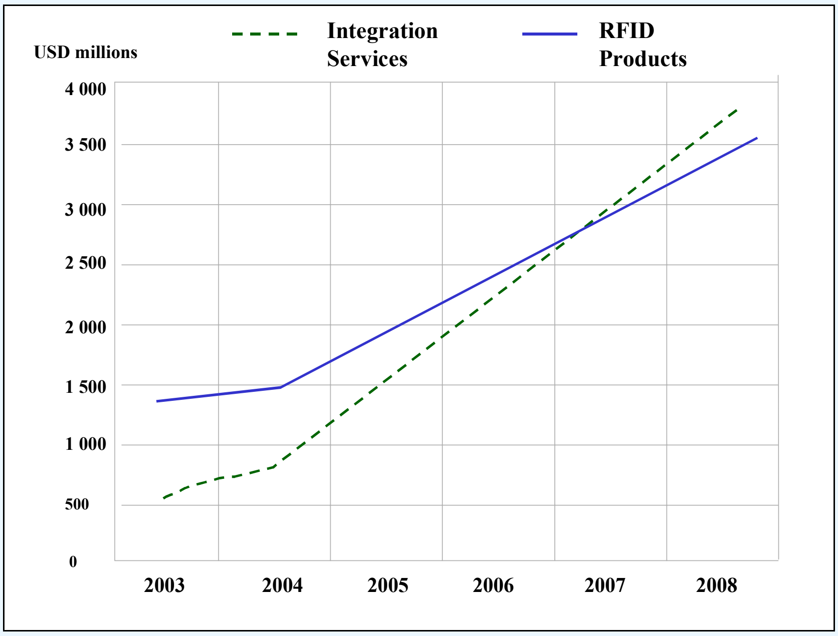
This chapter begins with a brief look at the market for RFID, before exploring different areas for RFID deployment, from government services to business and lifestyle applications.

3.1 Nascent markets

According to Venture Development Corporation (VDC), global shipments of RFID systems (hardware, software, and services) reached nearly USD 965 million in 2002. VDC expects the shipment market to reach USD 2.7 billion by 2007. In terms of the market as a whole, RFID systems reached USD 1.3 billion in 2003, and VDC expects the market to experience a compound annual growth rate (CAGR) of 43% through 2007. The firm Frost and Sullivan is slightly more optimistic with an estimated total of USD 1.7 billion for RFID systems in 2003, with predictions of USD 11.7 billion by 2010.[25] Frost and Sullivan predicts that the total RFID-based applications market will experience a compound annual growth rate of 32.2.[26] Worldwide sales of RFID integration services are expected to reach USD 2 billion in 2006 and surpass sales of RFID products in 2007 at approximately USD 2.8 billion (Figure 3.1).

Figure 3.1: Worldwide RFID sales

Sales of RFID products and integration services from 2003 to 2008



Source: OECD Information Technology Outlook 2004, citing Allied Business Intelligence.

Most analysts agree, however, that much of the growth thus far has come from traditional and established applications such as security/access control, automobile immobilization, animal tracking, and toll collection. Supply chain management applications will most likely drive the growth of RFID technology in the short term. However, emerging application segments, such as electronic product codes and item-level tracking will provide the catalyst for widespread RFID adoption across numerous vertical markets in the medium term.

The Yankee Group predicts that consumer goods manufacturers, in particular, spent an average of USD 6.9 million each on RFID in 2004.[27] Currently, RFID tags for item-level tagging cost from 40 cents to USD 10.0 each, and active tags cost between four US dollars to hundreds of dollars There are a number of different predictions with respect to the declining costs of these tags. Some analysts predict that tags will cost as little as five cents in the near future. The timeline for this is uncertain. Analysts at Gartner predict that by 2009, the most competitive RFID tags will still cost about 20 cents. Some of the big players pushing for RFID development are Texas Instruments,[28] Alien Technology,[29] Philips Semiconductors,[30] Hitachi[31] and Matrics (now Symbol Technologies).[32]

3.2 Business applications

This section describes some of the key business applications that use RFID, such as transport, logistics, access control, supply-chain management, manufacturing, agriculture and health care.

3.2.1 Transport and logistics

One of the most promising areas for the application of RFID is public transport. RFID was first deployed for collecting fares on toll highways. Public transport companies are continuing to suffer losses due to the time-consuming and expensive sale of travel passes and tickets through automatic dispensers or in vehicles. Electronic fare management systems using RFID have been fairly successful in reducing overhead for transport companies and in facilitating travel for commuters. Typically, such systems use contactless smart cards, which last for about 10 years and are not easily damaged by liquid, dust or temperature fluctuations. In Europe, the Parisian mass transit authority, RATP, one of the most advanced networks in the world, uses RFID-based automated fare collection technology. The mass transit system in Seattle (United States) uses an Philips RFID contactless smart card for fare collection. In 2004, Transport for London (TfL) announced plans to spend up USD 65.3 million on new digital enforcement technologies for the Congestion Charging Scheme (CCS) for vehicles, which will most likely include radio frequency identification (RFID) tags for the identification of number plates.[33] But the Asia-Pacific region remains a leader in this field. The Korea “bus card” based on RFID has been around since 1997. Thailand’s Bangkok subway uses RFID contactless round token system for individual trips as well as a contactless card system (i.e. one which does not require the contact with a reading machine) for regular travellers. In Tokyo, even taxi drivers have begun using RFID to facilitate their operations. A trial of the payment system was launched in October 2004, and consists of a mobile phone with an embedded chip that stores an allocated amount of funds already charged to the phone owner’s credit card from JCB International (Box 3.1).

In addition to the transport of people, RFID is being used increasingly in the transport and delivery of parcels and postal iteMs RFID enables improved item tracking during the sorting of mail and delivery processes. More importantly, the technology does not require line of sight to assess an item and to track its location, or to transfer information. This will allow a great number of individual letters or parcels to be routed without physical manipulation.

Airlines are actively exploring the possibility of integrating RFID in baggage tags, in order to enhance the efficiency of systems employed to track customer baggage. One of the busiest airports in the world, Hong Kong International Airport (where passengers number some 35 million annually) announced in May 2004 that it would deploy RFID reader infrastructure across its extensive baggage handling facilities. At various nodes within the airport, including baggage carousels, unit load devices (ULDs) and conveyors, reader systems will have the capabilities to read and write to RFID tags that will be applied to passenger luggage. RFID-enabled handheld readers will also be used for handling luggage “on the move”.[34]

Box 3.1: Radio that cab fare
Taxis, mobile phones and RFID in Tokyo

Tokyo-area taxi drivers are exploring the possibility of being paid via RFID and mobile phones. Japan-based credit card company JCB International started a trial of the payment system (QUICPay or "Quick and Useful IC Payment") in November 2004.

Selected taxi drivers were given RFID readers, which can read a passenger's mobile phone chip, determine the fund balance remaining, and deduct the requisite amount. All mobile phones used in the trail will be compatible with NTT DoCoMo's mobile wallet handsets. These are equipped with the FeliCa chip from Sony, which uses Near Field Communication (NFC) passive RFID technology.

Source: Japan Corporate News and RFID Journal, October 2004.

3.2.2 Security and access control

RFID technology is increasingly being deployed to control access to restricted areas, and to enhance security in areas such as laboratories, schools, and airports. Many employee identification cards already use RFID technology to allow staff to enter and exit office buildings. The security programme of the Canadian Air Transport Authority (CATSA), for instance, uses smart cards equipped with RFID first deployed in March 2004. These contactless cards and readers offer physical access control enhanced by biometric authentication to restricted areas.

Educational institutions are also exploring the advantages of RFID for monitoring student populations. In China, in November 2003, RFID deployment began in an attempt to prevent fraud. China's Ministry of Railways and Ministry of Education were facing problems in authenticating genuine student cards, in particular for the purpose of checking eligibility for travel discounts. 10 million smart labels and microchips were delivered to China's Ministry of Education in 2003. Each chip can hold up to 2 kilobytes of data, and can be read at a distance of 1.5 metres. The chip presently stores the student's identification data and in the future will include all diplomas and degree information. Libraries are also using the chip to facilitate check out and to control the lending of books. Information on the tag is kept secure through the use of cryptography and includes tamper safeguards.[35]

The Rikkyo Primary School in Tokyo (Japan) has taken RFID a step further. In September 2004, the school carried out a trial of active RFID tags in order to monitor the comings and goings of its students in real-time. The system records the exact time a student enters or leaves the campus, and restricts entry to school grounds. Since the tags can be read by scanners from a distance of up to 10 meters, they don't require students to stop at designated checkpoints (Box 3.2). The Asia-Pacific region is a leader in this field, but now schools in North America have begun following suit. One example is the Enterprise Charter School in Buffalo (New York), which deployed an RFID smart label system from Texas Instruments in 2003. This system, in addition to exercising control over access to the school campus, is also being used to identify and secure assets such as library books and laptop computers. The ID cards enable students and staff to make selected purchases at the cafeteria.[36]

3.2.3 Supply-chain management

RFID represents one of the most significant advances in supply-chain management since the first bar code was scanned in 1974. Coupled with wireless systems and intelligent software, RFID has the potential to further revolutionize the supply chain.[37] Already, supermarkets are tagging pallets, cases, and other returnable transit containers such as plastic crates used for fresh foods. Tagging these items permits transparent and total visibility of assets and inventory. The ability to write to the RFID tag also allows the entry and management of information such as contents, expiry date, manufacturer and country of origin. In this manner, RFID enhances the accuracy of shipments and deliveries. In addition, it can address what is known as "product shrinkage" or product theft. The majority of this loss occurs between the manufacturer's front door and the retailer's back office. Electronic product codes transmitted through RFID can determine product arrival and departure at all points of the supply chain, thereby pinpointing the location where a given product was last reported seen. RFID can be used in the tourism and hospitality industries, for instance, to manage uniforms for their staff (Box 3.3).

Box 3.2: RFID – The student's new hall monitor?
Real-time tracking of students at Tokyo's Rikkyo Primary School

At Rikkyo Primary School in Tokyo, full roll-out of an RFID tracking system is set for April 2005. All students and authorized staff are given active RFID tags, which can be attached to book bags or other personal iteMs This allows for the real-time monitoring of students, thereby ensuring their safety and thwarting truancy.

The main features of the system are as follows:

1. Individual Recognition via active RFID tags: The system automatically and instantaneously records the comings and goings of multiple individuals passing by the many scanners, at a distance of up to 10 meters.
2. Unobtrusive Monitoring of School Entry or Exit: Due to the 10-meter read range, students and teachers need not stop at security checkpoints or specialized gateways.
3. Detection of unauthorized entry: Unauthorized entry is detected by this system through RFID tags and infrared sensors.
4. Privacy and Data Security: The active RFID tags carry no individually identifying information, but only a number code. Thus, no personal information can be obtained from the tags should they be lost or stolen.
5. E-mail notification: The RFID system can send an e-mail notification to parents or guardians when their child enters and leaves the campus.
6. Dedicate Website for Confirmation of School Arrival/Departure: Teachers and staff can verify the arrival and departure of all the children at the school via a dedicated and secure web site, which shows both active RFID tag timestamps and security camera imagery. Parents and guardians also have secure access to this site to check information about their own children.
7. Urgent E-mail Network: The system supports an e-mail based urgent contact network feature, for providing important informaiotn to the school community on a timely basis. This can be used, for example, in the case of a public safety warning due to accidents or weather-related incidents.

Source: Fujitsu, September 2004.

Box 3.3: RFID in the closet
Tracking uniforms

Open 24 hours a day, Star City Casino in Sydney (Australia) manages a wardrobe inventory of 80'000 uniforms valued at some 1.8 million USD. Its guest rooms, health clubs, gaming floor, nightclub, sports facilities, etc., each require staff to dress in themed garments. A solution for managing the complex laundry procedures in such an establishment was needed.

RFID provided just such a solution. As early as 1997, RFID tags were embedded in each uniform (e.g. in the waistband, shirttail or collar), enabling their tracking from the point of issue to the laundry chute, from the laundry cart to the laundry machines, using strategically-placed RFID readers. Unlike the traditional barcode, which typically has to be replaced every one or two years, RFID chips usually outlast the associated garment itself (i.e. chips can endure over five years).

RFID readers and tags render inventory management more accurate. Tracking through RFID ensures that the right uniforms are ready to wear every time there is a change in shifts. All of the above has meant significant cost savings for the Casino.

Source: Accenture, Technology Labs.

RFID is seen by many businesses as a key method to streamline business processes and cut costs. Procter and Gamble, one of the earliest adopters of this technology, expects to increase after-tax profits by USD 150 million and to realize a working capital increase of USD 1 billion through the adoption of RFID.[38]

3.2.4 Medical and pharmaceutical applications

An important application of RFID is in the medical and pharmaceutical fields. In hospitals, RFID enables a fully automated solution for information delivery at the patient bedside, thus reducing the potential for human error and increasing efficiency. When used in combination with secure wireless networks, such as Wireless LANs, tags embedded in medication or on patient bracelets can provide fast electronic access to patient records and other information. Key examples of RFID use in health care include:

- *Point-of-care data delivery*: Staff badges, medication packaging and patients' identity bracelets contain RFID technology. This facilitates identification of a patient by caregivers, who are thus able to submit orders in real-time at the very point of care, instead of being handwritten and sent off for future input. This system saves time, and reduces the chances of human error. Any changes in medication can be updated immediately, and any contra-indications automatically cross-checked. In addition, diagnostic codes can be verified upon admission, thereby ensuring timely and accurate patient billing.
- *Patient location*: Tracking the location of patients is particularly important in cases of long-term care, mentally challenged patients, and newborns. But its benefits are even more widespread. The ability to determine the location of a patient within a hospital can facilitate and expedite the delivery of health care. For instance, when a patient arrives in a lab for a radiology exam, medical staff is instantly alerted via the RFID tag, and the transfer of records can be effected immediately. The development of RFID technology for tracking patients received a boost in October 2004, when the United States' Food and Drug Administration (FDA) approved subcutaneous RFID implants for patients.[39]
- *Asset tracking and locating*: Tracking medical staff as well as medical equipment can ensure an efficient response to medical problems and emergencies. This also optimises inventory management, saving unnecessary purchasing costs.[40]

Box 3.4: RFID to combat counterfeit drugs

Pilot project "Jumpstart" at pharmaceutical distribution centres in the United States

By using RFID tags on bottles of medication destined for pharmacies and drug stores, the pharmaceutical industry hopes to better detect counterfeit drugs, as these do not typically travel through the usual supply chains. In July 2004, a group of manufacturers, including Abbott Laboratories, Johnson & Johnson, Pfizer, and Procter & Gamble, began shipping bottles of pills with RFID labels. McKesson Corp. and Cardinal Health are the participating distributors.

In addition to tracking fake drugs, tagged bottles can serve to prevent theft, as well as to manage recalled and outdated medication.

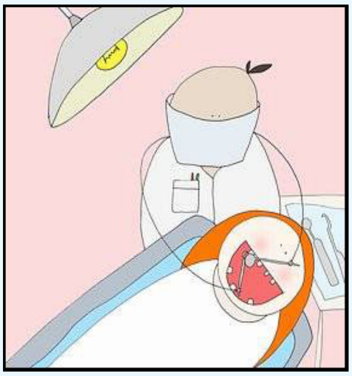
As pharmacies receive medication through specific distribution centres, bottles would be tagged reflecting their point of origin. Alarms could thus be raised when an incomplete or inaccurate set of locations were found on a tag.

In early 2004, the USA's Food and Drug Administration issued a report recommending that pharmaceutical companies use RFID on bottles of the most commonly counterfeited drugs starting in 2006 and on bottles of most drugs by 2007.

Source: Information Week, 26 July 2004, at www.informationweek.com/showArticle.jhtml?articleID=25600213

For instance, a number of pilot studies are under way to determine how RFID can improve the accuracy of the delivery of blood supplies of the appropriate blood group to patients, compared to the current bar-code method. RFID offers the distinct advantage of enabling the accurate matching of blood samples/transfusions to the correct patient, through non line-of-sight data transmission, which can be effected through and around the human body, clothing, bed coverings and non-metallic materials.[41]

Box 3.5: Sink your teeth into RFID
Using RFID to manufacture dental prosthetics



The French company Dentalax has launched an RFID-based system for the manufacturing of crowns and bridges for the dental industry.

A dentist typically makes an initial cast of a patient's teeth, which is sent to a dental laboratory. The lab uses the initial cast to make a second cast, which is then used to manufacture the bridge or crown. In the Dentalax system, an RFID tag or chip is embedded into the second cast before it hardens. The tag is thus locked into the dental prosthesis, recording every action or procedure on the prosthesis. The identity of the cast can also easily be checked using an RFID reader, ensuring that it reaches the correct recipient. Before the prosthesis is delivered to the dentist, the lab retrieves the data on the RFID tag, and saves it on a smart card that can be delivered to the patient. Such cards may be made available to succeeding practitioners as required.

The Dentalax RFID package is currently priced at 380 Euros, and is made up of 100 PicPass chips, the requisite software and one reader. Individual readers are priced at 290 Euros, and a pack of 100 chips costs 100 Euros.

Source: RFID Journal, 25 October 2004.

In sum, the advantages of RFID deployment in-patient care lie in enhancing patient safety and optimising hospital workflow. Its use is equally pivotal in the pharmaceutical industry, where electronic product tags on medication can curtail counterfeiting (Box 3.4), streamline revenue distribution, reduce prescription errors, and decrease returns. RFID can also assist in the manufacture of medical prosthetics, such as dentures or crowns (Box 3.5). Finally, tracking medical waste materials as they are moved for disposal may also prove to be an important application of RFID: IBM and Japan's Kureha Environmental Engineering are currently testing waste containers equipped with RFID tags.[42] The University of California is even considering embedding RFID in cadavers to thwart the sale of body parts on the black market, and to ensure that bodies donated to science are treated with respect.[43] The use of RFID would allow authorized individuals walking past the body with a handheld device to readily identify the cadavers, or locate individual body parts that had become separated from the corpse.

3.2.5 Manufacturing and processing

Manufacturing and processing is increasingly relying on computer-controlled mechanisms and information technology. RFID tags, coupled in some cases with sensors and actuators, can enhance accuracy and overall efficiency in factories and labs. For instance, the use of RFID can speed up the assembly line for the manufacture of golf cars (Box 3.6). For products that are sensitive to time or external conditions, RFID enables tracking and monitoring: for instance, in the case of selected health and beauty products (Box 3.7).

3.2.6 Agriculture

Agricultural applications for RFID, from wineries to meat packers, have been emerging over the last couple of years. A good example is the RFID trial launched in November 2004 to track containers of frozen beef from Namibia to the United Kingdom. The goal of such a system is to track shipments, for the purpose of ensuring the quality of the meat.[44] RFID tags included with the shipments will be able to detect and record where a container's seal has been tampered or broken during its journey, and when a particular shipment has been static in excess of a pre-determined length of time.

Box 3.6: RFID eases production of golf cars

Assembly line RFID

Golf car manufacturer Club Car streamlined its assembly process through the use of RFID. Introduced in 1999, RFID has since cut the time required to assemble each vehicle from 88 minutes to about 46 minutes.

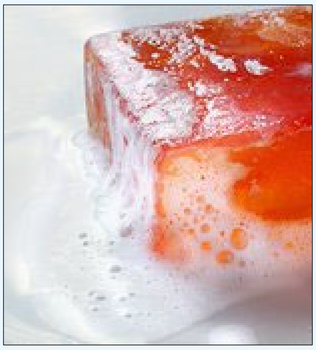
Under the old system, workers used a handheld reader to scan the bar code label on the vehicles for tracking purposes. These were manually pushed between workstations. The new system uses a single production line that moves vehicles automatically, and uses RFID to define and verify the assembly process at each stage.

When a new vehicle is complete, the RFID tag is read and all accessories and specifications are checked automatically against a list of production requirements.

Source: RFID Journal.

Box 3.7: Tag that soap

Canadian soap maker looks to RFID



Canada's Canus manufactures skin care products manufactured from goat's milk. In April 2004, the company began a pilot scheme to deploy RFID in its three distribution centres and two manufacturing plants. The main objective was to streamline operations and reduce waste. RFID is meant to save the company resources, as the tags can check the status of shipments and deliveries and determine the exact location of a shipment while in transit.

In the future, Canus plans to extend the RFID system to enable real-time monitoring of its products and their associated processes. The bulk of its fragrances, which are made from goat's milk, must be maintained at temperatures ranging from 4 to 40 degrees fahrenheit. RFID tracking coupled with monitoring can determine the point at which the products transgressed pre-set limits (e.g. temperature, expiry date, etc.).

Source: Canus.

The use of RFID tags in greenhouses can offer a great improvement over traditional bar codes. The latter need to be clean and dry to be read by a scanner. RFID tags, on the other hand, are protected from water or dirt and can be read at a faster rate. RFID sensors with antennae mounted upon benches and located within greenhouses can be used by plant-growers for purposes of tracking production and developing accurate inventory.[45]

Farming is an area ripe for RFID implementation (Box 3.8), and a number of farms in the United States have begun using RFID to help track their produce. For instance, "Global Berry Farms" in the state of Michigan has started a trial of RFID tags on its crates of blueberries, and is working with other interested companies, from pharmaceuticals to educational institutions, to further test its systems.[46]

3.3 Government applications

It is not only private industry that is using RFID to streamline business processes. National governments, too, have begun exploring the potential benefits of this technology, particularly in the current climate of political uncertainty and international terrorism. This section describes a few pioneering governmental applications for RFID.

Box 3.8: Tag farming
RFID for efficient farming

Paramount farms processes about 60 percent of the US (United States) crop of pistachios, and it exports to more than 20 countries. It now uses an RFID system to automate and streamline a core business operation, processing the incoming shipments of pistachios from its many partners (50 per cent of the pistachios it processes come from approximately 400 partners). Only a narrow period of time can be allocated to processing, e.g. six weeks, given the perishable nature of the produce. And in order that the company's partners are paid for their shipments fairly, the company must be able to accurately calculate and account for those nuts that are acceptable for consumption.

The farms' automated processing capabilities are based on a new GRS, or grower receiving system, which uses Microsoft technology and RFID. Upon receipt of a shipment, this receiving system weighs the trailers that are filled with nuts, and then each full trailer is tagged. Inside the "scale house", there are a number of RFID readers. The tags used are 915 MHz and passive. The unique ID number of each trailer records such information as weight, license plate number, and owner information for later retrieval from the GRS database. This has, *inter alia*, reduced potential disagreements between Paramount and its partners.

Before the introduction of RFID, a Paramount employee would have had to manually check a stencilled number on the side of each trailer as it entered the scale house, and then write down the trailer number. This left the system open to human error and inaccuracies. Information about product delivery and status is also more readily available to managers through the GRS database (as well as handheld scanners), thereby allowing more informed decision-making.

Source: RFID Journal.

3.3.1 E-government

Many public sector authorities are considering RFID to make e-government services more flexible, efficient and secure. In the United States, for instance, the inclusion of RFID tags on driver's licenses is under debate. The main objective of such tags would be to help thwart fraud: the downside, as, many privacy advocates argue, is that such remotely readable tags will make it easier for government agencies to spy on citizens and increase the possibility of "identity theft". Virginia, in the United States, is one of the first states to consider the use of RFID in drivers' licenses. These may in the future employ a combination of RFID and biometric data (e.g. fingerprints).[47] In February 2005, the United States House of Representatives approved a measure that would compel states to design their driver's licenses by 2008 to comply with federal antiterrorist standards.[48]

RFID enables the so-called "Internet of things", which may be further extended to the tracking of human beings. The United States' Food and Drug Administration has already approved implantable RIFD chips for people (see Section 5.1). The concern among ordinary citizens and privacy advocates vis-à-vis this development is undeniable, as hoax stories such as a U.S. government plan to implant all homeless people with RFID tags have been widely circulated over the Internet.[49]

In Europe, there has been increasing press coverage since 2001 on the possibility of embedding RFID on Euro bank notes, in order to thwart counterfeit, fraud, and money laundering. The European Central Bank has been in discussion with various technology partners such as Philips Semiconductors, Infineon, and Hitachi on projects to tag European currency.[50]

3.3.2 Defence and security

RFID offers significant potential for governments wishing to fortify their national defence and security systems, particularly in a climate plagued with increased international terrorism. Border crossings offer a good example. The border between the special administrative region of Hong Kong and Schenzhen (China) is highly regulated and is a case in point: since 2002, China's Schenzen authorities have installed an RFID system to facilitate the flow of low-risk traffic and goods across that border, and to thwart smuggling.

As already observed, the use of RFID can go further still, affecting the lives of individual citizens. Following the events of 11 September 2001, the United States has already mandated that all American passports contain biometric data, such as fingerprints. This requirement has been extended to apply to nationals from those countries not requiring a visa for travel to the United States. More recently, the government has advocated the use of RFID in combination with biometric data on passports. This measure has raised concerns among some technologists and civil libertarians. They fear that information on such chips can be read remotely, thus enabling a person's biographical information and photo to fall into the wrong hands.[51]

3.3.3 Library systems

RFID is increasingly being deployed in libraries to automate the loan and return of library materials through real-time visibility of inventory. These were traditionally identified using bar code labels that had to be read individually with bar code readers. With RFID, libraries can check in and out materials using scanners (placed on shelves or in hand-held devices), thereby resulting in the reduction of personnel, a higher degree of accuracy in inventory management, and fewer losses. The Vatican City Library has opted for RFID to manage its collection (See Box 3.9).

Box 3.9: Tagging the ancient
Vatican Library deploys RFID

The Vatican Library, containing a 40-million piece collection of books and manuscripts, began deploying RFID in 2003. About 30'000 books were tagged as of October 2004. It is likely that an additional two million pieces will be tagged.

RFID was chosen due to its low cost and for the fact that it did not damage the collection, which includes ancient manuscripts and the oldest known complete version of the Bible.

Source: CNN.Com, 14 October 2004.

In the Netherlands, publishing companies are getting into the business: NBD Biblion, which sells 2.7 million books to Dutch libraries annually (i.e. 80% of the national market), began tagging all of its books in September 2004.[52] In Tokyo, the Roppongi Hills Library has been tagging its books since 2003.[53]

3.4 Consumer applications

Though they may not always be aware of it, individual consumers have been exposed to RFID in action: on toll roads, in offices, and in libraries (as discussed above). Over the next few years, these small tags will be increasingly used to add further convenience to day-to-day living, from sports events to retail shopping. This section describes some interesting current applications of RFID and their future potential.

3.4.1 Personal welfare and safety

RFID applications for the medical industry (e.g. hospitals) mentioned in Section 3.2.4 above are set to address current lacunae in patient treatment and welfare. But as tags are location-sensitive, they can also be used to enhance personal safety in general. In this context, not only have schools begun deploying RFID to keep track of pupils, but public leisure parks such as Legoland in Denmark (Box 3.10) are using the technology to attract families concerned for the personal safety of their children and elderly relatives. Large shopping malls and department stores may not be far behind, particularly as many have begun using RFID readers and tags for tracking inventory.

Box 3.10: LEGO of my RFID!
RFID helps parents keep a tab on their kids

When it opened in March 2004, the Legoland amusement park in Billund, Denmark, launched a child-tracking system based on RFID and wireless LAN.

Parents can choose to rent RFID-enabled wristbands from the park's administration for the purpose of keeping a check on their children's whereabouts.

Parents and guardians wishing to locate separated or missing children can use their mobile phone to send a text message to an application known as "kidspotter". The application rapidly returns a text message stating the details of the child's last location, such as coordinates, name of park area, etc.

Source: Network World, 3 May 2004, Vol. 21, Issue 18.
See also www.lego.com/legoland/billund/Default.asp?locale=2057&bhcp=1

3.4.2 Sports and leisure

In the sporting world, RFID tags have been used in marathons to track runners, allowing both participants and spectators to benefit from the combination of mobile SMS and RFID (Box 3.11). RFID technology has been used to determine with remarkable accuracy the winner in an Indy 500 car race (Box 3.12) by tracking cars as they pass the finish line.

Hands-free access systems using RFID for ski lifts have been introduced since the last 1990s. For instance, in 1999, Texas Instruments together with the Austrian company TeamAxess deployed an RFID system for access to ski lifts and slopes in Europe. Remote-operated gates equipped with readers can detect a valid ski pass and open automatically, thus leading to shorter line-ups and more efficient customer processing. The credit-card sized RFID-enabled ski pass can easily fit into a jacket pocket, and is scanned in place, thus obviating the need for manipulation.[54] The passes can also be used to locate skiers (e.g. in cases of injury, or for the location of children).

RFID can also assist in preventing theft of property, particularly in relation to travel or leisure activities. In Germany, for example, Philips Semiconductors introduced an RFID labelling system to protect recreational boats (of which there are 660'000 in the country) from theft by providing secure electronic identification. In the past, boats were simply identified by painting numbers on them. This system of identification suffered the considerable disadvantage of fraudulent removal or modification. Since RFID tags allow the identity of a boat to be determined remotely, German authorities can check the status of a boat against their databases of stolen and registered boats, without the need for a search warrant. The RFID labels are thin and waterproof, and can be read at a distance of up to 60 centimetres, even through materials such as wood or fibreglass. Plans to extend the current system to other forms of high value property such as trailers, caravans and bicycles are being actively considered.[55]

In the travel and hospitality industries, RFID tags are enhancing and facilitating customer service. Manchester City Football Club in the United Kingdom was the first football club in Europe to adopt RFID, thereby giving fans ticket-less access to football grounds and significantly reducing the time it takes spectators to enter the grounds.[56]

Box 3.11: High-speed RFID
RFID tracks runners in marathons

Marathon organizers in such cities as Boston, London, New York, Berlin, Los Angeles, and Capetown are bringing high-tech communications to participants as they run the course.

For example, all of the official entrants in the 2004 Boston Marathon were issued with the "ChampionChip", a small token that is either tied onto the runner's shoe or attached to a wheelchair. These chips time the runners at various points throughout the race, including the starting line. As a runner crosses stationary mats located throughout the race, his/her time is recorded.

The chips contain RFID tags that transmit the runner's time at the checkpoints to databases operated by the Boston Athletic Association and its technology partners (Hewlett-Packard and Verizon Wireless).

Some 33,000 runners competed in the London marathon on 18 April. Participants could have their positions tracked and recorded by electronic tags attached their shoes. Friends and family of competitors were able to follow their progress by signing up to an SMS text message service that will send athletes' positions as they make their way around the course. Special mats were positioned every 5 km along the marathon course. When an athlete ran over the mat, their time and position was sent to an Oracle database. Running over special mats with receivers would send a message to those who signed up to receive the alerts.

Source: ITU Internet Reports 2004 "The Portable Internet", www.itu.int/portableinternet

Box 3.12: Racing forward with RFID
Indy 500 and active tags

An RFID system by the name of "Tranx Pro", developed in the Netherlands, is being used for automatic identification and tracking by a number of sports organizations across the world, from car racing to athletics. In the case of the Indy 500 in May 2004, tags embedded in the cars and in the antennas in the asphalt turn the 2.5-mile racetrack into a giant stopwatch that measures the time-gap of successive cars crossing a given point to an accuracy of 10'000th of a second. RFID provides for speeds of up to 200 miles per hour, and with 33 cars completing a lap every 40 seconds.

RFID transponders measuring approximately two square inches in area and one inch thick, are typically installed in the same location on each car, 33 inches from the front and 12 inches above the asphalt. A detection loop installed in the track's surface at the start/finish line picks up the unique ID code of each vehicle as it crosses the line.

Source: RFID Journal, 31 May 2004.

3.4.3 Shopping and dining out

Wal-Mart was the first to deploy item-based tagging using RFID for the purposes of streamlining their supply chain. Other major stores such as Tesco (UK), Metro AG (Germany), Home Depot (United States), and Mitsukoshi (Japan) are among the growing list of large retailers joining this new method of tagging products. This section looks at RFID in the retail world from the consumer perspective.

Clearly, the advantage to customers of a retail store deploying RFID is a speedier checkout. If every item in a consumer's shopping basket is tagged and the necessary reader is suitably installed, there should no longer be any need to lay the items on the belt and manually scan each one for purposes of determining the final bill. Eventually, when users will also be equipped with contactless payment cards, the onerous and dilatory checkout procedure could be eliminated. All items in the shopping cart would be automatically debited from the consumer's account upon exiting the store. Early contactless payment solutions using RFID are already being deployed around the globe, for instance for ticketing applications. Calypso is a good example of a global player in this area. And in February 2005, Visa introduced a system using RFID to enable consumers to make purchases by simply waving their cards. Meanwhile, McDonald's have introduced a Mastercard wireless system using RFID to make their fast food even faster (Box 3.13).

Box 3.13: McDonald's and RFID: Lovin' it
Was that with a tag on the side?

McDonald's has chosen to provide a wireless credit card system using RFID technology to make their fast food even faster. Customers need simply wave their "Mastercard PayPass" card near a "VeriFone" RFID card reader. The device then automatically interprets the wave, charging the amount of the order to the customer's Mastercard account.

First tests will be carried out at McDonald's restaurants in New York City and Dallas in late 2004 before nationwide deployment.

Source: San Jose Business Journal, 18 August 2004, www.sanjose.bizjournals.com/sanjose/stories/2004/08/16/daily33.html

Retail stores are not the only ones to benefit from RFID technology. Restaurants can use item-level tagging to improve the customer experience and facilitate the billing process. Pintokona, a Sushi restaurant in Tokyo, has introduced RFID tags to track and price their plates of sushi that are presented on a rotating belt. Sushi freshness is a critical requirement for Pintokona, as dishes should typically be exposed no longer than thirty minutes. RFID tags associated with individual dishes contain the precise time of their placement on the rotating belt, thus facilitating their withdrawal upon the expiry of the pre-determined period. The system also assists with the calculation of the bill, as each tag contains information such as price, sushi type, and chef.[57] Future applications of RFID for the consumer are discussed in Chapter 4.

3.4.4 Smarter homes, smarter people?

An important market segment emerging in technology-savvy environments such as Korea is the use of RFID and other wireless sensor and communication technologies (e.g. Zigbee) for consumer applications such as smart houses and smart cities. There is significant interest in introducing RFID functionality in the construction of new urban landscapes and in consumer appliances. In March 2004, the Korean government opened a museum in Seoul, "Ubiquitous Dream" that includes a mock up of a "smart home". The design includes a networked refrigerator that initiates the automatic re-ordering of food items, contactless security systems and wireless sensors (e.g. for lights), and smart laundry machines (that determine treatment required for different fabrics).[58] RFID tags, readers and sensors can also create in-home environments that could make it possible for the elderly or physically challenged to continue to live at home. A smart home system could detect, monitors and record the daily living activities of a resident by collecting data tiny RFID tags affixed to household items, thereby ensuring their independence and reducing the burden on caregivers.[59] Data harvested from RFID tags would reassure family and caregivers, for instance that the elderly patient had taken their medication.

If homes seem to be getting smarter, so too are people, with the help of portable smart devices. A good example is RFID-enabled wearable technology such as the "smart watch system", being developed by the University of Washington in collaboration with Intel. This smart watch helps people remember to take their essential items with them when leaving the house, or leaving a public place (Box 3.14).

Like tags, readers are also being developed that are smaller in size, and friendlier to a mobile, and more invisible technological environment. For example, the company SkyeTek developed its new RFID reader, dubbed "M1-mini", measuring 1 inch in diameter and 0.1 inch in thickness.[60] The tiny reader can be integrated in a glove, or in a mobile phone, to read tags on items such as medication to warn users of any contra-indications, or ensure secure access to homes, entertainment systems, and appliances. In the future, clothing may be equipped with sensors, readers and tags,[61] for local adjustments or remote monitoring: the collected data would then be sent wirelessly to other devices such as watches, mobile phones or personal digital assistants.

Box 3.14: Watch this RFID: an important step towards smart technological ubiquity
Radio frequency tags in smart watches remind people that they may have forgotten something

A working prototype of what might be called a "smart watch system" has been developed by a University of Washington computer scientist, in collaboration with Intel. The watch is an intelligent, integrated, and responsive system, capable of prompting users who leave the house or workplace without essential items, such as keys, wallet, glasses, etc.

The wristwatch acts as an interface and is driven by a small personal server, easily carried in the pocket, which could eventually be integrated with the wristwatch itself. Important items in the household are embedded with RFID tags, and readers are installed in various locations, e.g. home, car, office, etc. When the wristwatch passes a reader, the information is sent to a personal server that checks whether all critical (tagged) items are present. In the future, wireless location systems may also determine the location of the user (whether they are arriving or leaving), and use this information for decision-making.

Source: EurekAlert, 6 October 2004, www.eurekalert.org/pub_releases/2004-10/uow-awt100604.php

4 RFID IN THE LAB

4.1 RFID and wireless sensor technology

While RFID tags are being tested and deployed in a number of industries, sensor technology is in its early stages of development. The traditional function of sensors is to measure specific phenomena or determine the status of the environment through the collection of physical values, e.g. temperature, humidity, pressure, noise levels, presence of absence of objects, speed, etc. The addition of wireless communication capabilities to sensors significantly extends their potential, giving them more autonomy and collaborative potential (e.g. collaboration with other objects or with a remote interrogator).[62]

Not surprisingly, sensors such as temperature tags, vibration sensors, chemical sensors etc., can significantly enhance the functionality of RFID technology. Such smart sensors will provide yet another mechanism for acquiring data. Their integration with accurate time and location-sensitive RFID tags will provide records of the status of a given item and how it has been handled.

For instance, biosensors that can detect that a perishable item has expired are being developed. Such sensors would be tiny and capable of detecting the presence of any biological or chemical agents.[63] Consisting of a transducer and a computer chip, the sensor would be embedded into a single RFID tag that could function inside a water bottle or even in the liquid at the bottom of a package of meat. Although RFID biosensors are some years away, a number of companies, including one of McDonald's largest beef providers, Golden State Foods, has been testing RFID biosensors since 2002. A system made up of RFID sensors would eventually allow the tracking and monitoring of all food supplies, thereby thwarting contamination and even bio-terrorism. In some instances, insurance coverage against terrorism may become available to companies employing RFID biosensor technology.

4.2 RFID and the mobile phone

The use of information stored on RFID tags in combination with sensor capabilities can enable computations and communication with peer objects, which can eventually create an environment in which the context of users and the status of "smart objects" can be continuously determined and monitored.[64] Mobile phones can serve as an important platform for users to communicate with smart objects and open up possibilities for location-based services.

For example, in 2003, the first trial of mobile RFID shopping was run in Tokyo, opening up an entirely new location-based shopping experience (Box 4.1). RFID technology in combination with mobile phones was used to locate customers wishing to receive information about the area. Targeted promotions, entertainment options, and customized shopping information could then be delivered to the customer.

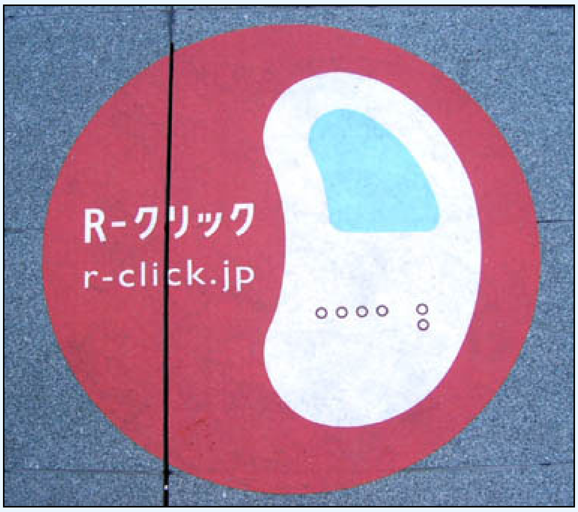
In March 2004, Nokia introduced the Nokia RFID Kit, a GSM phone with RFID reading capability for supply-chain applications.[65] Within a couple of years, the handset manufacturer intends to give consumers the ability to use their mobile phones to access data rich in information about consumer products sold in retail stores, through the use of RFID. Nokia is developing the RFID consumer phone jointly with Verisign. The potential applications of such mobile phones are manifold, including:

- One-touch warranty registration
- Allowing for quick ingredient look-up in supermarkets (of particular use those consumers with allergies)
- Customer service and brand management (e.g. promotions)

Given the immense potential RFID holds for information and communication access and machine-to-machine communications, technology developers continue to explore its synergies with the increasingly ubiquitous mobile phone. The Near Field Communications Forum (NFC Forum) is using RFID to bridge the connectivity gap between all kinds of devices (such as the mobile phone) and electronic information transfer.[66]

Box 4.1: RFID tags and Shopping in Tokyo's trendy Roppongi Hills

This use of RFID tags at Roppongi Hills in Tokyo has now been expanded to retail shopping: the trial of NTT DoCoMo's "R-click" service in 2003 and 2004 was a successful one. The R-Click service delivers information specific to a user's location using RFID tags. DoCoMo has issued about 4'500 RFID tags (embedded in small handheld terminals), which can be attached to users' mobile phones. Subscribers can inform the network of their wish to be located by pushing a button. The default setting is "off", in order not to surprise those customers not wishing to be disturbed by such information. The small handheld device then enables users to receive a wide variety of area information as they walk around the new metropolitan cultural complex of shops, restaurants, entertainment facilities, residences and hotels.



Source: Adapted from *ITU Japan case study on "Shaping the Future Mobile Information Society"* available at www.itu.int/futuremobile/

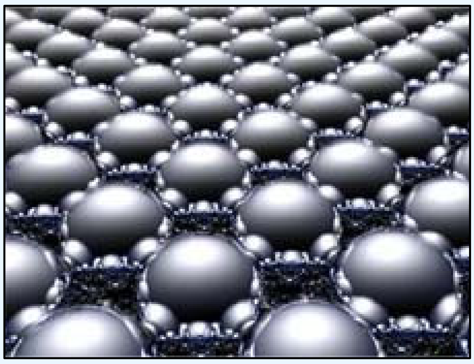
4.3 From smart chips to smart dust

At this time, radio-frequency identification tags are about the size of a grain of rice. But rapid advances in this technology herald an age of microscopic, or even "nano-scopic" computing capabilities. Looking beyond the early phases of RFID deployment, there is a silent revolution gathering momentum – one that applies the computing power in a tag or chip to a much smaller scale.

In the 1980s, personal computers running on the DOS operating system typically had 640 k of memory. Over the last 20-odd years, the size of desktops has remained relatively constant, but the power of the CPU (central processing unit) and the size of real memory (e.g. RAM or random access memory) have both increased by a factor of more than 1'000. Imagine this degree of enhancement applied to the size of the machine itself, rather than its power. One could then have at least the power of the old microprocessors in the 1970s in a surface not surpassing one millimetre, i.e. "smart dust".

Technology developers are already working on such particles (known as "motes") and other similar innovations grouped under what have become known as "nanotechnology" (Box 4.2). Universities and research institutes such as the Massachusetts Institute of Technology (MIT) and the University of California at Berkeley (United States) are working on autonomous sensing and communication for devices under a cubic millimetre.[67] Research engineers at the latter institution have recently developed a wireless sensor chip, integrating sensors and transmitters in a mere five square millimetres. The dust, known as "spec" by its creators, represents a milestone in the creation of low-power, low-cost wireless sensor devices, which will eventually be able to self-organize into networks of tiny sensors that can be manipulated remotely.[68]

Box 4.2: More than microscopic
Nanotechnology in a "nanoshell"



While many definitions for nanotechnology exist, three elements seem to be common:

- Research and technology development at the atomic, molecular, or macromolecular levels in the length scale of approximately 1-100 nanometer range.
- Devices and systems that have novel properties and functionality due to their small size.
- The ability to control or manipulate on the atomic scale.

Though the use of nanotechnology is limited today, nanoparticles are used in a number of industries. Nanoscale materials are employed in electronic, magnetic, optoelectronic, biomedical, pharmaceutical, catalytic, and materials applications. Areas reportedly producing the greatest revenue for nanoparticles are chemical-mechanical polishing, magnetic recording tapes, sunscreens, automotive catalyst supports, bio-labeling, electro-conductive coatings, and optical fibers. Applications that are already on the market include: catalytic converters on cars, burn and wound dressings, water filtration, protective and glare-reducing coatings for eyeglasses and cars, sunscreens and cosmetics, and ink.

The latest display-technology for laptops, cell phones, digital cameras, and other uses is made out of nano-structured polymer filMs OLEDs, or organic light emitting diodes will provide brighter images, be of lighter weight, use less power, and secure wider viewing angles than conventional devices.

It is widely acknowledged that high-performance nanotechnology materials will facilitate the production of ever-smaller computers that store vastly greater amounts of information and process data much more rapidly than those available today. Computing elements are expected to be so inexpensive that they can be embedded in fabrics, e.g. for smoke detection.

The impact of nanotechnology on new sensor technology, and therefore on the vision of the ubiquitous network society, is significant. The company NanoMarkets LC predicts that the overall nanotechnology sensor market will generate global revenues of USD 2.8 billion in 2008 and will reach USD 17.2 billion by 2012.

Source: Adapted from ITU, "Ubiquitous network technologies and their impact on the traditional telecommunication industry", Thematic Paper, April 2005, available at www.itu.int/ubiquitous

5 IMPLICATIONS OF RFID

A technology such as RFID, the core of the future "Internet of things", has the potential of becoming ubiquitous in every sense of the term, and as such is subject to a number of important public policy challenges. Apart from influencing the shaping of the ICT landscape, it also has significant implications for social constructs and behaviour.

Early signs of how such pervasive technologies might impact society can already be gleaned from the use and social dynamics of the use of mobile phones today.[69] Otherwise said, it may not be too early to draw lessons from a technology such as the mobile phone, widely celebrated for its "ubiquity" and pervasiveness, and apply them to the new and burgeoning are of RFID.

5.1 Public policy challenges

There are three main challenges that policy-makers face with the advent of RFID. From a technical standpoint, the optimal realization of an "Internet of Things" hinges upon technical interoperability and the creation of effective global standards. Once this is achieved, the governance of the system must be assured in a balanced and equitable fashion. Finally, one of the most widespread concerns over RFID technology is the control over individual data and the protection of consumer privacy.

5.1.1 Interoperability and standards-setting

Because the implementation of RFID technology can be an expensive investment, issues relating to compatibility and interoperability need to be identified and addressed across sectors and on a global level. However, the industry still lacks common standards for RFID on many fronts, ranging from data formats, to interoperability between RFID readers and tags from different vendors, to interference problems between products. Also, RFID systems used by the retail industry might differ greatly from those used by office access controls. Therefore, cooperation among the various RFID manufacturers will be essential for the promotion and widespread adoption of the technology.

5.1.2 Governance of resources

There is general agreement in many circles that the governance of the global Internet should be multilateral, transparent and democratic. Both the private and public sectors are being called upon for the achievement goals such as the equitable distribution of resources, facilitated access, network stability and security. The need for such governance becomes even more acute as the global Internet expands in content and accessibility, and therefore in strategic commercial importance. Domain names (e.g. companyname.com), for instance, have become more than a simple URL. In fact, they have become powerful marketing tools due to their ability to be easily identified and located with or without search engines.

In this area, VeriSign has somewhat of a monopoly. It manages the core Domain Name Service (DNS) directory that allows users to look up addresses for Web sites that end with ".com" and ".net". This monopoly over digital content has just been expanded as EPCglobal has awarded Verisign the contract to maintain its electronic product codes for RFID item-level tagging, which, as seen above, could eventually identify billions of products (and even people). EPCglobal chose Verisign due to its vast infrastructure. It is of the utmost importance that the current monopoly over the DNS system is not transferred to the future "Internet of Things".

5.1.3 Data protection and consumer privacy[70]

Strong opposition to the widespread deployment of RFID tags has been voiced by a number of consumers and privacy advocates. The main concern is the capacity of RFID to track things and people, and to record a wide array of information. RFID critics argue that stores, corporations and governments could eventually use RFID to spy on individuals.[71] In November 2003, a coalition of advocacy groups (e.g. the Electronic Privacy Information Centre, the Electronic Frontier Foundation, the American Civil Liberties Union) led by CASPIAN (Consumers against Supermarket Privacy Invasion and Numbering) released a "Position statement on the use of RFID on consumer products". This position statement called for a "moratorium" on RFID technology in order for a full assessment of the impact of the technology to be conducted.[72]

During 2003, consumer boycotts were subsequently organized against two large companies planning to deploy RFID, Benetton and Gillette. Benetton subsequently cancelled its plans to implement the technology. In 2005, CASPIAN called for yet another worldwide boycott of Tesco after the supermarket giant announced its plans to expand trials of RFID.[73] The group expressed concern that tags may continue to remain active once a product is purchased, and can therefore be scanned through clothing by third-party readers. This would also allow corporations to compile data transmitted by the tags to determine which products a consumer purchases, and when, and even where the product travels. The aggregation of this data could lead to the formulation of sophisticated consumer profiles including their income, health, lifestyle, buying habits and even location. This information could then be sold or made available to government agencies, employers, or other companies for marketing purposes and for use in the context of CRM (customer relationship management) databases .[74]

The deployment of RFID tags to track and identify individuals, outlined above, only fuels these concerns. Simson Garfinkel, previously of MIT's Auto-ID Center, has proposed an "RFID Bill of Rights" a framework for voluntary guidelines that companies deploying RFID could adopt:[75]

- The right to know whether products contain RFID tags.
- The right to have RFID tags removed or deactivated upon purchase of the associated product.
- The right to use RFID-enabled services without RFID tags.
- The right to access an RFID tag's stored data.
- The right to know when, where and why the tags are being read.

More recently, in January 2005, the European Union's Data Protection Working Party (set up under Article 29 of Directive 95/46/EC) published its first assessment report on data protection issues related to RFID.[76] This working document raises concerns about the impact of item-level tagging using RFID on the potential for direct marketing and customer tracking. Applications that link RFID tags with consumer bank accounts were also stated as problematic. The report suggests that consumers should be given adequate tools to delete any information on tags embedded in goods they purchase, or in the alternative, the ability to remove the tags after purchase. For passports and other identification mechanisms, the Working Party advises the use of standard authentication protocols (e.g. ISO) in order to ensure that the data is encrypted and unavailable to those without the requisite authorization.[77] The report identifies three main data protection areas related to the use of RFID.

The first is the use of RFID to collect information linked to personal data. This link might be direct of indirect. A supermarket, for instance, might use RFID to identify consumers by their names and record their habits in the store, including the sections they visit, and the number of times visits occur without purchases. The second is the use of RFID tags for the storage of personal data. A good example of this use is in public transport, where an organization could track the location of an identified individual carrying a contactless public transport card while he/she is within range of their readers. The third and final area is the use of RFID for tracking purposes, without "traditional" identifiers. This includes the following case: if a grocery store hands out re-usable RFID-enabled tokens for shopping carts, it can track the location of the cart as well as the content of the cart, thereby enabling the creation of a detailed database for marketing or dynamic pricing. This information could also be made available to third parties, all without the informed consent of the consumer.

After outlining these three areas of data protection, the report goes on to assess the applicability of European data protection legislation to the information collected through the use of RFID. A request for public comment to the document has been launched, with a deadline for submission of 31 March 2005.

Privacy concerns surrounding RFID deployment are only further exacerbated by the possibility of a "human bar code", or implantable RFID tags for the tracking and monitoring of individual citizens. Far from science fiction, RFID implants have already been used for medical[78] and entertainment uses. For instance, VIP patrons in clubs such as the Baja Beach Club in Barcelona receive access to exclusive lounges and facilitated payment services if they volunteer for the implants (Box 5.1).[79]

Recently, the Food and Drug Administration (FDA) of the United States has even approved and endorsed RFID implants designed by Applied Digital Solutions, and known as "VeriChips", that are injected under the skin. These would contain a unique ID number that would be used to access medical records on a remote server maintained by Applied Digital Solutions.[80] The stated objective of these chips is to provide better health care and reduce medical errors. In some hospitals, projects to tag newborn babies are being implemented,[81] and RFID implants have also been used to enhance security at prisons.

The principal concern in the mind of privacy advocates and sociologists is the retention and control of identity by individuals after the implantation of an RFID chip. Some argue that "identity theft" will actually grow in importance rather than diminish. Access to an individual's unique serial numbers and information must be strictly controlled.

With the multiplying population of reading machines (unavoidable in a ubiquitous network environment), and the current rate of technological innovation (likely to increase, if anything), it will become essential to ensure that user data does not fall into the hands of unauthorized parties. Without advocating the need for legislation to curtail the use of RFID at this early stage, the Progressive Policy Institute in its 2004 Policy Report on the subject,[82] does acknowledge the need for the industry to take privacy issues into account, notably customer choice and notice. It encourages retailers to take the following steps to ensure the smooth deployment of RFID:

- Label RFID-tagged items with recognizable logos;
- Indicate the location of RFID tags on tagged items;
- Conduct public information campaigns, e.g. through informative flyers or signs clearly indicating the presence of RFID tags in-store.

The Institute also recommends the use of commercial standards by both industry and government.

An RFID Privacy Workshop held at the Massachusetts Institute of Technology (MIT) in November 2003, highlighted the need for an ongoing dialogue about consumer rights and the benefits of RFID. Industry seems aware that sufficient consumer fear and outrage could slow and even thwart the development of the technology. Though some privacy concerns have been exaggerated, protecting consumers from illegitimate tracking was viewed as a legitimate issue that needs to be addressed by researchers and policy-makers.[83]

Technical countermeasures to block the scanning of radio-frequency ID tags are already in the making. These "jammers", like their mobile phone counterparts,[84] respond to privacy concerns about tagged consumer items being tracked within and beyond a retailer's premises. The blocker tag can be placed over a regular RFID tag, and can prevent the reader from scanning information transmitted by the tag. It does this by sending the readers more data than it is capable of reading, i.e. similar to a denial-of-service attack.[85]

5.2 Social and human impacts

No technological development is possible without effect upon society – desired or undesired. The world as we know it will be transformed by the diversification of RFID use, and its expanded adoption across industries.

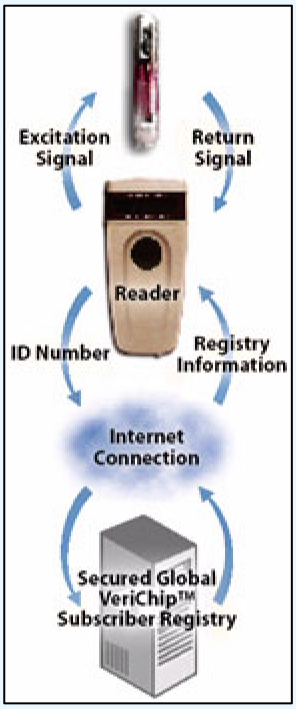
As discussed above, RFID can offer levels of convenience (e.g. in the home or in the shop) that are miles ahead of current standards. The technology can facilitate daily tasks and increase the speed of transactions. Individual items, or people, can be located and identified in wide or confined spaces. The mass deployment of RFID is likely to have a significant impact on the quality of life. Like so many other technical innovations, it is yet another extension of the human endeavour to control time and space.

For instance, applications of RFID technology in the health sector will aid in the care of children, the elderly and the infirm. This will not only go a long way towards the prolongation of life, but will make such lives more comfortable and productive. The development of ambient or ubiquitous networking environments (e.g. using RFID) will facilitate the practice of flexible working hours and reduce commuting time. This will in turn have positive spin-off effects on the quality of family life and on the environment.

Indeed, no one can deny that the expansion of these "anywhere, anytime" communication technologies, for "anyone and anything", will bring about increased convenience, greater access and a whole host of innovative applications and services. However, the capacity of these technologies to impact human lives (private and public) will grow correspondingly. This brings to mind the notion of the "Faustian Bargain"[86] in the context of technological change. In other words, while a given technological advance improves many aspects of daily life, it also risks reducing the advantages of earlier technological developments or earlier ways of life. It is only through an increasing awareness of this risk that humanity (and societal progress) can be preserved in what has become an ever-expanding sea of technology and automation.

Box 5.1: Implantable chips make for better bar hopping

RFID has its privileges for VIP patrons of Barcelona's Baja Beach Club



The Baja Beach Club in Barcelona has introduced RFID chips for their VIP patrons. An RFID implant (made by Applied Digital Solutions and known as the "VeriChip"™) injected via syringe allows club-goers to breeze past readers that instantly identify them and their VIP status. The chip contains information about access status and can open exclusive areas of the club for the "chipped" patrons. It also stores credit data, so authorized VIPs may purchase drinks and food by a simple wave of their "chipped" arm. About the size of a grain of rice, each Verichip RFID device contains a unique verification number, allowing access to a database. This database contains persona data relating to the VIP patron.

VeriChip works in the following manner. It is implanted just under the skin (typically in the upper arm) via a syringe. It can then be scanned when necessary with a Verichip™ RFID scanner. A small amount of radio frequency energy passes from the scanner, energizing the dormant chip, which then emits a radio frequency signal. The signal transmits the individual's unique personal verification ID number and provides instant access to the Global Subscriber Registry. This is done via secure, password-protected Internet access. Once data is confirmed by the registry, the appropriate benefits become available to the approved VIPs.

The United States Food and Drug Administration (FDA) recently approved the use of the VeriChip™ for use in hospitals.

Source: Adapted from ITU Internet Reports 2004: The Portable Internet, available at www.itu.int/portableinternet.

5.2.1 Society under surveillance?

The more complex and pervasive technological systems become, the more vulnerable they are to misuse and to malfunction. When a technological development is in its early stages, the consideration of possible abuses or undesirable effects is timely and crucial. The ubiquity of networking technologies, combined with the current political climate, raises concerns about citizen surveillance.

Even in the offline world, the monitoring of human behaviour has grown considerably, due largely to the use of credit cards, loyalty cards and cameras. Most citizens of industrialized countries now leave a sizeable trail of electronic data behind them as they go about their daily tasks. In addition, over the last several years, the location and activities of citizens are increasingly captured by the use of video surveillance cameras. According to one estimate, the average person in the United Kingdom is recorded by CCTV (closed circuit television) cameras over 300 times a day.[87]

The dawn of the online world has made this type of data collection cheaper and more efficient. The fact that on-line behaviour is tracked by websites is no longer a secret: cookies, which caused uproar several years ago, are now accepted as standard practice. Mobile phone records (calls, messages, etc.) are often kept by operators for years, and there is minimal legislation in this domain. Surveillance cameras have become more sophisticated and can now be connected to the World Wide Web, thereby enabling owners to operate them remotely from their personal desktops. In January 2005, it was discovered that simple searches using Google could give anyone (not only camera owners) access to data from over 1'000 unprotected surveillance cameras around the world.[88] Moreover, advances in digitization have meant easier storage and analysis of private and public data.

In this context, the growing adoption of RFID-based services has been a particular source of concern. RFID will make it much easier for companies and government investigators to establish the whereabouts of citizens, by accessing information on tags embedded in their clothing or other personal iteMs Today, investigators in civil and criminal cases regularly use records from E-Z Pass automatic tolls based on RFID to prove where an individual's car was located at any given time.[89] And it is, in general, possible for companies to use RFID tags to profile their own customers and share this information with governments or other agencies. This has important implications for human rights.[90] The use of such personal information needs to be carefully monitored and ideally limited in scope, as it is fundamental to the notion of human identity – its constitution and its preservation. The mechanism, purpose and extent of identification (be it RFID data, biometric data, etc.) must favour the citizen and adhere to principles of transparency and individual choice, thereby thwarting the development of an Orwellian-like[91] landscape of surveillance.[92] However, at this time, attention remains focused on industrial development, rather than the consideration of such issues.

Furthermore, as information and communication technologies become increasingly ubiquitous, they will be able to learn even more about individual citizens, gathering information about their habits, preferences and behavioural patterns. Although the initial purpose of such data collection might be limited in scope, national concerns over security and terrorism (in particular since 11 September 2001), coupled with public acquiescence over time, will lead to the inadvertent surrender of more and more intimate personal information by citizens. Once surrendered, this information may be open to analysis and manipulation by an ever-increasing number of actors and agencies.

Users of today's Internet already complete forms for various services (e.g. news alerts) using false names and addresses. People are increasingly afraid of revealing personal information when online. This climate of distrust may be exacerbated in a future in which all kinds of network appliances or items prompt users for personal identification. If data is constantly exchanged between things and people (in some cases unbeknownst to those affected), who will ultimately retain control over this data? Currently, most users can still choose whether or not to reveal their identity over the Internet. But in the future, tiny devices the size of a grain of sand might give the wind a pair of eyes, or fingerprint-activated doorknobs may recognize owners by a simple touch.[93] If such a future is allowed to come about without the appropriate checks and balances, the flow of personal data will become arbitrary and uncontrolled, thereby increasing the possibility of citizen surveillance.

5.2.2 Individuality, self-fulfilment and self-expression

The impact on the human psyche of any kind of surveillance, real of imaginary, cannot be ignored. If not kept in check, it would breed distrust and fear, creating intense anxiety in the exercising of choice and the taking of decisions, no matter how small. Decision-making is essential to individual self-fulfilment and self-expression, and to societal advancement as a whole. On the other hand, suspicion and paranoia have a negative impact on the growth of healthy social intercourse, as well as creativity and overall human development. In a pervasive environment of surveillance, both the availability and exercise of individual choice may decrease and finally disappear. It is important to remember that improvement is the other name of innovation, and innovation is founded upon choice (e.g. of a technical path) and the making of decisions. With the disappearance of choice, human beings are forever locked in a fixed scenario with no escape. If we have reached where we have today, it is because preceding generations have kept open for us the freedom to choose.

Ubiquitous networks and technologies, such as RFID, are important tools for business and personal life. But tools they must remain, and not pretend to replace the essence of human life,[94] such as social interaction, affiliation and the sense of belonging. Of course, the need for belonging and a sense of self are basic constituents of the human condition. In an environment of technological ubiquity, belonging and identity with place (cultural and geographic) is giving way to a sense of belonging to a network – a communications network. This is already the case with mobile phones, which enable users to be contacted regardless of the physical space in which they find themselves.[95] The advent of ubiquitous technologies will enable the construction of a home or office environment anywhere and anytime. The individual, himself or herself, then becomes in a sense the portal. As such, technical devices facilitating this portal have been increasingly seen as the embodiment of the self – pivotal to human identity. Technology is no longer limited to the function of a tool, but begins to reflect identity and inner consciousness.[96] The highly personalized nature of the mobile phone, for instance, is an indication of how the form and use of technology have become important aspects of the individuality and personality of a user.[97] The mobile phone has indeed become the most intimate aspect of a user's personal sphere of objects (e.g. keys, wallet, money, etc.) and an object of emotional attachment. This phenomenon will only become more acute as networked technology is more pervasive and is even implanted under human skin (Box 5.1).

Yet, it has to be remembered that such networked devices may enhance and reflect identity, but not replace it. Though technology is playing a greater and greater role in the creation of identity, it ought not be made out to be deterministic of it, as identity stems from a number of non-technical sources, namely culture, education, community, and personality. Moreover, as networks expand and become less visible, the boundaries between real and virtual worlds, real and virtual identity, are blurring. The important distinction between these two spheres must never be lost, either at the individual or at the community level.

Moreover, the creation of a network of smart things will serve to automate daily tasks, even more than is the case today. The full and complete automation of human activity, however, is not necessarily a desirable outcome. Humans are not automats, nor should they ever become so. Each human being, whether or not implanted with an electronic code for location and tracking, is a unique individual and should be seen as such. The increase of surveillance mechanisms discussed above may encourage people to suppress their individuality, as they will prefer not to draw attention to themselves. Society may indeed become more conformist. At the same time, a techno-political environment in which individuals are seen like mere numbers – one in which their uniqueness is not only of little import, but is felt as such – must be discouraged.

5.2.3 Human relationships and intimacy

Technology does not and cannot exist in a vacuum. Neither does the individual, whose need for socialization and social intimacy is fundamental.

Information and communication technology has gone a long way in satisfying the human need for communication. Mobile phones and the Internet have brought people across the globe closer to each other, and enabled more frequent communication between friends, family members, colleagues, and even strangers. In other words, existing social networks have hence been expanded, and new ones created (e.g. through bulletin boards and chat rooms).

However, this also means that human relations are being increasingly mediated by technology. The prodigious use of SMS (short message service), instant messaging and email are important and telling examples. Many young people today prefer to text rather than to talk. Moreover, the rise of communication technologies is eroding the boundaries of private space, accelerating the pace of life and reducing the amount of time available for personal and social development.

But relationships and intimacy remain important human needs. With the growth of technophile populations, the quantity of communication may have increased (e.g. through mobile phones and the Internet) but the qualitative aspect of human relationships may not have been correspondingly improved. In many instances, like the technical devices that facilitate them, these relationships are increasingly transient and ephemeral.[98] Modern information and communication technologies are already being blamed for making users less committal – many send text messages to cancel appointments at the last minute or to avoid awkward face-to-face contact. This phenomenon will only be more apparent as technologies grow and become even more intimate (and invisible) aspects of daily life.

5.2.4 New technologies, new divides

Given the rapid pace of current technological innovation, it is important to ensure that the divide between the technology "haves" and "have-nots" does not widen. The current digital divide is not only comprised of an inequality of access to computers and the Internet; it now includes mobile phones, satellites, and cable services. Far from being a single divide, it is a patchwork of varying levels of access to ICTs, including basic usage and applications development.[99]

In fact, it seems that this patchwork is becoming yet more complex. Without careful consideration of the social impact of new technologies such as RFID, we may bear witness in the future to a new kind of divide – a "privacy divide". The current widespread use of loyalty card schemes among retailers is an early and telling example. Customers typically sign up for loyalty cards in order to receive discounts and reductions on various products. For retailers, these cards enable the collection of data about the shopping preferences of their customers. Some retailers, such as Metro AG, are considering the use of RFID in loyalty cards (though this firm subsequently dropped the idea).[100] The availability of discounted prices for loyalty card holders means that those without loyalty cards pay more at the cash register.[101] The end result is that those that cannot afford goods and services at their full (undiscounted) rate must surrender personal information and thus compromise their privacy.

Indeed, the effective cost of privacy is on the rise. While market forces and technological innovation may be threatening it, an increasing number of tools geared towards its protection are becoming available, e.g. “anonymizers” that enable users to mask their identities while they surf the Internet.[102] The possibility of “purchasing” privacy is a real one.[103] Despite the growing use of technologies that pervade all aspects of human life, privacy should not become a luxury available only to the rich. This holds true both at individual and community level. Though concerns over such issues in industrialized countries have become more frequently raised in recent years, there is little evidence of public concern over privacy in the world’s poorer countries, as it rarely figures in the policy agenda of developing and emerging economies.

6 Conclusion

RFID technology has tremendous potential to ease life and to improve the human condition. Still, further innovation and industrial deployment of this technology should be done in parallel with a careful exploration of all related aspects. First, in order to avoid market fragmentation and needlessly costly development, there is the need of a concerted effort towards the development of an international standard. Second, the development of RFID should not be the subject of monopolistic commercial development. Third, realization must grow that a fully effective development of RFID is not possible without the consideration of issues related to data protection and consumer privacy. Finally, the ethical and sociological impacts of any innovation are important to consider alongside with economic and technological issues. It is vital to ensure that amidst continuing technological innovation, the essence of our humanity remains untouched. “The tail must not wag the dog” is perhaps a trite saying but applies well to the case of RFID technology and expresses aptly the possible dangers surrounding its use, pitfalls that should be surveyed ahead, and thus avoided.

Endnotes

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CHAPTER V

UBIQUITOUS NETWORK SOCIETIES:
PRIVACY IMPLICATIONS

BACKGROUND PAPER

Acknowledgements

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Ubiquitous Network Societies: Privacy Implications

Table of Contents

UBIQUITOUS NETWORK SOCIETIES: PRIVACY IMPLICATIONS

1 INTRODUCTION

The BBC News technology website recently reported on a consumer study indicating that a majority of people in the UK have serious privacy concerns related to radio frequency identification (RFID) tags, believing that these tags can be read from a distance and thereby exposing them to unwanted surveillance.[1] RFID tags are an emerging technology that combines a microchip with antenna, making it possible to read the contents of the chip with a radio scanner, and represent a powerful new innovation in micro-computing and wireless networking. Despite the privacy concerns, many of those responding to the survey also recognized that RFID tagging could provide real benefits in the form of, lower retail costs, convenience, and crime detection.

The ubiquitous network society, however, presents a more fundamental problem for privacy rights than what may be suggested by its early incarnation in the form of RFID tags; namely, that the very conceptualization of the systems that will make this vision possible require that personal information be collected, used, and disclosed on a massive scale and under very different conditions from which we are familiar with in today's world.

If we are to begin to understand the intimate link between personal information, privacy and ubiquitous networks, a first step is to understand the vision and its various social, technical, and regulatory dimensions. From here, it may be possible to structure an informed and progressive debate on this vital issue at the heart of emerging networks and the societies we wish to build with them.

1.1 Context and aim

This paper is one of three thematic papers to be presented at the New Initiatives Workshop on "Ubiquitous network societies", held 6-8 April 2005 in Geneva Switzerland, and hosted by the International Telecommunication Union. In addition to the other thematic papers on RFID and network traffic management, there are country case studies from Japan, Korea, Singapore and Italy.

The aim of this paper is to stimulate discussion and debate on privacy in ubiquitous network societies by providing important background information and a sample of recent perspectives on the issue. As such, the paper does not attempt to provide clear answers to the problems identified, but instead has been written with a view to contributing to a better understanding of the subject matter, in part by reflecting critically on the issue of privacy as a cross-cutting concern that includes technical, regulatory, and social considerations.

The very term "ubiquitous network societies", as many readers will acknowledge, is problematic given the variety of assumptions that might be brought to bear on it. As such, the paper sets out one particular interpretation of the term in the introductory section, and then uses it as a baseline concept by which to develop and discuss the issue of privacy.

1.2 Weiser's vision for third-generation computing

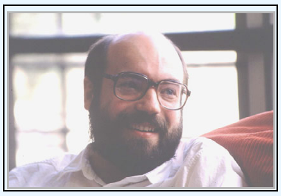
In 1991 computer scientist by the name of Mark Weiser published a paper in *Scientific American* titled "The computer for the 21st Century". Weiser and his team at the Xerox Palo Alto Research Center (PARC) in California had in 1988 begun to invent a vision of a third generation of computing systems, and this article was its first introduction to a mass readership. Essentially the vision described the historical transition from large mainframe computers of the 1960s and 1970s, to the standalone desktop personal computer (PC) of the 1980s and 1990s, and finally toward the networked computing appliance of the future. Third-generation computing was presented as an integrated system of advanced computing devices, intelligent interface design, and anytime, anywhere data communications.

Weisner (see Box 1.1) coined the term "ubiquitous computing" to describe this third wave of computing systems, which marked the initial articulation of a vision looking toward future ubiquitous network societies. What is most significant about Weiser's vision is that while it pre-dated the Web by a few years, it clearly embodies the idea of pervasive networked computers, assuming all kinds of shapes and located in all kinds of unconventional settings. Essential to the vision is electronic networking, for without the ability of these computing devices to communicate with one another the functionality of such a system would be extremely limited. In a later paper published in 1993, Weiser made this requirement clear, stating that the next-generation computing environment would be one "in which each person is continually interacting with hundreds of nearby wirelessly connected computers."[2] At the time such forms of wireless networking were primitive at best, but today with the likes of Wi-Fi and Bluetooth, the possibilities for such dense local area networks are entering the realm of commercial reality.

Box 1.1: Ubiquitous computing

In 1991 computer scientist Mark Weiser set out a future scenario for information and communication technologies characterized by three main innovations:

- Computing devices will become embedded in everyday objects and places;
- Designers will develop intuitive, intelligent interfaces for computing devices to make them simple and unobtrusive for users;
- Communications networks will connect these devices together and will extend to become available anywhere and anytime.



Source: Text LSE; Image: www.www2.parc.com/csl/members/weiser/

1.3 An international perspective

While one side of the Atlantic Ocean was working on a vision known as ubiquitous computing, or "ubicomp", the European Union began promoting a similar vision for its research and development agenda. The term adopted within this international setting is "Ambient Intelligence" but it seems to share most of the same features as Weiser's ubiquitous computing scenario, while perhaps giving more emphasis to the vision as an integration or convergence of three key innovations in micro-computing, user interface design, and ubiquitous communications networks. See Box 1.2.

In May 2000, the Information Society Technologies Advisory Group (ISTAG) commissioned the creation of four scenarios "to provide food for thought about longer-term developments in Information and Communication Technologies", with the intent of exploring the social and technical implications of Ambient Intelligence, and to provide a point of departure for structuring ICT research under the Sixth Framework Programme of the European Union. Among the findings, the scenarios suggested a set of "critical socio-political factors" that will be critical to the development of Ambient Intelligence, including the issue of security and trust. In particular, the report stated that "a key aspect is management of privacy: more open systems tend to lower privacy levels [where] technological developments are outpacing regulatory adjustments."[3]

The scenarios developed for and assessed in the ISTAG report were regarded as a first step toward the creation of a research agenda in the EU that would contribute to the development of "trust and confidence enabling tools" for the management of privacy within an Ambient Intelligence context.

Japanese policy initiatives in this field have adopted the term "ubiquitous network society" to describe a vision that in many respects may be ahead of that in other parts of the world, suggesting a future initiative under the label "U-Japan Strategy" to replace the current "e-Japan" policy framework.[4] Similarly, a recently held policy roundtable titled "Realizing the Ubiquitous Network Society" addressed a range of issues that appear to be closely associated with the EU's Ambient Intelligence research program. Results from the roundtable are intended as input to Japan's emerging technology policy beyond 2006 and centre on a normative view that the country "must realize a ubiquitous network society in which convenient communications without restrictions will be allowed via broadband platforms, to which diversified equipment including [consumer equipment] will be connected." The final report of this roundtable was published in late 2004 and has been posted on the website of Japan's Ministry of Internal Affairs and Communications (Japanese only at the moment).[5]

Box 1.2: Ubiquitous Computing versus Ambient Intelligence?

"Ubiquitous Computing (Ubicomp) and/or Ambient Intelligence (AmI) refer to a vision of the future information society where humans will be surrounded by intelligent interfaces supported by computing and networking technology that is everywhere, embedded in everyday objects such as furniture, clothes, vehicles, roads and smart materials. It is a vision where computing capabilities are connected, everywhere, always on, enabling people and devices to interact with each other and with the environment. Computer devices are becoming increasingly small and cheap, interconnected and easy to use in order for them to find application in all aspects of our everyday lives. Computing capabilities will therefore not only be available in computing devices but also in everyday objects. These devices will be able to sense, think and communicate.".

Source: Punie, Yves. (2003). A social and technological view of Ambient Intelligence in Everyday Life (Technical Report EUR 20975 EN): Institute for Prospective Technological Studies, Directorate General Joint Research Centre, European Commission.

1.4 A corporate vision

While IBM is credited with coining the term "pervasive computing" to refer to a shift in corporate computing systems, Philips Research has chosen the term "ambient intelligence" to describe a new paradigm for home computing and entertainment.

One of the first prototypes developed by Philips is a system that supports "smart home" applications based on collection and use of personal information that allows the creating of user preferences and profiles for customizing entertainment and other applications. One example of this idea has been given the name "PHENOM" and is designated as a long-term research project at Philips. The idea behind PHENOM is to create an in-home environment that is aware of the identity, location and intention of its users, and that might eventually perform like an electronic butler. To support this prototype, researchers have designed "an intelligent Memory Browser system" that "recognizes multiple users, devices and objects, and learns from their behaviour."[6]

Similar work is being done (see Box 1.3) at the crossroads between industry and academia under the name Project Oxygen at the Massachusetts Institute of Technology (MIT) in the United States.

Box 1.3: Project Oxygen at MIT

Perhaps one of the most well known corporate/academic partnerships for developing ubiquitous ICT prototypes and applications is located at the Massachusetts Institute of Technology (MIT) and called the Oxygen Lab. The name is intended to emphasize the "ambient" quality of such technologies. Project partners include Hewlett-Packard, Nippon Telegraph and Telephone (NTT), Nokia, and Philips Research.

> "Oxygen enables pervasive, human-centred computing through a combination of specific user and system technologies. Oxygen's user technologies directly address human needs. Speech and vision technologies enable us to communicate with Oxygen as if we're interacting with another person, saving much time and effort. Automation, individualized knowledge access, and collaboration technologies help us perform a wide variety of tasks that we want to do in the ways we like to do them.
>
> Oxygen's device, network, and software technologies dramatically extend our range by delivering user technologies to us at home, at work or on the go. Computational devices, called Enviro21s (E21s), embedded in our homes, offices, and cars sense and affect our immediate environment. Handheld devices, called Handy21s (H21s), empower us to communicate and compute no matter where we are. Dynamic, self-configuring networks (N21s) help our machines locate each other as well as the people, services, and resources we want to reach. Software that adapts to changes in the environment or in user requirements (O2S) help us do what we want when we want to do it."

Source: www.oxygen.lcs.mit.edu/

Whereas companies like Philips are engaged in an ambitious vision that involves the private domain within the walls of the home, more mundane scenarios marking an important step toward ubiquitous network society are being implemented today, often crossing into public space. One example is the growing use of RFID tags (radio frequency identification tags)[7] to enable supply chain and inventory management in the private and public sectors. These tags represent an early entry point into pervasively networked environment, involving a radio-enabled microchip attached to an object (e.g., item of clothing, or shipping container) that can be read by a radio receiving device.

A recent survey conducted for the Information Technology Association of America, for instance, revealed that of a large number of US government IT executives interviewed, over half of them "described RFID as an emerging technology that would improve government processes, indicating that applications for RFID technologies within government organizations likely will support homeland security, asset visibility, business process and productivity improvements."[8] Despite the fact that privacy concerns about its use remains controversial, there is a strong interest in the use of RFID systems within the asset management community. To the extent that RFID systems are the thin edge of the wedge in the move toward ubiquitous network societies has already started.

1.5 A growing area of attention

The essential qualities of the ubiquitous network society vision are invisibility and pervasiveness. The visionaries dream about the computer "disappearing" into the background while at the same time becoming ever more central to our daily lives through the presence of pervasive electronic communications networks. Is this a utopian vision? Or perhaps it is more appropriate to describe it as dystopian? When Howard Rheingold first conveyed this vision to readers of *Wired* magazine in 1994, the response was clearly mixed with some readers taking issue with Weiser's use of the term "dissent" to describe those who might refuse to participate in such a system. The point was that ubiquitous networks clearly do have "Orwellian implications" as Rheingold plainly observed, and one critic of such a vision suggested that if we are to avoid slipping into an unprecedented society of near-total surveillance, our normative or "default" stance on the design of such systems should be "offline" or otherwise unconnected.[9]

These were early days for the ubiquitous network vision and the simple formulation of the "offline" default stance may have seemed a valid proposal at the time but it is far less feasible today in a world where mobile phone ownership has exceeded fixed line connections globally, prompting an "always-on" culture of electronic communications practices. Similarly, the ubiquitous network vision has had time to mature since its introduction in 1991 and our understanding of its privacy implications are far more sophisticated in part from the work of those involved in the technical fulfilment of Weiser"s original vision. Research into privacy and ubiquitous networks, for instance, has been taken up by numerous research projects located around the world, in at least two special issues of academic journals, and is featured as a regular topic for papers and panels at numerous conferences (see Box 1.4).

Box 1.4: Selected research on privacy and the ubiquitous network society

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- European Conferences on Computer Supported Collaborative Work (papers and panels on ubiquitous computing and privacy), www.insitu.lri.fr/ecscw/
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Source: LSE.

1.6 Ubiquitous Network Societies: A working definition

This background paper will adopt the term "ubiquitous networks" to describe the convergence and interconnection of computing devices – some with advanced user interfaces others being simple sensors and detectors – with a pervasive communications network comprised of both wireline and wireless segments. A ubiquitous network society will also include both public and private information spaces, such as those that might provide real-time public information on traffic or public transit conditions versus virtual private networks for commercial fleet tracking, inventory management, or other forms of corporate communications.

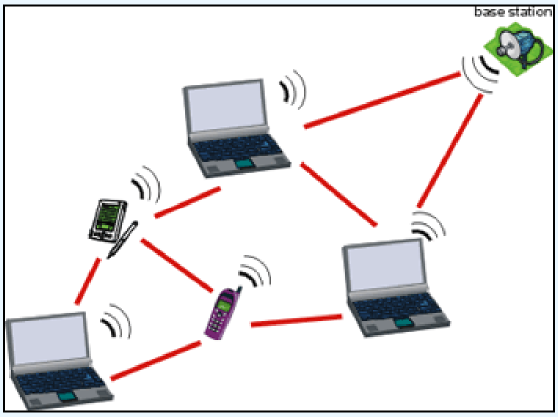
If we combine the public and private distinctions with another important classification based on the architectural design of ubiquitous networks, we create a basic classification scheme that divides the field into quadrants, each with possibly distinct privacy concerns. For example, some ubiquitous networks will be comprised of fixed to mobile connections, such as that with traditional mobile phone networks or the "ActiveBadge" type system first developed by Weiser's team at Xerox PARC in the early 1990s. In each of these examples, a mobile client interacts with a fixed network infrastructure by using a wireless connection.

Other ubiquitous networks will be comprised of mobile-to-mobile connections (see Box 1.5). With this architecture, a mobile device interacts directly with another mobile device, sometimes referred to as "ad hoc" networking. If more devices are introduced into the arrangement, a "mesh network" may be created comprised entirely of mobile nodes. In most cases, particularly in commercial applications, much ubiquitous networking will include a gateway interconnection to a server over a fixed line infrastructure. Nonetheless, ad hoc networking will become more significant as protocols such as Wi-Fi and Bluetooth continue to be adopted in the marketplace. In fact, a serious privacy concern for Bluetooth has already been observed in the case of so-called bluejacking of mobile phones. In a "bluejacking" incident, a mobile phone user sends an anonymous message to another mobile phone in the vicinity – usually to a stranger whose mobile phone has been left in "discoverable" mode. For some individuals, being bluejacked may simply be an annoying intrusion of privacy, but some experts have suggested that it could have more insidious consequences for the transmission of viruses and for attempts to gain unauthorized access personal information contained on mobile phones in public places.

Box 1.5: Ubiquitous network architectures

Ubiquitous networks will include two types of basic designs: fixed-to-mobile and mobile-to-mobile, also known as ad hoc networks. A fixed-to-mobile network resembles the current cellular mobile phone networks, where a mobile client interacts with physically situated base stations. In a mobile-to-mobile arrangement, mobile clients work together to act as repeaters, creating a mesh of interacting hubs.

The image depicted here shows an ad hoc network comprised of laptop computers, a PDA, and a mobile phone. These are connected to each other and to the Internet through gateway access provided by the base station. In a ubiquitous network society, such ad hoc networks might include a wide range of micro-computing devices and sensors located in both public and private spaces.



Source: www.ercim.org/publication/Ercim_News/enw57/santi.gif

2 INFORMATION PRIVACY AND UBIQUITOUS NETWORKS

2.1 Understanding privacy

Privacy is a central issue in ubiquitous computing vision and has been identified as such from its earliest inception. Many in the research and development community clearly recognize the inherent challenge that an invisible, intuitive and pervasive system of networked computers holds for current social norms and values concerning privacy and surveillance.

The inherent privacy challenge from ubiquitous computing, at least as it stands as a design concept today, stems from two innovations necessary to its success: the enhanced ability to collect data on people's everyday interactions (in multiple modalities and over large spans of time and space) and an enhanced ability to quickly search large databases of that collected data, creating greater possibilities for personal profiling, and other forms of data mining.[10] One leading researcher in the field has identified a set of generic privacy concerns that ubiquitous networks will very likely raise for users:[11]

- A pervasive network of interconnected devices and communications will mean that the sheer quantity of personal information in circulation will increase greatly;
- The introduction of perceptual and biometric interfaces for certain applications, will transform the qualitative nature of personal information in circulation;
- In order to personalized services, ubiquitous networks will require the tracking and collection of significant portions of users' everyday activities.

If users are to be persuaded to participate in a ubiquitous network society then they will need to be given a reason to trust that their privacy will be protected at all times (see Box 2.1). The challenge is daunting if we consider the privacy concerns and mistrust that have followed from the introduction of RFID tags and smart cards into the marketplace. For instance, an American group called Consumers Against Supermarket Privacy Invasion and Numbering (CASPIAN) have been lobbying against the use of RIFD tags in consumer products, publishing an ominous warning on the website spychips.com:

> "Unlike a bar code, [RFID] chips can be read from a distance, right through your clothes, wallet, backpack or purse – without your knowledge or consent – by anybody with the right reader device. In a way, it gives strangers x-ray vision powers to spy on you, to identify both you and the things you're wearing and carrying."[12]

The rhetoric of "x-ray vision" and corporate conspiracy that is sprinkled throughout CASPIAN's website could be criticized for being alarmist and even inaccurate with respect to the limits of current RFID technology, but given that these very early steps toward a ubiquitous network society have the ability to create such a furor, what might be in store for a the far more ambitious undertakings proposed by the visionaries?

Box 2.1: The Privacy Paradox

The following are excerpts from researchers working on the technical design of ubiquitous networks and devices. Their comments reflect the inherent privacy paradox created when designing pervasive, "invisible" systems, such as those characterized in Mark Weiser's ubicomp vision or by proponents of Ambient Intelligence.

- "Ubiquitous computing usually implies embedding the technology unobtrusively within all manner of everyday objects which can potentially transmit and receive information from any other object. The aims are not only to reduce its visibility, but also to empower its users with more flexible and portable applications to support the capture, communication, recall, organisation and reuse of diverse information. The irony is that its unobtrusiveness both belies and contributes to its potential for supporting potentially invasive applications."[13]
- "By virtue of its very definitions, the vision of ambient intelligence has the potential to create an invisible and comprehensive surveillance network, covering an unprecedented share of our public and private life..."[14]

Source: www.media.hunton.com/pracareas/photos/tech_privacy.jpg

2.1.1 What is privacy and why is it an important value?

From a political standpoint privacy is generally considered to be an indispensable ingredient for democratic societies. This is because it is seen to foster the plurality of ideas and critical debate necessary in such societies. In order to expand on this claim, some ubiquitous network developers have turned to legal scholar Lawrence Lessig's writing to identify specific reasons for protecting privacy.[15] The resulting list is based on four arguments:

- Privacy empowers people to control information about themselves;
- Privacy is a utility that protects people against unwanted nuisances, or the right to be left alone;
- Privacy is related to dignity in the reciprocal obligations of disclosure between parties;
- Privacy is also a regulating agent in the sense that it can be used to balance and check the power of those capable of collecting data.

Lessig's list of reasons for protecting privacy belongs to what Colin Bennett and Charles Raab have called the "privacy paradigm" – a set of assumptions based on more fundamental political ideas: "The modern claim to privacy … is based on a notion of boundary between the individual and other individuals, and between the individual and the state. It rests on notions of a distinction between public and private. It rests on the pervasive assumption of a civil society comprised of relatively autonomous individuals who need a modicum of privacy in order to be able to fulfil the various roles of the citizen in a liberal democratic state."[16]

The importance of this observation is that it helps to put into question the notion of privacy, and suggests that our commonly accepted ideas may not be the only perspective. For instance, critics of the privacy paradigm may call into question the motives for wanting privacy in the first place, arguing that it supports tendencies toward anti-social behaviour or that it promotes selfish thinking whereby the welfare of the individual is placed above that of the community. Taking this idea one step further, Bennett and Raab point out that some critics "might even argue that some of the most creative civilizations in history – such as ancient Greece and Rome, and Renaissance Italy – flourished despite, or maybe because of, the lack of individual privacy."[17]

In spite of the potential for debate on the finer points of the issue, privacy is clearly a value that is important in modern societies and will likely remain so for some time to come (see Box 2.2). The difficulty lies in establishing a balance between the rights of the community and those of the individual, particularly in the face of new technologies that dramatically increase our ability to collect and use personal information. In many cases, this ability is a desirable innovation to the extent that it can improve the efficiency of governments and businesses, thereby reducing costs to citizens and consumers. On the other hand, such technological developments threaten to sustain a surveillance society involving pervasive data collection from our public lives and unwanted intrusions into our private actions through data mining of our ever-expanding information trails. Ubiquitous networks embody the potential for both, and it is this ambiguity which could transform privacy into an issue that computer scientist Mark Ackerman terms a "killer threat" to their very success in the future.

Box 2.2: Changing ideas about privacy?

Is "privacy" a universal value the same across all cultures and historical periods? Or does the idea of privacy itself change in relation to history and our technological developments? It appears that researchers working on ubiquitous network systems are asking these same questions, suggesting that we may need to re-examine our basic assumptions about privacy in the future.

"Designing policies that realize the full potential of pervasive technologies while simultaneously protecting privacy begins with understanding the interaction of these elements with one another. Such understanding *is a critical element in deciding what we, as a society, want the new social norms to be*" [emphasis added].[18]

"What should smart things be permitted to hear, see, and feel? And whom should they be allowed to tell about it?"[19]

"…these emerging technologies have forced us to ask a very important question: What are the implications of these [technological] challenges for the meanings that we, as a society, want to assign to personal privacy and for the legal protections that we want to give to it?" [20]

Source: Various (see endnotes).

2.1.2 A point of clarification of terms

A number of terms are used when discussing privacy and privacy-related concerns and ubiquitous networks. Among these are five common concepts, each with slightly different connotations:

- Privacy
- Anonymity
- Surveillance
- Security
- Trust
- "Privacy" and "anonymity" are related concepts, but with some important differences. With respect to communications, privacy implies the possession of personal information and the subsequent terms and conditions by which it is used, retained, and disclosed to others. Anonymity, however, implies an absence of information about a person and relates to the terms and conditions by which such information might be collected in the first instance. Both concepts highlight the importance of empowering people to control information about themselves.
- "Surveillance" is also related to privacy, but implies something quite specific as the intentional observation of someone's actions or the intentional gathering of personal information in order to observe actions taken in the past or future. Unwanted surveillance is usually taken to be an invasion of privacy. This concept highlights the importance of privacy as a utility that protects people against unwanted intrusions and the right to be left alone.
- "Security" is a term often used in software development to describe the capability of a technical system to protect and maintain the integrity of personal data circulating within that system. Privacy violations can occur when a system is not secure and it leaks personal data to unauthorized parties. This concept highlights the importance of providing regulating mechanisms to balance and check powers of those that provide and those that collect data.
- Finally, the term "trust" suggests the quality of a reciprocal relationship between two or more parties with respect to the use and disclosure of personal information and the respect of privacy rights. This concept highlights the importance of dignity and mutual obligations between human beings (often interacting through corporate or other bureaucratic systeMs

Each of these concepts has a distinct emphasis, which is important in the range of considerations affecting ubiquitous networks; however, for the sake of simplicity in this paper the term "privacy" will be used to refer to them as a bundle of related issues and concerns.

2.2 Studying privacy and emerging technologies

Insofar as the ubiquitous network society remains a vision of the future, it poses a challenge for identifying and debating specific privacy implications today. Such an undertaking therefore calls for a bit of technological foresight on the one hand, which leads to its own pitfalls in terms of predicting how a technological system might develop and become adopted by a society. On the other hand, however, this situation also poses a unique opportunity to the extent that the ubiquitous network vision represents a technology project in its earliest stage of development and which is therefore most open to social shaping in accordance with social norms and desires.

The work of Wiebe Bijker is often cited in studies that consider the social shaping of technological systems, especially those that emphasize the indeterminate character of such systems in the early stages of research and development.[21] The method used in researching this paper was adapted from Bijker and is based on "the principle of symmetry," which is a core tenet of the social shaping approach to technology policy research. Essentially, the principle of symmetry states that investigators should accept all problem formulations as equally valid during the early stages of a technology project. The idea contrasts with other research approaches that seek to identify the correct solution as something that only needs to be uncovered, rather than something that is "constructed" through the interactions of various stakeholder groups with an interest in the technology. With the issue of privacy and ubiquitous networks, however, it is the case that there are many different problem formulations found in the technical and social policy literatures, and reflected in the focus of various research projects. The principle of symmetry proscribes fair regard for all of these formulations, with the idea that each of them may offer critical insights into the future possibilities of this technology project.

In this paper the term *technology project* has been adopted to make an important distinction between relatively "closed" technological systems (e.g., GSM for mobile phones) with open-ended, contingent, and indeterminate efforts such as those that characterize the current state of ubiquitous networking.

Respecting the principle of symmetry, the "ubiquitous network society" is a technology project – a site where social actors and technical elements come together, and where stakeholder groups attempt to persuade other groups as to the merits their *problem formulation* (often drawing on empirical research to support a claim to "truth") and the consequent *design propositions*. Design propositions emerge from problem formulations and represent attempts by stakeholder groups to establish a specific technical system, usually with intended (as well as unintended) implications for social practice and public policy. When several stakeholder groups have different problem formulations, it is likely that a number of alternative design propositions will also be put forward.

This theoretical approach to studying technology projects is useful to the extent that it frames the issue of privacy and ubiquitous networks as an ongoing project of many possible outcomes, and suggests the some specific questions that may shed light on this complicated socio-technical process:

- Who is interested in the privacy issue as it relates to ubiquitous networks?
- How is the problem of privacy formulated in relation to the various elements and actors involved in ubiquitous networks?
- What are the proposed designs to solve the privacy problems that have been identified?

In addressing these questions, the research for this paper has involved a detailed review of peer-reviewed literature and informal consultations with those in the research and development community involved in activities variously termed "ubiquitous" or "pervasive" computing, or "ambient intelligence" as the case may be. A growing number of journal articles are now reporting on the problem of privacy in ubiquitous network systems and a growing community of researchers is now at the forefront of this technology project, defining the problem of privacy as it might be imagined, and proposing solutions intended to support the viability and adoption of future commercial systeMs

2.3 Three domains of information privacy

It is helpful to acknowledge that there are three domains of information privacy, each of which is distinct but also necessarily related to the others:

- The technical domain
- The regulatory domain
- The sociological domain

Within the technical domain privacy is taken up as a design issue related to such areas as network security and user interface design. The regulatory domain takes up privacy as an issue in the context of data protection and related statutes and regulations. The sociological domain, by contrast, considers privacy as a social issue related to cultural practices, ethics, and institutions (see Box 2.3). Problem formulations and design propositions for privacy and ubiquitous networks will assume some proportion of these three domains. For example, a research study that considers the importance of gaining consent in the collection and use of personal information will make assumptions about the feasibility of technical solutions based on perceptions of social behaviour and cultural norms, and perhaps counting on the presence of certain regulatory obligations to provide a legal framework favourable to the proposed technology.

The following section will discuss each in turn, noting a number of subdomains to further develop the framework for studying privacy and ubiquitous networks.

Box 2.3: Three domains of the privacy problem

It is useful to divide the problem of privacy and ubiquitous network societies into three distinct domains. While each of these domains raises its own unique set of problems and proposed solutions, they are also interdependent:

Technical solutions

Regulatory Solutions

Social solutions

Source: www.eurocosm.com/Application/images/Innovations/fingerprint-lock-2.jpg; www2.sjsu.edu/justicestudies/images/justice.jpg; www.mnstate.edu/schwartz/

2.3.1 The technical domain

The technical domain can be subdivided into four layers that correspond roughly to the functional building blocks of all communication systems, including ubiquitous networks. This so-called layer model approach is based on the OSI-reference model used in system design and recently adapted for technology policy research.[22]

All layer models share the same basic feature of classifying electronic services into a set of distinct but interconnected functional strata. In some cases, the layer model is put forward as an enhancement to the traditional "silo" model used where communication systems have been traditionally conceived of as separate systems more or less divided into standalone vertical stovepipes such as voice telephony, radiocommunications, and broadcasting. Within the layer model, these vertical silos are replaced by a series of horizontal, functionally distinct, but interacting, subsysteMs The layer model may be more appropriate for ubiquitous networks, given the centrality of digital convergence to their design.

One version of this model, for instance, consists of four layers arranged from bottom to top (following the OSI convention), from physical systems based on hardware elements to more logical systems based on software elements. The primary layer is that of "physical infrastructure," which includes the provision of transmission capacity and basic physical interfaces. The second layer is that of "network services," which includes the provision of routing and gateway services. At the third layer is "value-added services" that provide access to information content. Finally, at the fourth layer is "information services" where content is created and supplied to or from the end user.[23]

A simple example of the layer model in action is the delivery of a weather bulletin to a mobile phone through short message service (SMS). A combination of wireline and wireless infrastructure (layer one) must enable end-to-end connectivity between a content provider and a handheld wireless device; network services (layer two) then enable the correct routing (and perhaps billing) for the data from the content provider's network, perhaps through a series of gateways, on to an intermediary public network and eventually to the appropriate wireless service provider and the correct cell-site location for radio transmission to the mobile client device that has requested the information.

In this scenario a variety of suppliers are required to support this relatively simple service. At layer one, a physical infrastructure operator is required to provide end-to-end connectivity. In some cases where large distances or organizational boundaries are crossed, several layer one operators may be involved in the physical delivery of the data through routers and other software elements (layer two). The wireless carrier, or perhaps a third party service provider, must operate a portal (layer three) that enables access to weather bulletins for its customers by creating a special user profile account. Finally, a content provider (e.g., a national meteorological bureau) must supply weather data either in a raw or customized form (layer four). All the layers must work together in a secure fashion order to provide customers with a trusted communications service.

Using this model it is possible to identify a number of distinct subdomains of privacy concerns that tend to reside in each of the layers. For instance, at the physical layer, privacy concerns may revolve around the need for encryption of transmissions over public and private infrastructure; at the network layer, the question of anonymity is often raised particularly with respect to spam and the use of “anonymizing” servers; at the value-added services layer, privacy concerns range from the placement of cookies on web browsers to more insidious threats of spyware and trojan horses entering through insecure backdoors of applications, and at the information services layer, we often come across privacy issues related to consent and the use of personal details gathered at websites or through other forms of electronic transactions.

2.3.2 The regulatory domain

In order for the otherwise technical domain of “data processing” to crossover into the regulatory domain of information privacy, a number of actions must take place. For example, a report from the Electronic Privacy Information Center at Duke University looking at location-based services in mobile environments distinguishes three discrete operations needed to transform raw data into personal information.[24] The first of these is the initial gathering of transaction-generated data, the second is the processing of that data in order to transform it into useful information, and the third is the application of that information to enhance commercial or public services. In a ubiquitous network setting, for instance, a service provider might collect raw location data (e.g., in the form of geographical coordinates) from a mobile client device and transform it into a visual representation on a map using Geographic Information System (GIS) software, and then supply that information back to the customer as a value-added service for personal navigation.

This discrete set of actions is reflected in the regulatory and policy domain as four distinct subdomains of information privacy: (1) the initial *collection* of personal information and (2) subsequent *use* and (3) *disclosure* of that information, and (4) the *preservation* and *retention* of information. With these distinctions in mind, it is also important to recognize that transaction-generated data unto itself is not necessarily equivalent to “personal” information, although it has been argued elsewhere that in some instances it should be regarded as equivalent.[25] For example, location information gathered as part of routine traffic data in mobile phone networks might be interpreted as both transaction-generated information and personal information, to the extent that it indicates the presence of an individual. Where the latter classification provides for more extensive privacy protection, which is often the case in regulatory arrangements, the distinction may be important for consumers and operators alike.

Nevertheless it is clearly the case that the gathering of such data and its use and disclosure in combination with other kinds of information – what one privacy scholar has termed the “coordinability” of identity traits – could provide the basis for the creation of personal, even intimate, profiling of customers and users of ubiquitous networks.[26] Moreover, stakeholder groups looking to the development of commercial location-based services for mobile phones (and other mobile client devices) have clearly identified this data-matching operation as essential to their business plans. The technical function of data processing in communication networks is therefore an activity closely aligned with information privacy concerns in the regulatory domain (see Box 2.4).

Indeed, this vital aspect of data-capture and data-matching for customer profiling is behind both the blessed vision and dreaded “Orwellian” curse of the ubiquitous network society, or what we might call the privacy paradox. More significantly, however, the layer model described in the section above suggests that privacy concerns may not be of the same magnitude or type within each segment or operation of a ubiquitous network. Each discrete operation might involve a different set of actors and network elements handling customer or transaction-generated data, thereby creating a hand-off or boundary problem for the management of security and privacy in such networks (see Box 2.5).

Box 2.4: Data Matching for Location Based Services

Location information by itself is of little value to service providers. It is only by data-matching that location information with other customer properties that a profile can be created for delivering value-added services. It is this data-matching process that transforms raw impersonal data into privacy-sensitive information.

Those working in the location-based services sector for mobile clients clearly understand the importance of being able to carry out data-matching as integral their business plans:

> "…knowledge of the user's location is only part of the problem. Depending on where, when, how, with whom, and why customers are navigating in physical space, their needs will vary. …Even if the LBS [location-based services] provider was able to push information or advertising with great reliability to these customers, they might have an extremely difficult time figuring out what the customer is doing or want at that location in real time.
>
> …There is an urgent need for sophisticated mobile marketing techniques based on detailed knowledge of customer profiles, history, needs, and preferences. Information existing in customer databases developed by retailers like Amazon.com, for example, can be used in parallel with location-based information.[27]"

Source: www.esri.com/news/releases/03_1qtr/graphics/orangecell-lg.jpg www.bargainpda.com/assets/2718.jpg

Those stakeholder groups with an interest in promoting ubiquitous network services must address this boundary problem in both technical terms (network security) and in terms of harmonization of regulation and policy across various jurisdictions by taking into account transnational, domestic legal, industry self-regulation and other instruments currently in force or under consideration. In the not too distant future, ubiquitous network services will likely be provided within a diverse range of contexts, ranging from local areas networks, urban environments, and ultimately encompassing global roaming. Privacy protection in one setting must be assured in other settings if these services are to be viable, which suggests that regulation and policy on transborder data flows, encryption and security will have a powerful influence on their development and scope of deployment.

Box 2.5: The Problem of Trust Boundaries

"At the heart of the ubiquitous computing vision lies an inherent contradiction. On the one hand, a computing environment must be highly knowledgeable about a user to conform to his or her needs and desires without explicit interaction – almost reading the user's mind. On the other hand, a system that is truly ubiquitous will encompass numerous users, physical regions, and service providers. At such large scale, perfect trust among all parties is an unattainable ideal. Trust boundaries thus represent seams of discontinuity in the fabric of pervasive computing".

Source: Satyanarayanan, M. (2003). Privacy: The Achilles Heel of Pervasive Computing? *IEEE Pervasive Computing*, 2 (1), 2-3.

Finally, the potential availability of transaction-generated data and personal information profiles is of considerable interest to law enforcement, national security and public safety organizations. The regulatory and policy domain can be therefore subdivided into two further subdomains, one stemming from state interests and referred to as "lawful access" and/or "public safety" provisions, the second to private commercial interests in the general area of "electronic commerce" (see Box 2.6).

The current regulatory domain consists for four predominant types of policy instruments: data protection laws, anti-spam laws, freedom of information policies, and lawful access provisions. For instance, in the UK there are four distinct statutes governing information privacy concerns. The UK Data Protection Act which applies to all organizations that process personal information. It provides a set of enforceable principles intended to protect personal privacy and gives individuals the right access information about themselves held by those organizations. All organizations that handle personal information in the UK must register with the government as data controllers.[28]

The Freedom of Information Act in the UK gives people the general right of access to information held by or on behalf of public authorities. It introduces publication schemes to improve the amount and quality of information routinely made available to the public by public bodies, and establishes the right to ask public authorities for any information they hold.[29]

The UK Privacy and Electronic Communications Regulations are based on a European Commission Directive and cover network and service providers and individuals, using public available electronic communications service, particularly for direct marketing purposes. It is primarily concerned with direct marketing activity by telephone, fax, or email. In terms of the layer model, it addresses concerns raised at layers two and three, by establishing provisions that discourage anonymous distributions systems and provide an accountability regime for those involved in direct marketing activity by electronic means.[30]

The Regulation of Investigatory Powers Act governs the interception of communications, including setting the terms and conditions by which the UK government and designated agencies can acquire lawful access to communications data, conduct intrusive or covert surveillance, and gain access to encrypted data. In terms of the layer model, this statute addresses a number of concerns at the physical layer (layer one) subdomain.[31]

In countries where steps toward a ubiquitous network society are perhaps farther along, new policy guidelines and types of legislation have been introduced in an effort to address new challenges to information privacy. For instance, Japan has embarked on policy efforts to reduce social anxiety and threats to privacy caused by the widespread adoption and use of RFID tags in that country. The Japanese Ministry of Public Management, Home Affairs, Posts and Telecommunications (Soumu-Sho) and Ministry of Economy, Trade and Industry (Keizai-Sahgo Sho aka METI) jointly released a set of RFID Privacy Guidelines in 2004, including provisions for consumer awareness, regulations on collection and use of data gathered by RFID tags, and accountability provisions for data handlers using RFID tags.[32]

Recent advances in mobile phone technology have also created an information privacy problem for those visiting saunas or swimming pools, or trying to protect access to other forms of visual information. A security expert speaking about the situation in Korea is quoted as having said, “You should think that at least three cameras are watching you when you're in public.” In response, the Korean Ministry of Information and Communication (MIC) and Telecommunications Technology Association now requires all camera phones to have clicking noises as loud as 60 db to 68 db, and major handset makers such as Samsung and LG, are now required to add clicking sounds that are activated when their camera phones take a picture. However, it seems that users have already come up with several ways to mute the clicking noise, making this information available to others through the Internet.[33]

Box 2.6: Privacy, Electronic Communications and Emergency Access

In the European Union a distinction is made in Article 10 of the EC Directive on Privacy and Electronic Communications (2002/58), which on the one hand requires subscribers to actively consent (“opt-in”) to the use of their location information while, on the other hand, directing network operators to ignore “…the temporary denial or absence of consent of a subscriber or user for the processing of location data, on a per-line basis for organisations dealing with emergency calls and recognized as such by a Member State, including law enforcement agencies, ambulance services and fire brigades, for the purpose of responding to such calls.”[34]

While the Directive assumes a telephone call as the primary mode of contact, it is reasonable to assume that other network client devices, such as those that might become prevalent in a ubiquitous network would not be exempt from such requirements. A similar provision is contained in American legislation passed following the launch of the FCC mandate to create nationwide Wireless E9-1-1 capability. The Wireless Communications and Public Safety Act was passed in 1999 and requires a service provider to disclose any and all subscriber information that “is in its possession or control” including information pertaining to subscribers whose have chosen to be otherwise “unlisted” in a public directory.[35] Again, this statute appears to be aimed principally at telephony but it has clear implications for any form of wireless communications service that might be useful in responding to an emergency or aiding in an investigation.

Source: European Commission.

2.3.3 The sociological domain

The sociological domain of information privacy can be subdivided into at least three subdomains: (1) the differences between activities that take place in public versus private space; (2) the importance of social power relations in the control over personal information *inflows* as well as information *outflows*; and (3) the importance of consumer education and awareness related to information privacy threats and protections.

The distinction between public and private spaces, and the related privacy concerns, is a matter far less straightforward than one might think. Sociologist Gary Marx, for instance, has made this case in describing privacy as a "border crossing" problem – similar in some respects to the boundary crossing problem found in the technical domain. Clearly data-matching and legitimate customer profiling in a ubiquitous network environment will require the assembly of bits of information from a range of sources collected in both public and private domains. One simple example is the use of RFID tags to track an inventory of groceries in the kitchen as a means of communicating to a commercial server that supports "smart" shopping application in a grocery store. In this case, information is collected in the private domain of the customer's home, is then transited across a public telecom network, and then used by a commercial service provider to provide a value-added service in a retail space.[36] Several boundaries or borders are crossed in providing this service, each of which raised serious concerns with trial participants and which have distinct implications for the protection of information privacy.

Marx's work in this area has attempted to highlight the problem of establishing a fixed distinction between public and private spaces, stating that "the public and the private involve multiple meanings over time and across cultures, contexts, kinds of persons and social categories". One simple example is the treatment of email in corporate settings, where security policies may vary widely. A strong policy might treat all email over the corporate network as "public" in the sense that administrators and managers may request access to such communications. In a different office setting, however, such communications might be treated as personal and "private" and thereby given a higher order of protection from third party interceptions. To sort out the conceptual difficulties that arise in determining public and private distinctions, Marx has identified a set of parameters for consideration, three of which are particularly relevant for the problems created by ubiquitous networks:[37]

- Legally defined places, either geographical or in terms of information access;
- Customary expectations concerning public and private distinctions;
- Accessibility of information to non-enhanced senses (i.e., without an artificial detection device)

Based on these parameters, a more nuanced formulation of the public/private space model might include the idea of unique information spaces within, for example, an office building where various levels of permissions and privacy requirements are established based on the activities and resources present in those physical locations. Similarly, it would raise the problem of the status of data produced by human bodies and possibly detected by network-enabled sensors to measure presence or movement.

The key to the privacy problem as it pertains to notions of public and private space is in the violation of personal borders, regardless of how it is done. These personal borders may be natural ones (clothes, walls or closed doors, or sealed packages that contain information), or these borders may involve social norms (expectations as to confidentiality with certain people such as doctors or lawyers); or they may involve spatial or temporal borders related to old information (e.g. deleted files) or bits of history of one's past. Ubiquitous networks may permit new opportunities for violations in each of these types of border crossing, particularly in the spatial and temporal factors. Computer scientist Frank Stajano, for instance, has noted that with the running costs of data storage dropping so dramatically in recent years, "there is no economic requirement ever to delete anything. Whatever was once digitized is now stored forever. This property, which I shall call *denied oblivion*, is the source of many new privacy probleMs"[38] Stajano's denied oblivion describes a scenario in which events from one's past are forever potentially retrievable, creating an emergent border crossing threat. Some in the research and development community have drawn explicitly on Marx's border crossing model to structure their work on information privacy for ubiquitous networks.[39]

A related problem to privacy in the sociological domain is that of "anonymity", where people wish to interact with others but to conceal some features of their identity. In addition to his border model of privacy, Gary Marx in a related study suggests that there are several discrete forms of identity knowledge. When used in combination these traits may reveal relatively unique patterns of behaviour, thereby rendering anonymity difficult to achieve in practice:[40]

- Legal name given to a person
- "Locatability" of a person in space
- Pseudonyms (traceable or untraceable) used by a person

- Patterned behaviour of a person
- Social or physical attributes of a person
- Symbols of eligibility/non-eligibility (e.g., member of a club)

As regards issues of power relations in the micro-social settings of everyday life, an early and widely cited paper on privacy in ubiquitous computing environments establishes a framework for assessing the design of networked systems and control over personal information. Examining the social domain from the perspective of system design, Belloti and Sellen identified "two classes" of problems related to information privacy in ubiquitous network environments. The first of these is related to what we might term the "hostile observer" and is primarily a security-related concern. The second type of problem, however, addresses a more difficult problem related to everyday life of the user and control over the flows of personal data that a ubiquitous network system may enable:

> "Mediated interactions between people via technology are prone to breakdowns due to inadequate feedback about what information one is broadcasting and an inability to control one's accessibility to others. This disrupts the social norms and practices governing communication and acceptable behaviour."[41]

Further in the paper, Belloti and Sellen identify two concepts to explain how such breakdowns might lead to potential privacy intrusions:

> "The underlying causes of such problems lie in the fact that the technology results in *disembodiment* from the context into and from which one projects information … and *dissociation* from one's actions. These phenomena interfere with conveying information about oneself or gaining information about others" [emphasis in original].[42]

While the authors are concerned primarily with human-computer interface (HCI) design as a method of preventing intrusions on privacy, their paper also highlights inherent tensions in the relationship between information inflows versus outflows that are likely to be present in a ubiquitous network environment. For instance, the paper formulates the privacy problem as one of information *control* and *feedback*. More specifically, the authors refer to these as "two important principles," that seek to empower the user to stipulate what information about them is being collected, used, disclosed, and retained. While the principles are clearly desirable from a social and human rights standpoint, the feasibility of putting them into practice is another story, as will be seen when this paper turns to consider the range of design propositions put forward by the community of ubiquitous network experts.

Consumer education and awareness is another subdomain of information privacy concerns that falls within the sociological domain (see Box 2.7). The growth of electronic communications systems and massive collection of personal information even in today's world, makes it extremely difficult for consumers to know when information about them may be collected or to understand their rights with respect to the collection or use of their personal information. Such challenges extend to the complicated privacy policy statements found on websites or in service agreements that are routinely ignored by people and even when carefully examined may not be fully comprehended by those without some degree of legal training.

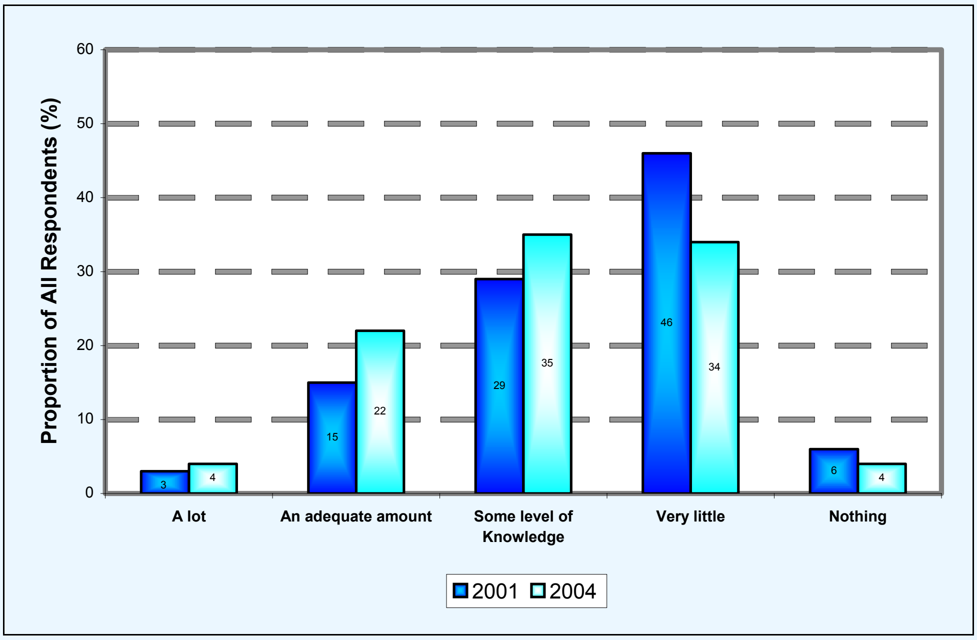
To further complicate this subdomain, there may be instances of individuals who clearly show a blatant disregard for their information privacy, and simply ignoring warnings. An often cited study by Westin suggests, for instance, that it is possible to identify three distinct groups of attitudes in relation to information privacy: the marginally concerned, the privacy fundamentalists, and the privacy pragmatists. Whereas the marginally concerned are mostly indifferent to privacy concerns, the privacy fundamentalists are uncompromising and proactive in their protection of personal privacy. Most people tend to fall into the pragmatist camp, willing to trade personal information if the benefit seems appropriate.[43] Given the prominence of this utilitarian motive, it seems all the more important to make consumers aware of the pitfalls in order that they can make informed judgements.

Box 2.7: Knowledge about rights to personal information protection

Responses to an Australian Privacy Commissioner 2004 survey on community attitudes toward privacy indicate that members of the public may not be well informed about their rights when it comes to the protection of personal information. For instance, the study asked respondents: *How much would you say you know about your rights when it comes to protecting your personal information?* The results were then compared to those obtained in a 2001 survey. The 2004 report states:

> "Since 2001, respondents report a greater knowledge about their rights to protect their personal information. However levels of knowledge are still low, with only one in four respondents claiming to know an adequate amount or more about their privacy rights as a whole. One group that appears to have better knowledge now than in 2001 is the 18-24 year olds. In the 2001 study, 52% of the younger respondents (18-24) claimed to know very little about their rights to protect their personal information. By 2004, this had reduced to 36%, which is not significantly different to the rest of the population 18+."[44]

Responses to the question asked: "How much would you say you know about your rights when it comes to protecting your personal information?"



Source: www.privacy.gov.au/publications/rcommunity/chap4.html

3 ADDRESSING PRIVACY CONCERNS IN A UBIQUITOUS NETWORK SOCIETY

The following section considers the privacy paradox from the point of view of those in the research and development community, and divides the current field into a number of distinct areas for consideration. These involve a range of problem formulations and design propositions, each taking up the privacy problem in a slightly different manner depending in part on the domain that is most emphasized (e.g., technical versus regulatory or sociological).

3.1 The consent problem

The consent problem is apparent in a recent survey that examined public views on privacy and "popular ubiquitous technology" that includes the London Underground Oyster Card, the London Congestion Charging System, and mobile phones.[45] The paper offers seven "privacy recommendations" that echo four assertions shared among similar studies: ensure full disclosure and transparency in design of the systems as it relates to collection, use and disclosure of customer information; simplicity of interaction for user access to and control over personal data; seek active consent from users (to address user apathy); employ mutable privacy conditions depending on context of use.

On the one hand these assertions correspond closely to the control and feedback principles espoused by Belloti and Sellen and, for the most part, are already expressed in existing legal instruments. On the other hand, however, they represent a starting point from which to ask important follow-up questions that begin to deepen our appreciation of the consent problem as it relates to ubiquitous network systeMs For instance, the seven recommendations overlook the fact that personal information is not simply that which has been explicitly collected from an individual but may also include transaction-generated information (TGI) that may not be apparent or known to the user. Moreover, asking a user to approve or consent to every tiny ping for data makes the ubiquitous network vision unwieldy, hence the need for mutable privacy conditions depending on context of use. Yet, how are boundaries established to distinguish context of use, who determines such boundaries, and on what grounds might we designate a third party or software agent to give consent to release personal details on our behalf? Under what circumstances might we want to supersede our agent and how will it/we know when those kinds of situations have arisen?

3.2 The challenge of anonymity

Work done using the Active Bat at AT&T Lab in Cambridge, has considered the problem of anonymity in ubiquitous networks. For these researchers, the primary focus is on location privacy, defined as "the ability to prevent other parties from learning one's current or past location."[46] In effect, the research contributes a formulation of the data-matching problem, particularly in public or otherwise insecure environments where "hostile observers" can collude and share information to build profiles on users.

The typical solution to such a problem is to develop a technique for assigning pseudonyms to users to create an opaque identifier and thereby protect the matching of location data with personal information. However, it also finds that even when pseudonyms are being employed to protect privacy it is still possible to track users movements and to match those interactions with other kinds of transaction-generated information to produce a unique profile. The experimental approach used in the study has two components: frequently changing pseudonyms and mix zones. A mix zone is a connected spatial region in which no user has registered with any specific application. Users enter and exit a mix zone from application zones, where they may be registered under a pseudonym to obtain service. To avoid tracking a single pseudonym from place to place and matching it with other data that may be generated in association with applications, the pseudonym is changed whilst in the mix zone, where some form of "anonymizing" proxy is used to carry out this operation. The idea of this solution is to prevent linking of old and new pseudonyms, thereby rendering them untraceable.

In this system, the border-crossing problem is turned to an advantage for the user by enhancing their anonymity as they move from one space to another. However, the limits of anonymity are reached depending on the size of the mix zone and the number of people in it at the time a user makes a visit. The fewer people present in a mix zone, the lower the anonymity factor. In response, users may refuse to provide location updates to an application until the mix zone they are in achieves a certain level of anonymity.

3.3 What your body might betray about you

Others in the R&D community have identified the problem of user awareness and the ability of ubiquitous systems to collect data from a wide range of sensors, both active and passive. One ethnographic study, for instance, looked at an "eldercare facility" in the USA, which finds that users are most unaware (and likely to remain so) of the potential and actual uses of sensor data gathered in the residence.[47]

A report on the study begins with the premise that "too little empirical research exists to inform designers about potential users." Complicating this is that ubiquitous systems are intended to be invisible, making it more difficult for users to understand or even become aware of the impact such systems might have on their personal privacy. One typical example is the use of so-called load cells in the eldercare residence, installed on each leg of the residents' beds, "primarily to track trends in weight gain or loss over time." While these sensors may play an important role in tracking the health of the residents, they may also be used in conjunction with other kinds of collected data for either intended or unintended purposes. Sensors that report changes in mass of an object, for example, can be used to determine when residents get into or leave their beds, and if sensitive enough they might detect the fitfulness of sleep, or indeed if more than one person is sleeping in the bed. Used in conjunction with other information, such as sensors to detect the use of doors, such load cells might inform unwanted observers of the presence or absence of a person in a room, thereby opening up an opportunity for theft or other intrusion.

Our bodies emanate a great deal of information that may be collected, unbeknownst to us, about our behaviours. In most cases, this data will need to be matched with other forms of information to produce useful profiles for intended services. In other cases, however, such data may be collected and used without our knowledge or for purposes that are clearly unintended.

3.4 Autonomous computing

Related to the passive capture of data in ubiquitous networks is the problem of establishing trust relationships using established procedures and techniques:

> "User authentication and access control are cornerstones of traditional information security systems, and are aimed at ensuring that information is neither disclosed nor modified improperly. Given the long history of research in this space, these mechanisms are, obviously, the natural counterparts of what we require for pervasive systeMs Thus the obvious first approach to our problems is to attempt to deploy traditional mechanisms in this new environment. Sadly, this approach is flawed."[48]

The authors of this paper argue that empirical evidence points toward the difficulty of ensuring certainty in user identification and, moreover, to a fundamental shift in the foundations of computing systems characteristic of ubiquitous networks, where underlying elements and interactions are not relatively stable but, on the contrary, highly dynamic and radically scaleable:

> "Emerging network technologies repeatedly stress and provide functionality that supports the mobility of components, dynamic and distributed program execution, heterogeneity of services and a massive increase in the numbers of components and their geographical distribution. Consequently, an unreasoning reliance on traditional security mechanisms simply because they are traditional is, at best, flawed and, at worst, life threateningly dangerous."[49]

Establishing trust relationships is linked to privacy inasmuch as the creation and maintenance of such relationships will depend to some degree on willingness and ability to collect and disclose information between parties, be they individuals in a direct exchange or perhaps software agents acting on behalf of individuals. Where ubiquitous networks are characterized by an absence of centralization, "network resources are forced to make trusting decisions locally, in light of the information that they themselves can gather."[50]

This radically decentralized architecture of autonomous, or "autonomic", computing systems that are proposed for ubiquitous networks have serious implications for privacy, although these implications are often presented as a penultimate slide problem, meaning that they appear as closing thoughts in much of the literature on system design.[51] Nonetheless, we can glimpse some of the implications by looking at how developers have put into question various aspects of ubiquity and invisibility by looking at the challenges of linking the physical world with information networks, and in particular the crucial necessity of enabling network nodes to operate autonomously. As one observer puts it, "perhaps more than any other dimension, autonomy is most significant in moving us from embedding instruments to embedding computation in our physical world."[52]

The need for such decentralized systems as the underpinning of ubiquitous networks, suggests that individual nodes in such networks will require the migration of user consent and authorization away from centralized databases and toward the peripheral elements:

> "...we cannot realize long-lived autonomous systems by simply streaming all the sensory data out of the nodes for processing by traditional computing elements. ...we must construct distributed systems whose outputs are at a higher semantic level – compact detection, identification, tracking, pattern matching, and so forth."

Among other things this raises the problem of privacy as it relates to machine-to-machine communication (sometimes called "telematics") in ubiquitous networks, where human intervention is largely relegated to setting policy and implementing it through software systeMs Table 3.1 summarizes some of the problems identified in such autonomous architectures and the foreseeable privacy issues that might arise.

Table 3.1: Autonomous Computing and Privacy

Design Factor	Problems Identified	Privacy Concerns
Immense scale of ubiquitous network architecture	Need to use a vast number of small devices, each with limited capacity but achieving reliability from a large quantity of partially redundant measurements and their correlations.	Boundary crossing and insecure gateways; data matching and profiling necessary to produce reliability from small, partial samples.
Limited access to nodes and some devices	Inaccessibility of some embedded devices requires that they perform autonomously, with limited human attendance. For example, increased miniaturization means that every tiny sensor and controller may need to have its own processing and communication capabilities.	Information sharing with unknown systems (e.g., ad hoc network or in a mobile context); and data retention (e.g., multi-task and memory requirements); location privacy with mobile systeMs
Devices and networks exposed to extreme environmental dynamics	Sudden and relatively high-level flows of data must be accommodated, which means that components must be capable of rapid coordination and adoption, often involving some form of information sharing.	Data retention at decentralized points to avoid need for active consent; data matching permissions related to multi-modal sensors and consent (e.g., biometric data used to trigger a flow of another mode of personal data).

Source: LSE.

3.5 Hard security problems

The problem of establishing trust and protecting privacy in ubiquitous networks has numerous dimensions, many of which are nicely summarized as a set of "hard security problems".[53] An interesting observation about these problems is that they reside within overlapping domains of technical, regulatory, and social factors. As such, they help to illustrate the complex nature of addressing privacy concerns while attempting to realize the ubiquitous network vision of invisibility and pervasiveness.

The first problem is a fundamental matter of establishing trust, with the question "Who or what am I talking to?" This is a basic "trust-bootstrapping problem," in relation to the user having confidence that the other party or device with which they are interacting is indeed what it claims to be. For instance, a customer using a mobile client to conduct an e-commerce transaction will want to have some a priori assurance that the server is part of a bona fide service and will not be engaged in illegal skimming of credit card details. A more problematic situation might be one in which a malicious device masquerades as a seemingly innocuous device, say perhaps a remote printer, and under that guise gains access to a user's private account information stored on their mobile client. Perhaps ironically, this problem of establishing certainty as to the device identity on electronic networks, is intractable without "an initial exchange of information via a trusted physical channel", which may require initial exchanges to take place beyond the boundaries of a ubiquitous network, perhaps requiring the physical presence of other people or devices or through some other embodied form of contact.

Related to the initial problem of establishing trust at the outset, is the other problem of trusting the integrity of a device once its identity has been determined. Such a problem may require the development of trust-negotiation protocols that can assess the reputation/trustworthiness of devices. Some form of security assurance, for instance, may be necessary to categorize devices based upon their various technical properties, in particular those combined elements in the lower layers (physical, network access and application). Early work in this area has been done by the Trusted Computing Group (TCG), setting out specifications that include: "support for mandatory controls, trusted runtimes, hardware-based software integrity reporting, secure storage, support for non-repudiation in transactions, tamper-resistance, domain-based isolation, network-immunity, self-healing mechanisms, theft-deterrence, and fail-secure capabilities" (see Box 3.1).[54]

Box 3.1: Security and ubiquitous network systems

Privacy and trust are related to the security of network systeMs If devices and networks cannot provide certain minimum levels of security assurance, then users will not have the confidence to use them. In response to the hard security problems of ubiquitous networks, industry stakeholders have formed the Trusted Computing Group to develop and promote security assurance solutions. Although many consumers may never become aware of these solutions, they will no doubt play a major role in establishing trust by promoting minimum standards of security assurance in the marketplace.

"The Trusted Computing Group (TCG) is a not-for-profit organization formed to develop, define, and promote open standards for hardware-enabled trusted computing and security technologies, including hardware building blocks and software interfaces, across multiple platforms, peripherals, and devices. TCG specifications will enable more secure computing environments without compromising functional integrity, privacy, or individual rights. The primary goal is to help users protect their information assets (data, passwords, keys, etc.) from compromise due to external software attack and physical theft."[55]

A growing concern addressed by TCG is the threat of software attacks that may lead to incidents of identity theft and industrial espionage. The threat is seen to be increasing due in part to three continuing developments:

- Increasing sophistication of hackers and hacking techniques, including automated attack tools
- An increase in the detection of vulnerabilities in complex computing environments
- The increasing mobility of users

The TCG, citing data from the Software Engineering Institute at Carnegie Mellon University, notes that reported vulnerabilities doubled each year between 2000 and 2002.[56] With the deployment of ubiquitous network systems, it is conceivable that these vulnerabilities will continue to increase in numbers and in terms of difficulty of detection. Each point of vulnerability in a ubiquitous network is a potential threat to privacy, but perhaps more importantly the perception of vulnerability promulgated in media reports and rumours could seriously erode the trust of consumers.

Source: TCG

3.6 Encryption and shared consent

An interesting proposal for the problem of intrusive devices, such as camera phones and other portable recording devices is to combine encryption with an algorithm that requires shared consent to enable access to collected images or other forms of information. A number of proposals have already been developed to address the growing problem of portable recording devices, including an idea called Safe Haven, which proposes to transmit a disabling signal to camera phones in a specified area as a means of preventing unauthorized recording of images. Candidate locations for such a system might be a change room at a public swimming pool or in cinemas or other entertainment venues.

Critics of this proposed solution suggest that it may have several drawbacks; namely, that it is a relatively crude system that ignores the possibility that certain occasions may arise where it is reasonable and perhaps necessary to permit portable recording devices in an area. Concerns about the use of mobile phone silencers (radio jamming devices that render mobile phones useless in a specific area) in public locations, for instance, have centred on the fact that in some instances, such as during an emergency, having access to a working mobile phone may be a matter of life and death. It may not be so far-fetched to suggest with portable recording devices, that privacy may in some cases be a matter of context and that there may be legitimate reasons for capturing images or sounds in otherwise prohibited areas.

Another critique levelled at the Safe Haven type solution is that "in practice, the usefulness or sensitivity of a recording is sometimes only apparent long after it is created and may depend on who it allowed to replay it."[57] As such, the privacy concern with portable recording devices may not be with the actual moment of data collection but rather with later moments of use and disclosure. One proposal to address the drawbacks of existing privacy protection methods would encrypt data as it was being recorded by a device. The resulting file would be effectively sealed against use or disclosure, even if it were removed from the original device, until all parties to that recording provided consent for its de-encryption. This proposal errs on the side of privacy and is based on two underlying principles:

- Unanimous consent. All parties to the recording must consent to its use; otherwise it effectively remains encrypted and relatively useless.

- Confidentiality of policy. Any party's decision to grant or withhold consent is not revealed to any other party to the recording.[58]

The solution, while perhaps viable in theory, faces some formidable challenges in practice. For instance, it involves a sophisticated architecture that would require all devices present in the recording situation to be aware of each other and to have sufficient computing power to carry out compatible cryptographic operations. In effect it is established on the assumption that all devices present in a situation will have similar features and capabilities and, moreover, will be activated.

Assuming that devices are compatible and activated – however unlikely it might be in practice – there is another and more difficult problem with this kind of shared consent design proposition. Let's take a look at what the designers consider to be a simple scenario to see just how problematic this concept might be when introduced into a public location:

> "Some cases are easy. For example, an audio recording of two people conversing obviously implicates the privacy interests of both participants. We [can] generalize this by assuming that whenever a recording is made, every person who is present at the time of recording has a privacy interest in it. We [can] include even people who, though present, are not directly recorded, such as participants in a group conversation who never speak. We do this on the conservative assumption that speech addressed to a person may implicate his privacy interest whether or not he speaks. … we believe that … giving each person present a veto over creating recordings, and over the subsequent release of such recording, is the best available course."[59]

Whereas the intent of the unanimous consent approach is to ensure a democratic authorization when it comes to disclosing information, it appears to overlook the scenario of unintended disclosure of information to unknown parties. For example, in the above scenario it is easy to imagine that there could be someone who is neither part of a conversation nor part of a group but is nevertheless within the vicinity of a recording. As such, if this person has a mobile client that is activated with the appropriate application they may be included by default in a shared consent request (simply because they are in the vicinity of the recording). This person may have no interest in denying consent and so gives approval. If all parties approve, then the recording may be released to all including, unbeknownst to the intended parties, the unknown individual(s) that happened to be in the vicinity of the time it was made. In other words, unanimous consent in this instance might in fact result in unintended disclosures of personal information to third parties.

Nonetheless, the shared consent approach, using encryption to protect personal information is important to the extent that it recognizes the principle noted earlier in this paper that privacy is a collaborative undertaking among two or more parties and that design propositions should take this into account as a fundamental consideration if they are to be effective when dealing with the complex social and technical interactions enabled by ubiquitous networks.

3.7 The sticky policy paradigm

Problem formulations that emphasize the need to minimize undesirable boundary crossings as threats to information privacy may adopt a sticky policy paradigm based on a system of unified privacy tagging. Research efforts that draw on the previously described border crossing model of privacy, for instance, establish a concept of "information space" to describe a means of creating virtual boundaries that interact with "sticky" privacy tags assigned to a device or application.

The sticky policy is established on three operations that can be applied to objects interacting with an information space:

- The capability of being able to read and write (to and from) an object regarding its privacy status.
- The capability to promote and demote an object's status (e.g., its visibility to the network; the longevity of the privacy tag).
- The capability of aggregation of data through an object (e.g., access to multiple information sources, the level of information detail an object is permitted to collect, use and disclose).

Owners assign permissions to each operation for each object within an information space and boundaries may be identified by physical presence (e.g., location-aware devices); and/or social activity-based criteria (e.g., application being used).[60] For instance, a sensitive digital document might be tagged with a set of specification that allow it be uploaded and accessed by specific individuals while they are in a specific location, such as a meeting room. When the individual leaves that room, the document then becomes unreadable or is deleted from their laptop computer. Similarly, the document may be tagged to permit certain levels of detail depending on the individual in possession of it. Whereas as a corporate CEO might have full access to all financial details in a digital document, a clerk might be authorized to see only certain less sensitive sections of the same document.

In essence, the sticky policy paradigm means that a privacy policy is assigned to a device or other data object and then travels with it over time and space. Proposals for this system of "unified privacy tagging" would be based on a form of metadata that would consist of at least three parameters:

- a "space handle" specifying the information spaces to which an object belongs;
- a "privacy policy" specifying permissions for different types of operations (see list above);
- a "privacy property list" specifying an object's lifetime, accuracy, and confidence parameters.

The privacy tagging approach tends toward an administrator-centred design proposition as contrasted with other possibilities that place greater control with the individual user.

3.8 Privacy enhancing technologies (PETs)

The term "privacy enhancing technologies" or PETs describes a range of technological solutions to privacy management for the individual user, that attempt to provide direct control over the revelation of personal information, such as cryptographic systems, "anonymizers", and cookie management software.[61] Despite their promising role in protecting personal privacy, PETs have not been widely accepted by individual consumers and are subject to at least four types of criticism coming primarily from the social domain: one, that PETs are often too complex for many users; two, that PETs are not well suited to the contextual shifts in identity management that take place when users move from one kind of interaction to another (e.g., from a familiar website to an unfamiliar website); three, that they place the burden of privacy protection on the individual in the face of commercial pressures to surrender personal information in exchange for products and services; and, four, that PETs reinforce the notion of privacy as an issue about individual rights rather than it being a wider community or social value.[62]

Findings from studies that have examined the problem of privacy management and new technologies suggest that the limitations of PETs will be exacerbated in a ubiquitous network society and that new or different models for control of personal information will need to be adopted. For instance, the authors of one report claim that "effective solutions will not come solely from repairing the usability problems associated with existing technologies, because the very nature of those technologies – the ways in which they conceive of the problems of [privacy] – is a source of the trouble ...effective [privacy] will require that we examine the conceptual models on which our systems are built."[63]

More specifically, in studying the everyday activities of PETs users, researchers have confirmed that privacy management is a highly contextualized activity, where "it may be inherently implausible for typical users to specify, in advance of particular circumstances, what their security needs might be; [and that] those needs arise only as a result of specific encounters between people, information and activities."[64] One of the problems with PETs today is the requirement for users to specify their privacy preferences in an abstract manner, away from the intuitive and situated context in which many of these kinds of decisions are often made.

Design considerations that stem from this finding are threefold: first, information sharing and information protection mechanisms are two sides of the same coin, as it were, and should be available in combination; second, privacy protection applications need to be highly visible as part of the routine work flow of the user, rather than being preset and then disappearing into the murky depths of the device's operating system; third, the appropriate unit of analysis for privacy management is two or more parties, rather than the individual. This implies reciprocity between parties rather than a simple one-way flow of information.

The first two considerations also respond to problems associated with the context of privacy-related decision making, as well as memory and visibility. With respect to memory, the problem is when a user sets preferences at one point in time and then forgets about them. With respect to visibility, a problem results when a user is given limited control over privacy settings in the first place (e.g., an administrator is the only authorized person to change settings on a device).

Design propositions stemming from these observations will need to correct for memory lapses and visualization problems in privacy-related decision making, on the one hand, while considering privacy management as a problem in two-way information flows rather than with individuals surrendering their personal data. Clearly the latter point is important, as the issue of "trust" cuts both ways in a ubiquitous environment because users will not adopt services without assurances from service providers and service providers will not have incentives to invest in pervasive computing without effective means of establishing identity and authorization of users. In fact, authentication and authorization questions are paramount considerations, particularly with respect to how techniques might be improved or re-considered for ubiquitous network environments.

Some suggestions for expanding the current range of PETs include techniques to increase awareness of privacy exposure level of a user through the deployment of privacy beacons, or the possibility of maintaining an audit trail of privacy-related interactions, while some in the development community have proposed the development of a "sixth sense" for alerting users to certain situations, which could involve something like a reputation system used in e-commerce arrangements such as e-Bay.[65]

Practically speaking, a compromise along this line of thinking seems to point to one or more of the following criteria in terms of favourable designs for the next generation of PETs :

- The need for active decision-making and feedback for users means that privacy systems evolve into active but relatively discrete "desktop" applications, much like a dashboard indicator in an automobile. Users will assume a certain degree of responsibility for their own risk taking behaviour.
- The increased risk to users means, however, that trust through verification will become important, suggesting the creation of certification mechanisms or trusted intermediaries for interactions and privacy alerting.
- Together, these two requirements suggest the need for an infrastructure element that triggers alerts and provides information to allows users to assess risk and make decisions quickly and relatively unobtrusively.

All of these proposals, however, could be criticized on two key points mentioned previously: one, that the "invisibility" mandate for ubiquitous networks seems to be at odds with the requirement to place a privacy management system upfront at the user interface and where users might be continuously prompted or reminded about this concern. Second, that social issues of power and control within the workplace and, perhaps more widely between users and providers of commercial services, will likely created obstacles to more equitable model of privacy management. Certainly in a corporate setting, there is a strong incentive in many circumstances to reduce the scope of user control to ensure security and asset protection. Likewise with a commercial service, operators and providers may want to limit liability through certain control mechanisms imposed on their customers' access to network services and parameters.

Other foreseeable difficulties include a requirement to preset a range of privacy thresholds (perhaps using the dashboard metaphor this might suggest the idea of "privacy limits") and leaves open the problem of deliberate risk-taking behaviour or simple ignorance on the part of users as to what these indicators might mean. The technique of producing an audit trail of privacy transactions creates a second-order problem of who or what will manage the audit trail, which then touches upon other privacy management concerns such as data retention and unintended disclosure of information.

3.9 P3P and other labelling protocols

Labelling protocols offer a means of negotiating informed consent in electronic transactions in cases where anonymity is neither possible nor desirable (e.g., e-commerce transaction). The protocol solution is different from the sticky policy paradigm insofar as it is based on a meta-model for defining a privacy negotiation during a client and server transaction, rather than being a policy that travels with an object.

One major attempt at developing such a labelling protocol has been the P3P initiative of the World Wide Web Consortium (W3C), which is described as an ongoing effort to develop a privacy standard for the Web. Computer scientist Mark Ackerman refers to P3P as "the first social protocol", meaning that it is a system designed specifically around resolving social needs rather than technical ones.[66]

In essence, P3P addresses the problem of user consent by delegating this task to a protocol that will assist in reaching informed agreements with service providers, ridding the user (to some extent) of having to read and attempt to understand potentially complex privacy statements each time a service is requested (see Box 3.2).

Despite its initial success, the P3P concept has been criticized on several points: first, along political economic lines, similar to those levelled at PETs, that P3P reinforces a normative framework where privacy is turned into a form of market good, and that the terms and conditions of defining privacy for implementation in P3P are a strategy to avoid proper regulation of the Internet.[67] David Phillips, for instance, has suggested that certain privacy enhancing technologies frame the social debate about privacy within a narrow notion of it being freedom from personal intrusion, while excluding another perspective more concerned with growing forms of social surveillance and the value of asserting a collective right of privacy under such conditions.[68] Such critiques pose a challenge to many of the fundamental assumptions of developers, policymakers and users alike; namely, that privacy is a matter for individuals to decide for themselves. Although these critiques are not addressed at length in this paper, they are important for a wider ethical debate about privacy rights within a ubiquitous network society.

Other experts have been slightly less ambitious in their critiques of P3P, focussing on user interface design, and arguing that so far most design propositions are based on a far too simplistic understanding of the consent situation, or what others have termed the "configuration pitfall."[69] According to some in the development community, good design for ubiquitous network devices "should not require excessive configuration to create and maintain privacy," and that "they should enable users to practice privacy management as a natural consequence of their ordinary use of the system."[70] A major problem with interface design crops up when users are asked to spell out their privacy needs out of the context of use. This may impose an awkward arrangement on users who may forsake active configuration with simple default settings for all contexts, rather than taking time to apply more nuanced adjustment of privacy parameters.

Reflecting on this criticism of user interface design, which Mark Ackerman believes reflects a "socio-technical gap" that exists between user practices and technical capabilities. The first of the problems is vocabulary, insofar as P3P and other protocols require succinct and unambiguous concepts that are not well matched with the multi-dimensional, situational experience of users in the process of negotiating consent. Achieving a balance between simplicity and understanding remains a major hurdle, as other researchers have noted.[71] Similarly, the configuration pitfall involves a fundamental disruption to the invisibility aim of ubiquitous networking, given that "no one knows how to construct a user interface that is suitably flexible but does not require the user to interrupt social interaction" for it to operate effectively. The socio-technical gap, in other words, exists where natural user practices are constrained by the limits of technological know-how.

No such protocol like P3P yet exists for the challenges that ubiquitous networks are expected to present but Ackerman suggests that a next generation labelling protocol is a valid way forward, noting several new considerations that will need to be addressed:

- Heterogeneity of environments – individuals will be in a wide variety of social and organizational contexts that may change quickly and radically in terms of user preferences for privacy management when on the move across these contexts.
- Intensity and diversity of data requests – in certain contexts, users may be continuously bombarded by requests for personal information. User interface design will need to balance between the need for active notifications and automated approvals or denials based on pre-configured user preferences.

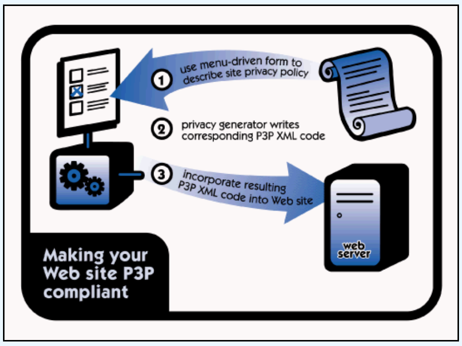
User (mis)understanding – even with effective user interface design, users may need help to understand the full implications of their decision at any given moment. Privacy risk management, backed up by enforcement mechanisms, will need to be considered for next generation labelling protocols.[72]

Box 3.2: P3P (Platform for Privacy Preferences)

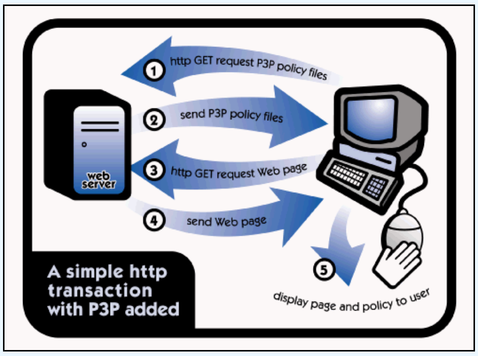
The World Wide Web Consortium (W3C), a group formed in 1994 by Tim Berners-Lee, to promote and guide the Web's development, is behind the P3P initiative. P3P was inaugurated in 1997, with its first working draft issued in 1998. Since then this labelling protocol has undergone considerable development with the aim of providing a relatively simple means to allow users to gain more control over their personal information when browsing the Web. Computer scientist Mark Ackerman regards P3P as useful point of departure for what he terms "next generation" labelling protocols that will be needed for ubiquitous networks.

The official P3P website describes how it works as follows:

"P3P enables Web sites to translate their privacy practices into a standardized, machine-readable format (Extensible Mark-up Language XML) that can be retrieved automatically and easily interpreted by a user's browser. Translation can be performed manually or with automated tools. Once completed, simple server configurations enable the Web site to automatically inform visitors that it supports P3P."



"On the user side, P3P clients automatically fetch and read P3P privacy policies on Web sites. A user's browser equipped for P3P can check a Web site's privacy policy and inform the user of that site's information practices. The browser could then automatically compare the statement to the privacy preferences of the user, self-regulatory guidelines, or a variety of legal standards from around the world. P3P client software can be built into a Web browser, plug-ins, or other software."



Source: www.w3.org/P3P/

3.10 Social norms and conventions

The banning of individuals or devices from certain areas is another proposal for addressing privacy problems in ubiquitous networks. Camera phones and other discrete surveillance devices illustrate the potential problem of unwanted data collection in public or private spaces. In many cases, even where a technical solution has been implemented, such devices might be banned from certain spaces, such as corporate offices or entertainment venues. In other cases, a cultural practice might arise that frowns upon the use of such devices in certain circumstances, leading to a socially reinforced norm that is strong enough to elicit compliance on the part of most people. Of course the earliest example of this, although it is far from perfect in many instances, is the ringing of mobile phones in cinemas and other location. The creation of quiet zones on trains and in public spaces also represents non-technological solution that may come to have parallel forms in terms of privacy protection in ubiquitous network societies of the future.

A more ambitious perspective on social norms comes from sociologist David Lyon who has written extensively on the ethical problems that will accompany a ubiquitous network society. He makes an important point about systematic collection and use of personal data and the negative consequences of social sorting that is enabled by pervasive computers and communications:

> "Today's surveillance is computer-assisted – indeed, because it depends on computer codes it is in a sense computer-driven – and the information infrastructures permit data-sharing and increasingly diverse data collection on an unprecedented scale and at an accelerating pace. The surveillance concerned is a form of social sorting, of categorizing persons and groups in ways that appear to be accurate, scientific, but which in many ways accentuate difference and reinforce existing inequalities."[73]

Lyon, and others, call for a new ethical approach to privacy in which respect for the "whole person" is asserted against tendencies toward creating and prioritizing increasingly digitized representations of people that are suited to data processing and data mining operations. Lyon is not necessarily calling for a halt to progress but, rather, his sociological stance is one that seeks to retain a concept of personhood less obsessed with extending control over every feature of human existence.

4 CONCLUSION

The aim of this background paper has been to stimulate discussion and debate on privacy in ubiquitous network societies by providing background information and by drawing attention to a sample of recent perspectives on the issue. To reiterate a point made in the introduction, this paper is not intended to provide clear answers to the challenges that ubiquitous networks will bring to privacy but, rather, to draw out a number of cross-cutting concerns and distinct domains of interest.

The paper began with a brief discussion to establish a working definition for the term "ubiquitous network societies", identifying points of commonality between various communities of interest, including those that fall under the terms ubiquitous computing and Ambient Intelligence. It was established for the purpose of this discussion that the ubiquitous network vision describes the convergence and interconnection of computing devices with pervasive communications networks composed of both wireline and wireless segments. Three key innovations to support this convergence are the embedding of computing devices in everyday objects and places; the development of intuitive, intelligent user interfaces to make these devices simple and unobtrusive for users; and, the availability of data communications anytime, anywhere.

Having established a working definition of the setting, the paper considered the issue of privacy, noting a number of generic privacy concerns related to ubiquitous networks, such as the expected growth in the quantity of personal information and its qualitative transformation through perceptual and biometric interfaces. The appearance of highly personalized services is also expected to require tracking and collection of everyday activities, raising the stakes for information privacy concerns. The paper then introduced three domains of information privacy: the technical, the regulatory, and the sociological, and described a number of subdomains and concerns associated with each. A number of distinctions were made within these domains including those associated with a layer model portrayal of privacy concerns; the important differences between collection, use, and disclosure of personal information; and the problematic idea of establishing fixed distinctions between public and private when dealing with ubiquitous information environments.

The paper then considered a range of privacy concerns specific to the ubiquitous network society as identified by those involved in the research and development communities. A number of problem formulations and design propositions were introduced as a selective sample of the ways in which this area of concern is now being taken up within this specific community. Problem formulations include user consent, the limits of anonymity, unintended and passive data trails, the challenge of granting autonomy to computing devices and emerging security probleMs Design propositions included encryption systems, sticky policies, Privacy Enhancing Technologies (PETs), and labelling protocols.

In moving toward implementation and deployment of the ubiquitous network society, developers and indeed the entire community of stakeholders will need to expand on the early efforts at assessing questions about privacy and information and communication technologies (ICTs). While there is a growing range of research on human computer interface design for ubiquitous network devices, and a recognized set of principles for the design of privacy management systems, discussions that address the deeper social roots of risk and vulnerability in the domain of information privacy appear to be less well developed for this particular field. It is perhaps within the sociological domain where the technical and regulatory measures designed to protect information privacy will be most vulnerable. According one research study, the biggest threat to the user's privacy may in fact be the user him/herself.[74]

Aside from further study on user behaviour with regard to personal privacy and new ICTs, the subject of privacy also open us a range of more or less societal-level questions that may become increasingly relevant in a world of ubiquitous networks. This paper will conclude with four such questions along these lines.

4.1 Privacy for the privileged

Some researchers have suggested that ubiquitous networks will lead to a future scenario where anonymity or privacy become commodities achieved through paying premiums to insurance companies, or in supermarkets, buying instead of renting in a pay-per-use scheme, etc.[75] Is it possible that in the future ubiquitous network society privacy will be something for those who can afford it? Will we need to consider privacy as part of a universal service obligation on the part of network service providers?

4.2 Cultural and demographic considerations

Given that "public" and "private" are such culturally laden and context-sensitive distinctions, how will conceptions of privacy rights change across cultures, or indeed across generations as younger people begin to adopt ubiquitous network services? Will our very notion of privacy change, or will consumers adapt new strategies for protecting their privacy?

4.3 Security and safety

What will ubiquitous networks mean for the delicate balance between privacy rights, public safety, and national security? Is it possible to strike a reasonable balance when so much information is circulating on electronic networks? Is it realistic to assume that biometric and other passive collectors of data increasingly deployed in an effort to prevent terrorism and crime will not also be deployed for commercial purposes? What are the ethical issues that this might introduce with respect to the use of new forms of social sorting and social exclusion?

4.4 Policy and regulation

Clearly the policy frameworks and various regulations that are now in force (e.g., data protection, anti-spam) are necessary step toward ubiquitous network societies, but are they *sufficient* to realize the fullness of the vision? What impact might new policy initiatives, such as the U-Japan Strategy, have on trans-border data flows and the international context of information systems and practices? Will new institutions need to be established, or are the current international bodies suited to the demands of the foreseeable future?

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CHAPTER VI

UBIQUITOUS NETWORK SOCIETIES:
THE CASE OF ITALY

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The Ubiquitous Network Societies case studies programme is managed by Lara Srivastava <lara.srivastava@itu.int>, under the direction of Tim Kelly <tim.kelly@itu.int>. Other country case studies (Japan, Singapore, and Korea) on ubiquitous network societies, as well as three background papers, can be found at www.itu.int/ubiquitous.

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UBIQUITOUS NETWORK SOCIETIES: THE CASE OF ITALY

1 INTRODUCTION

Ever since Antonio Meucci[1] filed a patent caveat for a telephone device in December 1871, revolutionizing the daily lives of ordinary people, Italians have been amongst the most enthusiastic telephone users in the world and it is estimated that there will be 60 million mobile users by 2007.[2]

In recent years, major advances in ICTs, combined with the rapid growth of global networks, such as the Internet, have transformed businesses and markets, learning and knowledge-sharing empowered individuals and communities with new ways of doing things, and created significant wealth and economic growth in many countries. This revolution also means that public access to communications facilities no longer implies that the need to be physically located near urban areas where most information and production is generated. It has completely eliminated the constraints of time and distance.

The next goal is to realize a ubiquitous network society, in which people can access and exchange all information freely, at any time, from anywhere, and from any appliance through the use of broadband and mobile access, as well as intelligent home appliances and RFID tags that can access networks. Progress will not be linear and will require many different elements to fall into place; for this reason, substantial differences can be observed in the strategies adopted by the players in the Italian telecommunication market.

1.1 Why Italy?

Italy was chosen as an ideal case study and survey candidate, because it has one of the highest rates of mobile phone ownership in the world; the country currently ranks second in Europe in terms of mobile telephony penetration levels,[3] fifth in total number of mobile subscriber worldwide and boasts one of the highest per capita short message service (SMS) usage rates in the world.

By 2006, digital terrestrial television, with its mould breaking, interactive and single-theme channels, will have replaced analogue television completely. Here, Italy will have a particular advantage, as the current level of cable infrastructure is lower than in many other European countries.

1.2 Scope and outline of the report

This analysis forms part of the background research for an International Telecommunication Union New Initiatives Workshop on “Ubiquitous Network Societies” (www.itu.int/ubiquitous/) to be held in Geneva, Switzerland from 6 to 8 April 2005.

In preparation for the Italy case study,[4] a total of thirteen of the most important players in the Italian telecommunication market were interviewed: Maurizio Gasparri, Minister of Communications; Roberto Viola, General Secretary of Italian Communications Authority; Mauro Paissan, Commissioner of the Italian Data Protection Authority; Guido Salerno, Managing Director of Fondazione Ugo Bordoni; Luigi Battezzati, Professor of Politecnic of Milan; Riccardo Ruggiero, Chief Executive Officer Telecom Italia; Tommaso Pompei, Chief Executive Officer of Wind-Infostrada; Marco De Benedetti, Chief Executive Officer, TIM; Pietro Guindani, Regional Chief Executive Officer of Vodafone; Silvio Scaglia, Chairman of Fastweb; Vincenzo Novari, Chief Executive Officer of 3 (H3G); Dario Calogero, Chief Executive Officer of Ubiquity; and Elio Lannutti, President of ADUSBEF. Furthermore, to provide an outside view, Mark Thatcher, Senior Lecturer from the London School of Economics (LSE) was also invited to contribute his opinions. These were incorporated as the “Survey on Ubiquitous Networks Societies: The Case of Italy.”[5]

This survey has provided some very interesting and illuminating insights into the prevailing moods and expectations within the Italian telecommunication sector regarding the progress towards the ubiquitous network society in Italy. The respondents replied to the questions with great enthusiasm and were prepared to deal with the key issues in some detail, with the result that the information they provided proved to be extremely useful additional information for the Case Study Ubiquitous Network Societies: The Case of Italy.

The Italian case study is just one of four that explores the implications of a future ubiquitous network society. The other three will cover Singapore, the Republic of Korea and Japan. This ITU New Initiatives workshop serves as a forum for telecommunication policy-makers, national regulators, private sector participants, and academics, in which they can examine the impact of new technologies on the telecommunication industry and society in general, and deal with the issues of social inclusion, diversity, user-protection and security.

This report aims to outline the vision of the future ubiquitous network society in Italy. Section two provides an introduction to the country. Section three provides an overview of the ICT sector and describes the legislative and regulatory framework. Section four highlights the path to the Italian ubiquitous network society. The conclusion looks at the opportunities, challenges, risks and threats within the Italian ubiquitous network society and along the path leading towards it.

2 About Italy: An overview

2.1 Geography, politics and demographics

Italy is truly a cradle of Western civilization, with one of the longest histories and richest cultures in Europe. Popular iconography describes the "*bel paese, dove 'l sì sona* – the beautiful country of the ringing" (Dante, Inferno, XXXIII, 80) as being shaped like a boot, set in the Mediterranean and surrounded by islands, the two largest being Sicily (measuring 25'426km^2) and Sardinia (measuring 23'813km^2). There are around forty medium-sized and smaller islands.[6]

The Italian Republic is a member of the European Union and shares land borders with Austria, France, The Holy See (Vatican City), San Marino, Slovenia and Switzerland.

Italy is divided into 20 regions, 103 provinces and 8'100 municipalities.

The 20 regions are: Abruzzo, Basilicata, Calabria, Campania, Emilia-Romagna, Friuli-Venezia Giulia, Lazio, Liguria, Lombardia, Marche, Molise, Piemonte, Puglia, Sardegna, Sicilia, Toscana, Trentino-Alto Adige, Umbria, Valle d'Aosta and Veneto.

Italy's land mass is 301'230km^2; its population is nearly 55 million; it is a land where the traditional distinction between the north (with GDP per capita in line with the best EU performance) and the south – on its way to socio-economic development – is still valid when analyzing the features of the Italian marketplace. In fact, geography is very significant for Italy, as in many cases it has led to very different economies and markets. Around half of the population (more than 29.7 million – Jan. 2004) reside in the north[7] but it should be borne in mind that the most populous city is Rome (2'644'000), the capital, situated in the centre; the third city, Naples (with more than 1 million people), is in the south. About 1.3 million people live in the second city, Milan, the economic heart of the country. The age structure of the population is as follows (2004 estimation): 0-14 years – 14 per cent (male 4 181 946, female 3'935'535); 15-64 years – 66.9 per cent (male 19'590'497, female 19'256'747); 65 years and over – 19.1 per cent (male 4'608'479, female 6'484'243). The annual population growth rate is 0.09 per cent.[8]

Ethnically, Italy includes small clusters of German, French, and Slovene-Italians in the north and Albanian-Italians and Greek-Italians in the south.

Italian is the official language but other languages are spoken; German in parts of Trentino-Alto Adige, French by a minority in Valle d'Aosta and Slovene by a minority in the Trieste-Gorizia area. The right to education is enshrined in the Italian Constitution and is obligatory until the age of 16; this law was enacted to fight illiteracy and the exploitation of minors.

The dominant religion in Italy is Roman Catholicism, the faith of more than 80 per cent of the people. However, the Catholic Church's role in Italy is declining: only about 25 per cent of Italians attend Mass regularly and a law passed in 1984 abolished Roman Catholicism as the official state religion and ended mandatory religious instruction in public schools. The constitution guarantees freedom of worship to the religious minorities, which are primarily Protestant, Muslim, and Jewish.

Figure 2.1: Italy at a glance

Republic of Italy	
Geography	
Coordinates	42'50 N, 12'50 E
Area	301'230km^2
Terrain	Mostly rugged and mountainous; some plains, costal lowlands.
Population	
Total	54'950'000
Growth rate	0.09%
Life expectancy	79.54 years
Women	82.66 years
Men	76.61 years
Median age	41.4 years
Economy (GDP, 2004 est.)	
Total (PPP)	USD 1.55 trillion
Per capita (PPP)	USD 26'700
Growth rate	0.4%
Language	
Official	Italian

Source: World Factbook, 2005 and ITU World Telecommunication Indicators Database.

2.2 Political system

Following the institutional referendum of 2 June 1946, Italy ceased to be a monarchy and became a republic. The new Constitution, which entered into force on 1 January 1948,[9] established the institutional principles. At the top of this system is the President of the Republic, who is the head of state and represents "national unity". The President of the Republic chooses the Prime Minister, whose status is *primus inter pares*, and the President also appoints the various ministers at the Prime Minister's recommendation.

Legislative power is entrusted to Parliament, which consists of two Chambers, both of which are elected every five years by universal and direct suffrage (women did not obtain the right to vote until 1946): the Chamber of Deputies contains 630 members and the Senate comprises 315 elected officials. Executive power is exercised by the government, which comprises the Prime Minister and the various ministers. A particularly important role is played by the Constitutional Court, which is made up of 15 judges, each of whom holds office for nine years, and is responsible for defending the Constitution at the highest level.

Drawing strength from its tradition and the respect it commands as a founding father of the European Union, Italy has contributed to some of the most important accomplishments in the organization's history. Having become a member of the United Nations in 1955, Italy has also been amongst the most advanced countries with respect to European integration, as demonstrated by the re-launch of the Community after the defeat of the European Defence Community (EDC), which saw the peninsula at the centre of some of its major steps forward: from the Messina Conference in 1955 to the Venice Conference in 1956 and the historic signing of the Treaties of Rome on 25 March 1957, which founded the European Economic Community and the European Atomic Energy Community. A founder member of the original European Coal and Steel Community (ECSC), which developed into the European Union (EU), Italy has long been at the forefront of European economic and political unification and, in recent years, has made many official policy changes, in order to be eligible to participate in European Economic and Monetary Union (EMU), which it joined in 1999. At the beginning of 2002, the national currency, the lira, was replaced by the single European currency, the euro.

2.3 Economy

During the last decade, the Italian economy has displayed a consolidated robustness and, has implemented key structural changes. Currently it is ranked as the world sixth- largest industrial economy and belongs to the Group of Eight (G-8) industrialized nations.

A predominantly agricultural country before World War II, Italy has developed a diversified industrial base, particularly in the north, which contributes significantly to the economy. In fact, after 1950, industrial development was so rapid that by the 1990s, industry contributed about 35 per cent of the annual gross domestic product and agriculture less than 4 per cent. Since 1992, economic policy has focused primarily on reducing government budget deficits and reining in the national debt, in order to meet the requirements of the Economic and Monetary Unions. According to the World Bank,[10] in 2003, Italy's GNP was USD 1'101 billion, or USD 19'080 per capita, whilst the gross domestic product in 2004 was estimated at USD 1,55 billion, or about USD 26,700 per capita. In 2003, industry contributed about 28.9 per cent of the value of domestic output; agriculture 2.2 per cent and services about 68.9 per cent.

An ongoing problem of the Italian economy has been the slow growth of industrialization in the south, which lags behind the north in most aspects of economic development. Government efforts to foster industrialization in the south have met with mixed results. This capitalist economy remains divided into a developed industrial north, dominated by large corporations and an immense number of small and medium-size companies (SMEs) well known for their enterprising approach to business, and a less developed, welfare-dependent agricultural south, with 20 per cent unemployment. The main Italian industries are tourism, precision machinery, motor vehicles, chemicals, pharmaceuticals, electrical goods, food processing, footwear, ceramics, fashion and clothing.

The Italian economy is forecast to grow by 1.2 per cent in 2005. Consumer spending will become more stable, given a gradually improving economic environment. Meanwhile, business investment is expected to grow faster, along with the further improvement of the EU economy and a faster growth in foreign sales, the recent oil price hikes notwithstanding. Exports will be lifted by a stronger demand from other EU member states and the further recovery of the world market, despite a strong Euro.

The country has a total workforce of approximately 24.15 million (2004 estimation). Unfortunately, unemployment, although a regional issue, remains a problem throughout the country; the overall national rate has been estimated at 8.6 per cent in 2004.[11]

3 ICT SECTOR OVERVIEW

3.1 Basic indicators

Italy boasts the world's sixth largest economy and is Europe's fourth largest market for information and communications technology (ICT). Despite the modest growth of the Italian economy, the country's tele-communication sector has performed well, growing by three per cent in 2004.[12] Technological innovation and early adoption have been the distinguishing characteristics of the Italian telecommunications market. Nevertheless, it is generally acknowledged that a host of different factors, particularly those rooted in society and commerce, have combined to drive Italy's ICT penetration levels from the earliest days of the global mobile market. Between 2002 and 2004, the Italian information and communication industry expanded from EUR 30'063 million to EUR 30'803 million.[13] Some of Italy's ICT statistics are presented in Figure 3.1.

Figure 3.1: Italy's ICT statistics
A snapshot of the ICT industry in Italy.

Italy (2003)	
Mobile Telephones	
Penetration rate	101.76
Total	55.918.0
Growth rate (1998-2003)	22.2
Fixed Lines	
Penetration rate	48.40
Total	26.596.0
Growth rate (1998-2003)	0.5

Italy (2003)	
Internet	
Users	18'500'000
Users per 100	33.67
Internal. Bandwidth (Mbits/s)	119'794.0
PCs (est.)	13'025'000
Broadband	
Total subscribers	2'200'000
Subs per 100 inhabitants	4.00

Source: ITU World Telecommunication Indicators Database.

3.2 Evolution of the Italian market towards a ubiquitous network society

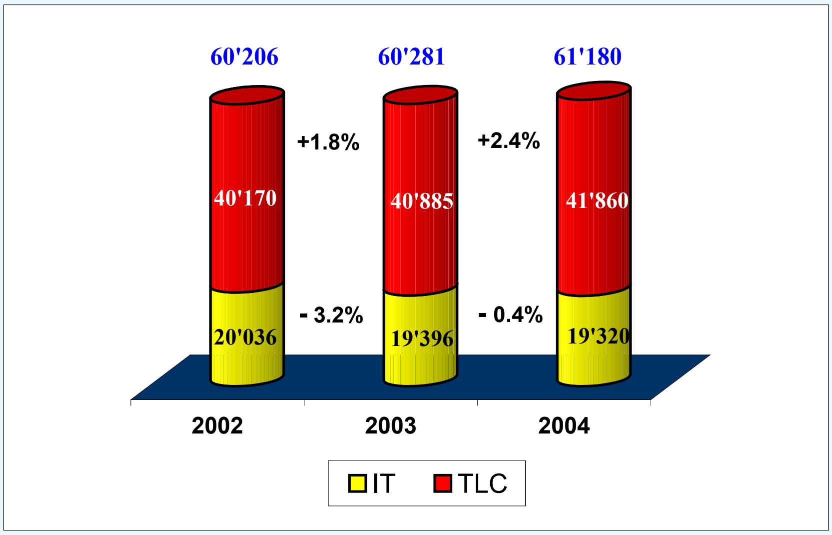
Several interesting and evolving scenarios have given the Italian ICT cause for optimism. These include the continued development of the mobile technologies, the extraordinary growth of broadband, the diffusion of digital terrestrial TV and the introduction of technologies like VoIP and RFID. If well managed and supported by the government, these could make Italy into a real ubiquitous network society, particularly as it boasts a well-established ICT infrastructure. Meanwhile, the government, the private sector and the R&D entities (universities, consortiums and events) have realized the importance of automating communication between people and making it easier; they have also recognized the potential of converged networks and related services.

3.2.1 Market trends

The major reference point for the Italian ICT industry is Assinform,[14] the Italian ICT companies' association. Since 1947, when it was formed as an association of office product manufacturers, Assinform has expanded, initially into Information Technology, and now represents the entire ICT sector; amongst its members are Italy's leading IT, telecommunications and content providers, as well as many multinational organizations. According to Assinform Report,[15] as the Italian ICT market has grown over the past two years, especially on the telecommunication side (Figure 3.2), so the IT side has slumped. The growth in the telecommunication market owes more to the investment in telecommunication services and the projects implemented, than to infrastructure or hardware. This is because in the area of mobile service, for example, the huge demand for standard services, such as voice, has saturated the market during the past few years and the operators are now focusing on making their products and services better, trying to create new opportunities and offering new packages to attract prospective customers (Figure 3.3).

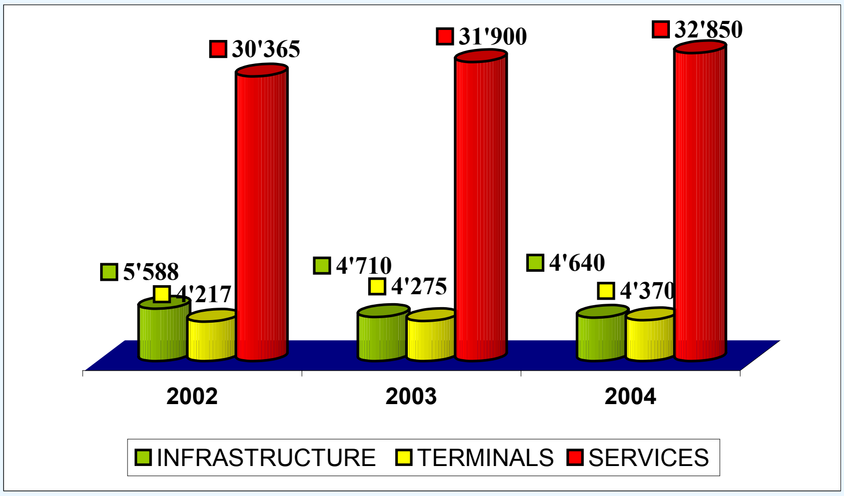
Because of the high cost of intelligent handsets, such as smart phones, there has been no growth in network infrastructures and communication devices, although an increase in the sales over 2005 is foreseen. As the introduction of converged services inevitably involves the conversion to more functional devices, this could affect the move towards the ubiquitous society (Figure 3.4).

Figure 3.2: ICT market in Italy
Progress of ICT market in Italy (millions of Euros).



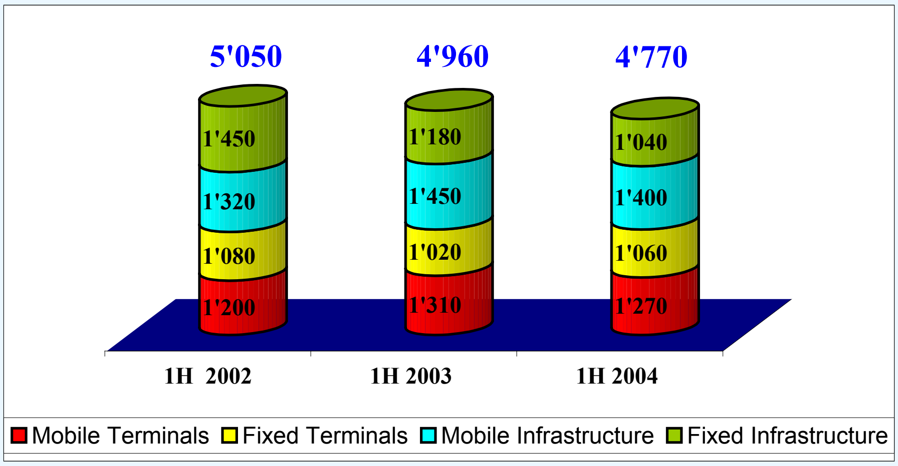
Note: IT is hardware, software and services, whilst TLC is fixed and mobile telecommunications. The percentages represent an increase or decrease in the respective markets.
Source: Assinform Report, 2005, www.assinform.it/

Figure 3.3 Telecommunication market in Italy
Progress in TLC market (millions of Euros).



Source: Assinform Report, 2005, www.assinform.it/

Figure 3.4: Telecommunication infrastructures and devices market
Progress of telco infrastructures and devices (millions of Euros).



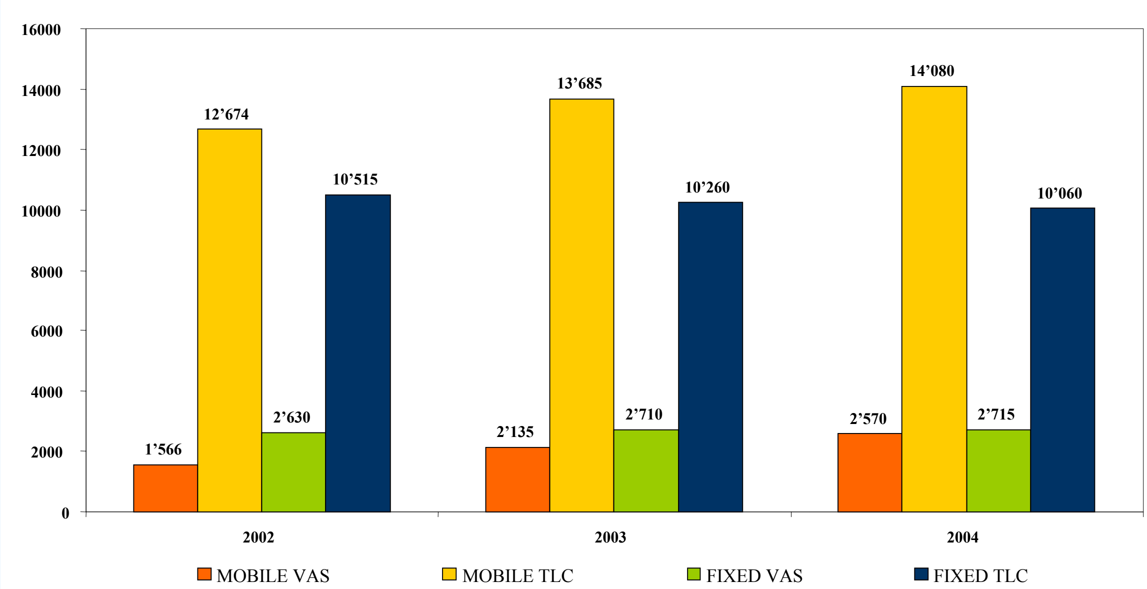
Source: Assinform Report, 2005, www.assinform.it/

In Italy there are three major forces[16] driving competition and playing a key role in the new digital world of convergence. First of all, the extremely high penetration and technological leadership in mobile telephony (by 2007, 80 per cent of Italian adults will be using mobile phones; the lion's share – 88 per cent – will go to GPRS/EDGE and 3G technologies, with penetration of 3G at 22 per cent, which is higher than the European average of 13 per cent). Secondly, the accelerated penetration and growth of broadband wire line access (by 2007, 27 per cent of European households and 21 per cent of those in Italy will have access to broadband, with the ADSL share being 70 per cent in Europe and 80 per cent in Italy). Thirdly, the planned phasing-in of digital terrestrial TV, which will completely replace analogue TV by 2006; this is the most important of the three driving forces. The advent of digital terrestrial TV will force the broadcasters to expand their range of offerings by introducing single-theme and interactive channels. Italy's lack of cable infrastructure will give the country a further advantage over other European countries. The development of the mobile phone elevated Italy to a lofty position in the European markets and the scheduled phasing out of analogue TV in 2006 will do the same. According to EITO, even by 2004, interactive digital TV (including satellite, cable and terrestrial) was reaching 32 per cent of Italian families, compared to the European average of 27 per cent. In 2007 this advantage will be maintained, bringing Italy's penetration to 57 per cent, compared with the European average of 44 per cent.

This very promising situation will be a key factor in the establishment of the ubiquitous society, as the existence of the network infrastructure will greatly facilitate its spread. Another key element of the ubiquity mosaic is the growth in the offers for standard services. The third and most important aspect is the capability of the operators to provide services with "added value" (called VAS) to augment the basic functions of the service, thus integrating it into a converged operational environment and making it ubiquitous (any place, any time, with any object).

Meanwhile, the fixed world (broadband and related systems) has just finished consolidating its role as the driver of communication technology. It was not until 2004 that broadband and Internet services began to justify investment by the private sector, to provide tangible added value services. This does not mean that broadband producers lack innovation, rather that they are rather late entrants in the race towards ubiquity and have also been more affected by the nature of the various technologies involved – a mobile phone is easier to use and more intuitive than a fully equipped workstation with broadband access and several different applications running at the same time. The growth of value added services is more evident in the mobile market than the fixed market (Figure 3.5).

Figure 3.5: VAS services in the Italian ICT market
Progress in VAS services offered (millions of Euros).



Source: Assinform Report, 2005, www.assinform.it/

3.2.2 Network infrastructure and deployment in Italy

Communications are crucial to the development of the ubiquitous network society; this is acknowledged by all players in the Italian telecommunication industry and reflects one of the key objectives of the Italian government's broadband policy, which aims to give all Italian citizens the opportunity to participate in the global information society by stimulating secure services, applications and content based on a widely available broadband infrastructure.

For these innovative services to develop and expand through increased integration and interactivity, as well as greater use of multimedia channels, they will need telecommunication networks with ever-greater capacity (broadband).

The new network infrastructure and flat rate pricing ensure advanced connectivity services and are essential for spreading innovative processes, both directly in the ICT sector and indirectly, as an enabling factor for product and process innovation in Italy. The impact of the availability of advanced infrastructure on innovative processes for the various participants in the information technology field can be traced in different ways.

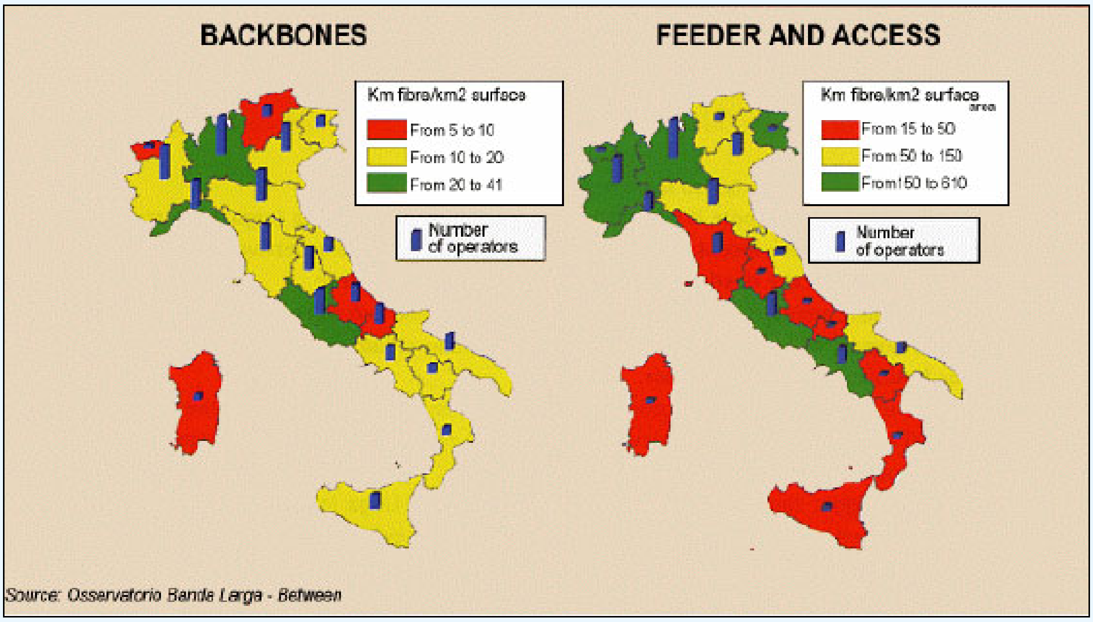
Firstly, the development of communication systems that improve the exchange and distribution of content and information increases the general propensity of the public (both individuals and households) to adopt innovative technologies and services, which will be delivered over the network itself, thus extending the range of opportunities. The impact for firms is twofold, as it concerns both process and product innovation. First of all, advanced infrastructures allow better interaction between the various company structures (the effect is even greater if these structures are situated in different locations) and between these structures and the rest of the world (customers, suppliers, partners, etc.). All this has direct repercussions on the effectiveness and efficiency of corporate processes and RFID technologies can also play a key role. The availability of a new "intangible" distribution channel (communications networks) also extends the firms' reference markets, generating new opportunities for growth. Furthermore, the new telecommunication networks make it possible to create new products and services, which can assist in the differentiation and diversification of the firms' activities, thus impacting product innovation directly. The characteristics of innovation in the new network technologies can also have an impact on business models, as shown by "always-on" technologies and flat-rate pricing (i.e. not linked to connection time) that are invading the Italian telecommunication market.

A fixed-line communications network can be divided into three main parts: backbones, area feeder networks and access networks. In Italy, the status of these three components differs significantly. Although optical fibre was initially the transmission medium of backbones, since the mid-1990s its use at the metropolitan area network level, including at the feeder level, has increased significantly.

According to the Broadband Observatory,[17] the situation in March 2004 was characterized by an excess supply of optical fibre at the backbone level and fierce competition on the strategic links in the centre and north of Italy (Turin-Venice and Milan-Rome), which caused costs to fall rapidly.

The distribution of backbone systems broadly reflects the distribution of telephone lines, with nearly 50 per cent of fibre laid in regions in the north (the north accounts for 40 per cent of the surface area of the country and 45 per cent of the population). The average fibre density in the large northern regions is double that of the southern regions (Figure. 3.6).

Figure 3.6: Regional density of communication networks and level of competition
The status of fixed-line communication network in Italy.



Note: The fixed-line communications network is divided into three main parts: backbones, area feeder networks and access networks.

Source: Osservatorio Banda Larga – Between.

Italy was one of the first countries in Europe to see metro Ethernet appear as a broadband access service.[18] At the access level, projects primarily regard the Milan-based provider Fastweb initiative, which is based on a powerful combination of fibre and xDSL technologies. It offers customers connection speeds of between five and ten Mbit/s, which is significantly higher than normal DSL networks. By the end of 2004, FastWeb's services were available in 14 major Italian cities. Business customers totalled 56'500 and residential clients amounted to 320'000, representing about 500'000 phone lines (March 2004).[19]

In 2002,[20] 13 operators received licences for regional Wireless Local Loop (WLL) and alternative access networks using point-multipoint radio systems are being constructed. Given the technical and economic constraints, WLL will probably be limited to business users in very concentrated areas, making it a complementary technology to other access systems

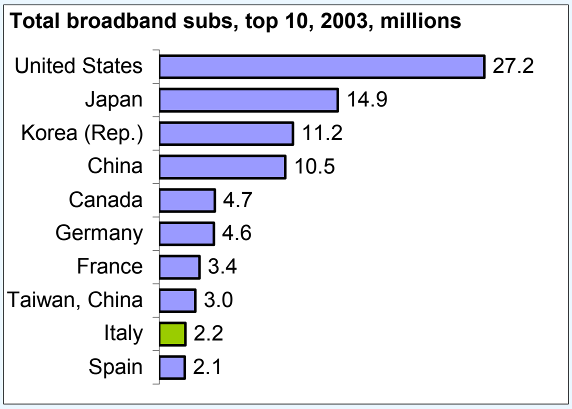
The recent changes in the regulation of Wireless-Local Area Networks (W-LAN) will increase the pace of development of broadband connectivity solutions.

Satellite access, which can cover the entire country, is a different matter altogether; although there are interesting prospects for developing the potential of this technology using geostationary satellites in the Ka band (20/30 GHz), with a significant increase in resources for the return channel, this looks as if it will also be playing a complementary role, especially in the less populated areas. The current expansion difficulties are being exacerbated by the scarcity of band resources and also the costs, especially those of bi-directional systems (i.e. systems that do not use the traditional telephone line for the upload channel).

3.2.3 Penetration of broadband

In 2003 there were more than 2 million broadband subscribers (Figure 3.7), with one of the fastest growth rates in the world. At the international level, in 2003, Italy had moved up one position in the world ranking of countries according to the number of xDSL connections, rising to 9th place (ahead of Spain).

Figure 3.7: Total broadband subscribers, top 10, 2003, in millions.

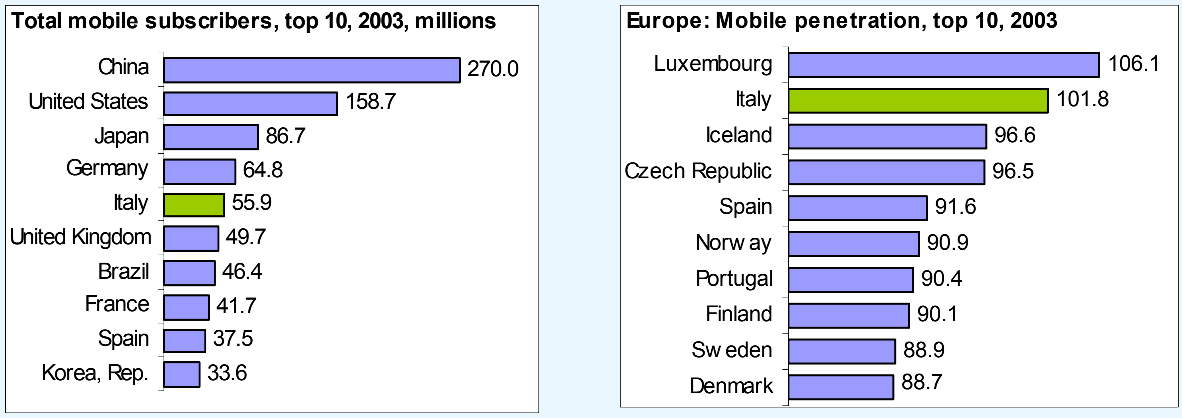


Source: ITU World Telecommunication Indicators.

According an EU report in July 2004,[21] there were around 3’500’000 broadband lines, 92 per cent of which were using DSL technology, with around 5 per cent using fibre and 3.4 per cent being satellite connections. With of one of the lowest monthly rentals in the EU (EUR 8.3) and stringent regulation, the unbundling of the local loop (LLU) has proved an effective way for alternative operators to compete in providing broadband connections. The number of active unbundled local loop lines in July 2004 (697’530) was amongst the highest in the EU (and had doubled since July 2003) and almost 30 per cent of the new entrants’ broadband retail connections were based on LLU. During the period July 2003-July 2004, the incumbent increased its share in the overall retail broadband market (from 63.8 per cent to 70.3 per cent) and in the ADSL market (from 73 per cent to 76.2 per cent). In October 2004, there were 1.6 million active 3G lines; if 3G connections are included, the incumbent’s market share and the broadband penetration rate are, respectively, 55.9 per cent and 7.8 per cent. In 2003 the UMTS coverage (H3g only) was about 37 per cent of the population and 13 per cent of the surface. In 2004 the coverage provided by H3g has outpaced 60 per cent of population, in addition in May 2004 both TIM and Vodafone were able to offer UMTS services, covering about 30 per cent of population.

As regards mobile communications, Italy ranks second behind Luxemburg in mobile penetration in Europe and fifth in the total number of mobile subscribers in the world (Figure 3.8). The rapid growth of mobile services is largely because of the introduction of prepaid card services. In the year following the introduction of the prepaid card service in 1996, Italy’s mobile penetration rate ranking among OECD member countries jumped from 12th to 8th and since then it has grown every year. The Italian market has one of the most dominant mobile players in Europe, namely Telecom Italia Mobile[22] (TIM), with around 47 per cent market share and EBITDA margins of 54.5 per cent (in Q3, 2003), followed by Vodafone, Wind and H3g. The entrance of a fifth mobile player into the Italian mobile market early in 2005 has already been announced; this will be I-mate, the world specialist in end-to-end wireless device solutions. This new player could change the Italian market by introducing new business models already implemented in other parts of the world.

Figure 3.8: Mobile Communications in Italy



Source: ITU World Telecommunication Indicators.

One of the most important developments in Italy during recent years has been the fact that in 2003 the mobile market overtook the fixed market in terms of revenue (EUR 16.7 billion compared with EUR 16 billion).[23] In some cases this has taken the form of fixed to mobile substitution, in terms of the number of connections and the traffic volume. The rapid growth of Italian mobile communications has been confirmed by the penetration rate that is currently above 100 per cent.[24]

Some effort has been made to re-start the competitive process; in June 2001, Italian mobile phone operators TIM, Vodafone, Wind, and 3 (H3G) reached an agreement on mobile number portability,[25] which enables customers to switch operators, whilst keeping the same number. This promotes competition within the market (Box 3.1).

Box 3.1: Number portability in Italy

Millions of Italian mobile users choose to keep their mobile numbers, when changing the operator.

For the first time, 3 (H3G) and Wind rate number one for the net number of acquired clients who have chosen to keep their phone number: in particular, the Mobile Video Company of the Hutchison Group, the Italian leader in the UMTS market, has registered a net positive balance of 21,726 units between clients acquired and those lost, even though it started the service 11 months after the introduction of MNP. Wind drops to second, while TIM and Vodafone have lost a total of almost 450’000 clients.

Since the introduction of Mobile Number Portability in Italy, a total of almost 2.8 million people have chosen to change their mobile operator, but keep their number.

Number Portability Distribution (April 2004)		
Operator	**Mobile numbers lost**	**Mobile numbers gained**
3 (H3G)	**0.6**	**7.3**
Tim	**36.1**	**33.7**
Vodafone	**29.7**	**24.1**
Wind	**20.56**	**34.9**

3 has once again lodged an urgent application with the Communication Authority for an inter-operator price level of activations lower than the current EUR 10.02; the final zeroing still has to be carried out. To date, the total cost of allowing users to carry over their numbers is almost EUR 2.5 million.

Source: AGCOM.

In addition, for the first time, the incumbent mobile subsidiary’s market share (in terms of revenues) has decreased to less than 50 per cent. The increasing uptake of mobile data services is expected to lead, in 2005, to a repeat of the good 2004 growth. Demand for MMS services is translated into positive spending in new handsets; although growth has been moderate over the last two years, it is expected to pick up in 2005, thus confirming the existing trend. It is also worth mentioning the subsidy initiative launched by 3,[26] which allows customers to buy the latest model UMTS mobile phone at a lower price. On the other hand, 3 utilizes the SIM lock system, which means that these customers are obliged to use 3 tariffs for an established period of time if they want to benefit from this offer.

3.3 Legislative framework

The AGCOM (Italian Communications Authority), based in Naples, is the regulator in the telecommunication sector while the Ministry of Communications has the responsibility of policy making in the sector.

The new regulatory framework[27] is found in the *Codice delle Comunicazioni Elettroniche*[28] (Electronic Communication Code), which entered into force on 16 September 2003.[29] The Italian Government has also recently passed a law on audiovisual markets (Gasparri Law n. 112/2004 of 3 May 2004[30]), which contains, *inter alia*, the framework for broadcasting transmission networks. The same law also mandates the government to unite the existing regulations in a Radio and Broadcasting Code (*Testo unico della radiotelevisione*). In the meantime, the analysis of the above national provisions and their conformity with the new regulatory framework continues.

3.3.1 History of ICT regulation and policy

The alignment of telecommunication policies with EU standards provided the initial impetus for the reform of the Italian telecommunication market. The ongoing liberalization was assisted by the release of the 1987 "Green Paper on the Development of the Common Market for Telecommunications Services".

Until 1992,[31] telecommunication services in Italy were provided either directly by the State, through the ASST (Telephone Services State Agency) and the Posts and Telegraphs Administration (PT), or indirectly through several concessionaires, such as SIP, ITALCABLE, TELESPAZIO, SIRM, and TELEMAR.

The Italian Government then decided to award the management of all telecommunication services to the concessionaires (Law No.58/92). When they subsequently realized that the division of telecommunication operations had weakened the overall development of the Italian telecommunication industry, the government merged all the concessionaires, with the exception of TELEMAR, into a single company, Telecom Italia.

In 1995, all telecommunication services except fixed voice telephony, mobile and satellite services and network installations were liberalized. Furthermore, in 1997, satellite networks and services were liberalized by Decree-Law 11 February 1997, No. 55. On 31 July 1997, the Italian Parliament enacted Law No. 249 on the "creation of the telecommunications National Regulatory Agency (AGCOM – *Autorità per le Garanzie nelle Comunicazioni*)" (see Section 3.3.2).

In November 1997, the Ministry of the Treasury privatized Telecom Italia by selling virtually its entire stake through both a global offering and a private sale to a group of shareholders, thus starting the full liberalization of Italian market. Since then, several new entrants to the Italian market have changed it completely. By 1 June 2003, there were 230 licences for PSTN network and/or service providers in the fixed voice telephony market. Alongside the incumbent, Telecom Italia, the major fixed voice telephony service providers are: Infostrada (owned by the National Electricity Co. [ENEL]), Fastweb, Tiscali, Albacom, and Tele2.

In the mobile market, Vodafone-Omnitel, the second mobile operator commenced services in 1995 and Wind, the third mobile operator, commenced operations in March 1999. Blu S.p.a., which obtained a licence as the fourth national operator on 4 August 1999, began providing a DCS 1800 service in the summer of 2000 but it finished in 2001. In addition, five UMTS licenses were awarded in November 2000 and in 2003 H3g entered the Italian market, also providing UMTS services. In 2004 the merger between Telecom Italia and TIM was announced and it should be completed by 2005.[32]

3.3.2 The National Regulatory Agency: AGCOM – Italian Communications Authority

The National Regulatory Agency[33] was established in 1997 by ordinary law no.249 and became operational on 22 July 1998 as the regulatory body for the whole communication system, including:

- Telecommunications
- Broadcasting
- Press

This horizontal regulatory competency over the whole Italian communication sector gives AGCOM one of the most comprehensive regulatory roles in the European Union, with power in both the telecommunications and the broadcasting sector.

AGCOM is fully independent and has authority over all regulatory issues in the telecommunications sector. It acts as a regulator, ensuring equitable conditions for fair market competition and pursuing technological innovation, as well as supervising the control of prices, the introduction of new services and technologies and analyzing the market. It acts as guarantor, protecting the fundamental rights of all citizens, safeguarding pluralistic information and defending the copyright of audiovisual and software products. It also guarantees the protection of the fundamental rights of the operators, promoting and safeguarding competition in the telecommunication market, as well as applying anti trust rules in the field of broadcasting and organizing the Registry of Communications Operators. According to law no. 249[34] AGCOM shares the task of spectrum planning and allocation with the Ministry of Communications.

AGCOM has always focused on fostering long-term, facilities-based competition. In March 2000, Italy became one of the first countries to introduce local loop unbundling obligations; this required Telecom Italia to provide a wide range of services and options to competitors and to supervise the implementation step by step. AGCOM assumed the key role of local loop unbundling for broadband network deployment and forced Telecom Italia to provide DSL wholesale offers to alternative network operators and Internet service providers, with the aim of preventing the incumbent from pre-empting the emerging market. AGCOM has also introduced many additional regulatory provisions supporting broadband competition, such as the decision to admit ISPs to Telecom Italia's leased lines wholesale offer and DSL wholesale offers. In July 2002, AGCOM issued technical rules that opened up Telecom Italia's interconnection offer to ISPs, according to national law no.59/02.

Since the organization's inception, AGCOM policy has fostered the unbundling of the local loop, provided a stable regulatory framework, guaranteed bitstream and leased line access and developed a policy that does not discriminate amongst existing technologies, but does foster the development of alternative technologies, such as satellite, WLL and 3G optical fibre.

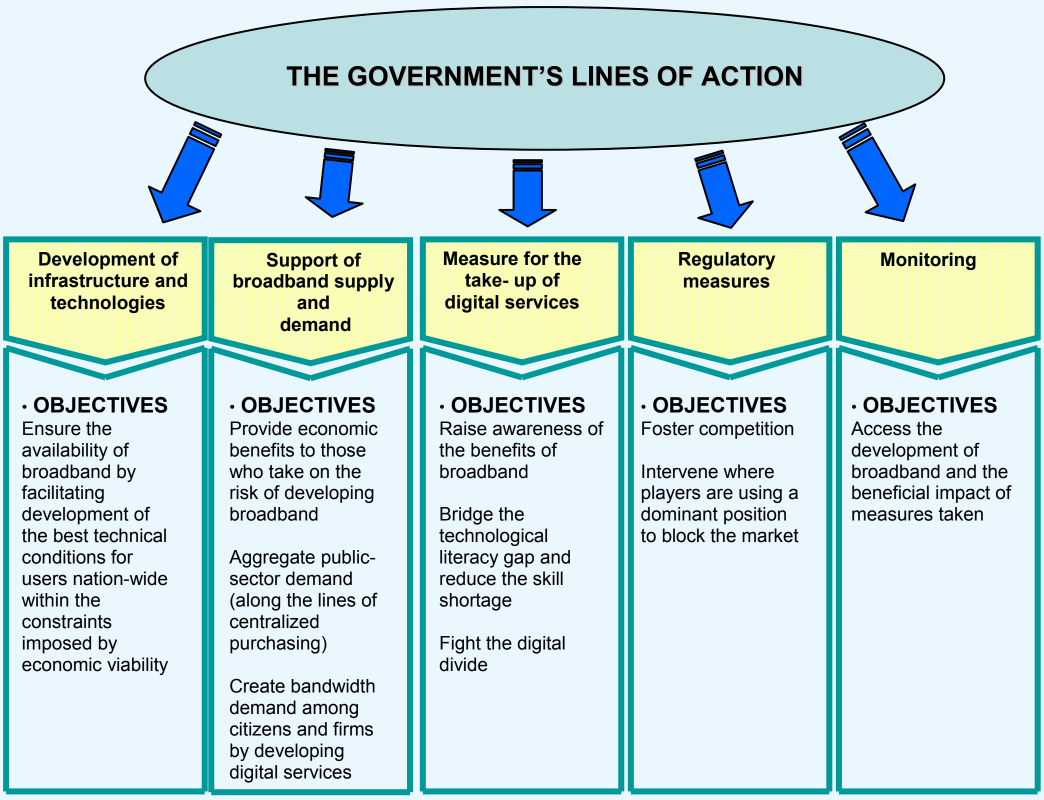
Competition in the market will ensure the continuation of the downward trend in prices that began at the start of the liberalization process. Policies to facilitate interconnection, local loop unbundling, access by new operators, monitoring of charges (interconnection, wholesale prices of leased lines, etc.) remain a priority and are a key factor in supporting and facilitating the development of infrastructure and new broadband services.

In the market there is a broadly positive consensus on AGCOM's implementation of the regulatory framework and during the past two years, AGCOM has introduced some important pro-competitive regulatory measures; for example, the *ex ante* replicability test for the incumbent's retail offer. Nevertheless, operators and consumer associations have expressed some concerns about the slow pace of AGCOM's decision-making process in some areas. The delay in analyzing the market has created problems for operators, not only because of the consequent uncertainty about the new regulatory framework, but also because it has held back the definition of various existing regulatory obligations that had not yet been fully implemented; this has been acknowledged as one of the reasons why the ubiquitous network society in Italy has not yet been achieved. After several years' confusion over the allocation of tasks between AGCOM and the Ministry of Communications, a final agreement was notified to the Commission in July 2004, under Article 3 of the Framework Directive. Furthermore, in January 2004, AGCOM and the National Competition Authority signed a cooperation agreement; this regulated the general consultation mechanism, in particular market analysis and spectrum trading.

3.3.3 Scenarios and policies for the Italian ubiquitous society

The Italian Government is committed to making Italy a leader of the digital age; modernizing the country through the widespread use of new information and communication technologies, in both the public and private sectors. The government also aims to boost the country's competitiveness by accelerating the spread of the online economy and developing a model of the information society based on innovation and knowledge that both improve the quality of life and prevents exclusion[35] (Figure 3.9).

Figure 3.9: The government's lines of actions



Source: Minister for Innovation and Technologies.

To achieve its goal the government has implemented several financial incentives, such as: contributing to digital TV (EUR 150 per household) and broadband access (EUR 75 per household)[36]. The Budget Law for 2003 contains a provision for reducing the cost of buying or renting the equipment needed to access these networks. A subsidy of EUR 75 is available to individuals or legal persons (limited liability companies, stock companies, partnerships limited by shares, and associations, foundations, specific committees and public entities) who buy equipment for transmitting and receiving data on the Internet via broadband. The government made the sum of EUR 31 million available for the year 2003; this was equivalent to around 410'000 broadband connections and the uptake was rapid. This provision was proposed again for the Financial Bill of 2004 to the tune of EUR 30 million.

Other initiatives taken include:

- *Stimulating government use*: the SPC (*Sistema Pubblico di Connettività*) is the network that connects public administrations; currently around 20 per cent of public administration offices have broadband and a target has been set to take this to over 80 per cent by the end of 2005;
- *Connecting schools*: the objective is to have PC and ADSL access in 70 per cent of the 11'000 schools by the end of 2005.

3.3.4 Minister for Innovation and Technologies

The role of the minister and his department is to steer, coordinate and encourage action by other branches of the central administration, with the aim of defining specific projects, action plans and programmes to deploy information technologies, thus bringing more effective and efficient services to citizens and businesses and enhancing the economic, social and cultural conditions in the country.

A large part of the strategy has been focused on the private sector, with the following objectives:

- Support of development and diffusion of ICT amongst small and very small companies;
- Digitalization of industrial districts;
- The South of Italy;
- Infrastructure deployment (broadband);
- Legislative measures.

Through the Ministry for Innovation and Technologies, the government has directed its efforts towards setting up and directing each initiative within a general scheme of action.

In 2001, the Ministry for Innovation and Technologies and the Ministry for Communication established a Broadband Taskforce[37] to monitor the rate of broadband network implementation and evaluate proposals for action (Box 3.2).

Box 3.2: The Broadband Task Force Report

In November 2001, the Broadband Task Force, with the active contribution of operators, local administrations, trade associations and experts, issued a report and submitted it to the ministries for their approval. The report opens with a new definition of broadband: "...the technological environment that permits the use of digital technologies at maximum level of interactivity..." This open notion, which does not refer to a specific technological situation, appears to be particularly suited to a changing scenario and it also overcomes the divergent broadband definition approaches adopted so far, anticipating the forthcoming Italian ubiquitous network society.

The report underlines the need for a virtuous circle of expansion, with a range of broadband services and applications increasing the demand for higher bandwidth and encouraging further investment in infrastructures. It emphasized the role the government ought to play in addressing and supporting the demand for, and supply of broadband. However, the public approach that has been envisaged should be applied indirectly and selectively; the government should focus on stimulating demand (in both the public and the private sectors) and supporting private investment. With these guidelines in mind, the Task Force outlined a range of actions:

a) The promotion of new network deployments, optimising the use of public resources and complementing the private sector with selective actions. The government can play an important role by proposing first-level regulation and administrative actions, which minimise uncertainties for operators and foster the use of different technologies (WLL, satellite) to overcome geographical constraints.

b) Fiscal incentives for operators and end users can support both the supply and demand sides.

c) The aggregation of public demand with a "central purchasing system" has been envisaged as a means of supporting the supply side.

d) The development of public digital services and digital educational programmes could increase the digital needs of citizens and support the demand side.

e) Continuous, in-depth monitoring of the effectiveness of public initiatives, especially in terms of geographical distribution and the range of technologies available.

The report confirmed the importance of sector regulation, identifying competition in the access market (in a broader sense, including the provision of leased lines and the regulation of rights of way) as the key issue for the broadband case.

Source: Task Force on Broadband Communications.

One of the taskforce's key recommendations was the reduction of digital divide. Such was its importance, that early in 2002, the taskforce became a permanent committee to coordinate and direct broadband initiatives; one of its key goals was the diffusion of broadband infrastructure. The new body's strategy[38] foresaw two lines of action: firstly, incentives to encourage investment in the infrastructure; and secondly the stimulation of demand by developing digital content and online innovative services. Sviluppo Italia (the National Agency for Enterprise Development and Investments) has been tasked with developing digital content, services, applications and broadband infrastructures and bridging the digital divide and infrastructure gap that penalizes the southern regions. To do this, the government and Sviluppo Italia have cooperated in the creation of two agencies to promote and roll out broadband services and infrastructures; these are *Innovazione Italia* and *Infratel Italia*[39] (Box 3.3).

Box 3.3: Innovazione Italia
A company that supports regional and local initiatives.

Innovazione Italia – a company entirely owned by Sviluppo Italia – was set up by the Ministry for Innovation and Technologies (MIT) to achieve the Information Society's objectives. The company supports regional and local innovative initiatives and promotes consistency with regards to the rollout of the Information Society and e-government. Innovazione Italia's objectives, projects and activities have been established in collaboration with the Ministry for Innovation and Technologies, and technical aspects and standards for projects are defined together with the National Centre for Informatics in the Public Administration (CNIPA).

Innovazione Italia's objectives include:

- Projects under the research programme for the Information Society and within the Broadband Programme to increase demand, and implementation of plans for the development of the Information Society (Committee of Ministers for the Information Society);
- Identification and evaluation of innovative initiatives to supply high added-value public services in collaboration with regional and local administrations and private operators. The company also acts as an incubator for new business initiatives in the high-tech sector;

Support initiatives by Sviluppo Italia, making the most of overall resources and competencies to achieve objectives.

Source: OECD, Working Party of the Information Economy, Digital Broadband Content Panel, Paris, 3 June 2004.

3.3.5 Bridging the Italian divide – Coverage of under-served areas

The digital divide in Italy covers both urban and rural areas and even in the most developed parts of the country there can be areas where the private sector has no interest in building up the infrastructure necessary for broadband services; this is because of low-density population, market potential, mountainous regions, etc. An interesting example would be the fact that in Italy more than 15 per cent of the population live in areas known as *comunità montane* (mountain communities), which have specific infrastructure needs. It has been estimated that without a public initiative, around 6 million inhabitants would risk being denied broadband services ("long-term digital divide") (Figure 3.10).

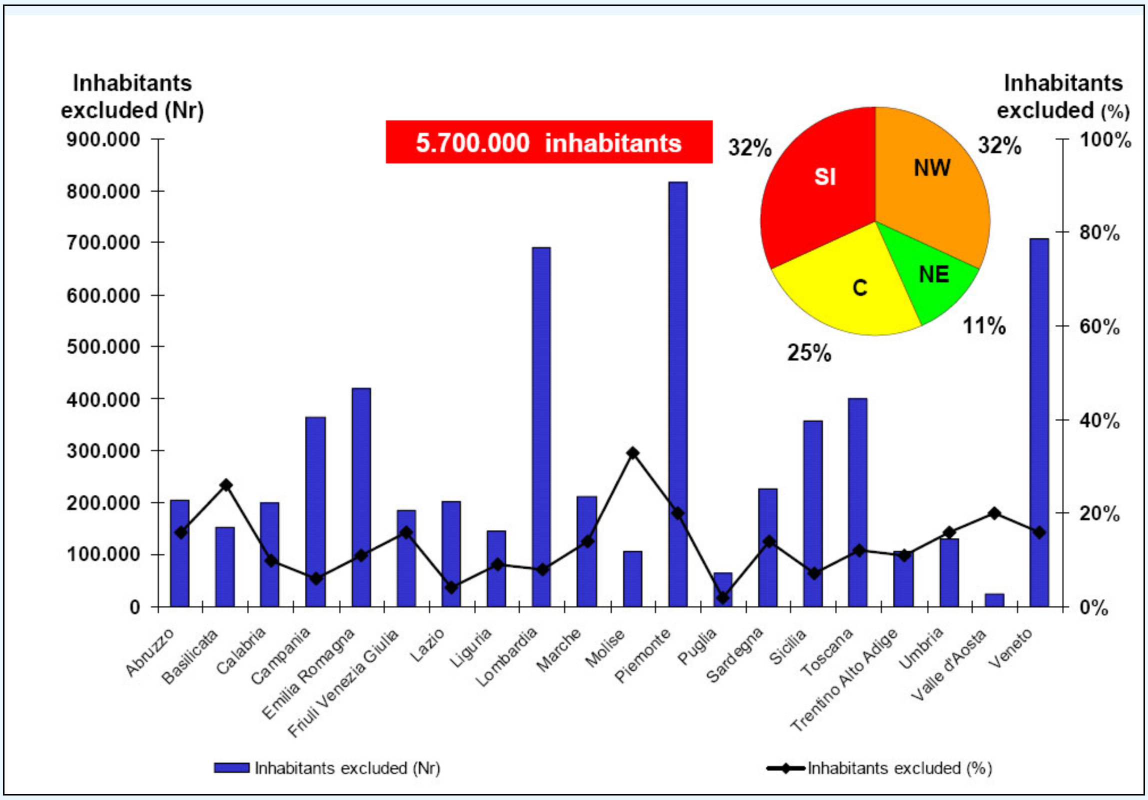
Recent studies on the take-up of Broadband[40] throughout the country reveal that Italy is behind schedule compared to most other EU countries, and that the South is lagging even further behind. A vicious circle exists, with the private sector uncertain of the return on their investment and the consequent lack of infrastructure hindering the development of applicative multimedia services, as well as the demand for high-speed connections. This leads to a reduction, especially in the South, in the opportunities for the development of an economy based on new communication technologies.

Italy's National Executive "Broadband" programme intends to break this vicious circle, create suitable circumstances to make the investments profitable and reach a balanced development of both infrastructure and services; to do this, it is pursuing the following lines and objectives:

- the role of public demand;
- public connectivity system: guarantees the exchange of information among all Public Administration System (central and local government), citizens and enterprises, with high-quality security;
- stimulation of private demand, in particular through incentives for the use of digital and IT devices;
- facilitate the creation of infrastructure.

A five-year strategy for broadband development in southern Italy was launched; it was coordinated by Sviluppo Italia and cost EUR 193 million, 60 per cent of which was public money. To monitor the development of broadband coverage in 2002, the Ministry for Innovation and Technologies and the private sector joined forces to establish a three-year "Broadband Observatory" project.

Figure 3.10: The long-term digital divide in Italy
Inhabitants that risk being excluded from the broadband services.



Note: The segments in the pie chart correspond to the south and the islands (SI), the north-west (NW), the north- east (NE), and the centre(C).
Source: Italian Broadband Observatory, 29 September 2004.

The project started in 2002 with the aim of monitoring the development of broadband in Italy in terms of: coverage (with different technologies: xDSL, fibre optic, wireless local loop, etc.), broadband offering (residential and non residential services and number of service providers), demand (consumer, business, public administrations), local models (regions, municipalities), technology (costs analysis and technological scenarios) (Figure 3.11).

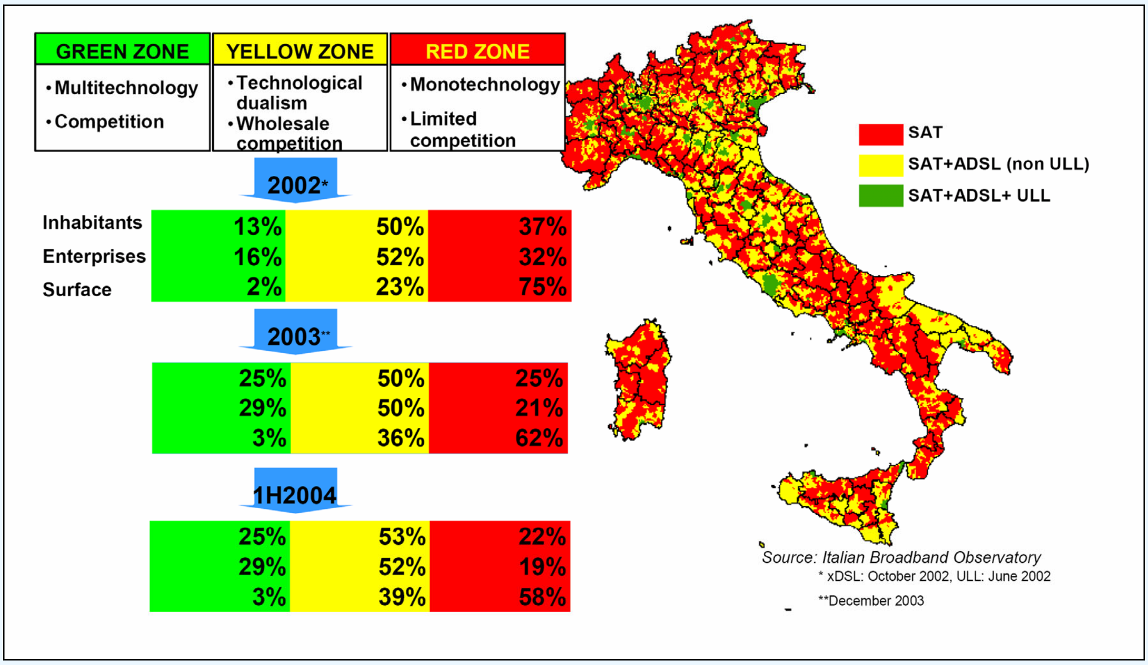
Since then, a range of new initiatives aimed at accelerating ICT infrastructure coverage and increasing ICT uptake has been introduced; these include the broadband incentive to increase uptake of high-speed connections more widely across the economy.

Towards the end of 2003, the Ministry for Innovation and Technologies and the Ministry for Productive Activities launched their "Action Plan for ICT Innovation in Enterprises"[41] that promotes the adoption of ICT in Italy through the close coordination of the ministries involved. The action plan funds the projects as follows:

- EUR 126 million has been allocated for e-government and information society projects, such as public access centres for integrated online services: e-health projects and local e-government initiatives in small and medium-sized towns.
- EUR 150 million has been allocated to support demand for the development of broadband in the fields of e-learning in schools and the promotion of ICT in industrial districts.

The aim is to develop major national projects more rapidly and roll out large-scale policies (e.g. the development of e-medicine) and increase the support offered to businesses, especially SMEs. These projects will complement others linked to the diffusion of e-government that are being implemented by both local and central administrations, and are helping to make federalism more efficient.

Figure 3.11: The evolution of digital divide in Italy
Monitoring the development of broadband in Italy.



Source: Italian Broadband Observatory, 29 September 2004.

3.3.6 Ministry of Communications: current and upcoming ICT initiatives

In September 2002, decree no. 198/2002 finally set out clear and common rules for network installation activities at the national level. A few provisions deserve to be highlighted: the definition of a fast authorization procedure (with short response times by local administrations and a silent procedure system); the central role of the Ministry of Communications for the coordination of digging activities and the promotion of civil infrastructure sharing; the harmonization of the level of digging fees imposed by the local administrations and a prohibition on them imposing any additional burden for digging activities; provisions enabling the construction of vertical ducts in new buildings. The operators have greeted the decree enthusiastically, although some local administrations have expressed constitutional concerns. In April 2002, another of the guidelines' regulatory interventions was turned into reality; Law no.59/2002 allowed ISPs to access to Telecom Italia's Interconnection offer as well, seeking operational rules from AGCOM.

In 2002, the Ministry of Communications awarded WLL licenses, according to the general framework set out by AGCOM. The auction raised around 35 million euros for the public budget and ensured a potential national coverage by at least two operators. As regards the indirect approach, e-government initiatives can play an important role, since they can stimulate the demand for new services and applications by both final consumers and public administration.

The government asked local administrations to submit their digitalization projects by June 2002; these were aimed at making savings of around 50 per cent over the traditional systeMs These projects have been financed, for no more than 50 per cent of their total costs. Around 400 projects have been submitted, covering about 90 per cent of the population. As the total value of projects submitted has been estimated at approximately EUR 1'200 million, and the first round of financing has been reduced to EUR 120 million, the Ministry has selected 138 projects to be financed in the first round.

Other noteworthy actions for e-government[42] include the opening, in June 2002, of the new government website; the start up of an electronic ID (with a target of 1,5 million ID cards issued by 2005 and total national coverage by 2006) and digital subscription projects. These objectives should be verified and possibly reassessed, considering the amount of money that will be devoted to the e-government issue by the State budget.

3.3.7 Broadcasting policy

These days, the digital revolution is the dominant factor in the convergence scenario of broadcasting, telecommunications and new information technologies; because of this, digital terrestrial television (DTT) will play a leading role.

Together with UMTS and fixed broadband access, DTT is highlighted in the e-Europe 2005 action plan[43] as one of the three main access platforms to the information society. The Italian government fully shares this view as can be clearly gauged from the legislative initiatives and regulations that have been already implemented to develop DTT in particular and broadband in general.

The transition from analogue to digital broadcasting[44] started in Italy in 2004 and, because of its broadcasting environment, has proved to be a very challenging process; for example, the terrestrial spectrum in Italy is almost completely occupied and there are currently around 700 local and 11 national broadcasters.[45] The peculiarity is that the majority of these do not have a licence and have been occupying the frequencies on the authority of a decision taken by the Constitutional Court in 1976, which ruled that the monopoly of public service broadcasting was not justified at the local level. Only in 1990, after the situation had settled down, was a systematic Broadcasting Act introduced. Because of this, there is no spare capacity to allocate to existing broadcasters or new operators for them to start up simulcast of existing programmes and new digital terrestrial services. Nevertheless, the transition to digital is seen as important, for two main reasons:[46] firstly, it will enable the reallocation of the spectrum and secondly, it will lead towards the convergence of services delivered via the TV set, thus bridging the digital divide and turning the e-society into a reality, which could finally herald the advent of the Italian ubiquitous network society.

Digital Terrestrial Television Infrastructure

In Italy[47] broadcasting has traditionally been through free-view analogue terrestrial frequencies. Satellite was introduced just 10 years ago and pay-television operators do not have a very large market share (at present only Sky Italia is active, with about 3 million subscriber accounts). The traditional Italian broadcasting operator is a dual-purpose entity, which provides content to be broadcast and owns the network on which such content is broadcast. Previous regulations did not allow for terrestrial operators to split these activities.

However, digital terrestrial television has introduced a different concept; network operators can now operate separately from content providers. These entities can be two separate enterprises, bound to each other by service and capacity agreements. Such distinctions weaken operators' vertical integration, which has characterized the analogue television scene and favours the access of operators to the market. The above distinction gives consumers a wider choice of programmes and promotes integration with other communication sectors, such as publishing and Internet activities.

The New Broadcasting Act[48]

During the past two years, the Italian Parliament has dedicated much time towards the media, focusing in particular on two main issues: on the one hand, a law and regulations have been drafted to regulate the transition to digital terrestrial television, and on the other, a great deal of time has been spent discussing the need for a new Broadcasting Act to redefine, in the new convergent context, the role of public service broadcasting.

According to a European law (Law 66 of 2001), all television broadcasting must be digital and all citizens of the European Union must be able acquire a device able to convert or broadcast digital signals. In Italy, the law for putting into force and disseminating digital terrestrial television are contained in the "Gasparri Law", which was finally passed on 3 May 2004 and provides for the shutdown of analogue terrestrial television by 2006.

Art.1, "Application framework and aims", reads: *"This law identifies the main principles which form the structure of the national, regional and local radio and television system and upgrades it to the advent of digital technology and the convergence process between radio and television and other personal and mass communication fields, such as telecommunications, the press, even electronic and Internet in all its applications." It continues: "Included in the application framework of this law are broadcasts of television programmes, radio programmes and data programmes, even with conditioned access, as well as the supply of associated interactive services and conditioned access services on terrestrial frequencies, via cable and* *via satellite."* It states that the purpose of this law is to provide a new set of principles to update the television broadcasting system, taking into account the introduction of digital media, convergence and the Internet. All television and radio broadcasts (terrestrial, cable and satellite) fall within its scope of application, together with interactive services and pay-television services provided in connection with such broadcasts.

The new act tries to redefine "public service", both in terms of programming obligations and of the mission of a PSB company in the digital era. The act also states what kind of programmes the public broadcasters will be obliged to produce and broadcast: the details (the number of hours, etc.) will be re-defined every three years in a contract between the PSB and the Minister, drafted on the basis of guidelines issued by AGCOM.

More remarkably, for the first time, PSB will be subject to accounting separation. Annual fees paid by viewers to finance public service broadcasting will be used solely to fund public service programming, as defined by the contract. In addition to programming obligations, the legislator has assigned PSB the task of encouraging the transition to digital terrestrial. The digital network must have national coverage (80 per cent of the population) by 2005 and achieving this will be extremely challenging.

The "frequency trading"

As the 112/2004 "Gasparri" law came into effect it brought significant innovations to the world of television, both local and national. Over the next few years the transition to digital transmission technology, which was already anticipated by the 66/2001 law, and has been confirmed by the 112/2004 law, will revolutionise the value chain and business models so far consolidated in the television sector. The law takes into consideration another situation peculiar to broadcasting in Italy, namely that there is no capacity for the simulcasting of digital and analogue. As administrative tribunals protect the prerogatives of local broadcasters in maintaining the use of the frequencies, there is very little chance of changing the situation. Because no digital plan has been adopted, there is no accurate estimate of how many channels and services will be available in the new digital context. Given this, the only way to push small local channels to give up their capacity was to allow broadcasters to trade their frequencies. This will allow national broadcasters (cable, satellite and terrestrial) and consortiums of operators to start up digital programmes with the acquired capacity.

In this scenario, local television companies will play a prominent role and, by integrating their current business of television broadcasting with that of telecommunications network operator, they will be able to exploit interesting new opportunities. Using their own digital broadcasting networks, local companies will also be able to transmit content for third parties and supply interactive services, as well as managing t-government applications in collaboration with the other local authorities, pursuing new business models and exploiting their investments to the full.

The safeguard of pluralism

To guarantee pluralism and stimulate competition, the regulation reserves one third of the broadcasting capacity for local content providers; national networks will also be allowed to carry local content, in order to encourage local broadcasters (more than 700 operators in Italy) to find an agreement with the (mainly national) network operators and free up their frequencies, in exchange for a portion of a multiplex. Most local broadcasters in Italy will not have the financial resources to switch to digital and will, therefore, become mere content providers carried on national networks. Some of the most important local broadcasters are trying to reach an agreement to create their own local networks. Moreover, a content provider may not be granted authorization for free-to-air or encrypted broadcasting, which would allow it to broadcast more than twenty per cent of national digital television programmes. The *ex-ante* threshold has been set on content providers.

By 2004, the authority had issued rules aimed at guaranteeing access to content providers that were neither directly nor indirectly related to network operators and principles, in order – when resources are not sufficient to satisfy all reasonable requests by content providers – to guarantee access to broadcasting capacity by all content providers on a non-discriminatory basis.

4 THE PATH TO ITALY'S "UBIQUITOUS NETWORK SOCIETY"

4.1 Concepts: an overview

This chapter will assess the status of the technologies and describe the projects already carried out by the major Italian players to achieve a ubiquitous network society.

In recent years, the concept of ubiquitous networking has become an increasingly important aspect of the ICT strategies of several countries and governments. Since its creation, in 1988, almost all R&D entities, as well as the private and public sectors, have been exploring the possibility of implementing the ideas driving ubiquitous networking. At the same time, the term "ubiquitous" has started appearing in ordinary newspapers, magazines and corporate advertising and its use has become increasingly diverse. Starting with the ubiquitous network and ubiquitous computing, it now includes the ubiquitous information society, the ubiquitous revolution and the ubiquitous solution.

The original definition of "ubiquitous" was made by Mark Weiser,[49] a researcher at Xerox, who identified and articulated a new computing paradigm, which consisted of a context-aware concept, in which computing capabilities are incorporated everywhere and linked, automatically generating the optimal operational status.

From the above definition, ubiquitous networking must be seen not as an individual ICT, but as a total, comprehensive ICT paradigm. Sometimes, the term "ubiquitous" is treated as a synonym for "mobile internet with cellular phone", or is placed in the same category as digital home appliances with communication capabilities. During the last two years, there has been a tendency to call anything using electronic tags "ubiquitous". The ubiquitous network does not refer simply to such individual ICT elements, but is a single, integrated ICT paradigm, which covers a full range of key elements, from network infrastructure and digital equipment to digital platforms; it represents the environment for ICT utilization.

Japan, which is one of the most important incubators and implementers of the paradigm, has provided us with a meaningful definition of "ubiquitous". This defines the ubiquitous network as an environment for ICT utilization, where "a network is connected at any place, any time and with any object". It defines the ubiquitous network from the user perspective, rather than referring to individual ICT elements. In this sense, ubiquitous networking is not something that will be achieved merely through the spread of specific ICT elements, such as 3G mobile communications or wireless and broadband access, rather it represents a very big change, involving the entire social system; from legal frameworks, to usage practices.

To clarify the above concept and understand how the Italian system is positioning itself in relation to ubiquitous, it is worthwhile delving deeper into the real meaning of "at any place, any time and with any object". The first aspect, "at any place" represents the capacity to access and use a specific IT service through different access technologies and physical devices. The use of Internet has shortened the distances and practically redrawn the geographic maps, enabling communication between continents with a simple click. However, this advantage disappeared as soon as the user got up and left the PC.

The introduction of the new communication technologies has led to a new way of communication, which enables a user to be connected to a network without using a PC. These technologies include Bluetooth, wireless LAN and related protocols (IEEE802.11), electric power line networks (Internet connections using existing electric lines), RFID (Radio Frequency Identification), network cameras, car navigation systeMs Making full use of these technologies should enable access to specific services "at any place," thus reducing the total cost drastically. At home, at the office, from the airport, in the stadium, in a vehicle or simply when walking, a user is able to connect to the ubiquitous service.

The second aspect relates to connecting "at any time", meaning that the service must be "always-on". With the spread of broadband technologies and the recent introduction of digital TV, the concept of having a service available at all times is becoming real. However, even if 24X7 dedicated access is provided from a carrier perspective, "always-on" connections mean nothing to users who are not physically in front of their PC. To enable connections "at any time," access must be possible "at any place" and on an always-on basis. The third and final aspect refers to connections "with any object". The ubiquitous network enables the use of a wide variety of non-PC equipment, such as cell phones, game machines and car navigation equipment, in addition to the desktop and laptops. Whilst this improves connections between people, the next step will require a better connection between people and objects.

Digital home appliances with communication capabilities and network cameras will play a big role in satisfying the more sophisticated needs of users by connecting people with devices such as refrigerators, DVD recorders, audio and light systeMs These technologies will allow the user to reduce or even eliminate the barrier imposed on the use of the devices by the necessary learning process, making available human-object interfaces that everyone will be able to handle. These are the three fundamental elements to identify and classify a service as ubiquitous. Over the past two or three years, several governments, including those of Japan[50] and the Republic of Korea,[51] have been creating a much more focused ICT strategy, implementing, with some success, the concepts of ubiquitous networks. In these countries most of the enabling technologies (e.g. broadband and mobile Internet) are well established and have eased the passage towards a potential ubiquitous environment.

Italy, on the other hand, is just starting to introduce such technologies; and with encouraging results, especially on broadband, although they still lag behind the above countries. This means that the concept of ubiquitous is still perceived as an emerging paradigm that will certainly be implemented in the future, but only when the enabling technologies are so common as to require the next level of integration and interaction (Box 4.1).

Box 4.1: Reconfigurable Ubiquitous Networked Embedded Systems (RUNES)
Project to expand and simplify ubiquitous computing.

A consortium of European scientists has been created to enable the billions of electronic devices in everyday use to be networked together for use in several different environments. The main activity of the consortium has been the implementation of RUNES, a project funded by the European Community with the participation of 22 partners form Europe, Australia and private companies like Kodak and Ericsson. Italy is contributing through the Polytechnic of Milan and University of Pisa.

The RUNES project aims to expand and simplify existing and future networks of devices and embedded systems and will create a standardized computing infrastructure that can adjust itself to various environments and different demands placed upon it.

RUNES aims to assess and overcome barriers to the exploitation of these technologies and to create standards that make it easier for programmers to develop practical and profitable applications. One of the project's main outcomes should be adaptive and intelligent middleware systeMs

Source: www.ist-runes.org

4.2 Towards ubiquitous services: where we are now?

4.2.1 Broadband (fixed lines)

For the business and consumer clients in Italy, broadband is characterized mainly by DSL technology, with an evident increment of Fibre and Wireless, provided at the moment by just two operators (Fastweb and Colt).[52]

The offer is very fragmented; for a few years, all operators have included DSL access with their products and services packages, either through unbundling solutions or wholesale offers of the incumbent, where pricing schemes for alternative operators are established by the Communications Authority (AGCOM).

The market price is dropping by the day; every month new types of offers are being made, in an attempt to integrate standard DSL services, such Internet access and e-mail, with some value added services, or giving more bandwidth for the same price. For example, Telecom Italia announced an increase (for the same price) of the entry-level bandwidth for its DSL offer from 256 kbit/s to 1.2 Mbit/s. The operators, and in particular the market makers, have identified in broadband access the opportunity to capitalize on their investments, reaching huge number of potential customers coming from narrowband and ISDN.

It is, therefore, important to differentiate the offer, with respect to the competition and the end users, by enriching the standard offer with value added services, especially in family and retail markets, in order to reduce the costs of the infrastructure. This is because, in Italy, broadband is still seen as the enabling technology for the access to and use of more integrated and interactive services. This will make it easier for the companies willing to implement and distribute services oriented to a possible convergence voice, data, video; in other words to deploy ubiquitous services.

Many important initiatives have been taken, covering almost all elements of broadband technologies, especially convergence. Fastweb for instance has decided to build a business model based on fibre. This strategic direction has allowed the company to differentiate the offer, creating a valuable alternative to standard ADSL (Box 4.2).

Box 4.2: Fastweb and MEF (Metro Ethernet Forum)
The "fibre" company focuses on metropolitan fibre cabling, adding value to its broadband services.

Using Ethernet over fibre links, FastWeb is delivering true broadband services, including video on demand, at a time when most people's experience of broadband consists of ADSL, which typically runs at one-twentieth the speed that many of FastWeb's customers are enjoying. What's more, FastWeb has created a successful business model whose ARPU (Average Revenue Per User) is much higher than that of a simple bit-provider. In other words, by combining services with connectivity using modern Metro Ethernet technologies, the company has demonstrated the true value of Metro Ethernet networks.

Services being delivered include video on demand, telephony, video conferencing, VPNs and of course, Internet connectivity. None of this would be possible using simple Ethernet. Instead, Metro Ethernet technologies allow faster, flexible service scalability, economic services with lower engineering and support costs. FastWeb has proved that Ethernet has moved beyond being just a local area technology.

With demand for data bandwidth continuing to grow to support applications such as distance learning, imaging and video and storage area networking, enterprise IT managers have realized that traditional data services based on legacy technologies, such as private line, Frame Relay, and ATM, are inadequate. That is because these technologies are hard to scale, operationally complex and slow to upgrade.

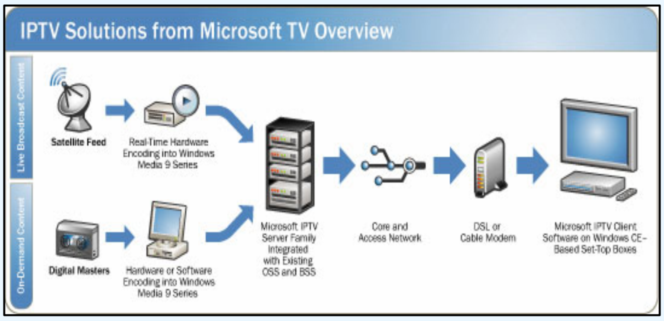
Metro Ethernet technologies deliver higher, more scalable and flexible throughput, all at a much lower overall cost, bringing advantages for consumers, enterprises, and service providers alike. FastWeb' s commendable installation demonstrates how the future looks, today.

Source: www.telecomtv.com/vzine/ ethernet/docs/FastWebSidebar.doc

Telecom is instead focusing on service integration and convergence, launching a portal (Rosso Alice)[53] for its customer community, containing a wide range of integrated services (music, games, films) trying again to aggregate services that in the future will be accessed independently of the device connected. In particular, Telecom has developed and put on the market two interesting applications oriented toward convergence, which, in terms of innovation, could raise expectations for the introduction of ubiquitous services in Italy. The first one is related to broadcast movies on ADSL (Box 4.3).

Box 4.3: TV and cinema on ADSL
Telecom Italia moves towards multimedia services, providing cinema and TV over ADSL.

Telecom Italia, in collaboration with Warner Bros and Microsoft, is focusing on integrating multimedia services using its broadband solution. Two services have been developed and delivered:



- TV over ADSL – Microsoft has launched the pre-release of Microsoft IPTV (television on IP protocol). The initial phase will involve only a subset of Telecom clients (in particular Alice service customers). Starting from the beginning of 2005, around 1'000 customers will be able to use TV over ADSL.
- Cinema over ADSL – A two-year deal has been signed between Telecom and Warner for the distribution of more than 100 movies each year via the Rosso Alice broadband portal. From 1 December 2004, all ADSL users have been able to purchase new movies, as well as library titles. These are available in streaming mode for 24 hours after their purchase and will be geo-filtered to ensure that they are available only to Italian users.

Source: Telecom Italia, www.itportal.it

The second one is related to integrated telephone services and ADSL, extending the capacity on the client premises, allowing the customer to use several lines for voice and broadband (Box 4.4).

Box 4.4: The home phone gets personal

Telecom use ADSL network to offer every member of the family their own telephone and personal number for phone calls and SMS and MMS messaging.

The home telephone continues its evolutionary progress. After the introduction of Aladino, the fixed videophone, Telecom Italia's "fixed-line revolution" is gathering pace and transforming the home phone. The latest development enhances innovative phone features by upgrading the phone line itself.

The brand new Alice Mia option routes normal phone calls over the broadband Internet. This makes it possible to "carry" up to six telephone numbers into the home, and assign a personal number and telephone to each member of the family.

Leveraging the full potential of broadband, it is now possible to make up to three phone calls at the same time over a single phone line – one call routed over the traditional line, to ensure service in an emergency – plus up to five ADSL connections, including Wi-Fi coverage.

Phones can also be used as an intercom network between different rooMs Alice Mia can handle up to three phone calls and five ADSL connections at the same time, at speeds from 640 kbit/s/256 kbit/s.

Source: Telecom Italia.

These examples show how the Italian ICT private sector is moving towards convergence in a realistic and quantifiable way. As operator interest in VoIP has increased during the past three years, some other initiatives have been taken in this field. This communication medium is well known in the market; it is a technology that allows voice transmission over the Internet using the IP protocol. The signal is digitalized, divided into packets and sent over the network. The receiver device reconverts the packets and transforms them into audio format.

When traditional circuit switching is replaced by packet switching, the obvious advantage is the drastic reduction of the infrastructure investments, since all communications use Internet, meaning lower costs for the final customers, especially for long distance calls.

VoIP is already seen as an important element in achieving the "Triple Play"[54] offer, namely the integration of voice, video and data. In particular, Fastweb has based all its offers on VoIP, rolling out services in an integrated manner. The company provides both business and residential customers with a complete, integrated system for the optimized simultaneous use of telephone, video telephone, Internet and video services on-demand. FastWeb's services are now available in 14 major Italian cities, including Bologna, Genoa, Milan, Naples, Padua, Rome, Turin and Venice.

Other entities are focusing on VoIP and offering this service as stand alone, or integrated into standard offers, as Fastweb is doing. The box below summarizes the state-of-the-art of VoIP in Italy (Box 4.5).

It is clear that broadband is growing rapidly; most of the market players are investing and trying to provide new and more integrated services. Nevertheless, the offer is still not homogeneous and lacks the standard business model necessary to align the services being offered. This aspect is very important for achieving the ubiquitous society; if all players go in different strategic directions, the necessary coordination of the implementation and distribution of ubiquitous services could prove difficult or even impossible.

Box 4.5: VoIP grows in Italy

Several companies, and not only those in the technological sector, aim at VoIP to reduce the costs and create an alternative for mobile voice.

In addition to Fastweb, Telecom has also started to provide VoIP services. One of the biggest newspapers in Italy, *La Repubblica*, has given its on-line customers the opportunity to make a call via Internet using VoIP.

The trend is very encouraging and VoIP could really become the main communication media for voice traffic, but not the only one. The natural integration with the IP protocol enables the extended use of VoIP, (e.g. video conferencing).

The numbers are eloquent;[55] according to research conducted by Databank in 2002, 14’000 Italian companies were using VoIP; by December 2004 the number had risen to 50’000 and in 2006, the forecast is 85’000. The Ministry of Communication explains that at the beginning of 2004 only 5 per cent of families using PCs and Internet connectivity were using the network for telephony. The trend is that in 2008, VoIP could become the most used Internet functionality.

Forrester Research estimates that in 2006, 10 per cent of voice traffic will be on Internet; by 2013 the migration will be almost finished. In 2020 the traditional phone calls will no longer exist.

Source: La Repubblica.

As a final example, it is worth mentioning the efforts of the Italian railway company (*Ferrovie dello stato*) to build the first “Broadband-interactive train,”[56] together with Alenia Spazio, a satellite construction company. This project shows how convergence, and so the ubiquitous approach, can be applied to any sector and not just to ICT related areas (Box 4.6).

Box 4.6: Italy experiments with broadband solutions on trains

FIFTH is a programme of the European Commission developed entirely in Italy and assigned to an industrial consortium led by Alenia Spazio, with Trenitalia as a partner.

FIFTH will experiment multimedia services like digital television, Web TV and Internet on high-speed trains using a broadband satellite as the main means of communication. During their journey, passengers will be able to view some digital TV channels, enriched with interactive content and information, and will be able to surf the Internet from their own PCs, read or send e-mail and contact colleagues and customers; in short, they will be able to carry on working as if they were in the office. Each train will be equipped with a beam-scansion antenna and a sophisticated gateway able to handle the TV programmes and Internet access.

FIFTH goes well beyond a simply Italian context, will also function at a European level to promote the use of trains, on which passengers often pass many hours.

With the successful conclusion of the validation, the programme should now move on to the construction of an initial prototype on an ETR500 train an engineering system that gives the passengers access to the services has been requested.

Source: Ferrovie dello stato.

The integration between human transport (in this case trains) and broadband services opens the door to a huge variety of possibilities, eventually allowing travellers to be connected at any time, independent of the physical location (at any place). This concept can be applied to virtually any means of transportation (cars, aircraft, boats, etc).

4.2.2 Mobile computing

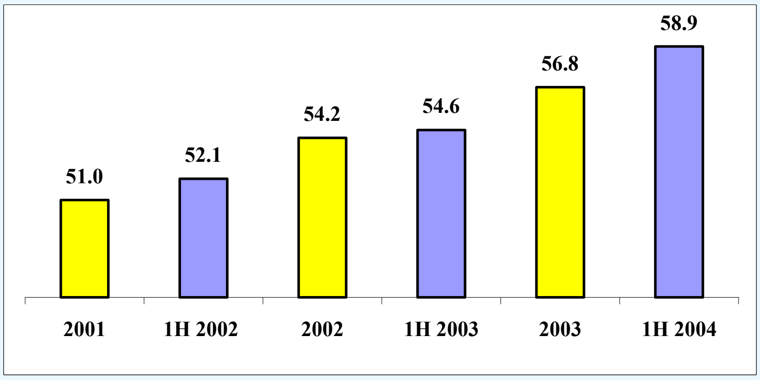
The Italian mobile communication market is characterized by a high rate of service penetration and today the market is very mature, with four official operators providing voice services in a strong competitive environment, and many minor operators providing other type of services.

After a boom in the 1990's, the voice market is now almost saturated and the focus of the operators is moving towards added value services, to maintain and reinforce their market position. There is still a related growth in the activation of mobile lines and requests for voice services (Figure 4.1).

The assignment of UMTS licenses and the evolution of technologies that facilitate the convergence mobile-Internet, have raised great expectations and provided new and interesting opportunities for producing and deploying "mobile services". However, one important consideration is the deployment of the UMTS network, the infrastructure for which has not been prepared and set up homogeneously[57].

Figure 4.1: Mobile Lines and users

Progress of mobile lines and SIM cards: "flat rate and pre-paid cards in million units".



Note: The value 58.9 refers to the activated lines.

Source: Assinform Report, 2005.

Some areas, especially in the south, cannot yet be reached by this kind of service, whilst others, especially in the north, have benefited from a complete set of the services provided by the operators. This approach, could limit the diffusion of ubiquitous networks, since the network backbone that should enable the services to be used might not be ready (Box 4.7).

Alongside the big players, new companies have been created, concentrating their business on information and marketing services, leisure, software application, public utility services; this is to avoid competing on voice and creating a new market, in which the operators can integrate the standard voice and simple messaging offer (SMS) with a more interactive and extended one.

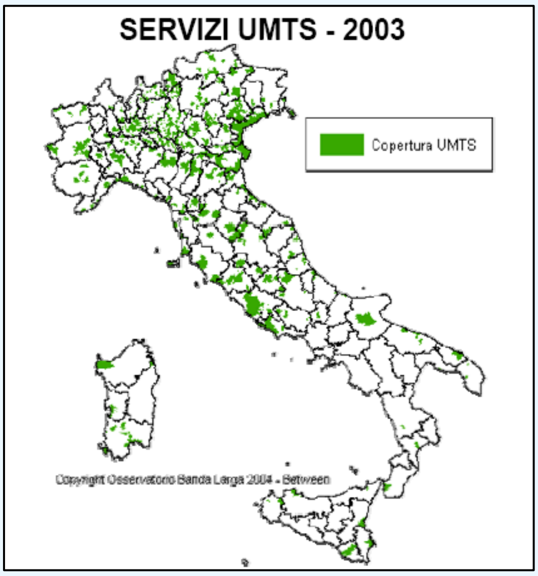
The 30 main entities present in the market are divided into the following three categories[58]:

- The four official mobile operators (TIM, VODAFONE, WIND, 3);
- Around 15 Wireless Application Service Providers (WASP);
- Around 15 Mobile Internet portals.

The first category represents over 97 per cent of the mobile communication market in Italy; these are big companies, often present on the international market as well.

Box 4.7: Coverage of UMTS Services in Italy in 2003

It is true that in Italy, UMTS is a relatively new communication technology and that the law of the market tends to give priority to the more developed areas (in the Italian market structure, this would be the north). The initiatives carried out by the operators show that the penetration of UMTS will soon be sufficient to allow the end users (wherever they are) to use ubiquitous services.



Source: Broadband Observatory, 2004.

All of them have acquired a UMTS licence, but only one (3, of the H3G group) provides mobile services based solely on this technology. The others are still providing services based on GSM and GPRS, with the exception of TIM which has implemented a "transition" technology called EDGE that is a type of technological gateway between GPRS and UMTS. 3 made a big and risky strategic choice, providing mobile services over UMTS only, but the ROI (return on investment) and the ARPU (average revenue per user) proved to be the winning move. 3 has been providing additional services (such as video telephony) since the beginning, acquiring discrete work experience and knowledge, which could prove a great advantage in such a competitive environment (see the example below, of the initiative taken during Christmas 2004).

Box 4.8: Christmas religious message on videophone

The message of the Pope in real-time

At Christmas 2004, for the very first time, the usual religious ceremony performed by the Pope could be followed using a mobile. Technically, it was a real-time streaming implemented by H3G (3 in Italy). Its customers were able to see the Pope celebrating mass directly on their mobile devices. This is a typical example on how using UMTS, a user can access a specific service from different locations and using different devices (radio, TV, mobiles).

Source: 3 (H3G Group).

The other operators need to perform migration policies and elaborate adequate business models, enabling them to provide, as soon as possible, UMTS based services to gradually write off the investment made in purchasing UMTS licenses. During the past year, the four operators have invested resources in promoting UMTS services.

In June 2003, Wind signed a partnership with NTT Docomo for the excusive distribution in Italy of "i-mode" a UMTS framework, which includes the distribution of ad-hoc handsets for UMTS integrated services. From January 2004, Wind has been able to provide its customers with a huge range of mobile added value services, encapsulated in over 200 sites, accessible through i-mode devices simply by clicking on special buttons.

In March 2004, TIM announced the launch of services based on EDGE technology, to be operational from June 2004 for business clients and from December 2004 for all TIM clients. As mentioned above, this technology complements UMTS, as it is based on almost the same protocol, which works with a similar bandwidth (200 kbit/s) and allows some typical UMTS services (such as video streaming, MMS, Internet and e-mail). This strategy will allow TIM to start distributing added value services and prepare the smooth migration to a full UMTS operational environment.

In May 2004, Vodafone officially launched its UMTS offer in Europe; in Italy it was launched in December 2004. Through "Vodafone Live!" the service portal accessible with UMTS devices, Vodafone is able to provide UMTS services to its customers.

In April 2004, 3 launched a UMTS Data Card, called Fast Mobile Card 3, which allows the use of notebooks, as they are connected to broadband lines. This facility provides Internet access using the UMTS network (where covered), or GPRS in roaming modality.

WASP also represents an interesting category of mobile services offer. There are around 15 companies operating in the Italian market, most of them small and medium-sized and operating only in Italy.

Their customers are mainly the official carriers and big companies, sometimes end users and their offer can be summarized as follows:

- Entertainment; services targeted on young customers, such as games, ring tones, logos and recently, Mobile TV;
- B2C (Business to Customers); services implemented by system integrators and software development to enable integration using mobiles for applications such as mobile banking, mobile booking, m-payment and so on;
- B2E (Business to Employee); in this case, the user is not the client but the professionals working in the company and the applications developed are more related to Mobile Office (using the mobile as an office automation tool), sales force automation, including solutions to integrate mobile devices, PDA and notebooks.

The third category refers to M-portal, or mobile-portals. They are mainly international companies, characterized by offers to integrate Internet-Mobile services. They act as system integrators to allow added value services to be accessed via mobile devices. As shown above, the mobile communications market is moving faster than other sectors, mainly because of the big boom in mobile voice services.

Today's mobile market is too full for further investment in voice; the operators cannot bring in new customers (in Italy everyone has a mobile) and so prospective clients can only be taken from other providers. In this competitive environment, only new and easy-to-use services can convince a client to choose one operator over another. The UMTS will allow this new market to grow, consolidate the operational environment and introduce new types of services, which can be regarded as ubiquitous (Figure 4.2).

Figure 4.2: Ubiquitous mobile

How the mobile can implement the ubiquitous concept.

The players have invested heavily in the implementation of the convergence mobile-Internet, and this is the first step in extending this integration with the other big networks (digital TV, and broadband).

Below are some examples of the new types of service:

- M-information; information services including news, weather, sport, lottery results, stock exchange, tourism, traffic information.
- M-entertainment; leisure services, such as screensavers, games, ring tones, videos and audios.
- M-banking and M-trading, where clients can access their bank account directly from the mobile and perform on-line transactions, etc.
- Tele-check in, where users can check in for flights using the mobile phone.
- Mobile-booking, where users can book goods and services (mainly via SMS) and make the related payment.

Source: "Larga Banda e TV digitale: la convergenza diventa realta", ANFoV, 2004.

In particular, in the area of mobile banking, a banking institute in Italy (Banca Intesa),[59] in collaboration with one of the most advanced ubiquitous oriented companies (Ubiquity),[60] has deployed a full set of banking services, using different technologies and devices. From the very beginning, Ubiquity has built a strong knowledge of new media platforms, designing and realizing solutions for the digital new media: mobile phones, PDA, interactive digital TV, corporate Intranet/Extranet and in the web marketing, the application management and the outsourcing services.

The innovative approach of such a company has been to develop and implement solutions maintaining their independence from technology vendors, both hardware and software, as well as from telecom operators, and wireless and wireline, always developing services that would be easy to use independently of both the network and the device the users have chosen.

This joint venture has proved a winning strategy, implementing banking services using one of the best-known communication tools in Italy (the cellular phone), eliminating possible technological barriers, but at the same time offering (with the modular approach) services to advanced and technology oriented customers (Figures 4.3, 4.4).

Figure 4.3: SMS message showing the status of a bank account

For simple operations and "non-educated" customers, Banca Intesa offers a packet based essentially on SMS to receive information on the account, credit cards and status of the investments. The activation via Internet or a simple telephone call facilitates the approach to the service.

Source: Banca Intesa.

Figure 4.4: Functions for advanced users

The world's first Mobile Banking using MMS in the world, for complete and personalized financial information.

For more advanced customers, investors and clients willing to get acquainted with the new technologies, Banca Intesa offers a full set of services, available in multichannel mode, and accessible by several devices (WAP mobiles and PDAs) to be able to execute banking transactions and operations in complete autonomy and from anywhere.

Source: Banca Intesa.

The degree of user satisfaction shows how the modular approach is a winning strategy in providing services, but at the same time indicates the need to build services according to the needs of the customer, aiming to use familiar technologies. Moreover, statistics show that most users appreciate the ubiquitous concept behind the banking service, which allows them to get connected from everywhere and at any time using devices that can be interchangeable. For mobile booking and m-payment, the city of Turin[61] has started a pilot project to evaluate the possibility of automating the parking procedures to reserve and pay for parking places (Box 4.9).

Box 4.9: Parking in Turin? Easy, if you have a mobile!
Turin and other cities experiment with "ubiquity parking", using mobile computing to pay and reserve parking places.

Turin is one of the first cities in Italy and Europe to introduce the possibility of mobile computing for parking.

The system is very easy: the user has to have a mobile and a smart card called Park Card; with an SMS, it is possible to activate the parking and the payment is automatically charged on the card, so avoiding cash payment.

The system is called Telepark and it has been adopted by Turin and other two cities in Italy. It is valid for the 55'000 parking places of the so-called blue zone (payment-based parking).

The mechanism for the use of Telepark involves the purchase of a smart card and its activation, via SMS, to a specific number, or by calling a call centre. Once the card has been activated, a set of specific commands appears, and the duration of the parking is entered simply by typing letters on the mobile.

Source: Il Sole 24 Ore.

4.2.3 Digital TV

2004 has been the year of the take-off of digital terrestrial TV. Currently, twenty programmes are available at the national level; 80 per cent of the population have at least one multiplex and 250'000 decoders have been sold, taking advantage of the contribution financed by the Italian government.[62]

The terrestrial analogue television that we have been using for 50 years is based on the correspondence frequency-programme, which means that, the broadcasting of a new programme (or channel) requires the setting-up of a dedicated infrastructure, composed of radio bridges, transmitters, and antennas. It is a typical vertical market, in which the company that has acquired the authorization to broadcast the signal is in charge of producing, transporting and distributing it through a specified, assigned frequency. Without any agreement with the broadcaster, the end user can access the television service via a normal TV device.

With a DTT, a dedicated network built to broadcast a channel and adequately integrated with computing devices to compose and modulate the signal, is able to broadcast several television programmes and services at the same time. The transmission of the signal is in accordance with DVB (digital video broadcasting), a core of technical regulations, promoted by the European Commission to standardize the broadcasting of the digital signal at the European level.

For the reception of the signal, the end user must have a "set-top-box", or simple decoder, to convert the digital signal into an analogical signal displayable on a standard TV.

As already stated in Chapter 3, according to the Italian regulations and the new technological operational framework, the role of the broadcaster, the entity entitled to produce and distribute the content is replaced by separated figures:

- Content providers, in charge of producing the programmes and the palimpsest;
- Network operators, owners of the distribution infrastructure and designated to the broadcasting of the content produced;
- Service providers, who enable the end users to have transparent access to the content through the infrastructure.

Furthermore, the implementation of interactive services using the remote control to execute operations and commands has already been foreseen; the decoder will interact with services made available by the content providers accessing a telecommunication network (e.g. Internet) for data exchange. This modality is called "return channel" or "interactive channel".

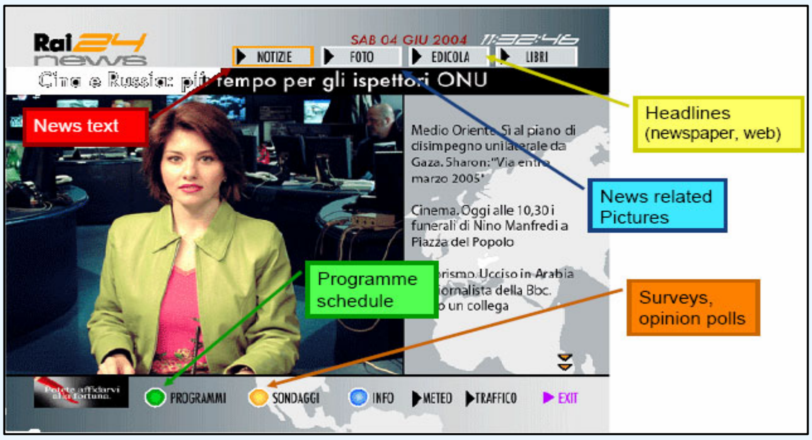
In 2001, the Italian Government approved the regulation governing the progressive conversion of all television systems to DTT; the government planned an experimental phase and set the final switchover date as 31 December 2006. At the same time, AGCOM identified the new value chain model for DTT market separating the roles and the players (content providers, network operators and service providers).

The DTT is developing a particular moment in the life of telecommunication; GSM and GPRS services are now consolidated, Internet services are mature and the customers are starting to accept culturally different ways to access and pay for online and electronic services. Furthermore, DTT with interactive services (interactive DTT) has a lot of advantages that facilitate its diffusion and acceptance: it is easy to use, we are familiar with TV sets and there are a huge number of them in the population. This conjures up the vision of an environment, in which the convergence of DTT with the other networks and related services is not just desirable but also necessary. DTT can incorporate the Internet world, especially in relation to public utility services, inaugurating a T-Government era (Box 4.10).

Box 4.10: RAI experiments with interactive and T-government services

Italian public television is investigating the potential of DTT implementing and delivering I-TV (Interactive TV) and a possible approach for T-government.

RAI, as public service, has adhered to DTT and deployed two multiplexes for a total of 10 channels. Furthermore, profiting from the potential of the return channel, it has prepared a strategy for I-TV and T-government.



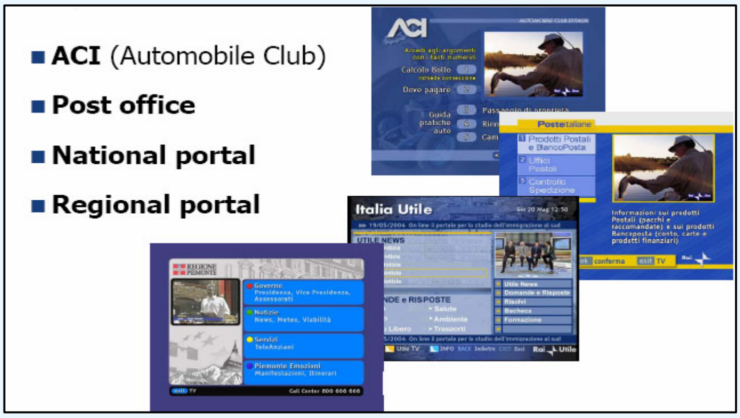
As regards I-TV, some of the services, such as interactive news (see below), are already available to the end users.

However, the most interesting aspect is related to T-government, which could be a key element in narrowing the digital divide and are already considered to be part of the public service mission.

Within this context, its integration with electronic smart cards (Electronic identity card and National Services Card, for more details see paragraph 4.2.7) has been foreseen.

Their use is a typical example of ubiquitous services, where available resources can be accessed from everywhere at any time and with any object (cards will ensure interoperability using the same file system for authentication and the same format for personal data).

Some applications have been already implemented aggregating services from different providers.



Source: RAI – Centre of Research and Technological Information.

Interactive DTT can constitute a common platform for the distribution of electronic services integrating broadband for the provision and deployment of the return channel, an interactive environment where services already available on Internet can be accessed with a TV and the remote control, allowing for a plurality of the providers (Network, content, services).

To support this ubiquitous vision of DTT, some new standards and technical regulations are to be implemented and almost ready to be deployed. The DVB-H,[63] (Digital Video Broadcast – Handheld), the latest evolution of DVB, aims to provide access to broadband services "at any time" and "at any place", through small terminals. This technology can complement the mobile communication network, due to its convergence with broadband and the predicted use of small devices (comparable in size and weight to a normal cellular phone). It has already evaluated with good results the possibility of producing multi-standard terminals DVB-H/UMTS.[64] The UMTS network then can provide the return channel, so making available interactive services that can be accessed by DTT via terminals DVB-H.

4.2.4 Wi-Fi

When the Communications Ministry[65] promulgated Wi-Fi access last year, it was immediately perceived as the "hot new thing" for those mobile users demanding immediate access to e-mail and the Web. A world bristling with thousands of hot spots was forecast, but so far, reality has fallen short of expectations.

After one year, the ministry began issuing Wi-Fi licenses to Internet providers, so Italy is lagging behind much of Europe. The regulation offers the opportunity to install networks, such as Radio LAN, to supply the public with access to electronic communication services on a band with a frequency range of 2.4 to 5 GHz by a simple authorization. Retailers who intend to offer the public Wi-Fi services must present the Communications Minister with a request to that effect, which gives the retailer the right to set up the service immediately, whilst respecting the conditions indicated in the regulation.

To avoid interference with other services and use the permitted broadcast power, the authorized subjects must respect the National Frequency Distribution Plan technical operating rules for using 2.5 and 5 GHz bands. This is because the frequencies used are collective and not assigned exclusively to each operator, as in the mobile telephone system.

The regulation also governs the use of Wi-Fi equipment for the public, spots open to the public and areas with high public attendance. Among the places chosen for the use of Wi-Fi are hotels, bars, restaurants, shopping malls and fast food chains, where people can have the opportunity to connect to the Internet with broadband wireless access.

The regulation also demands respect for security rules and the integrity of networks. It asks the retailers to use an identification code for users who access the public network. The installation of the Wi-Fi network should be set up in line with the principle of non-discrimination between the Radio LAN system and the other competing technology.

About 35 licenses have been issued so far, to companies ranging in size from Telecom Italia, to very small companies such restaurants and Internet cafes. Unfortunately there is no massive penetration of hot spots in Italy, which means that finding a hot spot can be difficult. Access points are mostly located in top range hotels, major airports and railway stations, Internet cafés and shopping centres.

Under Italian law, all users wishing to access a wireless network must register with a provider, and payment – which can be calculated in terms of time online, downloaded bytes or a flat fee – can be made with a pre-paid card or credit card. One problem with this is that the various service providers do not have commercial agreements that allow roaming between companies. This means that access via a provider bought at Rome's Termini railway station cannot be used at Milan's Malpensa airport, which may be covered by another provider. Moreover, some industry experts are very concerned about the disregard for Wi-Fi security. Almost all Italian access points are open; they are not encrypted, which means that data is easily intercepted.

The brief analysis above is a snapshot of a very unstable environment, possibly not sufficiently consolidated to welcome and support the desirable convergence between wireless networks and the other infrastructures. This does not mean that potential ubiquitous services cannot also be accessed through Wi-Fi; it seems that, according to the current status, Italy has been a little late setting-up and making the consequent investment in wireless. However, the big companies and most of the R&D entities are not endorsing the delay caused by this situation and are moving to identify the more effective technical solutions, at the same time identifying what might be the appropriate business model to put in place.

The following section summarizes, in highlight form, how the ICT sector, including R&D is reacting to this situation, aligning their current services and integrating the infrastructures already deployed with Wireless. Telecom Italia plans to increase the number of its hot spots from 200 to 1'500 and, to increase its Wi-Fi potential in Italy and abroad, it joined the Wireless Broadband Alliance,[66] which comprises 18 of the world's biggest providers, including British Telecom, T-Mobile US and T-Mobile International. Telecom Italia and TIM, the wireless arm of Telecom Italia Group, have also extended their dominant position on Wi-Fi, between them having more than 70 per cent of the active hotspots. Motorola Inc., Global Telecoms Solution Sector (GTSS) announced that it has worked with TIM to provide an end-to-end Wi-Fi solution. Motorola's Wi-Fi system is part of the corporate wireless service portfolio, which TIM offers to the enterprises throughout Italy.

Motorola was chosen by TIM to co-design, deploy and support a hybrid Wi-Fi system for private, as well as public Wi-Fi users within the enterprise. The private network provides wireless Internet and intranet access to employees, while the public network gives wireless Internet access to visitors, such as consultants, suppliers and customers. Users can benefit from broadband speed connectivity without the need for a wired connection. TIM chose the system proposed by Motorola because it could be integrated easily into TIM's existing user authentication solution (SIM-based authentication). Motorola is also specifically responsible for providing the Wi-Fi hardware and software and managing the installation, deployment and ongoing maintenance of the system at TIM's customer sites. The system Motorola designed is divided into three areas: the radio network, which includes Wi-Fi access points and cards; the core network, which includes routers and firewalls; and cabling, which will be provided by TIM. Vodafone, which does not have its own hotspots, is building several partnerships with minor companies (owners of the remaining 30 per cent of the installed base), in order to roam the traffic.

The Ugo Bordoni foundation (FUB) has coordinated an experimental phase (between March 2003 and February 2004), with the participation of most of the operators and Cisco Systems, to evaluate the possibility of building a Wi-Fi multioperator[67] infrastructure, a wireless network where different services (by different operators) were provided, using the same hotspots and access points. This important pilot project has proved and actually implemented the concept of integrating different authentication and authorization procedures, aggregating the accessible services into one single infrastructure.

4.2.5 Domotics

Domotics enable home-wide automation and communication for appliances; equipment enables distributed and remote control of domestic applications, from inside and outside the home. Automation, communication and shared-use of appliances in a home environment is the real challenge to imagination and life style.

Domotics integrate the various technologies present in the house, in order to offer a high degree of functionality and security and reduce installation and consumption costs. Moreover, they represent a big challenge and the opportunity to use converged services.

During the last few years, domotics have expanded their original scope, integrating additional functions, in line with technological evolution. It is now possible to control the functioning of doors and windows remotely, thus helping old and disabled people, as well as regulating energy consumption.

Some of the most important companies, especially the home-appliance producers, have released devices able to improve the level of automation even in the kitchen; for example, washing machines controlled by mobiles, able to choose the most appropriate washing programme automatically, ovens that download recipes from the Internet, refrigerators that inform the user if a specific item is missing, (by reading the bar code).

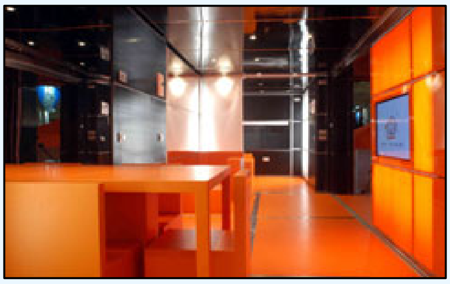
This new frontier is represented by interactive screens and displays, to bring together, in a single control device, all the controllable appliances, and schedule their activation and deactivation; also to connect to the Internet and write e-mail, etc. (Box 4.11).

In reality, the "smart-house" is not really that; the main principle is that home-appliances and services are not isolated and stand alone, but operate as part of an integrated environment, in which "coexistence" and convergence are the key aspects. Thanks to the use of new communication technologies, and possible new standards, the user can have all the necessary tools to keep the house under control, in an automated manner, thus creating a personalized environment, in which all systems work together to improve the quality of life.

The uplink to the Internet could also change our way of working, introducing "telework" and optimizing the time spent in the office (where physical presence is not necessary).

Box 4.11: Bticino implements MyHOME
The company has integrated a unique control system into the management of the house.

Bticino, a home control appliances production company, has released a domotic and teledomotic system to control the house called MyHome remotely.



With a mobile and via internet (through the service My home web) it is possible to activate or deactivate electronic elements in the house using a fixed or mobile phone (dialing a specific number with related codes) or using a PC with Internet access.

It is also possible to monitor the current situation in the house through video surveillance systems, accessible via

Internet. The website has a member area, with the images of the house.

Everything inside the house can be controlled by an interactive touch screen display

Source: Bticino.

An interesting experiment has been conducted by a partnership of various companies, which has tried to create an intelligent house, with state of the art domotic systems (Box 4.12). However, despite the progress, the market has not yet taken off, essentially because a lack of standardization and communication between the different domotic solutions. Therefore, the number of domotic technologies present could make their use more complicated rather than easier.

This is very relevant to ubiquitous networks, since one of their most important aspects is convergence, not only of the services, but also in relation to the communication media used (e.g. transmission protocols). The key players have not yet coordinated a possible standard approach and the present regulation is not adequate to cover domotic issues.

Box 4.12: The first domotic district is born

Joint venture between different providers to implement high technology network connected domotic houses.

Four of the major companies in Italy AEM, Bticino, EuroMilano and Fastweb have joined forces to build the first domotic residential area, in Milan.

For the very first time, Italy is proposing an innovative real estate where technology and convergence are the main drivers; the apartments will have an integrated domotic control system implemented by Bticino to control the functioning of home appliances and infrastructure devices such as lights. Fastweb will provide broadband access, with services like TV on demand and high speed Internet access. AEM will implement teleheating. A real intelligent house, completely integrated, that can be "administered" in a converged manner.

Source: www.domotica.it

4.2.6 RFID

Radio frequency identification (RFID) is a method of storing and retrieving data remotely using devices called RFID tags. A RFID tag is a small object, which can be attached to, or incorporated into a product. RFID tags contain antennas to enable them to receive and respond to radio-frequency queries from an RFID transceiver (Box 4.13).

Box 4.13: RFID tag

There are two main types of RFID tags: passive and active.

- Passive RFID tags do not have their own power supply; the minute electrical current induced in the antenna by the incoming radio-frequency scan provides enough power for the tag to send a response. Owing to power and cost concerns, the response of a passive RFID tag is necessarily brief, typically just an ID number (GUID). The lack of its own power supply makes the device quite small. There are even commercially available products that can be embedded under the skin. In 2004, the smallest of these commercially available devices measured just 0.4mm × 0.4mm, and was thinner than a sheet of paper; such devices are practically invisible. Passive tags have practical read ranges that vary from around 10mm up to around five meters.
- Active RFID tags, must have a power source, and may have longer ranges and larger memories than passive tags, as well as the ability to store additional information sent by the transceiver. At present, the smallest active tags are about the size of the average coin. Many active tags have practical ranges of tens of meters and a battery life of up to several years.

Source: Battezzati, Luigi (2003), RFID – Identificazione automatica a radiofrequenza, Hoepli.

As passive tags are much cheaper to manufacture and do not depend on a battery, the vast majority of RFID tags in existence are of the passive variety. In 2004, tags cost from USD 0.40 each; however, to make widespread RFID tagging commercially viable, they would have to be produced for less than USD 0.05 each. However, the chip manufacturers' supply of integrated circuits is not sufficient and demand is too low for prices to come down soon. Analysts from independent research companies, like Gartner and Forrester Research, agree that a price level of less than USD 0.10 per unit is achievable only in 6-8 years.

There are four different kinds of tags commonly in use and these are categorized by their radio frequency: low frequency tags (from 125 to 134 kHz), high frequency tags (13.56 MHz), UHF tags (868 to 956 MHz), and microwave tags (2.45 GHz). UHF tags cannot be used globally as there are no global regulations governing their use. An RFID system may consist of several components: tags, tag readers, tag programming stations, circulation readers, sorting equipment, and tag inventory wands.

The purpose of an RFID system is to enable data to be transmitted by a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the tag may provide identification or location information, or specifics about the product tagged, such as price, colour and date of purchase. The use of RFID in tracking and access applications first appeared during the 1980s and it quickly gained attention because of its ability to track moving objects. As the technology is refined, so more pervasive, and invasive, uses for RFID tags become likely.

In a typical RFID system, individual objects are equipped with a small, inexpensive tag, which contains a transponder with a digital memory chip that is given a unique electronic product code. The interrogator, an antenna packaged with a transceiver and decoder, emits a signal activating the RFID tag so that it can read and write data to it. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal; the reader then decodes the data encoded in the tag's integrated circuit (silicon chip) and the data are passed to the host computer for processing.

In Italy the RFID concept has had a mixed reception, since its acceptance and use tends to affect sensitive issues such as privacy. Several companies, other than R&D entities, evaluated the possibility of introducing RFID tags, and today there are two main areas of activity producing interesting RFID applications:

- RFID tags on products, which is related to the identification and management of productive cycles, what in economics is called the “supply chain,” not only facilitating the logistic productive process, but also providing information on the whole development cycle of the product, from the production to the distribution to customers;
- RFID tags on people, to allow the identification of an individual any time and at any place. Here the privacy aspect plays a big role, although in our current social structure, tracking people has become increasingly normal and even natural. The use of RFID in this area is more related to health care (e.g. the monitoring of patients to enable timely medical intervention).[68]

Several pilot projects have been started on product-based RFIDs, specifically in the field of Italian fashion, one of the most developed markets. Benetton and Prada, to mention just the largest, have tried to introduce RFID tags to monitor the sales of their products, to handle their stock and to draw up marketing campaigns for various specific products, according to the input from the RFID tags. Unfortunately, Italian public opinion did not agree with these experiments, regarding the life cycle product as the intrusive monitoring of individuals. Only Prada has managed to introduce RFIDs in some ateliers, but in only in the USA and not in Italy.

A more successful approach has been the use of RFIDs on products and the complete elimination of any possible interaction with human beings. Examples of how RFID has penetrated the Italian production system include stock management, automatic production of invoices through systematic reading of product tags, controlling the life cycle of consumer products (expiration date of milk or juices, etc.), intelligent distribution of luggage at the airport according to a specific flights and the classification of animals Not only has this improved the performance of the industry, it has also, and perhaps more importantly, made people’s lives easier.

The use of RFID technology has been adopted mostly by small and medium-sized enterprises, rather then the big multinational companies; furthermore, RFID is being used mainly inside the production cycle, to improve operational procedures. The re-engineering processes in small and medium-sized companies is surely less invasive, according to the amount of planning and implementation activities to be carried-out, than a in big company, where branches and factories are located worldwide, but it indicates also the potential that medium-sized enterprises represent in the Italian economy, especially in the adoption of new technologies. Big companies often do not want (for political and organizational reasons) to change consolidated, but sometimes obsolete, operational processes.

An interesting use of RFID has been the integration performed by Tappetifici Radici[69] (a carpet manufacturer) in their stock and shipment management (Box 4.14).

Box 4.14: Tappetifici Radici adopts RFID and Wireless for stock management

To solve problems in identifying merchandise to be shipped to its customers, Tappetifici Radici's EDP centre has implemented a solution based on RFID, wireless and bar codes.

The main issue was the limitation of the bar code, which did not enable the direct identification of the products in stock and those to be shipped. The personnel assigned to the warehouse used to spend lot of time identifying and taking out the specific product, loading it on a vehicle and sending it to the expedition sections.

To solve the problem, almost all products present in the warehouse have been tagged with RFID devices that are able to communicate wireless to a central repository, giving indications on their position on the shelves.

The vehicles have been equipped with wireless cards and 20cm screens to communicate with the central repository and locate the required element instantly.

In this way, warehouse personnel do not have to spend time identifying what is in stock and what has to be sent for, as they have all this information in real time and, with the use of Wireless, this is accessible from any part of the factory.

Source: www.rf-id.it

Even some religions have realized the importance of optimising their procedures (Box 4.15).

Box 4.15: Vatican library adopts RFID

Implementation of RFID technology for the library.

The Vatican Library in Rome, home of nearly two million books, manuscripts and other items, has adopted radio frequency identification (RFID) tags to identify and manage a significant proportion of its extensive collection. Using RFID, the library is finding misplaced books more quickly, maximizing floor space with frequently requested items and streamlining the inventory process. Previously, administrators closed the library for an entire month each year to verify its contents, manually cross-referencing what was found on each shelf against the library's collection database. When the RFID project is completed, the Vatican estimates that checking the inventory will take only half a day. Each RFID tag inlay stores the individual book or document's catalogue data on a specially designed 'library friendly' tag that prevents damage to the item. The printed tags also include visible text, allowing for faster labelling.

When new data are added to an item, the record in the library's collection database is updated simultaneously via wireless communication using a handheld reader and software management system. This integrated system allows the library personnel to obtain the real-time status of every single book; it also provides the visitor with useful information, such as the estimated return time for a specific item, and whether or not it is present.

Source: www.theregister.co.uk

The development of RFID systems applicable to people has been slower; this is because of its implications for individual privacy. However, one area where the application of RFID technology is universally acceptable is health care. In Italy health is considered to be an extremely important issue.

Numerous scandals and problems in the National Health Service have greatly reduced people's trust in the system and research in this field could usher in more positive interaction between the people and the government. An interesting project[70] to verify the feasibility of introducing tags into the human body for disease-monitoring purposes has already been implemented (Box 4.16).

Box 4.16: VeriChip: "Technology that cares"
Italy evaluating VeriChip health care application.

VeriChip is a sub-dermal, radio frequency identification (RFID) device that can be used in a variety of security, financial, emergency identification and other applications. About the size of a grain of rice, each VeriChip product contains a unique verification number that is captured by briefly passing a proprietary scanner over the VeriChip. The standard location of the microchip is in the triceps area between the elbow and the shoulder of the right arm. The brief outpatient "chipping" procedure lasts just a few minutes and involves only local anesthetic followed by the quick, painless insertion of the VeriChip. Once inserted just under the skin, the VeriChip is inconspicuous to the naked eye. A small amount of radio frequency energy passes from the scanner energizing the dormant VeriChip, which then emits a radio frequency signal transmitting the verification number.

The principal investigator, Dr Giorgio Antonucci, presented the study's protocol to the Italian Ministry of Health and has received approval to proceed. The study is designed to observe the VeriMed(TM) technology function during care provided to patients whose medical conditions impede the transmission of vital information to the hospital's medical staff. Patients will be given the opportunity to utilize the VeriMed(TM) technology to provide their personal identification information and recent medical history. Dr Antonucci and his staff are expected to begin patient enrollment in the programme immediately. It is anticipated that the objectives of the study will be achieved within six months, at which time the findings will be presented to the Italian Ministry of Health.

Source: www.cybertime.net

Clearly RFID can be identified as a key enabling technology for the creation of ubiquitous services; they can be incorporated into any network and will provide information on the status and physical location of the object in question. A strong and feasible integration can be seen also in respect to domotics, the science applied to information and communication technologies for more comfort and convenience in and around the home is another key enabling technology.

RFID and domotics can be integrated to build a home infrastructure, in which a central unit controls and manages the inputs and data provided by RFID tags installed on any home appliance (such as stereos, washing machines, lights, PCs and telephone lines) automating and controlling their use remotely. In this respect, Merloni,[71] one of the most important Italian home appliance companies, has succeeded in integrating RFID and domotics bringing the full automation of domestic appliances one step nearer (Box 4.17).

Box 4.17: RFID and domotics

Merloni implements intelligent home appliances.

Merloni Elettrodomestici is the first manufacturer to bet big on RFID. The company will unveil a new line of appliances that have RFID readers, which enable the machines to communicate with objects.

The line includes a refrigerator, oven and a washing machine. Antennas will transmit signals to products with embedded RFID transponders and retrieve important information about the product. The smart appliances will go into commercial production next year. And while very few of today's products have embedded RFID tags, Merloni clearly believes that many soon will and it wants to be a leader in the field.

The washing machine will read intelligent labels in clothes and retrieve information about the size, colour and type of fabric, as well as washing instructions. It will warn homeowners if they have placed items that should not be washed together into the machine. A colour screen can display messages, like: "This is the first washing [for this pair of jeans]. It is advisable to wash them separately."

The refrigerator is designed to track each item's expiry date and display information about its nutritional value. It can even provide recipes for dishes that can be prepared with the ingredients in the fridge. And the oven will automatically set cooking and baking times and temperatures based on instructions from tags.

Lab ID of Bologna, Italy, worked with Merloni on the project for five months. It developed special low-power (200 milli-watts) readers and small antennas for the appliances. The readers operate at 13.56 MHz and are compliant with ISO 15693 and ISO 14443A and B. Lab ID says the readers can read from and write to 600 different transponders in 10 seconds.

Source: www.rfidjournal.com

4.2.7 Public utility services

The Italian Government, together with ISPs and telecommunication companies, has invested a lot of energy in establishing policies to enable services to be provided in an integrated manner.

By harmonizing local and central administration ICT infrastructures, in a federated network with common authentication and authorization modalities, the government strategy has aligned itself with the basic concepts of ubiquitous.

The capillary presence of connectivity is necessary to guarantee the complete and efficient interoperability of back-office elements within the different administrations. The RUPA (*Rete Unitaria Pubblica Amministrazione* – United Network of Public Administrations) ensures this presence and is the public sector instrument for providing e-government services.

The RUPA consists of a network that provides 34 Mb/s and can be regarded as an intranet between central offices and local administrations, providing better integration in terms of accessibility, in addition to simplifying and harmonizing standard procedures. Furthermore, its use could extend the services provided by the Italian Government, ensuring their access in a converged manner, using several different access modalities (broadband, UMTS, DTT), thus moving toward the concept of u-government.

To support RUPA, a project has been implemented that aims to create a Centre of Excellence to ensure the penetration of services at local level and enable the interchange of experience, best practices and possible new operational models. Another interesting project has been started to aggregate on-line services and migrate others in an on-line fashion (Box 4.18).

The final objective is to ensure a single, distributed access point to all available services. To do this, it will also be necessary to introduce personal identification instruments that could enable convergence towards a unique standard where the distribution and management of the services provided is shared, applicable in all national territories and economically sustainable.

Two different identification models[72] have been foreseen; the CIE (*Carta d'Identitá Elettronica* – Electronic ID Card) and CNS (*Carta Nazionale Servizi* – Services National Card).

Box 4.18: PEOPLE project, a road to a virtual municipality

Fifty-four cities experiment with the whole migration to online services.

The aim of the Ministry for Innovation and Technologies is to modernize the burocratic and very articulated Italian administrative system through the online migration of most of the services from the traditional ones (such tax payment or health certificates) to the newest services.

Right now, 55 per cent of Italian net surfers are accessing governmental websites, compared to 50 per cent in Spain and the UK and 40 per cent in Germany. Most of the Italian administrations, from local small cities to big ministries, have a portal, sometimes with the possibility of interacting directly and in real-time with the governors, a very first step toward the e-democracy.

In line with the approach of the Ministry, 54 city administrations have started a project called PEOPLE (*Progetto Enti Online Portali Locali E-government* – Project On-line Portal for Local E-government).

Twenty million euro is the initial budget allocated to this activity, the aim of which is to create a national service to facilitate and speed up the execution of administrative procedures, such as the payment of local taxes, the issue of authorizations and concessions and school subscriptions.

Each section is coordinated by a different city:

- Genoa has implemented a virtual office to pay taxes;
- Bologna has created an online mechanism to execute online payments;
- Modena has coordinated the development of a system to have information of construction plans, housing, traffic information;
- Siena has implemented an online register of births, marriages and deaths.

The new portal will be placed inside all institutional sites of the cities involved in the project.

Source: www.panorama.it

Electronic ID Card

According to Italian Government sources, the distribution of the new national ID card has started in a number of the 56 Italian communities scheduled to be activated under the programme. The government's publicly stated plan to issue up to two million cards in 2004 puts Italy at the forefront of European countries, in terms of providing their citizens with secure, durable ID documents.

The CIE is a smart card allowing the holder to be identified "on sight" and is designed to permit transparent and easy exploitation of e-government services supplied by the Italian public administrations. The CIE achieves two important security goals: it makes electronic transactions very secure, because it adopts sophisticated authentication techniques (challenge/response, asymmetric cryptography) and also saves the user from having to remember a huge number of user-IDs, passwords and PINs.

The project started with a testing phase that ended in 2001; during this phase, around 100'000 CIE were issued. The second phase is about to start and within five years, all citizens will have an Electronic Identity Card, which will replace the traditional ID card.

The CIE is built on a laser card optical memory card platform, which includes a one megabyte optical stripe, to which a contact IC chip is added in Italy. The optical memory provides visual and automatic card authentication; a non-alterable audit trail of events (each digitally signed) in the card manufacturing, registration, activation, distribution, and issuance processes; a portable data "vault" containing each citizen's demographics, colour photograph, digitized signature and other biometrics; with back up should the chip fail.

Services National Card

The CNS represents a standard to access services provided by the public administration. It is a microprocessor card, with almost the same features as the CIE, but with different security elements (e.g. holder picture, holograms produced by the government to verify its authenticity). This simplification enables the use of easier and more flexible systems for distributing such cards, possibly delegating their production to a third-party, thus making the market more open and competitive. The CNS is an instrument to be identified on the network and through the introduction of the electronic signature will enable the holder to submit official documents and the government to provide certificates. These two elements will be completely interoperable, and the ownership of one will allow the user to access the services available through the other (with the necessary authentication alignment).

Another task of the information society is to strengthen e-learning policies and procedures. This initiative involves public schools, universities and public administrations, and aims to introduce alternative methods of acquiring knowledge, whilst at the same time providing the opportunity to study "at any time" and "in any place". Distance learning can bring Italians closer to ICT and educate users on the content provided and also in the use of IT tools.

The initiative has had positive results in connecting public entities to Internet resources via broadband and wireless access. At the end of 2003, following the e-Europe framework, 80 per cent of Italian schools were connected via broadband, 50'000 new PCs introduced and 8'000 multimedia labs established.

In health care too, the government has carried out important initiatives; telemedicine, as an ICT application for long-distance diagnosis and care, has an important role in allowing users to perform health-check and therapy in a ubiquitous manner (i.e. not being present in the medicine cabinet).

In particular, initiatives have been started to:

- identify the baseline in providing health assistance;
- create an integrated network of e-health and social services for the more critical and high risk potential patients (old people, chronic invalids and the disabled);
- the redesign of hospital networks and the creation of Centers of Excellence;
- The strengthening of the emergency number system.

An interesting initiative will be implemented to centralize and aggregate emergency numbers[73] (Box 4.19):

Box 4.19: Unique emergency number
One emergency number to access different type of services.

A national multi-channel "Contact Centre" will be set up to ensure access to all emergency systems through a unique national number (112 replacing 113 for Police, 112 for Carabinieri, 115 for Fire Brigades, 118 for E.R, etc.). The system will guarantee immediate coordination between the entities involved, ensuring an efficient and prompt service to the end user.

Source: "Strategie e politiche per la banda larga in Italia".

4.3 The convergence process; a key element: current state and predicted evolution

Convergence in telecommunications involves different services reaching the user irrespective of the communication medium. Thanks to convergence, it is possible to separate the service provided from the technological vehicle used to transport the information and to aggregate several contents on the same medium. In accordance with the definition of ubiquitous, convergence makes the provision of a specific ICT service "from any place" and "with any object" easier. Convergence is the result of a complex work of definition, aimed at sharing communication media to transfer different types of information and it must be seen and investigated at different levels.

Transport network convergence is defined as the transportation of information independent of the physical medium and protocol used. In Italy, and generally in the state of the art of the backbone infrastructures, this kind of convergence has already been achieved, harmonizing the backbone switching via gateways, and from the protocol point of view following the de-facto standard of the TCP/IP protocol, after the Internet explosion.

In terms of access network convergence, the current situation seems to exclude the standardization of the access modalities (wire line, wireless, narrow and broadband, etc.). The access methods are different from one another, and the operators have invested so much in setting up their access networks that is counterproductive to rethink them in a converged manner; the economy of scale in providing access to the services imposes the coexistence of the access technologies used.

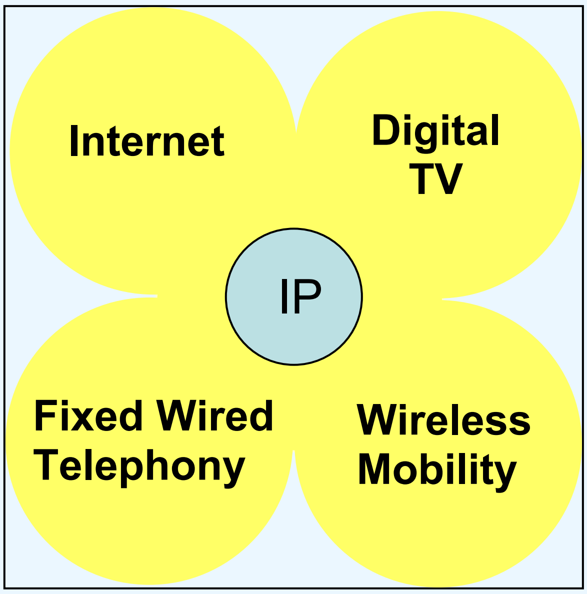
Instead, there is a strong interest in envisioning convergence in terms of the terminal used; this can be divided into three:

- Convergence at the level of access technologies, requiring multi-access terminals (GSM, UMTS, fixed, mobile, wireless);
- Network level convergence, end-to-end, already reachable for all terminals using the same protocol (specifically IP);
- Convergence at the transport-session-application level, already present today on the PC-based terminals, growing on TLC terminals (fixed and mobile phones), and foreseen for new generation terminals such as palmtops, pocket PCs, UMTS devices.

But the most important aspect of convergence is laying on the services provided, which means identifying opportunities for integration at the upper layer of the data exchange. This means ensuring the total interoperability of the services on the transit from one infrastructure to another, as well as guaranteeing compatibility on the implementation of the different solution proposed, through a common middleware to be used by everyone (as happened for Java Beans and Active X controls).

To obtain such convergence, the physical network should be overlapped by a logical one, composed of service nodes able to communicate with one another and with the terminals. The network will become a unified infrastructure, driven by a standard transport protocol (identified in the IP) and a "global resource" that performs the transfer/control/management of the information and the streaming of the service in question (Figure 4.5).

Figure 4.5: Network convergence "IP based"



Source: White book on TLC – Ugo Bordoni Foundation.

An additional benefit of this vision of converged network solution is its staying power. It is widely acknowledged by the communications industry and industry analysts as a whole, that the Internet Protocol is the universal transport medium of the future. The adoption and migration of vendors to the use of IP as a transport medium for data, voice and video applications reinforces this vision of the future.

An interesting application related to the possible convergence based on IP has been conducted by Cisco and University of Messina[74] (Box 4.20).

Box 4.20: Ubiquity University

Cisco collaborates with University of Messina for the integration voice-video-data.

Cisco has announced the adoption by the University of Messina of structured cabling and devices for wireless connectivity that will enable the convergence of voice, data and video. The infrastructure, based on Cisco AVVID (Architecture for Voice, Video and Integrated data), will allow the integration of voice video and data using the same IP network. The University will be able to provide multimedia services like videoconferencing, video elections, and on-line consultation of didactic material and the electronic management of students' progress through a single integrated network infrastructure.

This solution will facilitate the interaction between the different services making access by the users easier.

Source: www. cisco.com

The global network will be completed by interconnecting several access and transport technologies, such the IP infrastructure, mobile and wireless networks, broadband, cable and fibre networks, television networks and infrastructures built around users' premises (home networks). The next generation network will be characterized by billions of terminals, with "always-on" functions permitting the convergence of applications and services using new enabling communication media.

In light with vision, the IP protocol plays a major role in integrating and harmonizing the access and transportation of the information. However, the requirements prompting its creation have been already been overtaken; it can now be used by the majority of the devices connected and, according to the technical specifications, a fixed number of elements can be connected at the same time. The demand for IP addresses will continue to grow; as early as 2003, the number of addresses had almost reached one billion. A redesign of its structure has to be evaluated, providing a bigger addressing space, and consequently increasing the potential number of connectable objects.

The Internet Engineering Task Force (IETF) has identified a possible approach and several studies and pilot projects have been initiated to overcome the limitations. The technical details are out of the scope of this case study, but some clarification is certainly required. Today, the maximum number of addresses assignable to a specific entity or user is less than 3 billion. This is because the structure of the IP address foresees the use of 4 octets (for a total of 32 usable digits – from here the definition of IPv4). As the IT world uses binary language (1 and 0), the calculation is easy: the total number obtainable is 2 to the power 32 (apart from some reserved-range networks allocated for research and other purposes).

An extension of the available IP addresses is represented by the IPv6 initiative, aimed at making a much bigger number of addresses available, so allowing more devices to be connected, with a clear advantage in terms of presence on any network. Italy has also been initiating some interesting research activities (Box 4.21).

Beyond the technological view of convergence and, in a broader context, the development and transformation of the content market is the result of the tendency of the media world to integrate with the other ICT sectors, as part of a convergence process. This evolution can be due to the quick development of the broadband technologies (wire line and wireless, the progressive digitalization of television with the consequent introduction of digital terrestrial TV and the stronger perception of the potential on mobile computing.

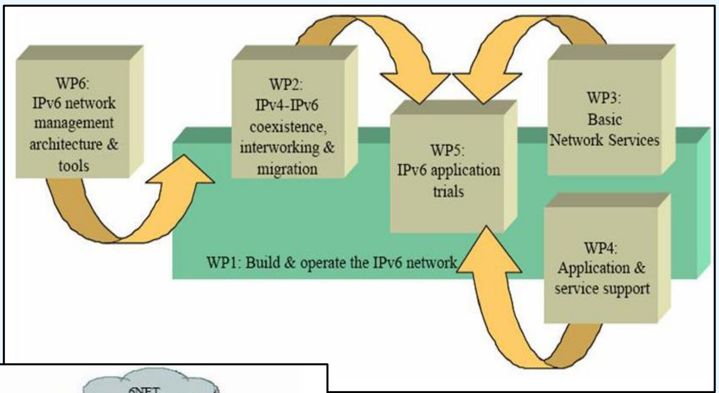
These aspects have motivated the operators (broadband and mobile) to extend and enlarge the market strategies towards the creation of new multi-service devices, more complete than a simple PC, to penetrate the market better and stimulate greater demand amongst customers.

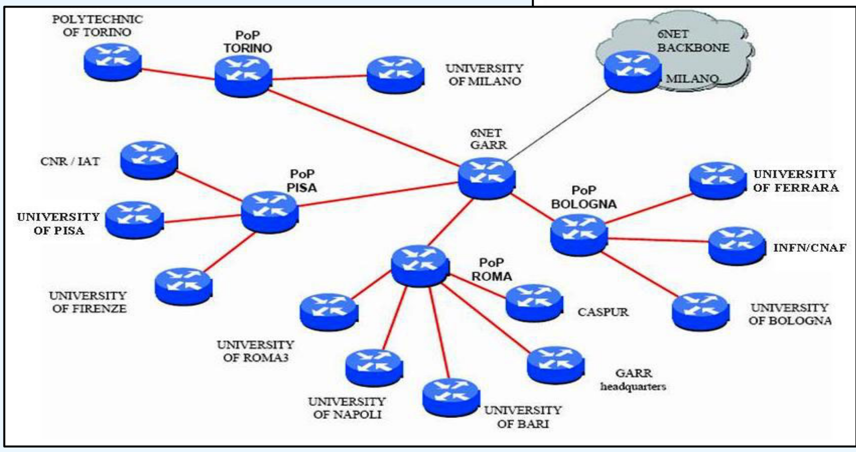
A few years after the introduction of access technologies more advanced than simple dial-up, Italy is emerging as one of the most reactive countries, having a national offer of broadband, in particular fibre, able to support high quality multimedia and business integrated services. It is also true that at present, not more than three or four providers are investing in and actually providing converged services, but in view of the success obtained, this could serve as a very strong stimulation for the others, especially those that already have expertise in fibre and backbones and have deployed them.

Box 4.21: The European project 6Net
Italy is participating actively in the introduction of the IPv6 European initiative.

6 Net is a joint project coordinated by the European Community with the participation of 31 partners from the public and private sectors to evaluate the implementation and impact on the market of the new IP framework version 6.

The project, divided into work packages, is focused mainly on identifying the evolution of the ICT sector, when the implementation and deployment of IPv6 will be accomplished, on the area of infrastructures, network services, and application-end user services.





Italy is strongly involved in the process, having started the testing phase and so positioning itself as driver for some of the activities. Using R&D entities, mainly universities, it has managed to deploy a fully operational test environment, connecting via IPv6 more than 15 structures.

Source: Gabriella Paolini – Il Progetto Europeo 6Net.

At the same time, the TV operators, who are vertically integrated, have started to recognize and use the advantages coming from a long analogical period re-capitalizing the investments in getting as many customers as possible and repositioning strategically within the digital market. This main advantage of this process is that it does not depend on geographical distribution (as was the case in the analogical world), as there is a direct relationship between digitalization and globalization. The analogical elements represent a barrier against integration and convergence. Given this, Italy can be regarded as a pioneer exploring new frontiers.

Digital television facilitates the distribution of contents traditionally belonging to broadcasting, in other words in modality "one to many," with the addition of interactive content typical of telecommunication environments (Internet, integration data, video, voice one the same communication channel).

This aspect not only provides interesting opportunities for the customers, who are able to use innovative technologies at very low costs, but also determines the separation between the technology used and the product distributed. The convergence market defines the technological opportunities (which systems for which technology? Which services to be provided independently by the technology used?) but also the competition for the control and maintenance of areas of the market, the definition of strategies to consolidate the players (through acquisitions and joint ventures) and the development of business models related to several new visions and the expertise of the operators and their position on the supply chain.

The availability of advanced infrastructures, such as broadband and UMTS, is the basic requirement for the development of convergence, in particular on the content side, due to their capacity to integrate the information exchange flow both quickly and efficiently. One of the most interesting phenomena associated with this is the tendency to consolidate and aggregate the content. This is motivated by the possibility of acquiring a potentially competitive advantage once innovative and high performance infrastructures have been set up to handle and control, at the global level, a client portfolio that is increasing in size, because it provides services that are usable anywhere, at any time and using different terminals.

The multiplatform, multiservice approach seems to be the winning strategy, because it can guarantee potentially universal access by the content provider, so meeting the users' needs in terms of portability, mobility and customer classification (business, home users), as well as creating the scenario, in which the ubiquitous society can become a reality.

4.3.1 Protecting data in Italy's ubiquitous network society

Italy's new data protection code came into force on 1 January 2004.[75] The Code is unique, in that it brings together all the various laws, codes and regulations relating to data protection introduced since 1996. As mentioned above, many objections and concerns have been raised relating to privacy and the invasion of people's lives, but, at the same time, new technologies, such as RFID, do offer us excellent opportunities to improve the quality of our lives. These mini-chips are becoming smaller and cheaper every day and can be read at a distance. The main privacy concern about the tags is that individual consumption patterns can be tracked and traced by any outsider with a reader, especially when the individual purchaser is identified via a loyalty-card. To address these concerns, in December 2004, the Italian data protection authority (*Garante della Privacy*) opened a consultation[76] on privacy issues related to RFID tags, loyalty cards, digital TV (pay per view etc.) and video-telephoning.

Moreover, on 26 February 2004, after a long debate, the government introduced a law modifying the provisions governing personal data protection legislation for data retention for the purpose of crime detection. This has led to the introduction of a "minimum" data retention period of 24 months for telephone traffic, which can be extended for another 24 months in the case of crimes against electronic systems and for information related to organized crime or terrorism.

5 Conclusion

Italy has always been amongst the leaders in the advance towards the ubiquitous network society and, with its people being amongst the most enthusiastic users of the new communication technologies, it will continue to be so. Although the truly ubiquitous network society has not yet been achieved, and will require the continued and concerted effort from all the players involved, great progress has been made, and there is every reason to be optimistic.

Particularly significant progress has been seen in the fields of integration and convergence and much of the credit for this goes to the strength of the Italian mobile technology sector and its related services. The Italians have also been particularly successful in carrying out the strategic re-positioning of the players towards broadband. Digital terrestrial broadcasting has been another area in which Italy has led the field and its continued introduction over the next few years will certainly overcome some of the current technological and geographical constraints. RFID and Domotics, are likely to act as incentives to ensure the achievement of a fully integrated services-network. If all these factors maintain their momentum and all the players continue to pull together, the spread of an Italian ubiquitous network society will surely be greatly facilitated.

The social implications of the ubiquitous networks are enormous; as well as improving the lives of the existing users of the new communications technologies, they will also reach out to include hitherto marginalized people including those living in remote and inaccessible areas of Italy, increasing their knowledge and with it, their social power and quality of life. The future is bright: technological development is fast and unpredictable and the pace of advancement towards the truly ubiquitous network society is breathtaking.

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CHAPTER VII

UBIQUITOUS NETWORK SOCIETIES:
THE CASE OF JAPAN

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The opinions expressed in this study are those of the author and do not necessarily reflect the views of the International Telecommunication Union, its membership, or the Japanese Government.

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UBIQUITOUS NETWORK SOCIETIES: THE CASE OF JAPAN

1 INTRODUCTION

In recent years, the use of information and communication networks is being promoted in an increasingly diverse variety of ways, heralding a future in which networks will be everywhere. The rapid deployment of broadband and mobile services over the last few years has already changed lifestyles and business practices. With the parallel proliferation of personal communication devices, the path to a "ubiquitous network society" is being charted across the globe. In Japan, this path is being pursued with particular fervour.

1.1 Why study Japan?

Japan is a leader in the use and development of information and communication technologies. For instance, it boasts the highest percentage of mobile Internet users as a proportion of total mobile users. It was one of the first countries to launch third-generation mobile services in October 2001 and the first country to launch commercial services based on the W-CDMA standard. Japan also has the cheapest, fastest broadband access in the world (Table 1.1). Moreover, mobile phone handsets are now becoming comprehensive devices equipped with such functions as e-mail, photo management, and video on demand. Consumer electronics as a whole are expected to grow, with significant development in enabling sensor networks and RFID systeMs Japan has a head-start with active R&D programmes already in place.

By capitalizing on these strengths, Japan is looking to realize significant advances in ubiquitous networks and computing. Its government has implemented a number of policy and strategy initiatives geared specifically towards this goal. As such, Japan presents an important case to study in more depth, with a view to gaining a better grasp of its vision of a future "ubiquitous network society".

Table 1.1: Comparative prices for broadband, top 15, July 2004, ranked by USD per 100 kbit/s

Economy	*Company*	*Technology*	*Speed (kbit/s)*	*Price per month (USD)*	*Price per 100 kbit/s*	*Change, 2003-04*
Japan	KDDI	DSL	47'000	25.85	0.06	–44.1%
Korea (Rep.)	Hanaro	DSL	20'000	47.86	0.24	-4.0%
Sweden	Bredbandsbolaget	FTTH/ DSL	24'000	58.63	0.24	–97.4%
Taiwan, China	Chunghwa	DSL	8'000	35.30	0.44	n.a.
Hong Kong, China	Netvigator	DSL	6'000	51.03	0.85	–33.2%
Canada	Bell	DSL	3'000	34.05	1.13	–66.6%
Belgium	Belgacom	DSL	3'300	48.40	1.47	19.6%
Singapore	StarHub	Cable	3'000	46.50	1.55	–31.3%
Switzerland	SwissCom	DSL	2'400	77.88	3.24	–73.3%
USA	Comcast	Cable	3'000	52.99	1.77	–50.0%
Netherlands	Wanadoo	DSL	1'120	42.35	3.78	5.5%
Finland	Sonera	DSL	2'048	82.28	4.02	–53.6%
Iceland	Vodafone	DSL	500	21.00	4.20	–37.1%
Denmark	Tele2	DSL	2'048	86.32	4.21	–32.1%
Norway	Tele2	DSL	1'024	62.95	6.15	–11.0%
Average			**8'429**	**51.56**	**2.22**	**–36.3%**
Best practice (top 20%)			**30'333**	**44.12**	**0.18**	**–48.5%**

Source: ITU World Telecommunication Indicators Database.

1.2 Scope and outline of report

The present report aims to provide an outline of the Japanese vision of the future ubiquitous network society. It is based on a case study on mobile phones in Japan released in 2004 for the ITU New Initiatives Workshop on "Shaping the Future Mobile Information Society"[1]. The present case study forms part of the background material for the ITU Workshop on "Ubiquitous Network Societies" held in April 2005 in Geneva (Switzerland)[2].

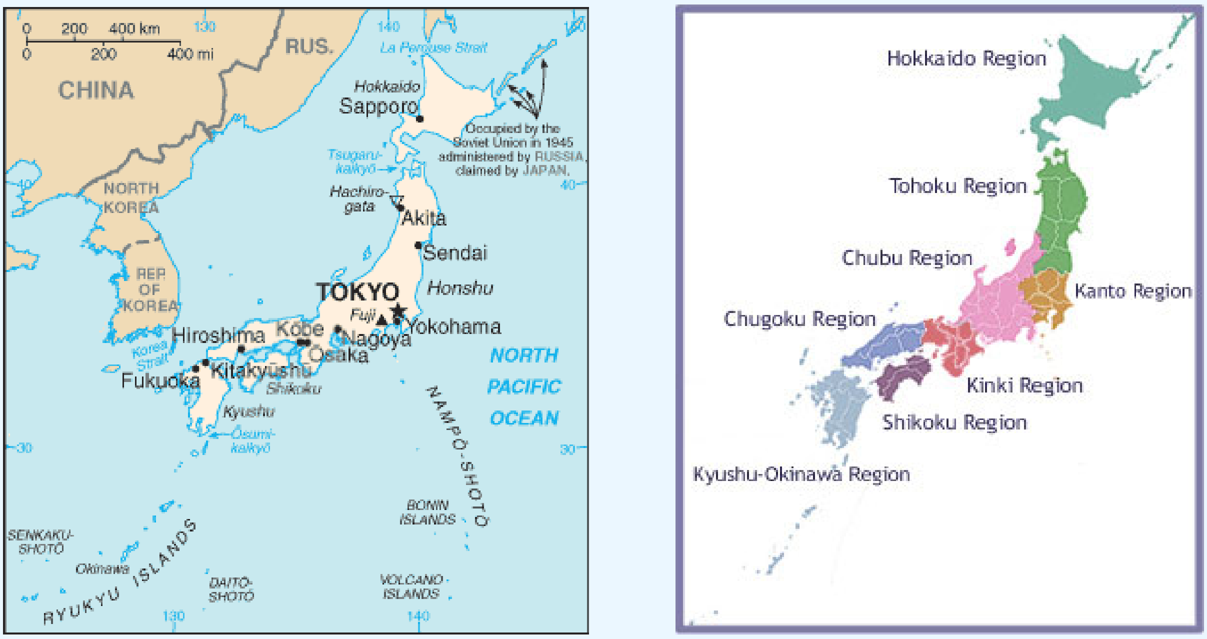
This paper is structured as follows. Chapter two provides an introduction to the country, followed by an overview of the ICT sector and institutional framework. Chapter three looks at a first generation of ubiquitous technical devices in Japan – the mobile phone. Chapter four examines new ubiquitous devices and technologies, and national policies towards the realization of the ubiquitous network society. Finally, chapter five posits on the social and human context.

2 About Japan: An overview

2.1 Geography and demographics

Not far off the eastern coast of the world's largest continent, Asia, lies the relatively small Japanese archipelago – almost at shouting distance from the Korean peninsula. This chain of islands, of which four distinguish themselves as the main ones, is home to some 127 million people, equivalent to almost half the population of the United States. Its land mass is 377'835 square kilometres, 71 per cent of which is mountainous. It is half again the size of the United Kingdom, but only one-ninth the size of the Indian subcontinent. The national territory is divided into eight or nine geographical regions. These regions are categorized mainly by their economic and human characteristics. The Kanto region, Kinki region and Tokai account for over 60 per cent of the total population. Apart from fishing (Japan accounts for 15 per cent of the world's catch), the country is lacking in natural resources. This is in sharp contrast to its huge economy, which is among the world's largest. Its rate of urbanization is high, as 80 per cent of its population now lives in crowded urban areas, a factor not be neglected in accounting for the considerable success of mobile communications in Japan. The national currency is the Japanese Yen (JPY). One language is spoken throughout the land even though two systems of writing prevail. They are: *Kanji*, written in the manner of Chinese hieroglyphics (3'000 symbols are in daily use) and the phonetic *Kana* (each with a 46-character set). Standard Japanese word-processors recognize up to 6'000 *Kanji* characters.

Figure 2.1: Geographical regions and population distribution in Japan



Source: The Kinki region is also known as Kansai.
The Hokuriku region is the northern part of the Chubu region and Tokai region is the southern part of the Chubu region.

Table 2.1 Basic social and economic indicators for Japan

	1997	1998	1999	2000	2001	2002	2003
Population (thousands)	126'166	126'490	126'500	126920	127291	127435	127619
Urban population (in per cent)	78.42	79.00	79.00	78.70	79.00.	n.a.	n.a.
Gross Domestic Product (GDP) (JPY Billion)	509'645	498'499	511'837	513'534	503'594	500'529	n.a.
GDP Per Capita (USD)	34'203	31'179	35'478	37'544	32'553	31'324	31’324
Average Annual Exchange Rate Per USD	120.99	130.91	113.91	107.77	121.53	125.39	115.93

Source: ITU World Telecommunication Indicators Database; International Monetary Fund.

2.1.1 Human development

Japan ranks ninth among the 174 countries that make up the United Nations Development Programme[3] 2004 Human Development Index and is placed in the “high” human development group. In this respect, it ranks ahead of France, Switzerland and Hong Kong China, but behind Canada, the United States and the Netherlands. Table 2.1 provides some relevant social and economic indicators for the country.

2.2 Political economy

Japan is universally regarded as one of the world’s leading industrial nations. Significant government-industry collaboration, rapid technological innovation and a strong work ethic have sustained the economy at its present high level.

One of the most remarkable characteristics of the economic scene is the “*keiretsu*”, or tightly knit groups consisting of manufacturers, suppliers and distributors. Much of the labour force enjoys lifetime employment and in general there is a high degree of staff loyalty. The use of robotic technology and telecommunications are important factors contributing to its economic strength. In fact, Japan possesses 410,000 of the world's 720,000 “working robots”.

Historically, the economy suffered greatly as a result of the Second World War, particularly due to destruction of infrastructure, severe food shortages and high inflation. Various social reforms were carried out after the war in order to establish a basic framework for economic recovery and development. The process of liberalization began with the break-up of the “*zaibatsu*”, or large business trusts. For instance, postwar demilitarization and the prohibition of rearmament are written into a new constitution, and Japan now spends as little as 1 per cent of its total gross domestic product (GDP) on defense.

In the latter half of the twentieth century, overall economic growth in Japan was phenomenal. In the 1960s, for instance, the annual growth rate averaged close to 11 per cent. This was far above the growth rates for the Federal Republic of Germany at 4.6 per cent and for the United States at 4.3 per cent during the same period. This growth was spurred by large investments from the private sector in infrastructure and equipment, and by the increased capital spending and the introduction of new technology.

There was a significant slowdown between 1992-95, largely due to the after-effects of increased investment during the late 1980s, and constrictive domestic policies intended to wring out speculative excesses from the stock and real estate markets. Since then, periods of growth have been frequently interspersed with stagnation. Growth picked up in 1996 following the introduction of stimulating fiscal and monetary policies coupled with low inflation. Again, in 1997-98, Japan’s economy took a downward turn. After the bursting of the IT bubble in 2000, Japan has once again plunged into a severe recession. The slowdown in the economy has been partially attributed to high unemployment rates, and low consumer confidence. The economy picked up somewhat in second and third quarter of 2002, but lost this momentum near the end of the year. There was renewed hope in 2003 however, when GDP figures confirmed a brighter trend, with a rise in investment and stock prices, and a slight decrease in unemployment. The year 2004 did not bring any significant improvement to the economy.

2.3 ICT sector overview

2.3.1 Basic indicators

Basic telecommunication indicators for Japan are set out in Table 2.2. Over the past few years, overall telephone density in Japan has been increasing at a rapid rate. However, like in many industrialized economies, the growth of fixed lines has been tapering off. In 2000, mobile lines outnumbered fixed lines in Japan. The penetration of PCs continues to rise, and the rate of 41.8 per cent at the end of 2002 had just about reached the average of high-income countries[4]. The Japanese information and communication industry expanded from JPY 79 trillion (USD 732 billion) to JPY 119 trillion (USD 1'141 billion) from 1995 to 2001. In 2002, there was a slight decrease (2.76 per cent) to 116 trillion yen.

Table 2.2 Basic telecommunication indicators for Japan

	1996	1997	1998	1999	2000	2001	2002	2003
Main telephone lines (000s)*	64'037	65'735	62'413	62'054	61'957	61'326	60'772	60'218
Main lines per 100 inhabitants*	50.88	52.10	53.35	55.75	58.58	59.71	55.79	47.19
Internet users per 100 inhabitants	4.37	9.16	13.40	21.37	29.94	38.42	44.89	48.27
Mobile phone subscribers, cellular and PHS (000s)	26'906	38'254	47'308	56'846	66'784	74,819	79'081	86'655
Mobile phone subscribers per 100 inhabitants	21.38	30.32	37.43	44.88	52.62	58.76	63.61	67.90
Number of personal computers per 100 inhabitants	16.21	20.21	23.72	28.69	31.51	34.87	41.80	n.a.

Source: ITU World Telecommunication Indicators Database.

2.3.2 Market structure and network deployment

In April 1985, Nippon Telegraph and Telephone (NTT), which had been a public corporation since 1952, was privatized. This marked the start of competition in Japan's telecommunication market. Statistics show that there were about 12'518 telecommunication carriers in Japan at the end of 2003, of which 1'562 were new entrants.

NTT was restructured to the holding company and its subsidiaries in 1999. This NTT group has two regional telecom subsidiaries, NTT East and West. They dominate the local voice-call market (over 90 per cent of market share). Another subsidiary, NTT Communications, owns long-distance and international networks. Some other subsidiaries, such as NTT-ME, also offer telecommunication services such as ISP service. Three operators – KDD (mainly international telecommunication), DDI group (long-distance and mobile) and IDO (mobile) – merged into KDDI in 1999. This is the second largest telecommunication group in Japan. The third largest is the Japan Telecom group. In 1999, Vodafone obtained over half of its stocks and since then, Ripplewood has controlled this group.

In the fixed line market, other than above-mentioned three groups, ten telecommunication subsidiaries of ten regional electric power companies own their nationwide networks. Their telecommunication networks are along electric power lines. In Japan, most CATV operators' service areas are only small areas. About 290 CATV operators offer telecom services. Most of their services are Internet access service. For the most part, Japan's Internet services market has been largely unregulated.

At the end of 2003, there were 77.3 million Internet users in Japan. Of these, there are 14.95 million subscribers enjoying a broadband service based on FTTH, DSL, cable Internet, or wireless (e.g. FWA). The take-up of DSL (11.20 million subscribers) is the most popular form of broadband. The number of cable Internet subscribers was 2.58 million at the end of fiscal 2003 and is growing steadily. In terms of broadband usage, the total number of broadband users at the end of 2003 was estimated at 26.07 million (a 33.4 per cent increase over the previous year). Broadband users in Japan now account for 33.7 per cent of the total population[5].

The first digital broadcasting (DB) services in Japan started in June 1996 with the launch of communication satellite DB. In July 1998, digital broadcasting became available in some areas with cable television. In December 2000, broadcasting satellite DB started. In December 2003, terrestrial digital television was launched in three major regions (Osaka, Tokyo and Nagoya). A complete shift from analog to digital broadcasting is planned for 2011, with the exception for terrestrial radio broadcasting.

In the mobile market, NTT's subsidiary NTT DoCoMo group owns about 60 per cent of the market share. KDDI (KDDI has Tu-Ka group that offer mobile service in three main regions) and J-Phone that is Vodafone's subsidiary are other players in this market. They offer nationwide mobile services. NTT DoCoMo, J-Phone and the Tu-Ka group adopted the Personal Digital Cellular (PDC) system – Japan's original 2G phone system. KDDI initially adopted this system too, but later replaced it by the cdmaOne system and terminated the PDC service in March 2003. These operators offer mobile Internet services based on these technologies, but with some differences (see details in the Annex A). In October 2001, DoCoMo launched its 3G service "FOMA (Freedom of Mobile Access)" based on W-CDMA system, on a fully commercialized basis. KDDI followed launching its 3G service in April 2002. It adopted cdma2000 1x that has upper-compatibility as its 3G system. J-Phone, which uses the W-CDMA system, launched 3G services in December 2002. J-phone officially changed its name to Vodafone in September 2003.

An alternative to PDC is the personal handy phone system (PHS) launched in 1995. NTT DoCoMo, DDI Pocket (a subsidiary of KDDI) and the ASTEL group offer nationwide PHS services. With the drop-off in the market share since 1997 due to competition from mobile, the operators have switched their attention to PHS data services. The PDC system allows for a much higher maximum transmission speed (128 kbit/s), compared with other 2G mobile systeMs

Like in many other countries around the world, since early 2002, wireless LAN (WLAN) hotspots, primarily based on the IEEE 802.11 family of standards (e.g. Wireless Fidelity or 802.11b), have emerged in restaurants, cafés and convenience stores as well as airports and train stations all over large metropolitan cities in Japan.

2.4 ICT regulation and policy

2.4.1 History

A Ministry of Communications was established soon after the introduction of telephone services, in 1890. It remained in place until the end of the Second World War, when it was split into the Ministry of Telecommunications and the Ministry of Posts. In 1952, the Ministry of Telecommunications became a public corporation and Nippon Telegraph and Telephone (NTT) was born. It was to be the monopoly domestic operator. At the same time, the Ministry of Posts became the Ministry of Posts and Telecommunications (MPT) responsible for the regulation of the telecommunication market. In the same year, the KDD Corporation Law of 1952 was enacted, establishing Kokusai Denshin Denwa (KDD) as the international operator. NTT was the primary regulator, responsible for the setting of technical standards, the development of telecommunication regulation, and for policy-making in conjunction with the Japanese parliament (the Diet). NTT already controlled an R and D system in collaboration with the large equipment manufacturers, such as Fujitsu, NEC, Hitachi and Oki Electric.

While substantial network development had been achieved, NTT was nevertheless perceived as being out of touch with user needs. Consequently, in 1970, the MPT set up a number of study groups to consider reforms to telecommunication policy. These study groups, made up of about 100 younger MPT staff, examined the possibility of reorganizing the NTT, and openly questioning its monopoly status. The report, released in June 1971, recommended the "reorganization" of NTT and the liberalization of value-added services. These reforms were not adopted until 1985, fifteen years later. And despite NTT's role as primary regulator, the involvement of the MPT in regulatory reform in the 1970s sealed MPT's future role as the telecommunications regulatory authority for Japan.

With respect to value-added networks, by the end of the 1970s, the Ministry of International Trade and Industry (MITI) and the MPT were in competition with each other. As the regulator for the computer and IT industry, the MITI was pushing for the liberalization of value-added services, whereas the MPT was of the view that all new entrants, including value-added service providers, should be subject to MPT regulation (for the purposes of ensuring consumer protection). Finally it was decided to liberalize value-added networks for small and medium-sized enterprises under the MPT's framework. At the same time, telecommunication reform got under way in Japan.

Significant reform in telecommunications occurred in the 1980s, as the United States began liberalizing its telecommunications market and started the process leading to the break-up of AT&T. In Japan, the Second Provisional Council on Administrative Reform (*Rincho*) announced a proposal in 1982 to introduce competition in all sectors of telecommunication services, as well as to privatize and "reorganize" NTT. Approval was given to separate telecommunication services on the basis of installation of circuit-switched facilities, rather service types. Under this scheme, Type I service providers (those owning their own facilities or infrastructure) would require permits from the MPT. Special Type II service providers (those not owning infrastructure but with a large user base) would need to register with the Ministry. Basic Type II service providers (confined to operation in limited areas) need to merely register. The licensing regime in Japan is just under revision (see below).

On 1 April 1985, three reform laws came into effect: the Telecommunications Business Law, the NTT Law, and the Background Law for the Telecommunications Law. Open tendering for NTT stock began in October 1986, when the government issued the first block of 200'000 shares. Complete privatization did not take place and the government still holds a substantial share in NTT.

The reforms of 1985 placed regulatory power firmly in the hands of the MPT, e.g. the authority over price and service regulation (the Diet's original domain) and technical regulation (NTT's original domain). The MPT also increased its role in telecommunication policy, and research and development. It even began exerting its authority over competition issues, for instance selecting new entrants (new common carriers – NCCs) in the 1980s and 90s. A large number of companies entered the market, and by 1996, 124 Type 1 and 3134 Type II carriers were offering services.

In the 1990s, the MPT evolved its regulatory framework significantly to adapt to technological innovation and changing market dynamics. It started with the liberalization of the cable TV market in the early 1990s. In 1996, the MPT embarked upon a deregulation process, which included, *inter alia,* a new regime for end-to-end interconnection with NTT (known as "ko-sen-ko" interconnection) and a relaxation of foreign ownership restrictions. Once the privatization process had begun, the MPT was able to focus more effectively on developing policies for information and communications technologies (ICT) in Japan. The MPT and two other ministries were merged into the Ministry of Public Management, Home Affairs, Post and Telecommunications (MPHPT) in the administrative reform of central government in January 2001. In 2004, the Ministry changed its name to Ministry of Internal Affairs and Communications (MIC).

2.4.2 Legislative Framework

In April 1985, NTT (until then a public corporation) was privatized and the Japanese telecommunication market was opened to new entrants. This was a turning point for the Japanese telecommunications industry, as up until that point, NTT held an unchallenged monopoly. At the same time, the *Telecommunications Business Law* (hereinafter referred to as the "TBL") was established to regulate telecommunication companies. Businesses offer telecommunication services are required to either to obtain permission, or to register/to notify the Ministry of their intention, depending on their type of operation.

The TBL classifies telecommunications businesses into Type I and Type II businesses. The latter are divided into General Type II and Special Type II businesses. Operators that install their own circuit facilities are classified as Type I businesses and others as Type II businesse*s.* The rationale behind this classification stems from the important role played by Type I operators, typically large telephone companies, who are responsible for providing basic infrastructure indispensable to people's lives and overall socio-economic activity. They are therefore subject to more stringent regulations. On the other hand, Type II operators, that do not install their own circuit facilities, are small value-added service providers with less direct influence on socio-economic activities. The "mobile virtual network operator" model stems from this distinction. MVNOs in Japan include Japan Communications Inc, NTT Communications, as well manufacturers Sony and Fujitsu.

However, over the last few years, the market has evolved. There are a number of small operators in the Type I category, such as CATV, W-LAN and CBD (central business district). Similarly, large-scale Type II enterprises have emerged, such as Internet, IP-telephony, and ADSL providers. These operators compete in the same market. If an operator owns circuit facilities, no matter how small, it is classified as Type I and is subject to more stringent regulation. The Government deemed that the distinction between Type I and Type II businesses was therefore in need of revision. In March 2003, the Cabinet submitted a bill to the Parliament (Diet) to amend the TBL. The main amendments, which have been in force since 24 July 2004, were as follows:

1. Abolition of the distinction between Type I and Type II telecommunications business;
2. Abolition of permission system for market entry with regard to Type I telecommunications business;
3. Abolition of permission system for suspension and discontinuance of business with regard to Type I telecommunications business;
4. Abolition of tariff regulations for non-dominant operators;
5. Abolition of ex-ante regulations with regard to interconnection such as prior notification of interconnection agreement for non-dominant operators;
6. Maintenance of asymmetrical regulations for dominant operators.

2.4.3 The e-Japan strategy I

Like many other industrialized countries, Japan is facing a number of challenges, including environmental concerns, a rapidly ageing population, falling birthrates, and expanded urban development. The introduction and rapid diffusion of information and communication technology is seen to be an essential factor in overcoming these challenges. However, up until 2000, there was no national policy on IT, in contrast to other countries in Europe and Asia. In this context, in January 2001, the government put forward "e-Japan Strategy", with the main objective of making Japan the most advanced IT nation in the world within five years (2005). The Strategy consists primarily the "e-Japan Priority Policy Programs" and "FY2002 Programs". In order to enable a rapid and focused policy implementation related to establishing advanced information society, a Cabinet-level IT Strategy Headquarters[6] (led by the Japanese Prime Minister) was established, to enforce the Basic Law on the Formation of an Advanced Information and Telecommunications Network Society (commonly referred to as "IT Basic Law") of January 2001[7]. The Headquarters announced the "e-Japan Strategy" in January 2001[8] and revealed in March 2001 the "e-Japan Priority Policy Programme"[9] with a view to clarify specific action plans. This programme, to be reviewed every year, sets out five policy areas for the country to concentrate on:

1. Infrastructure;
2. Human resources;
3. E-commerce;
4. E-government;
5. Network security.

In terms of infrastructure development, the programme clearly states that, "the private sector is to play a leading role in the area of IT". Although initiative was to be taken by the private sector, the government was to take concrete action in promoting an environment conducive to innovation and investment, through mechanisms such as effective IT policies, tax incentives and deregulation.

2.4.4 The e-Japan strategy II

In line with the e-Japan strategy, the goal of providing always-on high-speed Internet connections to 30 million households and ultra high-speed connections to 10 million households is well on its way to being realized. Furthermore, as mentioned earlier, the country's monthly broadband consumer prices are the lowest in the world[10]. In July 2003, the IT Strategy Headquarters adopted the second phase of the IT strategy, "e-Japan Strategy II", to ensure that Japan stays on course and maintains its position as an ICT Leader in 2006 and beyond. The second stage shifts its focus from infrastructure to the use of ICTs. In this respect, the main aim is to create a "vigorous, safe, impressive and convenient society"[11]. The strategy cites four strategic ideas for realizing such a society: structural reform, new value creation, individual perspective and new international relationships. On this basis, seven areas were designated for the promotion of ICTs: medical care, food, living, small business financing, intellectuality, employment/work, and government services. The e-Japan strategy II also includes specific infrastructure targets for the development of infrastructure, as a follow up to the first phase.

3 MOBILE JAPAN: A FIRST STEP TO UBIQUITOUS NETWORKS

3.1 The growth of mobile in Japan

Japan's mobile journey began, like in many other countries, with car phones, which were introduced by the NTT in 1979. In April 1987, NTT (privatized in 1985) began offering portable mobile phone services under an analogue "HiCap" system that it had developed. At the same time, NCC (New Common Carriers), IDO and Cellular Phone Group were established. IDO was a subsidiary of the long-distance fixed line operator Nihon Kosoku Tushin, and Cellular Phone Group was a subsidiary of long-distance fixed line operator DDI. IDO started its service from December 1988 in Kanto and Tokai region. Cellular Phone Group operators launched their service in other regions. At that time, two mobile operators (NTT and IDO or Cellular Phone Group operator) offered mobile services in each region. Roaming between operators was not an obligation and depended on negotiations between them. In August 1991, with a view to ensuring fair competition in the mobile market, NTT separated its mobile phone business, and NTT DoCoMo was established as a subsidiary.

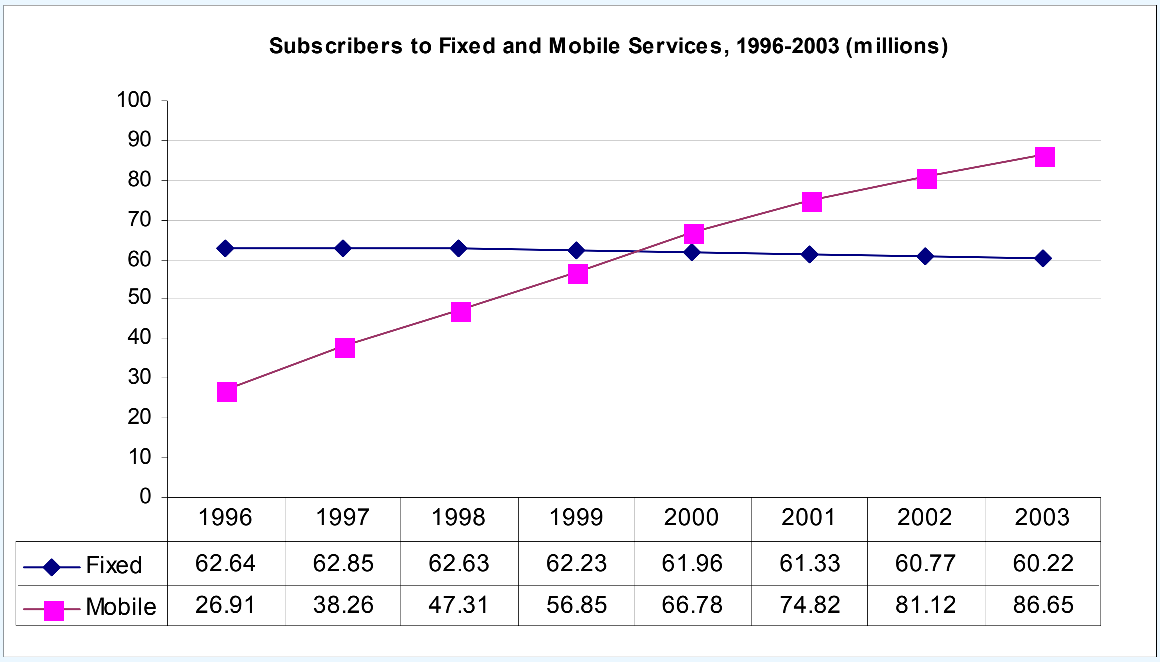
Digital mobile phone services in the 800 MHz frequency band were launched in 1993. Operators adopted the PDC (Personal Digital Cellular) system developed by NTT DoCoMo. In April 1994, the 1.5GHz frequency band was also opened up for mobile services. DoCoMo now uses this band in the Kanto, Tokai and Kinki regions, where population density is very high. In these areas, two additional mobile operators (Digital Phone Group of Japan Telecom and Tu-ka Group of Nissan) also entered the market in April 1994. In other regions, Japan Telecom and Nissan Motors jointly established one operator (Digital Tu-ka Group).

In July 1995, a new mobile phone system by the name of personal handy phone system (PHS) was launched. Three groups of PHS operators (NTT Personal, DDI Pocket, and ASTEL Group) launched their services simultaneously in each region. PHS had the advantage of low cost, long battery life and relatively fast data transmission rate (64 kbit/s compared to PDC's 9.6 kbit/s). However, it was primarily a cordless phone and thus had limited coverage. Although the early adoption rate for PHS was higher than for cellular mobile or PDC, its subscriptions declined, and now account for a fraction of the total mobile market. Over the last few years, the strategy of PHS operators has shifted to focusing on wireless PC data access (see Section 3.2.1).

The mid-1990s were crucial for the development of mobile communications in Japan. Take the example of the pager. At first its only function was to alert the user to a to a transmission with a ringing bell. Not unlike the mobile phone, its first use was limited to businesses. This situation was radically altered, however, with the introduction of the "display pager". This pager displayed the caller's number. This was quickly adopted as an important means of communication between high school students, who then used the pager code to exchange messages. Although the number of mobile phone subscribers in 1992 was about 1 million, the number of pager subscribers was 7 million. PHS was then developed and these three products competed fiercely for market share.

Deregulation accelerated the growth of mobile services in the 1990s. In April 1994, customer ownership of handsets was introduced. Within this system, handsets could be sold to individual customers, rather than making them available on a rental basis. In December 1996, MPT deregulated its procedure for amending mobile phone call charges from permission to simple notification. As a result, mobile operators could reduce their call charges more easily and efficiently. As a result, PDC operators abolished the use of connection fees and reduced their per-minute tariffs. They also introduced attractive handsets and customized tariff packages. This further led to phenomenal growth in new mobile subscriptions[12]. When the cellular mobile phone (known as “keitai” in Japanese) was first launched, its main users were business professionals, and it was considered a luxury item[13]. Today, however, the number of mobile subscribers (both cellular subscribers and PHS) has outnumbered the number of fixed-line subscribers (including ISDN) in 2000 (See Figure 3.1). Cellular mobile subscribers overtook fixed line subscribers in 2002. In terms of overall mobile subscribers, Japan has the third largest mobile population, and ranks only after China and the United States (Figure 3.2). The country also ranks in the top 10 in terms of mobile subscribers per capita. There are currently three main operators on the market providing mobile services: KDDI, NTT DoCoMo and Vodafone (previously J-Phone).

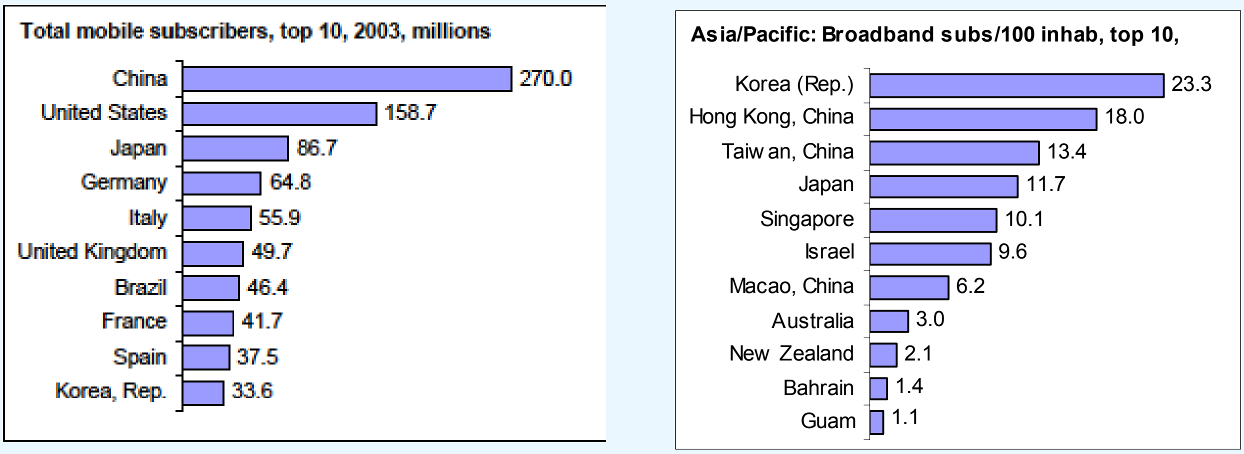
Figure 3.1: Mobile overtakes fixed in Japan (1996-2003)
Transitions in the number of subscribers to fixed and mobile communications from 1996 to 2003



	1996	1997	1998	1999	2000	2001	2002	2003
Fixed	62.64	62.85	62.63	62.23	61.96	61.33	60.77	60.22
Mobile	26.91	38.26	47.31	56.85	66.78	74.82	81.12	86.65

Note: The data above refers to the end of the fiscal year (i.e. 2002 refers to March 2003), and mobile subscribers include subscribers to the PHS system.
Source: MIC

Figure 3.2: Japan in Top 10 (2003)
Leader countries in terms of total mobile subscribers and Asia-Pacific leaders in mobile penetration



Source: ITU World Telecommunication Indicators Database.

3.2 Third-generation mobile (IMT-2000)

The policies on the introduction of higher-speed third-generation IMT-2000 services were finalized by the MIC in March 2000. They fixed the number of operators to three per region. New as well as incumbent operators were eligible for the licenses, with the exception of fixed regional operators. The main reason behind the limitation on the numbers of licenses was the shortage of frequencies. The regulator had a total of 60 MHz available for 3G services (uplink and downlink). This meant that in order to allocate a minimum of 2X20 MHz blocks of spectrum, only 3 licenses could be awarded. Owing to the shortage of frequencies experienced due to the unexpected growth in the number of 2G subscribers, the regulator was cautious in the allocation of 3G spectrum.

Operators were required to cover 50 per cent of the population in the first five years. The policies favored applicants with know-how of IMT-2000 technologies and systeMs 3G operators were chosen through a comparative selection process, and operators were free to decide on the radio interface they wished to use, between Wideband CDMA and CDMA 2000. The 40-day application period began in April 2000 and licenses were allocated in June 2000. Only the three incumbent operators, i.e. NTT DoCoMo Group, IDO and Cellular Group (KDDI), and J-Phone Group, applied, and obtained, the three available licenses in each region.

NTT DoCoMo was the first operator to launch 3G services in Japan, under the brand name “FOMA”, or “Freedom of Mobile Multimedia Access”, and based on the ITU standard W-CDMA (Wideband CDMA). The full-scale commercial launch of FOMA was initially scheduled for 30 May 2001. However, DoCOMo had to postpone the launch until 1 October 2001. In the first days of FOMA, DoCoMo was hoping to sign up 150,000 users by the end of 2001. However, due to the limited service coverage at the time of launch, the fact that the W-CDMA system does not have backward compatibility with its 2G service based on the personal digital cellular (PDC) system, relatively short battery life and lack of killer applications (the highly publicized video-phone capability was not a resounding success), it took another year to reach 152’000 subscribers (by the end of 2002). In early 2003, DoCoMo introduced new W-CDMA handsets, which have a battery life three times longer than previous handsets. In addition, through further expansion of the service area, introduction of flat-rate pricing, and the emergence of advanced handsets equipped with multimedia functions such as the videophone (900i series), DoCoMo’s 3G services have become more widespread. Moreover, efforts to integrate HSDPA (High Speed Downlink Packet Access) technology, which will significantly reduce throughput speed compared to the current W-CDMA technology, are ongoing (Table 3.1).

DoCoMo was not the only operator to suffer delays. Vodafone initially announced a delay of six months to June 2002, and full commercial deployment of its W-CDMA network occurred as late as December 2002. KDDI launched its CDMA 20001x service in April 2002, and introduced its packet service CDMA 2000 1x EV-DO on 28 November 2003, under the brand name “WIN”[14]. WIN will enable data transmission rates of up to 2.4 Mbit/s, and enhance delivery times for traditional mobile Internet services (e.g. Ezweb, EZMovie and EZ Chaku Uta). KDDI also plans to introduce a new series of services for the EV-DO network, including EZChannel, which will automatically distribute various multimedia programmes, and Live Camera, which will allow for the delivery of video content in real-time. In order to encourage take-up and allow for the increased data traffic, the operator will be introducing a flat-rate fee (EZ Flat), the first of its kind in Japan. Users will be able to benefit from unlimited use of EZWeb services, including e-mail, for a fixed monthly charge of 4’200 yen (USD 39.10).

Table 3.1 High-speed mobile systems in Japan: 3G and beyond 3G

		CDMA 2000 1x EV-DO	CDMA2000 1x	W-CDMA	HSDPA
Spectrum occupancy		1.25 MHz	1.25 Hz	5 MHz	5MHz
Services		Data only	Voice and Data	Voice and Data	Data only
Connection Mode		Packet only	Circuit and Packet	Circuit and Packet	Packet Only
Maximum Data Rate per User	**F/L**	2.4 Mbit/s	153.6 kbit/s	384 kbit/s and up to 2 Mbit/s	14.4Mbit/s
	R/L	153.6 kbit/s	64 kbit/s (153.6 kbit/s)	64 kbit/s and up to 384 kbit/s	2Mbit/s
Sector Throughput (F/L)		Approx. 600 kbit/s	Approx 220 kbit/s	Approx 1000 kbit/s	Approx 3000-4000kbit/s

Source: MIC and operator data.

At the end of 2004, there were over 25 million 3G subscribers in Japan. KDDI boasts the highest number of 3G subscribers, at 16.8 million, and discontinued the sale of its 2G handsets in March 2003. As of December 2004, NTT DoCoMo had 8.5 million W-CDMA subscribers, while Vodafone had 370,000 W-CDMA subscribers as of December 2004. The figures mean that subscribers to 3G mobile phones in Japan account for 30% of all mobile phone subscribers, which indicates a steady transition from 2G to 3G (see Figure 3.3).

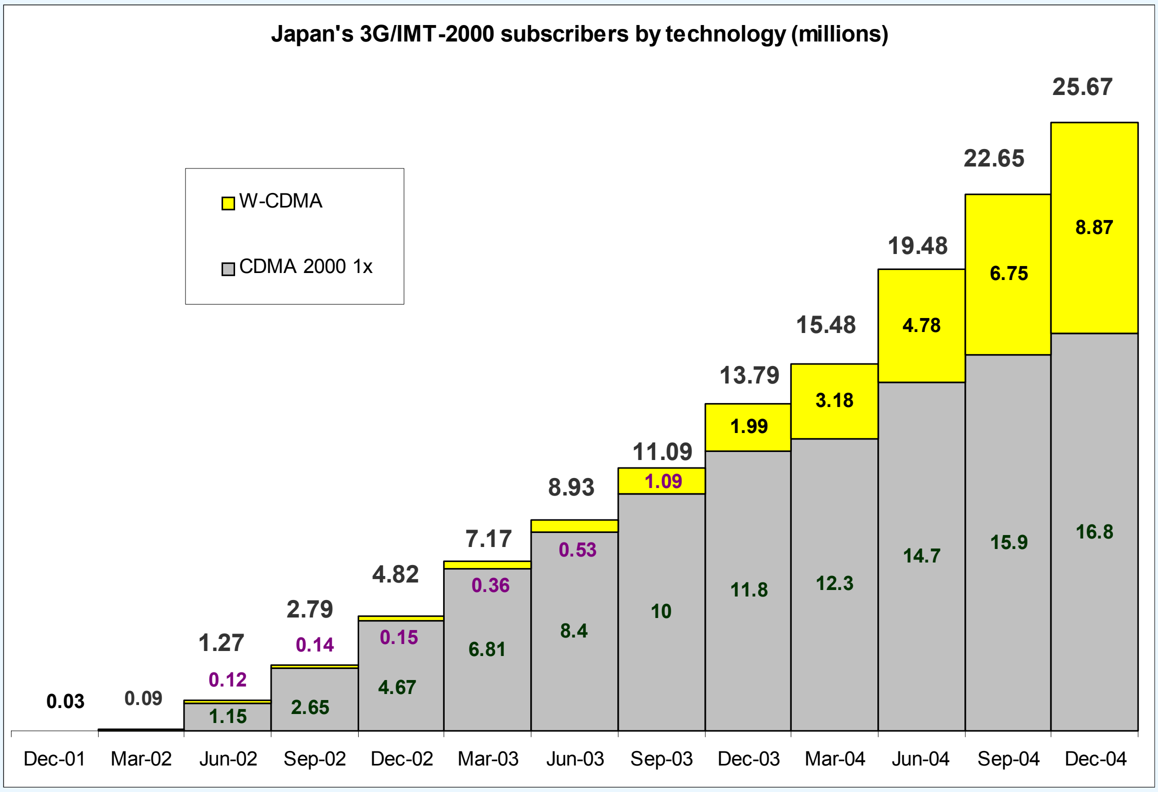
3.3 Fixed wireless and converged services

High-speed Internet access services, such as wireless LAN (local area network) were launched in 2002 in Japan. However, it seemed challenging task to develop a sound business model, attracting a large number of paying users. Much media attention was paid to the launch of the first commercial wireless LAN service called Mobile Internet Services (MIS) in April 2002, but service was suspended in December after only garnering around 1'300 subscribers in eight months.

NTT Communications launched in May 2002 its commercial wireless LAN service, branded "hotspot", and based on a combination of IEEE 802.11a and IEEE 802.11b specifications. There are also several wireless LAN access points offered free of charge by a number of providers. Still, "Freespot", which offers access points free of charge, has the largest number of access points in Japan. Overall, the number of high-speed wireless access points in public places increased from 1'624 in 2002 to 5'350 in 2003 (Figure 3.4). A survey by the MIC reveals that the use of WLAN access points by Internet users increased to 9.5 per cent at the end of 2003, up 0.7 percentage points from the end of 2002[15].

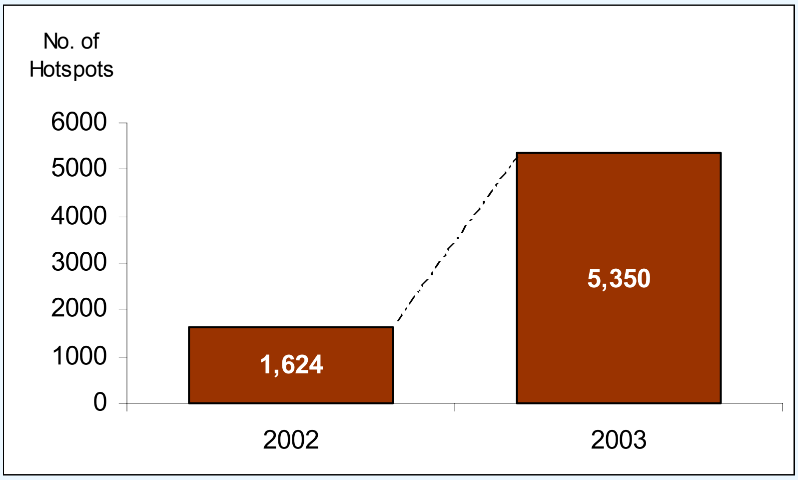
Still, other types of fixed wireless access services continue to be launched. And given the possible transmission speed of up to 11 Mbit/s, they are seen by some to threaten third-generation mobile services, which have a theoretical maximum speed of 2.4Mbit/s. Table 3.2 shows the various fixed wireless access systems in Japan.

Figure 3.3: IMT-2000 in Japan
Proportion of IMT-2000 subscribers by technology



Source: MIC.

Figure 3.4: The growth of Wireless LAN Hotspots in Japan
Hotspots in Japan in 2002 and 2003



Source: MIC White Paper 2004, "Survey of the Current Status and Issues of Networks".

Table 3.2: Wireless access in Japan

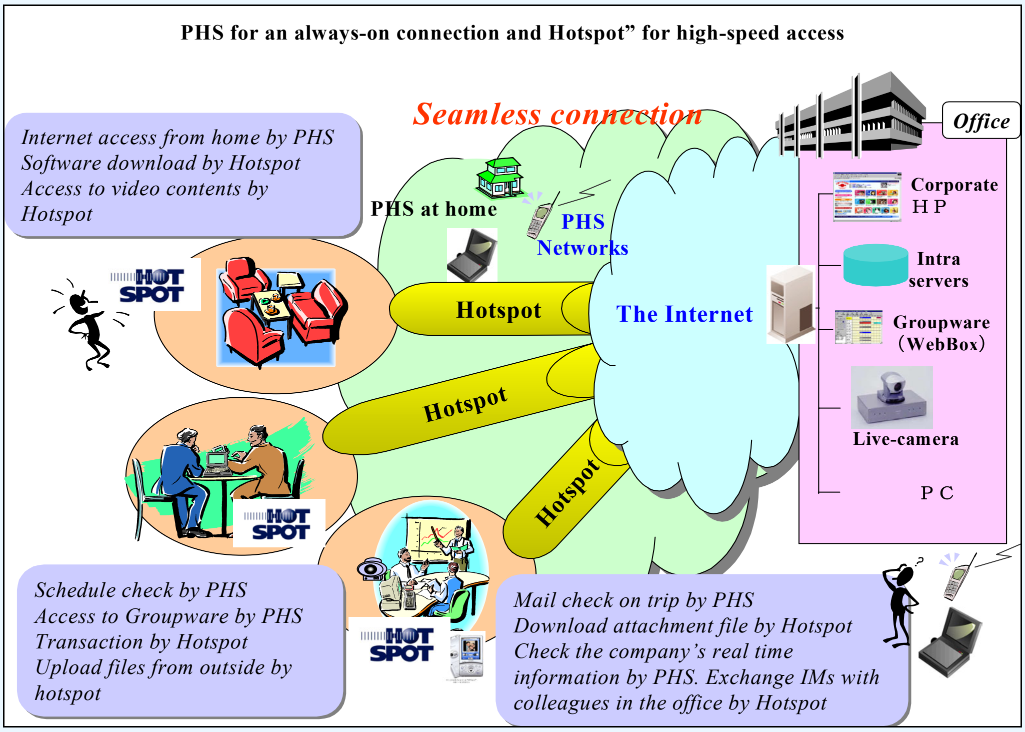
Frequency band	Examples of use	Transmission distance	Maximum Transmission speed	Licence for radio station
2.4GHz	(1) Wireless LAN in the office (2) FWA (in hot spots and to buildings) (3) Home Network	Around 5km	54 Mbit/s	Not necessary
5GHz	FWA (in hot spots and to buildings)	Around 3km	54 Mbit/s	Necessary
5.2GHz (Indoor only)	(1) Wireless LAN in the office (2) FWA (indoor hot spots) (3) Home network	Around 300m	54 Mbit/s	Not necessary
18GHz	FWA(for public use)	Around 5km	156Mbit/s	Necessary
22/26/38GHz	FWA (for businesses)	Around 4km	10Mbit/s (P-MP) 156Mbit/s (P-P)	Necessary
25/27GHz	(1) FWA (in hot spots and to buildings) (2) Relay line to access points (3) Wireless LAN in the office (4) Home network	Around 100m	100Mbit/s 400Mbit/s (Short distance)	Not necessary

Note: P-P: refers to a system in which one radio station communicates with another radio subscriber station. P-MP: refers to a system in which one base station communicates with more than one subscriber station.

Source: MIC.

Figure 3.5 PHS and WLAN nomadic Internet access

PHS and WLAN service provided by NTT Communications



Source: NTT Communications.

The lack of profitability of WLAN services is likely to persist for some time to come, and for this reason, a number of providers are exploring options to combine or integrate WLAN services with other types of services, notably NTT Communications and NTT DoCoMo. Since July 2002, NTT DoCoMo has been offering "Mzone"[16], a public wireless LAN service (11 Mbit/s). More recently, it has offered it in combination with its 3G or FOMA service, which typically provides speeds of 384 kbit/s. Users can benefit from 3G data transmission rates when away from wireless LAN access points, through the 3G network. Transmission at a much higher speed of 14.4 Mbit/s is being planned for the first half of 2005[17]. A service known as "Nomadic Internet Access" is now being provided by NTT Communications – it combines PHS and WLAN as set out in Figure 3.5. This system enables the use of PHS for always-on data connection and WLAN for high-speed stationary access.

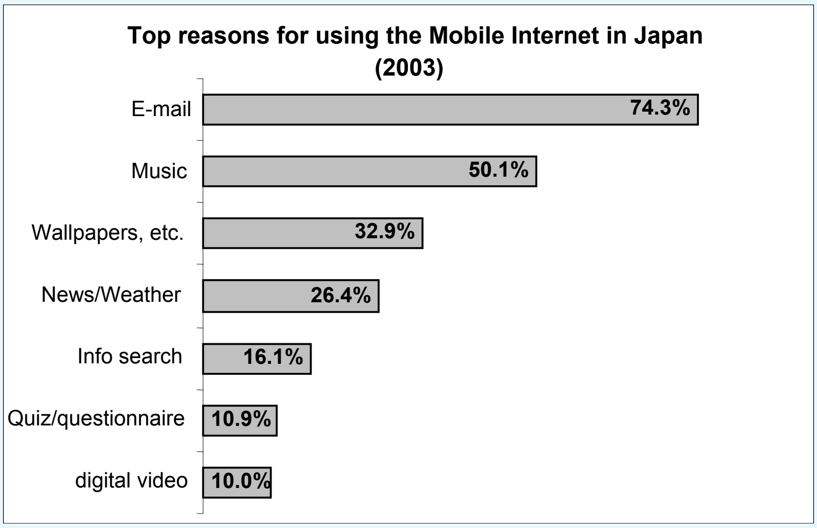
3.4 Mobile Internet services

In the 2G world, very few countries have been successful with the "mobile Internet" thus far. WAP in Europe suffered from low transmission speeds, paucity of content and disenchanted users. Japan, on the other hand, introduced a wide array of mobile Internet services, and witnessed phenomenal growth in usage and subscribers. In fact, Japan made mobile Internet services an integral part of mobile phone ownership, and even made charging for Internet content a reality. The country boasts the highest total number (and percentage) of mobile Internet users in the world: over 89 per cent of mobile users enjoy some form of Internet access (Figure 3.7). In terms of devices connected to the Internet, mobile phones now outnumber personal computers.

NTT DoCoMo launched its famous Internet connection service for mobile phones, 'i-mode', as far back as February 1999. The main services are e-mail, information services and applications such as Internet banking and ticket reservation. Other mobile operators also have competitive Internet connection services in 1999 (KDDI group launched Ezweb and the J-Phone group launched "J-Sky"). But, by far, the most popular service remains NTT DoCoMo's i-mode.

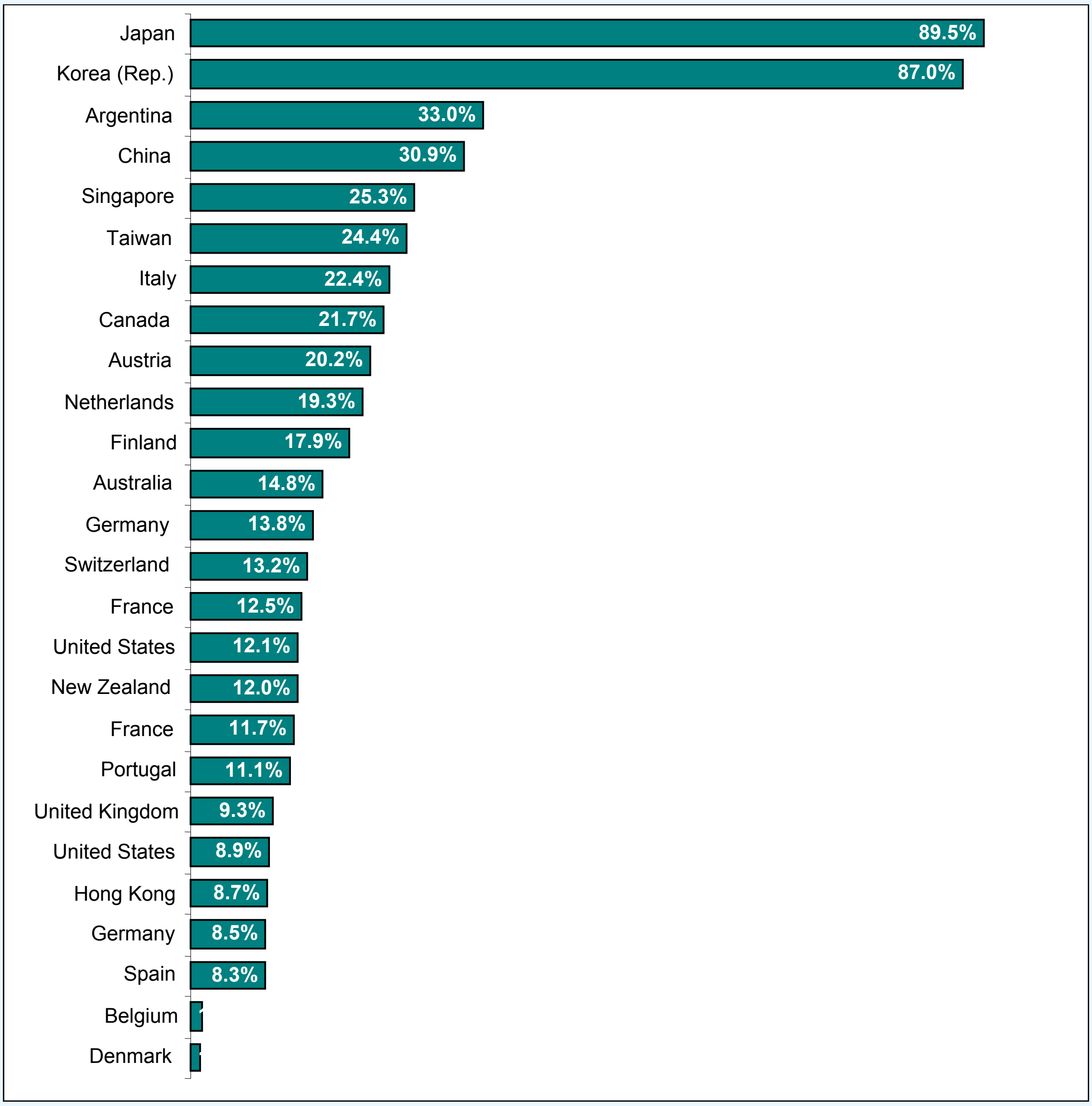
There are several factors contributing to the success of mobile networks for Internet access in Japan – low PC and Internet penetration are the most important ones. Some analysts point to the large number of long-distance commuters using public transport as a stimulus for growth. Early adopters of mobile services are usually young users, who account for the largest proportion of data traffic. It seems that the Internet and electronic services market in Japan will be spurred by the mobile industry. In fact, the demand for browsing services has been responsible for transforming NTT DoCoMo into the world's largest ISP almost overnight[18]. In 2003, the average annual revenue per i-mode user was USD 236[19] most of which stems from packet transmission charges. The introduction of colour handset in 1999 and of java-enabled handsets 2001 ("i-appli" service), were also driving forces. Though mobile Internet services are being used for a variety of reasons in Japan, the primary use remains email (Figure 3.6)

Figure 3.6 Top Reasons for using Internet services over mobile or PHS networks



Source: MIC (formerly MPHPT) Communications Usage Trend Survey

Figure 3.7: Mobile Internet users in selected countries
Mobile Internet subscribers as a percentage of total mobile subscribers (2003)



Note: For Japan, the figure includes paying subscribers, whereas in other cases (e.g. Korea), numbers may actually be lower, as those with Internet-enabled handsets may not necessary be subscribed to a particular service or using particular service.

Source: MIC compiled from *3G Mobile*.

3.5 Market peculiarities

One of the most distinguishing aspects of the Japanese mobile industry is that it is operator-led. Equipment manufacturers and operators work in closely-knit groups and supply the market with handsets and portable devices in a coordinated effort. The mobile operator retains ownership of the handset. As such, the operator's brand is dominant rather than that of the manufacturer. The Japanese subscriber must first select the service provider and then choose his or her mobile device. The subscriber's choice of handset is thus limited to those on offer and branded by the service provider selected. This differs remarkably from the European case, where the handset brand rests firmly with manufacturers such as Nokia and Ericsson, as does the responsibility for research and development[20]. By contrast, Japanese mobile operators play a leading role in research and development activities. The Yokosuka Research Park (YRP), just outside Tokyo, is well-renowned and houses one of the largest R&D centers in the world for 3G technologies. The close relationship between manufacturers and operators in Japan accounts in part for the sophistication and availability of handset technology and the take-up of value-added services. This relationship must be fostered in order to ensure further innovation and service take-up.

Another peculiarity of the Japanese mobile market is the agreement that was struck early on between content providers and operators. In principle, the mobile operator bills for content, retains a commission, and passes on the majority of the content fees to the content provider, which amounts to about 90 per cent. However, none of the revenues from the traffic that content sites generate is passed on the content providers. In addition, in many cases, a price cap has been introduced for content subscription charges. Many content providers and analysts argue that call charges should be included in any revenue-sharing for mobile content. One mechanism to address the perceived imbalance is to introduce flat-rate billing for data traffic charges. If operators bring down connectivity costs for data traffic, users will most likely increase their use of content sites. Thus, proportionately, in such a case, there will be a drop in traffic charges but a corresponding increase in content charges. However, such a system is more feasible for packet-based services. KDDI introduced flat-rate billing in November 2003, for all users subscribed to its CDMA 2000 1x EV-DO (WIN). It remains to be seen whether the issue of revenue sharing between mobile operators and content providers will be subject to renewed negotiation.

4 REALIZING THE "UBIQUITOUS NETWORK SOCIETY" IN JAPAN

There are different ways to characterize the "ubiquitous" information society. At its origins, the word "ubiquitous" is derived from the Latin "ubique", meaning that which exists everywhere. In the context of information and communication technologies, ubiquitous "networks" are those networks that can be accessed by anyone and anything via a wide variety of mechanisms or access methods, and this without limitations of time or space. However, there can be different approaches to fostering such a society, the concept of "ubiquity" being a relatively broad one. For Sony, ubiquity manifests itself through integrated circuit cards communicating with all kinds of devices. On the other hand, for Toyota, ubiquity may come in the shape of car navigation services. The Ubiquitous Networking Laboratory may consider that ubiquity can be achieved through the use of tiny chips and special communicators. But on a national level, the Japanese approach is a unified one, while still covering a number of different areas. This chapter describes that vision, outlines current research and development (R&D) initiatives, some current applications, and governmental policy and strategy.

4.1 Ubiquitous Net Japan (u-Japan)

As it approaches the target year for the e-Japan strategy, and in the present economic climate, Japan has begun creating a new vision for future generations of users of information and communications technology.

Given current technological trends, ubiquitous network technologies have now taken centre stage. It is expected that such technologies will create a society in which it is possible to connect to the network "anytime" (24 hours day or night), "anywhere" (at work, at home, in the city, in the country, or on the move), with "anything" (home appliances, individual items, cars, food products), and by "anyone" (adults or children, elderly or handicapped). This "ubiquitous network society" that Japan is aiming to achieve is known as "Ubiquitous Net Japan (u-Japan)".

It must be noted that the u-Japan vision cannot be realized in a short space of time, as a number of important challenges need to be overcome. The necessary policies to respond to these challenges have been grouped under the heading of the "u-Japan" policy. The basic concept of this u-Japan policy is based on the e-Japan strategy and e-Japan strategy I. It is made up of the following 3 axes, and represents a mid-term vision for the period beyond 2005.

1. *From broadband to ubiquitous networks*

   First, infrastructure deployment is crucial. Japan's main objective is the transition from existing networks (consisting mainly of wireline) to ubiquitous networks, thereby enabling the seamless connection between wireline and wireless networks and services. Rather than being limited to the geographical areas served by broadband, the country is working towards the development of a network environment facilitating seamless networks connections from any location, through organic linkages between wireline and wireless, networks and terminals, identification and data exchange. The end result will be the creation of a grassroots ICT environment in which networks merge with every facet of daily life.

2. *From the promotion of informatization to the resolution of issues*

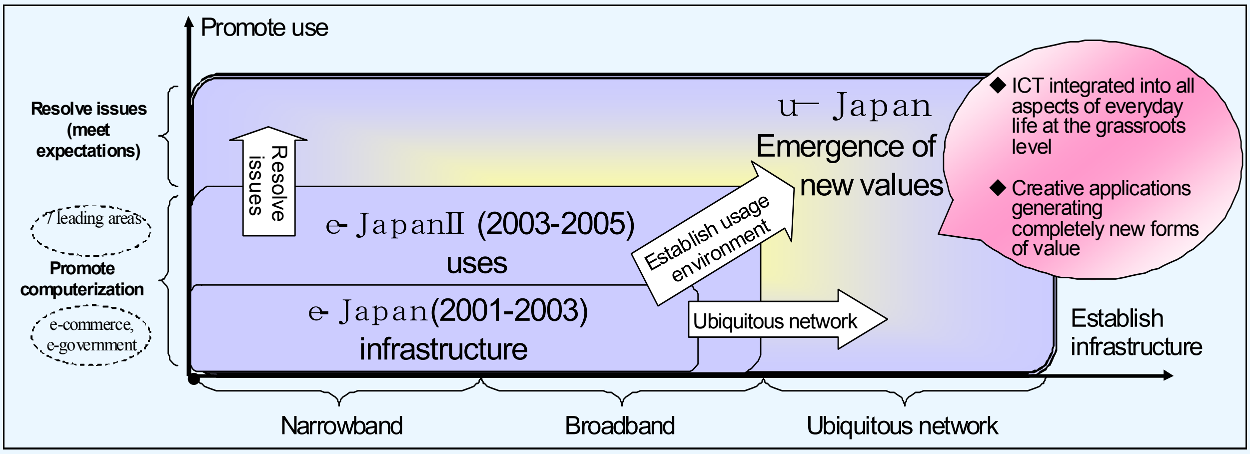
The second aspect relates to the user side, namely the shift from the "promotion of informatization" to the actual resolution of issues. Until now, the use of ICTs included measures to promote "informatization" and to accelerate the transition to "informatization" in those fields that are lagging behind. Japan is beginning to work on the positive utilization of ICTs in order to resolve the social problems of the 21st century. The power of ICTs as a tool for aiding society is being increasingly explored.

3. *Radical strengthening of the usage environment*

The third aspect relates to safety and security, in the context of the usage environment. With the growing role of ICT in private and public life, there is an increasing awareness of the need for enhanced privacy and information security. In order to surmount these unresolved problems (a thorn in the side of ICTs), it is vital to take radical steps for strengthening the usage environment, including the creation of concrete and all-encompassing policies.

The u-Japan policy has been progressing steadily in terms of the points outlined above. It must be noted that the u-Japan policy is not intended to be a mere extension of the e-Japan strategy. Rather, it represents a paradigm shift to a world in which ICTs become as natural as air or water. The positioning of the u-Japan policy described above is illustrated in Figure 4.1.

Figure 4.1 U-Japan policies – progressing from "e" to "u"



Source: MIC.

4.2 Research and Development (R&D)

The vision of Japan's ubiquitous network society is one where optical communications, mobile and consumer electronics, are connected to one network. For this, international involvement is indispensable. In order to realize this vision, MIC is focusing on key research and development areas. These are quite diverse. Since 2003, MIC has been focusing particularly on foundational, high risk, high wave-effect technologies. Working closely with industry and academia, it has created joint research and development structure for the three technology areas outlined below:

- *Microchip Network Technology*

  Network technology that enables connection control of the large volume of microchips, which enable all devices to connect to the network.

- *Ubiquitous Network Authentication and Agent Technology*

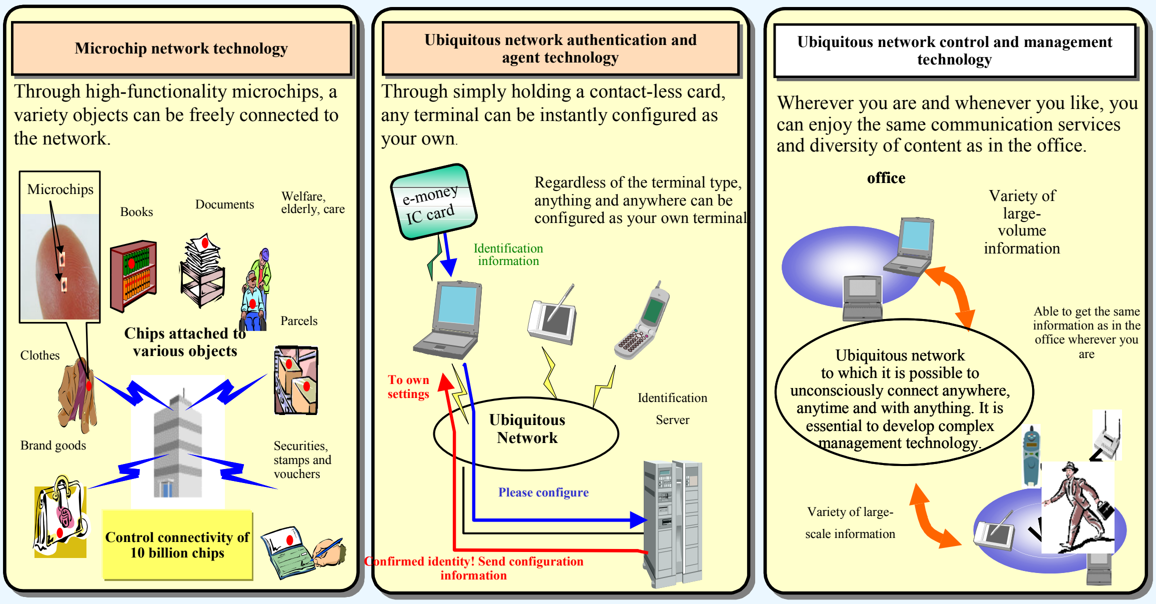
  Authentication and agent technology makes it possible, through the use of contactless cards, to instantly identify individuals. In turn, it allows individuals to use any terminal anywhere, and for that terminal to have the same configuration as their own terminal.

- *Ubiquitous network control and management technology*

  Technology to control and manage the network, allowing the user to connect to the network anywhere, anytime. An optimal communication environment is provided based on the situation of each specific user.

These three development areas are illustrated schematically in Figure 4.2.

Figure 4.2: Outline of Research and Development on Ubiquitous Network Technologies

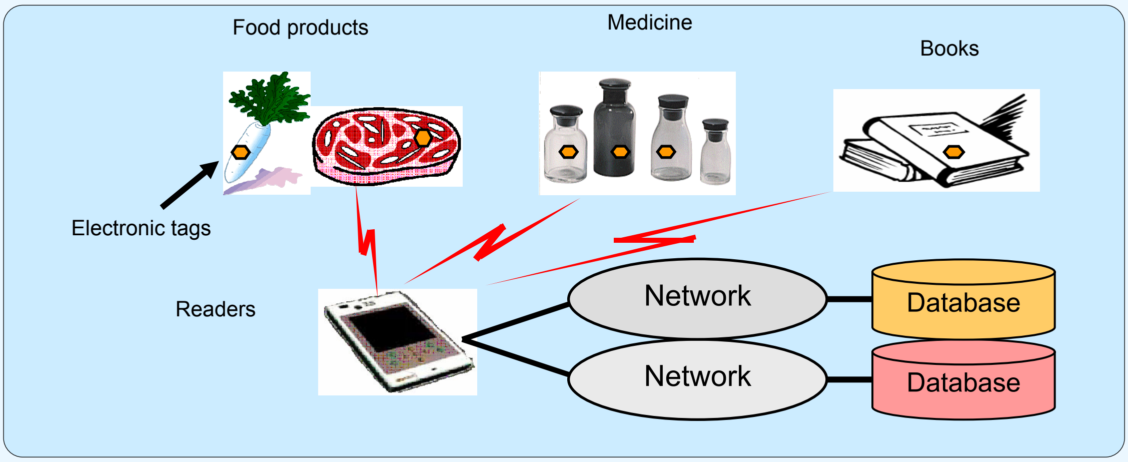


Source: MIC

4.2.1 Radio-frequency identification (RFID)

The MIC has embarked on a research and development programme as part of the 4-year "Research and Development for Utilization of RFID" plan, to realize sophisticated utilization of RFID in a variety of fields, such as food products, distribution, medical treatment and environment (Figure 4.3).

Figure 4.3: Schematic representation of RFID use



Source: MIC

The main technologies that are being explored under this R&D programme are the following:

- *Mutual exchange gateway technology*

  Research and development on technology to link RFID, network addresses and attribute information of objects on the network, and search and reverse probe information on IDs and attribute data.

- *Security adaptability control information*

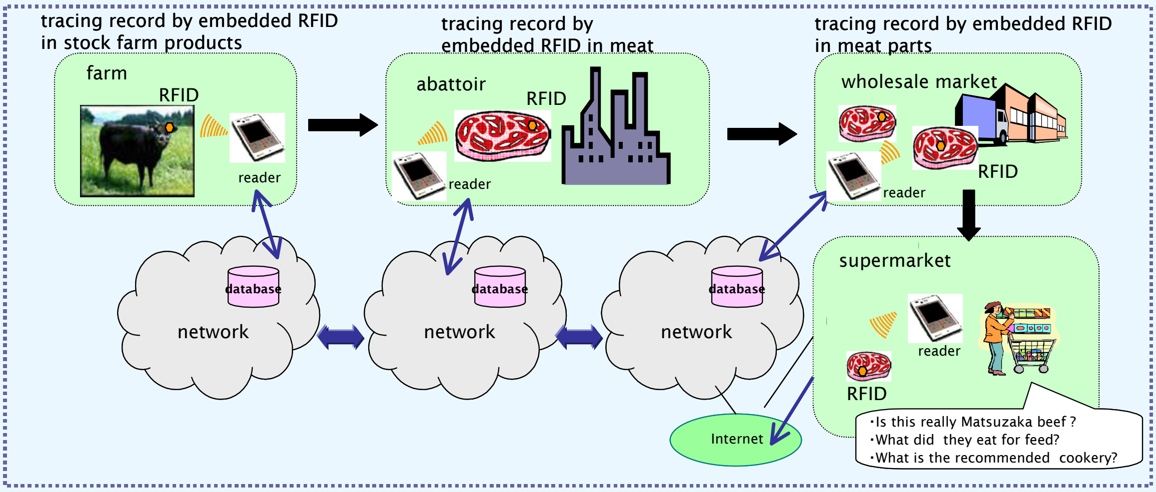
  For the exchange of information between RFID and the network, research and development on the prevention of forgery and illegal access of data stored on RFID or Database, and the flexible control the disclosure of privacy information.

- *Seamless tag information management technology*

  Research and development on technologies for the exchange of information contained in RFID systems between different platforms, as well as the seamless management of this information in line with any environmental changes.

In addition, as part of its research and development initiatives in the field of RFID, the MIC is undertaking a range of trials focused on users. A good example is the use of RFID tags in stock farm products to ensure that these products can be traced during the whole distribution process, from farms to the supermarket shelves (Figure 4.4).

Figure 4.4: RFID Research and Development



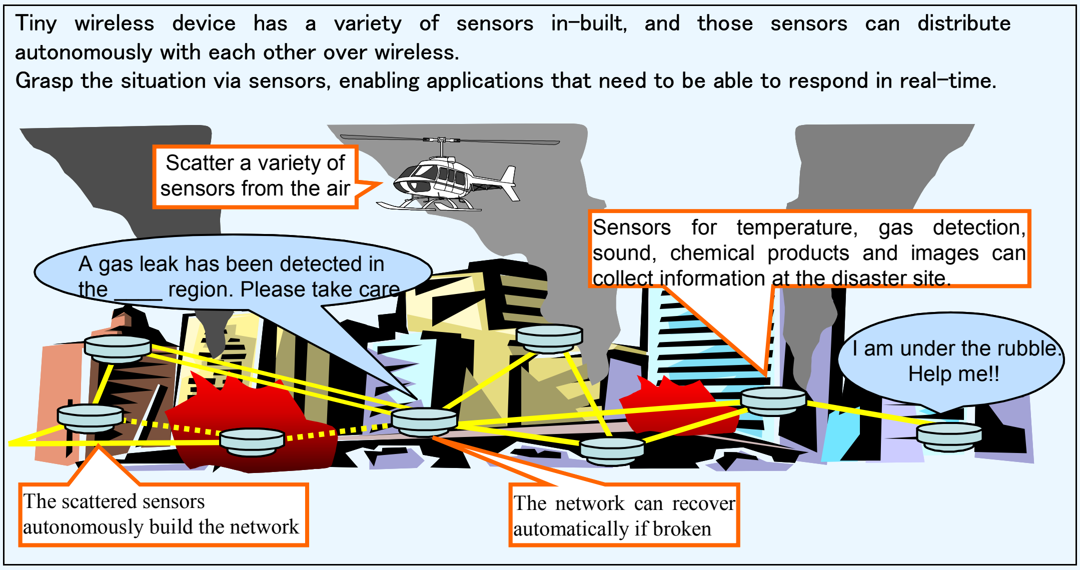
Source: MIC

The aim is that, through the linkage of RFID over the network, it will be possible to promote utilization of RFID that transcends corporations and industries and move from limited use of corporate and industry to further diffusion.

4.2.2 Ubiquitous Sensor Network technology

Ubiquitous sensor networks enable sensors to detect the status of people and objects and their surrounding environment, dealing with them in real-time through autonomous circulation of information between sensors. Through the development of this technology, it is expected that ICT support be strengthened in a wide range of social and economic activities, such as medical care, welfare, crime prevention, security, disaster management and environmental risks (Figure 4.5). The MIC plans to undertake research and development in this area as of 2005, thereby contributing to the creation of diverse applications and new services.

Figure 4.5: Ubiquitous sensor network technology



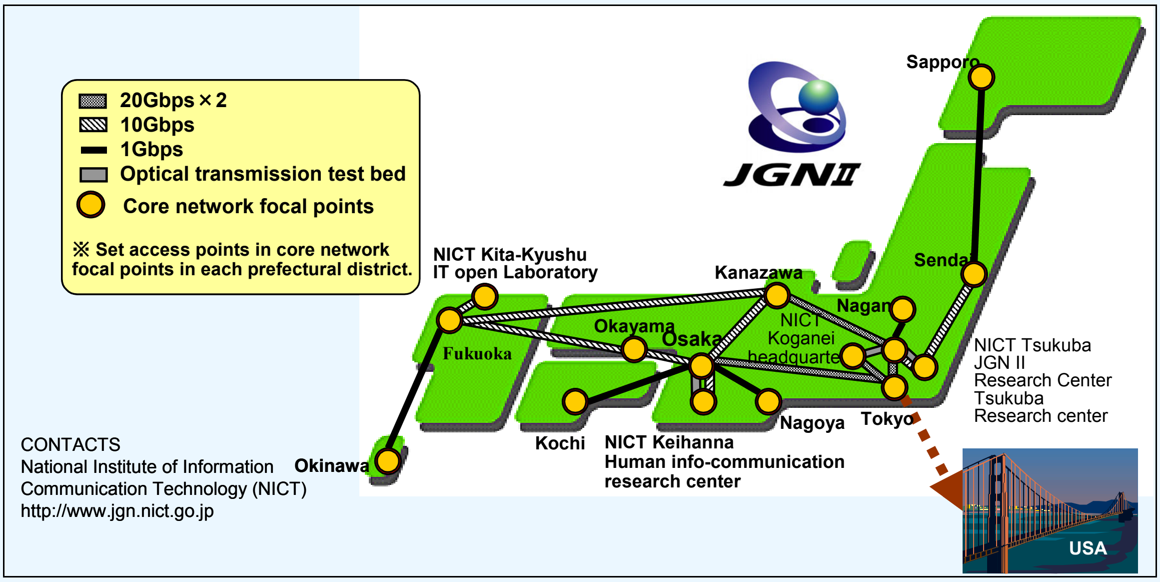
Source: MIC

4.2.3 Advanced Testbed Network (JGNII)

The research and development test bed network, with a leading approach to a variety of technologies through research and development and verification testing, is bringing about wide-ranging wave effects, such as in improving Japan's technological competitiveness, strengthening links between industry, academia and government, stimulating regional activities and nurturing human resources.

It has been verified that with the gigabit network (JGN: Japan Gigabit Network) operated from 1999 to 2004 as well, through its use by 650 institutions and 2000 researchers, large-scale benefits were brought about in the fields of broadband, stimulation of regional areas and nurturing of human resources.

Figure 4.6: Outline of R&D Testbed Network (JGN II)



Source: MIC

As the successor of the JGN, JGNII which began operation from April 2004 has leading optical equipment to enable high speed traffic of up to 10Gbit/s × 2, and by cutting-edge functionality for research and development, such as the establishment of an optical test bed environment that enables an IP network environment on a national scale and wavelength level optical testing, have established access points in all prefectures of the country, enabling linkups between industry, academia and government and regional linkups on a national scale, such as universities, research institutes, private entities and local governments.

The MIC is actively promoting a focused approach to the test bed network (Figure 4.6 above).

4.3 Current applications and services

4.3.1 Intelligent Transport Systems (ITS)

This section examines in-vehicular services in Japan that are offered over mobile networks. Japan is one of the most advanced countries in terms of car navigation systems, and the total sales of car navigation systems reached 15 million in September 2004. Car navigation systems are provided either as optional equipment by car manufacturers when a new car is purchased, or as additional equipment sold at car accessories shops. A total of 25 companies sell car navigation systems in Japan, including nine car manufacturers.

It can be said that car navigation systems saw three different generations of development. The first generation included map data in a CD-ROM format, which had memory limitations, could only contain comprehensive street information or detailed information to a scale of 50 metres or less. The second generation, still currently the most popular, contains map data in DVD-ROM format, thereby solving the problem of storage size. The next generation of navigation systems moved on to hard disk drives, providing significant advantages in terms of data updates and writing.

At the governmental level, the MIC, the National Policy Agency and the Ministry of Land Infrastructure and Transport are promoting the VICS (Vehicle Information and Communication System) project, which provides and collects various types of information from and to vehicles. VICS enables convenient and timely information services, such as traffic congestion, road works, car accidents and availability of parking lots. All the services are free of charge, once users buy and install the terminals. The information is provided through FM radio waves, radio wave beacons and optical beacons. A practical application is the service for drivers, which estimates the travel time to a given destination: this information is based on the calculation of another vehicle's travel time determined by the sensor ID. The total accumulated number of VICS units reached 10'439'373 at the end of September 2004, according to the Vehicle Information and Communication System Center.

Added functionality can be provided by the use of 3rd generation mobile systems with hard disk drives. For instance, map information can be updated continuously and delivered to the vehicle. A good example is Pioneer Corporation's product "Air Navi", which is equipped with a CDMA2000-1x communication module provided by KDDI. Once car navigation systems acquire always-on connectivity to the Internet, a large amount of relevant information can be provided during vehicular travel. This is not to say that second-generation car navigation systems did not provide an important information facility, allowing searches of various facilities such as hospitals, train stations, cinemas and restaurants near the position of the vehicle. However, that information was off-line and statically stored on a DVD-ROM. This was the first manifestation of Toyota's "G-Book" service. In 2002, the motor company released a new version of the service with a dedicated CDMA2000-1x data communication module. G-Book has user-friendly interfaces such as touch panel display, voice recognition and text-to-speech. Currently there are 60 different services falling into 5 different categories, as shown in Table 5.1 Toyota has released the first version of the on-line G-Book service in the car model "Will Cypha", a compact vehicle targeted at the younger generation. A large percentage of Will Cypha car owners subscribe to the service, a clear indication that demand is not limited to luxury owners. A surprisingly well-adopted service is karaoke, implying that users may be interested in information not related to driving or roads. From October 2003, Toyota has increased the number of models with G-Book, and expects to gradually expand the service to all of its car models. The main barriers of adoption are seen to be the cost of communications, the data throughput, quality of service and coverage.

Table 5.1: Service category and representative contents of G-Book

Category	Contents
Safety & security	Emergency Call support: HELPNET RoadAssist24: 24 hours accident support with easy operation by interactive menu selection. Remote Maintenance Service: Communication with the car dealer and reservation of annual maintenance My Car Search: Confirmation of current location by PC, PDA or mobile phone.
Live navigation	Shop Search: shop information in the present area or destination. G-Walker Gourmet: Restaurant information with recommendation in the present area or destination.
Information	News Information: provided by NHK (National Broadcaster) Traffic Information: Congestion, Regulation Information Location-based Information: Near Toyota Dealers, Hospitals, Clinics and Gasoline stand information Parking Lots Information: Availability of Parking Lots at the destination. Phone to Navi: Automatic phone call through Hand-free dialing News of Stock Exchange:
Entertainment & e-commerce	Gaming: Simulation game, Horoscope, etc. Karaoke: On-demand Karaoke service from the library of over 4’000 songs. Remote Monitoring: Accessing Remote controllable camera to monitor such as Pet’s condition. Shopping “GAZOO Shopping”: Accessing to cybermall operated by Digital Media Service.
Communication	BBS Service. Address Book: Shared also through Internet by PC, PDA and mobile handsets. “Friend Search”: Location Information of friends’ cars in case of group tour. E-mailing.

Source: Toyota

In Japan, the major benefits of ITS or Intelligent Transport Systems can be classified under the following two general categories:

a) Safety: Fatal traffic accidents are to be reduced to less than 5’000 by 2014

b) Creation of a new industry: The market scale of ITS is expected to reach a total of JPY 60 trillion by 2015 and create employment for about 1.07 million people.

4.3.2 The multimedia home

Owning a personal TV and stereo has been ranked high in the wish list of youth and adults alike in Japan. In terms of stereos, this wish has been partially realized through portable cassette, CD and mini disk players that make audio media easier to carry. However, watching TV in the private space of individual rooms was not always possible due to the lack of TV antenna interfaces in homes. Home networks are a technical solution to this problem. The section describes a few examples of home networking, either through the use of wireless LAN, or through mobile handsets and broadband for content viewing while outside the home.

SONY Corporation, for instance, has been developing a home server concept and in this regard, has released several multimedia terminals for home use. One of them is the personal IT Television known as “Air Board”, released in December 2000 (see Figure 4.7). “Air Board” was designed for late adopters or people who prefer simpler user interfaces and operations for using Internet access services. The “Air Board” is composed of a base station with a built-in TV tuner, an Ethernet interface and Wi-Fi, in addition to a mobile monitor detachable from the base station with touch screen and Wi-Fi connectivity. For getting recommended service menu and contents, users can sign up for the ISP service called “airbonet” by paying JPY 1’950/month as an option. Through Wi-Fi, people can enjoy the Internet connection and TV programming at home through the portable monitor. Technically, AirBoard can be regarded as a simple or first-generation home server and wireless home networking system.

Figure 4.7: Sony AirBoard: mobile monitor, base station and cradle (from left to right)

Source: Sony, www.sony.jp/products/Consumer/airboard/IDT-LFL1/index.html

Other examples include personal computers with built-in television tuners. SONY's PC "VAIO", for instance, (named after the concept of "Video, Audio, Integrated Operation"), covers a wide range of products from the ultra light mobile laptop, to the very high performance desktop. SONY released the first VAIO model (VAIO-R), with built-in TV tuner and hardware MPEG-2 encoder in 1999. Since then SONY has been promoting the use of PCs as video recorders by releasing software to facilitate easy recording and viewing. From the autumn of 2002, the company is promoting "VAIO Media", a collective term referring to the new uses of networked VAIOs. "VAIO Media" is a portal software provided to control content: stored video content by "Giga Pocket", stored music by "Sonic Stage", and stored pictures by "Picture Gear Studio". The following 3 major services are enabled by "VAIO Media".

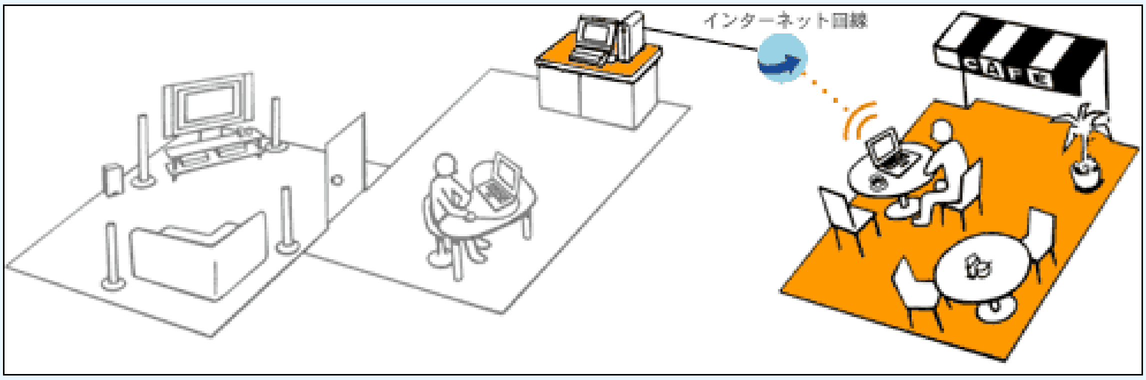
a) Content-sharing within home network: When a user has multiple VAIOs at home wired or wirelessly connected, users can share or access the multimedia contents stored in each terminal. For example, user can play music stored on a desktop in the living room from a laptop PC in the private room.

b) Real time streaming of TV programmes via home networks: Similar to the case above, user can enjoy TV programming in real time on their PC by streaming from the TV with network media interface.

c) Accessing contents at home from outside (Fig. 4.8): Users can access personal content from the outside, e.g. at hotspots. For example, users can enjoy Japanese TV programming recorded on one of their PCs or watch it in real time even while they are away from home, when they have Internet connection with a sufficient bandwidth. To use "VAIO Media" from outside the home, technical requirements are a) global IP address or DDNS (Dynamic DNS) and b) router with support of UpnP (Universal Plug and Play).

Another pioneering product is the channel server, "Cocoon", first released in November 2002 under the license with TiVo, a operating system of Digital Video Recorder of US company TiVo Inc., famous for its digital video recorder. The unique function of TiVo is the automatic programming and recording function, through the use of EPG (Electronic Programme Guide) and registered keywords reflecting the user's interests. The latest model includes a 500GB disk drive, where a maximum of 342 hours of video can be recorded. The unit is currently selling at 159,000 yen. "Cocoon" uses a TV antenna interface, plus an Ethernet interface, by which users can download EPG from the Internet.

Figure 4.8: Watching Virtual TV through 'VAIO Media'



Source: SONY VAIO Media Official Site (www.vaio.sony.co.jp/Products/Solution/VAIOMedia/basic3.html).

Also in the broadcasting context, a service called "One Push" has been released by CYBIRD Corporation, a successful mobile content provider established in 1998. The company's main focus is to provide linkages between mobile phones and other types of media. As described above, digital terrestrial broadcasting service was launched in December 2003, and can provide various related information such as metadata in BML (Broadcasting Markup Language) format, a Japanese local standard based on XML. "OnePush" links personal ID information with information provided BML, in order to create another new information cycle easily by sending information to and from the mobile handset. "OnePush" mechanism works as follows:

- First users should have "OnePush" java application included on their mobile handset with IrDA (infrared) interface.
- While watching a mail order programme or advertisement of interest on television, a user can push the appropriate button of their mobile handset once, after activating the "OnePush" application.
- That information is then sent to the OnePush center through the uplink of digital broadcasting service.
- The user can then receive more related information from the server directly to his/her mobile handset.

4.3.3 New handsets and services

During 2004, more than 20 new handsets appeared in the market along with new services. Five types of handsets were selected as representatives of current Japanese mobile services in this section.

4.3.3.1 Digital-wallet services

The digital wallet service using RFID is provided only for NTT DoCoMo customers as of March 2005. This service is realized technically by integrating in the mobile phone the contactless smart chip, FeliCa, developed by SONY Corporation. Felica has been widely used by Japan Railways for their electronic train passes and pre-paid cards known as Suica, as well as in digital wallet cards issued by credit card company EDY. The main services offered are:

a) Withdrawing cash at ATMs

b) Shopping at Kiosks and vending machines,

c) Train or air tickets,

d) Ticketing for concerts, cinemas and theatres,

e) Member's card of sports clubs and shops,

f) Key/ID to unlock automatic doors of home and companies, and

g) Online shopping (Figure 4.9)

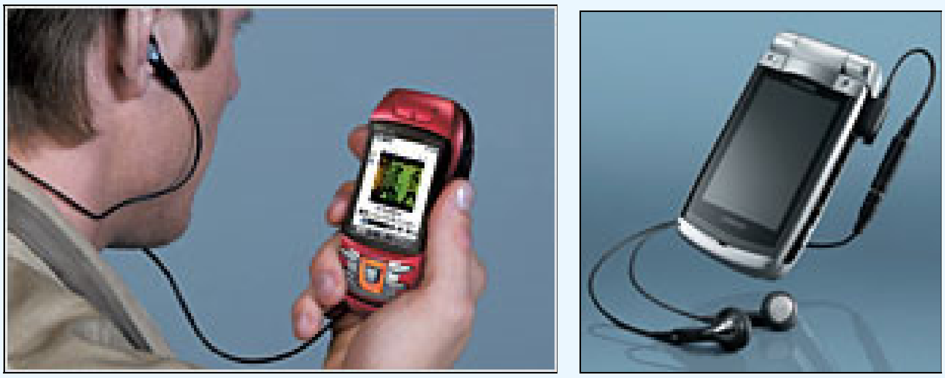
Figure 4.9: Digital wallet handsets
NTT DoCoMo's F901iC and FOMA F900iC

Source: NTT DoCoMo's URL (www.nttdocomo.co.jp/p_s/service/felica/f/lineup.html).

4.3.3.2 Mobile digital music

"Chaku-Uta Full", is the advanced version of the ringing tone service that was first launched for KDDI's 3G service in 2004. "Chaku-Uta" is the most popular value-added mobile service in Japan today (see Figure 4.10 for images of handsets). Initially the length of downloadable music tracks was limited to 15 seconds. With the "Chaku-Uta Full" service, the length of tracks has been extended, and it is now the most popular service among flat-rate service subscribers of KDDI's wideband 3G "WIN"(CDMA 1x Ev-Do). Though Japan is one of the leading countries in broadband, the download of music and videos over the Internet has yet to take off, as evidenced, *inter alia,* from the lack of the popular Apple iTunes Music store in the country.

Figure: 4.10: Handsets for "Chaku-Uta Full" (Casio W21CA, left, and Hitachi W22H, right)



Source: Casio and Hitachi, W21CA www.casio.co.jp/k-tai/w21ca/detail2.html and W22H www.hitachi.co.jp/Prod/vims/mobilephone/w22h/music.html

4.3.3.3 Portable TV

Like in many countries, television is a very popular home appliance in Japan. A large proportion of the more recent PCs for consumers are equipped with TV antenna and recording functions. TV is still believed as potential services also for mobile handsets when digital broadcasting service for mobile handsets will start. Vodafone Japan first released TV-integrated handsets in 2003 (Figure 4.11) and television is now a standard function for high-end 2.5G handsets.

Figure 4.11: Television handsets from Vodafone: V603T(left), V601N (centre) and V603SH (right)

Source: Vodafone Japan's Homepage (www.vodafone.jp).

4.3.3.4 Worldwide Roaming

Before the advent of 3G in Japan, there was little possibility for international roaming, due to the use of PDC, a proprietary 2G standard deployed only in Japan. But today one of the standard services for Vodafone's 3G handsets is worldwide roaming, which is made possible through the dual system handset of W-CDMA and GSM. Recent handsets are equipped with automatic mode selection between GSM and W-CDMA. As of March 2005, Vodafone was offering voice services in 114 countries and mobile Internet services under the brand "Vodafone Live!" in 43 countries, and video phone services "TV-call" in 4 countries (Figure 4.12). NTT DoCoMo also released a GSM and W-CDMA dual system handset, catering to frequent international business travellers.

Figure 4.12: Handsets with worldwide roaming capability

Source: Vodafone Japan's Homepage (www.vodafone.jp).

4.3.3.5 New handset dedicated only for voice communications

Amidst all technological advance, there has also been a clear demand for a simple mobile handset among seniors who are not good at learning complicated operation or do need neither mobile Internet nor CCD camera. TU-KA, 2G service brand of KDDI, released such a handset, "Tu-Ka S" in November 2004 (Figure 4.13). Tu-Ka S, which does not have LCD or a user manual, has been a smash hit for users over 60 years old.

Figure 4.13: Simple handset TU-KA S without LCD

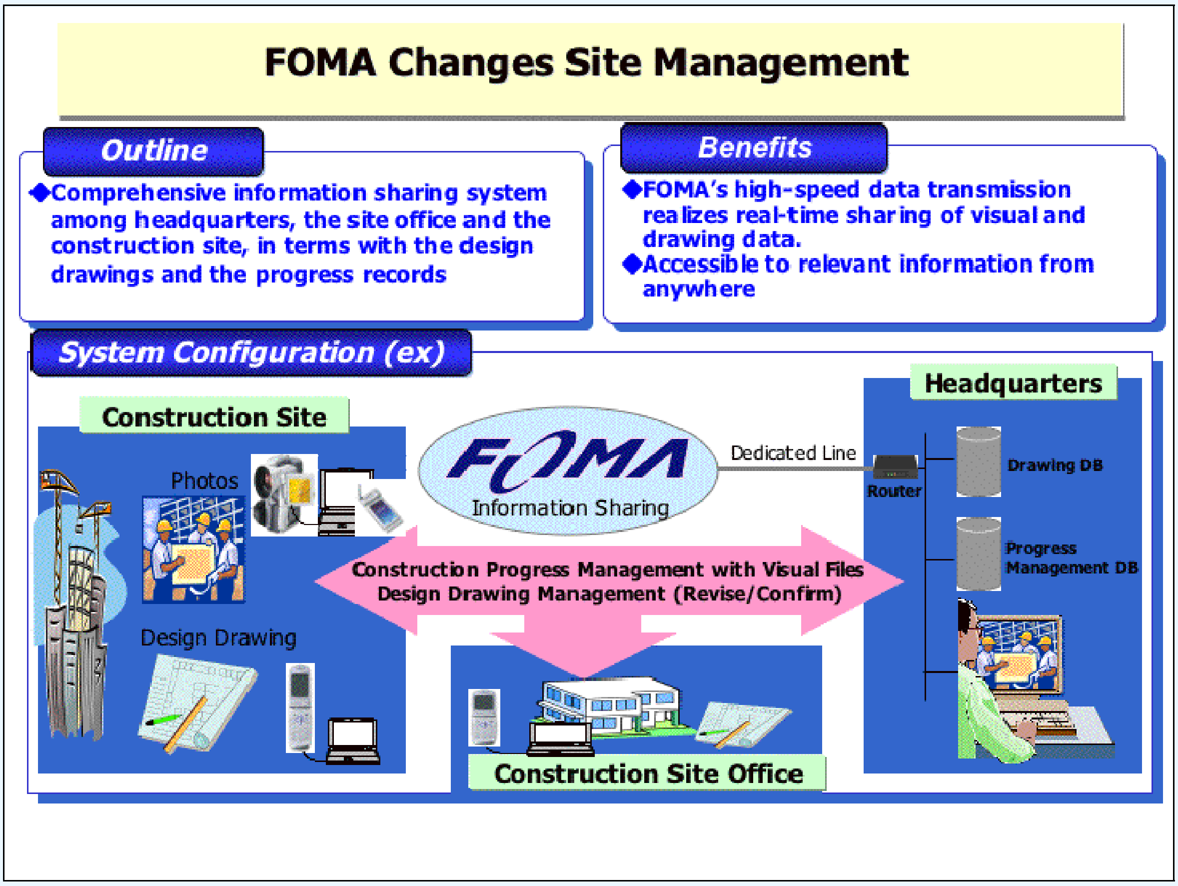
Source: TU-KA Homepage (www.tu-ka.co.jp/line_up/tu-kas.html) .

4.3.4 The ubiquitous enterprise

Japanese businesses are rapidly moving towards ubiquitous information and communication technologies. Figure 4.14 provides a schematic representation of the use of 3G mobile technologies for the seamless and timely communication between a construction site and headquarters. In this example, staff at headquarters can share information with the people at the construction site, through the use of rich multimedia communication, (including live video phone, mapping information, and diagnostics) offered by W-CDMA 3G networks. Another good example is that of remote system installation. Before higher-speed mobile networks, specialists had to physically travel to the installation site. Now, however, less skilled engineers or first-year engineers can replace specialists and install systems by contacting specialists remotely through 3G videophone transmission, if and when it is necessary.

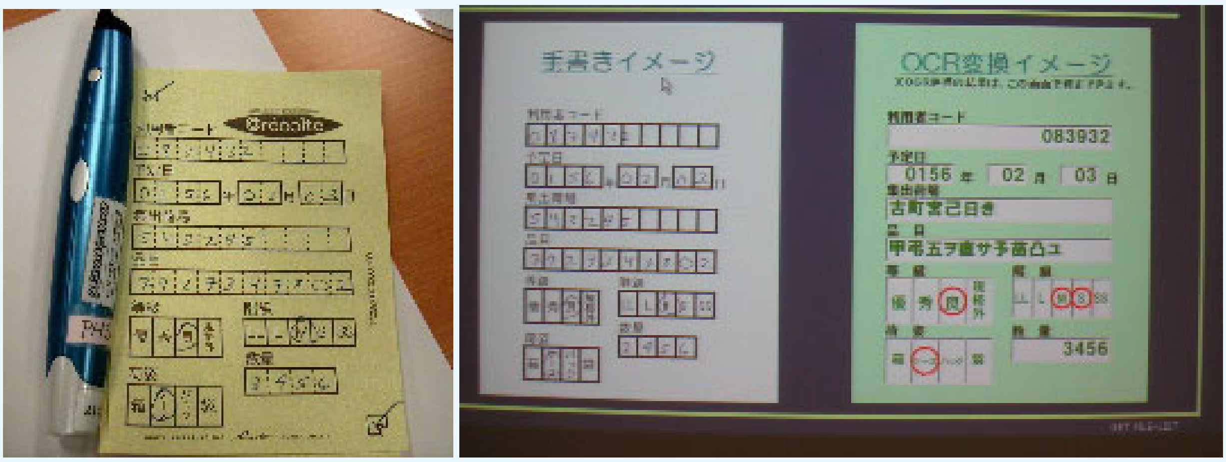
One of the disadvantages of the use of mobile terminals has been its poor user interface, due to its size and keyboard limitations. To realize the "ubiquitous networked society", in a sense of anytime, anywhere plus "anybody", there has been a call for innovative solutions other than carrying a PDA or an attachable keyboard. The digital intelligent pen "Anoto", developed by Swedish company Anoto AB is just such a candidate for providing a bridge between the pen and paper world, and the digital world. Anoto's digital intelligent pen is equipped with a bluetooth interface and sensor to read the exact location of the pen while writing on specialized 3M paper. The information is transmitted wirelessly via bluetooth (either through designated bluetooth terminals or a mobile handset), and then processed via OCR (Optical Character Recognition). The written data is automatically stored and can be utilized for various purposes as shown in Figure 4.15. One of the applications of this system by NTT DoCoMo is in the fruit and vegetable wholesale market, where people use the special pen and paper to write down information about the fruit's origin, size, reseller and delivery route. That information is then made available digitally, and can instantly be transmitted to interested parties.

Figure 4.14: Rich information sharing by the 3G



Source: NTT DoCoMo Inc.

Figure 4.15: Ubiquitous input method (Anoto Pen and Paper, left and recognized Info by OCR, right)



Source: ITU, NTT DoCoMo.

4.3.5 RFID and 2-D Codes

4.3.5.1 RFID

As mentioned above, microchip-networking technologies make up an important component of the government's R&D programme for the ubiquitous information society. Indeed, early manifestations of these types of technologies are already visible in Japan. NTT DoCoMo, for instance, has been fairly active in developing applications for radio frequency identification (RFID) tags.

RFID tags are essentially tiny microchips, some only 1/3 of a millimetre in diameter, that act as transponders (transmitters/responders), continuously waiting for radio signal to be sent by transceivers, or specially-designed RFID readers. When a transponder receives a certain radio query, it responds by transmitting a unique ID code. Most RFID tags are passive tags, that is to say they are not powered by any batteries. The most important functionality of RFID tags is the ability to track the location of the tagged item. RFID tags can cost as little as 0.50 US cents and the prices are dropping. Some analysts say that RFID will soon replace the familiar bar code in the retail world.

Since May 2003, NTT DoCoMo in collaboration with Tokyo's Academy Hills Library is testing an RFID library system in the trendy Roppongi Hills district[21]. Each one of the 12'000 books on the shelves of the Academy Hills Library contains an RFID tag on its binding. Each shelf is equipped with an RFID reader that can receive transmissions from books within 10-20 centimetres. Library users and staff are therefore able to locate books, even though they have been moved from their original position. Furthermore, checking out library books can be done quickly and efficiently using the RFID readers at the checkout desk.

A trial of NTT DoCoMo's "*R-click*" service[22] was run in 2003 and 2004. The R-Click service delivered information specific to a user's location using RFID tags (Figure 4.16). DoCoMo has issued about 4'500 RFID tags embedded in small handheld terminals. Over 200 stores were involved in the trial, and retails are now evaluating the commercial deployment of the service. Subscribers could inform the network that they wish to be located by pushing a button, but the default setting is off. The small, handheld device then enabled users to receive a wide variety of area information as they walk around the new metropolitan cultural complex of shops, restaurants, entertainment facilities, residences and hotels. Information transmitted to the user's i-mode phone was of three kinds:

1. **Koko Dake** (Area Limited) **Click**: While standing in any of approximately 10 to 20 areas (cells) in Roppongi Hills, the user can click the button on their RFID tag to receive information about that area. The user receives information tailored to their specific interests based on personal data that they pre-register.
2. **Mite Toru (**Watch and Receive) **Click**: When a user positions him or herself in front of an electronic board which shows commercials of products and services, the user can press the button on their RFID tag in order to receive information on their DoCoMo phone as well as URLs of products and services shown in the commercial multimedia presentation. The feature also allows users to go to the web pages later, at their own convenience (See Figure 5.6).
3. **Buratto** (Walk Around) **Catch**: This feature automatically emails area information as it detects the user moving about Roppongi Hills. The user receives information before actually entering a new area, because the system anticipates the user's movements. The information can be customized to a user's specific interests.

Whether the RFID tag has been activated or not, it is continuously sending identification and location information to nearby readers every 0.7 seconds. For this reason, the place and the forward direction of a user can be calculated for the delivery timely and relevant services. The R-click Service is part of the e!Project of the Ministry of Economy, Trade and Industry (METI). NTT DoCoMo and the Mori Building in Roppongi Hills had made a joint proposal for the service to METI, which funds the e!Project with the aim to promote the wider use of advanced information communication technology in Japan.

RFID tags are also making their appearance in food establishments. Pintokona, a Sushi restaurant in the Roppongi Hills district, has introduced RFID tags to track and price their plates of sushi that are presented on a rotating belt. The system facilitates the calculation of the bill, as each tag contains information such as price, sushi type, chef, time stamp and other types of information. And as it can track the precise time when the sushi is placed on the plates, once a thirty-minute period has expired, the sushi is automatically removed from the rotating belt, in order to ensure that only the freshest pieces are made available to patrons[23]. RFID is being used in for payment in Tokyo taxis[24], as well as in mobile digital wallets described in 4.2.3 above.

Figure 4.16 Only an R-Click away in Roppongi Hills
R-Click terminal and "Mite Toru" board (left picture). Service logo on a sidewalk in Roppongi Hills (right picture)

Source: ZDNet Japan.

The SIM (subscriber identity module) card embedded in GSM mobile phones will also see significant evolution. The new 3G version of the SIM card known as the UIM (universal identity module) will be incorporated into mobile phone with security measures such as PKI (public key infrastructure). This will enable secure user authentication, allowing for a wide variety of content to be stored on the mobile phone in the future, such as pre-paid coupons or credit card information as well as roaming information. Since 2002, the mobile operator KDDI's slogan has been "ubiquitous solutions company". It is currently elaborating plans for the enhanced use of UIM cards.

4.3.5.2 2-D Codes

Not only is RFID being explored as a building block for the Internet of things, but so too are two-dimensional (2D) codes and readers. The Quick Response Code (QR Code) is a 2D code developed by DENSO Corporation, and allows for the fast reading of large amounts of alphanumeric data.

Figure 4.17: Quick response for mobile phones
Image of a 2D or quick response code to be read by mobile phones

Source: NTT DoCoMo.

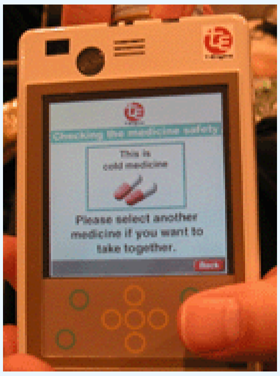
A QR code can contain up to 7'366 characters of numeric data and 1'888 Japanese characters, thereby enabling it to display to same amount of data smaller area than conventional bar codes (See Figure 4.17). NTT DoCoMo has already released two models with code readers, the Fujitsu 505i series and the Sharp 505i series. For a phone to be able to read the 2D code, it requires a digital camera and the appropriate software. From 2004 onwards, all of NTT DoCoMo's mobile phones will be 2D-code compatible. Codes will begin appearing on all kinds of products, such as newspapers, artwork, retail goods, foods and so on. By reading the code with their mobile phone, users will be able to download additional information about the product. In the early days, only text will be made available, the 2D codes will be static and off-line. But dynamic on-line

2D codes will be available shortly, embedding hyperlinks and multimedia content. This is likely to further transform the way in which we Japanese people use their mobile phones. There are currently 500’000 terminals with the appropriate software and camera capability in circulation, and NTT DoCoMo estimates that the development of a mass market for 2D codes is not far off.

The 2D code reader may be a first step towards the ubiquitous communicator or “U-Code” being developed by Japan’s T-Engine Forum (Box 5.1). The U-Code is currently at an experimental stage of development. Branded “U-code”, the device looks much like a personal digital assistant, but communicates in a wide variety of ways, through TCP/IP, VoIP, bluetooth, infrared and other systeMs It contains a special reader and writer for small RFID chips that can be embedded in a wide array of items, and which may eventually have broadcasting capabilities.

Box 4.1: The ubiquitous communicator
The ubiquitous communicator “U-code” at Japan’s Ubiquitous Networking Laboratory

Ubiquitous communicators can offer local-area communication for accessing microchips that store “ ucodes”, such as RFID tags or smart cards. Furthermore, such communicators incorporate functions for wide-area network (WAN) connections, in order to obtain information about the ucodes in objects, as well as additional services associated with the objects. For example, communicators support connections with one or more of the following networks: W-CDMA 3G mobile networks; public telephone networks (for PHS and other devices); WLANs via IEEE 802.11b; or personal-area networks (PANs) via Bluetooth.



The Ubiquitous ID Center itself provides a link to information services for the objects in which ucodes are embedded. This is done using both local area networks and wide area networks. A communicator works as follows:

1. 1. Step 1: A UC is positioned over an RFID tag in which a ucode is stored. As the UC is brought near, it uses local-area communication functions to read the ucode.
2. 2. Step 2: The UC sends this ucode information to the Ubiquitous ID Center's ucode Resolution Server to find out where there is information about the object to which the ucode is attached. The information might be available over a WAN, and the UC may be able to obtain a website address on the Internet.
3. 3. Step 3: The UC searches the product information database of the address obtained to retrieve information about the object.

Not only can data be retrieved, but the database function allows for data to be recorded as well.

If the RFID tag in question has only sufficient memory capacity for data about the object, the communicator can obtain this data directly from the RFID. And with the product information database, object information can be stored in the RFID or in the database. If the RFID has only enough memory capacity for data about the object, the communicator can obtain this data directly from the RFID. And with the product information database, object information can be stored directly in the RFID or in the database.

Source: Ubiquitous ID Center.

4.4 National policy and strategy

4.4.1 Promoting a "Frequency Open Policy"

As the recent explosive diffusion of mobile phones and wireless LANs has illustrated, as well as the recent interest in short-range wireless technologies such as RFID, the demand for radio spectrum in Japan has become greater and more diverse. As more new businesses emerge in the future, frequency use is becoming an indispensable factor.

In full awareness of these circumstances, an in an effort to create an advanced wireless broadband environment, MIC has been taking various measures to promote the large-scale opening up of frequencies. For instance, it is promoting a "Frequency Open Policy", described in more detail below.

4.4.1.1 Review of the Spectrum User Fee System

The Spectrum User Fee System was introduced in Japan in 1993 to ensure that radio station licensees would bear the cost of building and developing a sound radio spectrum environment.

Twelve years have passed since the introduction of this system. During this time, radio spectrum use has changed a great deal, with the introduction of important businesses such as the mobile phone business. In response to this, MIC set up a *Study Group on Policies Concerning the Effective Radio Spectrum Use* to review the Spectrum User Fee System. Following their recommendations, MIC will proceed in 2005 with a review of the system, as outlined below.

1) A new calculation system for spectrum user fees will be introduced to promote the effective use of the radio spectrum. The system will take into account factors such as the shortage of frequencies, bandwidth range and output. It will also follow the current system of sharing the burden of radio spectrum administrative costs equally between the radio stations.
2) Strategic measures for the development of a "radio-using" society will be expanded by using spectrum user fees for: a) research and development for the expansion of radio spectrum resources and b) expansion of possible areas of use for mobile phones and related devices

4.4.1.2 Promoting spectrum reallocation

In October 2003, MIC announced its "Frequency Reorganization Policy", which outlines their basic thinking on the reallocation of spectrum. To respond to radio demand and promote the rapid and efficient reallocation of spectrum, MIC has implemented an annual survey on the status of radio spectrum use. In addition, two new systems were introduced in 2004:

- A benefit system for the fixed compensation of losses, in exchange for the return of frequencies from existing radio spectrum users, in order to make the reallocation of frequencies smoother.
- A registration system for setting up radio stations, with a much simpler process than the existing licensing system, thus promoting the free development of the radio spectrum business.

Moreover, the MIC "Study Group for Wireless Broadband Promotion" was set up in November 2004. The topics of interest to Japan include: the image of wireless broadband use within a ubiquitous network society five to ten years in the future, the effect of penetration of wireless broadband on the economy, and the promotion of service take-up. It is in this context that the group has been investigating how to reallocate spectrum based on the MIC Frequency Reorganization Policy.

4.4.2 Broadcasting policy

Another key challenge that comes with the increased use of ubiquitous multimedia applications relates to broadcasting policy. In December 2003, Japan launched terrestrial digital broadcasting in the three major metropolitan areas of Tokyo, Nagoya and Osaka. This is the successor to communications satellite (CS) broadcasting, broadcast satellite broadcasting, and cable television broadcasting. Japan plans to switch entirely to digital broadcasting in 2011.

Digital broadcasting offers high-quality image and voice services, broadcasting to mobile terminals, storage broadcasting, and data broadcasting in combination with the Internet. This is expected to be one of the pillars that will support the "anytime, anywhere, anything and anyone" ubiquitous environment that will easily tie into networks.

It is already possible to receive current analog television broadcasting on mobile terminals. But the transition to digital broadcasting will make it possible to receive images equivalent to fixed-line standards, even when users are on the move. In addition, by integrating Global Positioning System (GPS) capability into mobile terminals, limited reception of information transmitted to users in a particular location will become possible. This is expected to have wide application across a number of service areas.

Through the development of digital networks, the television is expected to play a major role as an integrated information terminal. With server-type broadcasting expected to appear within a few years, various audio-visual options will become available in line with consumer needs and interests. These can be delivered at any time by using metadata (additional information on content attributes) on top of functions such as the large-capacity storage of DVD recorders, and automatic extraction recording using keywords.

Clearly, the medium of digital broadcasting is expected to play a major role in the realization of a ubiquitous society now and in the future, and the Japanese government is planning to promote appropriate measures for its expansion, starting with the public sector.

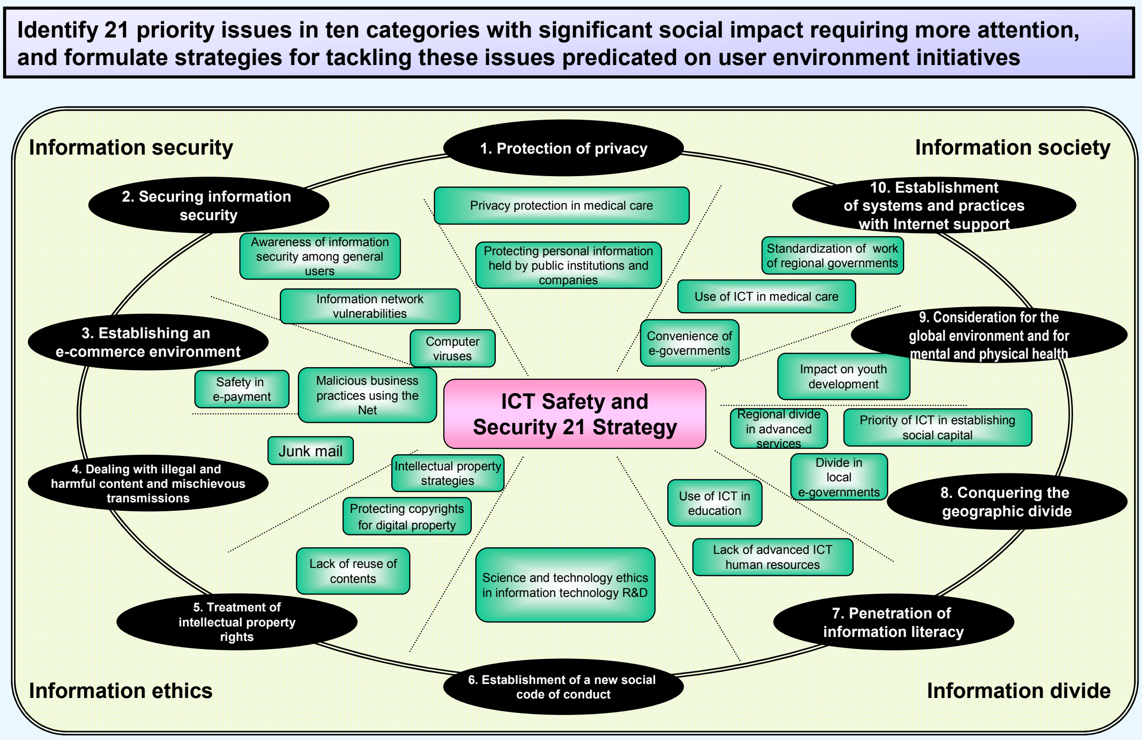
4.4.3 The user environment

Through the creation of new property and services, the ubiquitous network society will bring great convenience to people by connecting them to the network "anytime, anywhere, with anything and anyone".

Conversely, problems relating to the ubiquitous network society, such as anxiety or stress arising out of the use of ICT and any complications that need to be overcome are a cause of increasing concern. There is an even stronger call for the use of the appropriate methods to tackle and resolve these problems, which are casting a shadow over the development of ICT in Japan.

In order to achieve their stated goal of realizing "a society where 80% of the citizens can feel secure with ICT by 2010", the government of Japan is focusing on ICT safety and security. Twenty-one specific issues under the "ICT Safety and Security 21 Strategy" have been identified as priorities in this context (Figure 4.18).

Figure 4.18: ICT safety and security 21 strategy



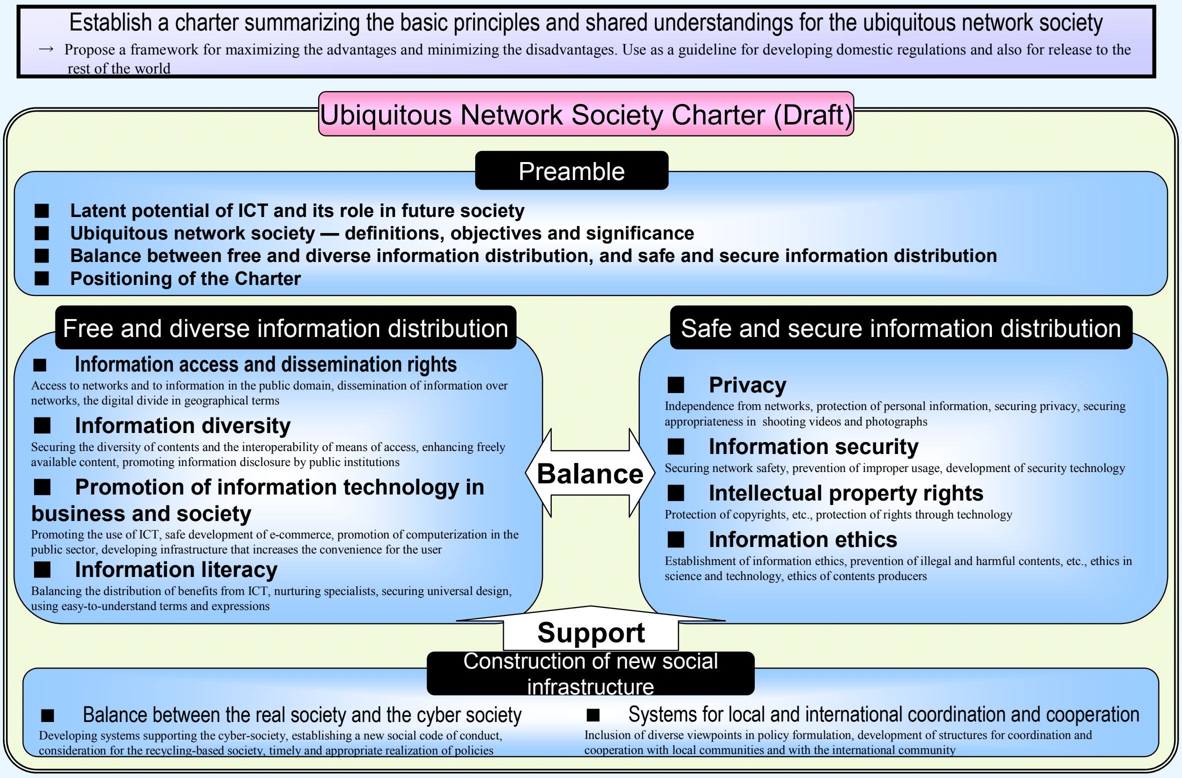
Source: MIC

4.4.3.2 Ubiquitous Network Society Charter

Addressing the "shadow" mentioned above, through the ICT Safety and Security 21 Strategy, will be a major step towards realizing the ubiquitous network society. Nevertheless, such problems are not temporary – in the future, new issues may arise, posing even greater challenges, particularly as technologies become increasingly sophisticated and pervasive.

There will, of course, be both unique benefits and disadvantages to the ubiquitous network society, many of which will be new to us. As Japan continues to investigate these issues, within the context of the unique nature of the ubiquitous network society, it has considered it appropriate to formulate guidelines, in the form of a "Ubiquitous Network Society Charter" (Figure 4.19). This Charter has been proposed to ensure that this society is realized in a smooth fashion, and in full awareness of the international environment.

Figure 4.19: Ubiquitous network society charter



Source: MIC

5 THE SOCIAL AND HUMAN CONTEXT

This chapter takes a look at the social and human considerations in a ubiquitous network society. As these are early days in the development of this future society, the near ubiquitous mobile phone is taken as a starting point for the analysis.

No one will deny the perception that the Japanese are a highly technophile people, who are regularly seen sporting the latest technological gadgets. This holds just as true for the mobile phone. No tourist visiting Japan can miss the dazzling array of mobile handsets and accessories on display all over Tokyo, and notably in the "electric towns" of "Shibuya" and "Akihabara". Indeed many of those interviewed during the research phase preceding the publication of this case study, pointed to the cultural factors affecting the take-up of new technologies in the country. In particular, they highlighted the fact that the Japanese consumer is informed and demanding, carefully choosing technology for its innovative quality, functionality, and value for money. At the same time, Japan is a highly homogeneous society, and consumers are keen on having the latest gadgets, in order not to be outdone by their neighbours and friends. Therefore, the threshold for a product to hit the mass market is much lower in Japan than in other countries. If a service or technology reaches 15 per cent penetration, it is well on its way to becoming a mass-market product.

In terms of manufacturing and distribution, Japan is famous for developments in miniaturization and product packaging. Foreign pharmaceutical firms, for instance, face significant challenges when distributing products in Japan, due to the strict packaging requirements imposed on them. The look and design of a product are key marketing elements, particularly for mobile phones, and the discriminating Japanese consumer takes careful note of these when purchasing electronics. Mobile phones and other electronic devices (e.g. mp3 players) are important fashion accessories in Japan today. Users have access to a wide variety of colourful tags and stickers that can be used to personalize mobile phones, in line with the latest trend and fashion of the day. Handset replacements are thus very common in Japan. According to a survey conducted by Video Research in July 2002[25], 63 per cent of users replace their mobile devices within two years. Young students have an even shorter replacement cycle: almost half of those surveyed reported an annual replacement cycle. 40 per cent of those who replaced their handset at least once, reported one of the following reasons for their latest replacement: a desire to have the latest model or service, or the fact that the design or function was "out of date". Mobile phones have become such trendsetters in Japan that KDDI has recently released a "retro" design, with a certain hint of the past, in order to appeal to the younger generation. The slim-line phone is known as "Infobar" and comes in three different colours, each with a different catchy name.

Another interesting aspect of the use of consumer electronics, in particular the mobile phone, in Japan is the portability and proximity of the device to the human user. According to the Mobile Content Forum, 70 per cent of Japanese mobile users keep their mobile within one meter of their body during the day time, and 40 per cent during the night, most likely not far from their pillow. In this respect, the mobile phone has become somewhat an extension of one's physical self, intrinsically linked to identity and accessibility. Box 3.1 describers a day in the life of a typical 22-year old Japanese and her mobile phone.

Box 4.2 A day in the life of 22-year old Kyoko and her *keitai*
A fictional story based on the observations of authors and interviewees while researching this case study

Kyoko, a 22 year-old woman works at an office in the city. Kyoko woke up at 6.30 AM to the sound of her mobile phone. She checks her *keitai* (the Japanese word for mobile phone) immediately for new mails: 10 e-mails from friends/family and 5 SPAM messages. Her best friend Noriko suggests a new movie tonight. Her newly met boyfriend Takeshi asks for a date over the weekend. Her sister Kaori, currently studying in USA, asks for easy Japanese recipes. Her mother in her hometown asking how she is. Her father on a business trip wants to know what souvenirs she would like. After acquiring a mobile phone, she has more had more contact with her father and he is so happy that he continues to subsidize her mobile bills. Kyoko then starts here commute to work.

During her time on the train, she replies to most of her messages. She interrupted her mobile game, after she received a call. Before she boarded the train, however, she had set her mobile to 'manner mode' so that it didn't ring. Her mobile also has a sticky film covering, an accessory for the LCD display. This film covering is recently a popular item to avoid a snooping by others especially in the very crowded trains. It means that mobile screens can only be viewed by the person who is facing the phone directly, and not by people on either side of the phone. Kyoko heard from her friends that a new ringing tone of a popular Japanese song has just been released, so she immediately downloads it to her mobile phone for a small fee. Kyoko works as a secretary for a worldwide trading company. Typically, she sits in front of her PC in the office, but she communicates with her friends only through her mobile phone, because she doesn't have computer at home.

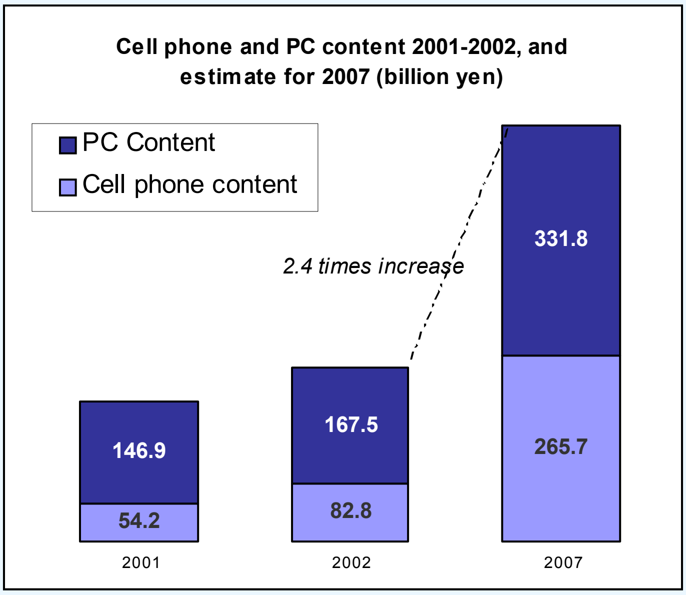
After her day at work, she goes shopping and replaces her mobile phone with a newer model, one that has a very secure system with fingerprint identification. Now, she can assign different fingers for accessing different data: for instance, the right forefinger for Noriko's folder, the left middle finger for Takeshi's folder and so on. Another attractive function that Kyoko enjoys mobile chatting: this allows a series of message to be exchanged in the form of near real-time dialogue similar to Internet chatting software. She did end up going to the movie with Noriko, after buying both tickets electronically through her keitai. She did not find the new movie interesting. So in the theatre, she wrote a few more e-mails and sent pictures to friends with her new mobile handset…

Source: ITU.

5.1 Good content, bad content

In 2002, one-third of all content revenues stemmed from mobile content. The MIC estimates that by 2007, mobile content in Japan will more than double (see Figure 5.1). For this reason, efforts to foster a healthy content market are being stepped up at the governmental and industry level.

Figure 5.1: Mobile phone and PC content



Source: MIC White paper on Information and Communications in Japan, 2003.

More and more content is being stored on the mobile phones of private users, such as personal e-mail, address book information and calendar. Managing the use of this data is vital for consumers to feel comfortable with current and future services.

The increase in unsolicited e-mail messages is also of particular concern. Most “spam” messages on mobile phones are supposedly sent from personal computers. Readily available e-mail address generating software can even automate sending processes. For this reason, in Japan and in many other countries, spam has become a serious problem, particularly exacerbated when users are charged for each e-mail they receive. Slogans such as “are you paying for spam?” have been bandied about by those operators offering free e-mail reception service. Many operators have since begun providing free incoming e-mail packages: in the case of DoCoMo for instance, the first 400 packets per month are free. As for other measures, operators are repeatedly encouraging users to change their mobile e-mail address so that it differs significantly from their phone number, or to use more complicated and original nicknames, in order to make it difficult for address-generating software. Users can already block all e-mails with Internet addresses and domains, but this may not be an effective measure given that spam messages are often sent from different addresses each time. On 25 December 2003, DoCoMo introduced a new anti-spam measure that will enable its i-mode users (including 3G or FOMA) to block all e-mails from user-selected domains of other cellular or PHS companies. DoCoMo has also taken aggressive countermeasures against spam mail sent from its i-mode network, such as limiting the amount of e-mails sent daily from a single i-mode account and suspending or rescinding the contracts of DoCoMo handsets registered to known spammers. With this new feature, users will simply go to the "i-Menu" official i-mode portal site in order to select which cellular or PHS domains to block. No packet transmission charge will be required to change the settings.

In July 2002, the Japanese government passed the “Law on Regulation of Transmission of Specified Electronic Mail”. This law addresses “Specified Electronic Mail”, which is defined as e-mail for advertisement purposes sent to users who have not opted in for the service. The legislation specifies that the sender’s name must be mandatory information, and prohibits e-mail delivery in the case of user opt-out and the use of address-generating software. Furthermore, it gives the right to Type I carriers to reject sending requests of "Specified Electronic Mail" and requires mobile operators to provide necessary information and develop technical solutions. Although the legislation has introduced some positive measures to address spam, critics of these measures argue that the law negatively affects user convenience, destroying legitimate business models like e-mail magazines. Japan's Spam Mail Consultation Centre received nearly 20'000 notifications of illegal email per month in 2003, which is still a fairly high number. Further work will be needed, at the national and international level, to combat spam.

Internet dating is gaining in popularity around the world. In Japan, given the success of mobile Internet services, mobile dating and flirting services have been particularly successful. However, the number of crimes linked to such services has increased. According to the national police agency, there were 793 cases of mobile dating crimes in the first half of 2002, which represents a 260% increase from the previous year. 400 of these cases related to prostitution of underage youngsters and 390 of these were directly generated through mobile Internet communications. Mobile operators and government are working in tandem to address this problem. KDDI and NTT DoCoMo, for instance, have included information on their websites regarding "access to dating sites" in order to alert users to the possible danger of dating services. In addition, as of August 2003, NTT DoCoMo introduced an access restriction service, which limits user's mobile Internet access only to authorized, "official" DoCoMo sites. At their end, in September 2003, the government enacted the "Law of regulating the act that attracts children using the Internet opposite-sex introduction sites", of which the following are the main elements:

a) Defines "dating service" as "electronic communication channel providing service for opposite sex";
b) Requires dating service providers to put effort to avoid subscription of youngsters under 18;
c) Requires dating service providers to announce that their service is only for an adult and confirm the age of the users;
d) Perpetrators of abuse cases, such as illegal prostitution for under age 18 or any types of dating based on payment will be punished. This means that, for instance, personal ads such as "I'll give you 30,000 yen if you play tennis with me" are prohibited.

The question of whether this law will give police the right to violate private information is still under discussion. The Mobile Content Forum (MCF), an initiative established in 1999 by the private sector to band together to ensure a healthy mobile content market, submitted comments to the Government on this new law. They argue that the law may become a barrier for the development of community sites, a key content driver for the mobile community. MCF also pointed to the lack of technology that can determine a user's age.

5.2 Data security and privacy protection

The explosive growth of the Internet has raised concerns relating to the protection of private information, e.g. the tracking of human behaviour and financial data. The ubiquity of the mobile phone, now an intimate part of daily life, has taken privacy concerns to a new level. Given the amount of personal information stored on mobiles today (e.g. text, photos, videos, and call data), operators should be required to limit access to this data by third parties. The advent of RFID and sensor technologies will exacerbate the situation even further.

To address these issues, the Japanese government has been issuing guidelines and taking legislative measures. The "Personal Information Protection Act" was enacted in May 2003. In December 1998, the MIC issued the "Guidelines on the Protection of Personal Data in Telecommunications Business" and has since been holding a regular study group concerning information privacy in the business field. Still, in February 2004, the personal information of approximately 4.5 million subscribers (including names, addresses, telephone numbers and e-mail addresses) in the possession of a major telecommunication carrier was leaked[26].

The "Unauthorized Computer Access Law" was enacted in 2000 to prohibit unauthorized access either by using the person's ID and password without authorization or by attacking a security hole. During 2003, there were 58 cases of infringement reported under this law, and 76 people were arrested (an slight increase from the previous year)[27].

The "Privacy Protection Law" came into effect in May 2003. This law gave individuals the right to obtain information that companies have collected about them and restricts the use and sharing of such personal data.

Backers of the new legislation say it responds to consumer complaints about personal information circulating in dubious databases and mailing lists.

Critics of the “Unauthorized Computer Access Law” argue that operators of Internet sites and other businesses will be overwhelmed by requests from individuals to delete personal information. There are statements mainly from the media that it could restrict freedom of speech. Its provisions were amended to exempt news reporting by media organizations, but magazine publishers have complained they may not necessarily be protected because they are not specifically mentioned in the law's definition of a media organization. Individuals who believe a company has misused their personal information can complain to the government, which can then act to put a stop for such activities or slap violators with penalties of up to six months in prison or up to 300’000 yen. It is likely that new mobile handsets with enhanced personal identification technologies such as biometrics (e.g. fingerprints) will be in great demand.

Important privacy concerns are also raised by the use and anywhere/anytime availability of digital cameras on mobile phones. Pictures have been taken of people surreptitiously and without their consent. Tipness Fitness, a chain of health clubs in Japan, has now banned camera phones from their facilities. Handset manufactures have also taken note: self-regulatory measures have ensured that each mobile phone makes a noise when the camera phone is used, so that at least others can be alerted to the opening and closing of the shutter.

In mobile and Internet chat rooms, discussions that might foster mental abuse or violate privacy rights can sometimes occur. Individual users may also violate important intellectual property rights through the fixed or mobile Internet. In an effort to address the role of service providers in this regard, “the Law to Limit the Liability of Electronic Communication Service Providers and Permit the Disclosure of User Information” was passed in May 2002. The purpose of the law is essentially to limit the level of responsibility that an electronic communications service provider will have to shoulder when they are confronted with complaints about the activities or conduct of their users. Providers will generally not be held responsible, with the exception of cases in which a provider does not take protective action when they are aware of a violation and have an effective technical solution to address it. If the measures taken are reasonable, exemption from responsibility is granted. Another objective of the law is to allow service providers to reveal the personal details of a user when that user finds that their information has been used unfairly in a privacy rights case.

5.3 User concerns relating to the future ubiquitous environment

With advances in radio frequency identification and location-based services, there is increasing concern relating to the impact of these technologies on the daily lives of users, and on social behaviour. In a ubiquitous communications environment, protecting private consumer data may well become a greater challenge. In order to ensure that users control information stemming from cell phone use, such as location and purchasing habits, appropriate regulatory measures should be put into place, and user awareness must be raised. In an effort to address these issues, the MIC has created website entitled “MIC Information Security Site for citizens – for safe use of Internet”[28]. On this site, users can find basic information about Internet security, a dictionary of terms, examples of real cases, as well as a number of recommendations for setting secure network environments. MIC has also set up a number of study groups composed of experts, academics and industry representatives, in order to continue its work in this area.

Since March 2004, the MIC has been conducting meetings of the Policy Roundtable on the ubiquitous network society, which is considering, *inter alia,* the “measures to remedy areas that fall into the dark side of the ubiquitous network society”. In this context, a survey has been conducted on the most common areas of insecurity relating to a future ubiquitous environment (Figure 5.2). The most common concerns are fraud and the protection of personal information. 62.7 per cent of those surveyed were concerned about unscrupulous and fraudulent business methods, 59.7 per cent about the leaks of personal information in the possession of businesses, 58.2 per cent about improper access and use of personal information. A surprising 49.2 per cent were also concerned about the increasing complexity of services.

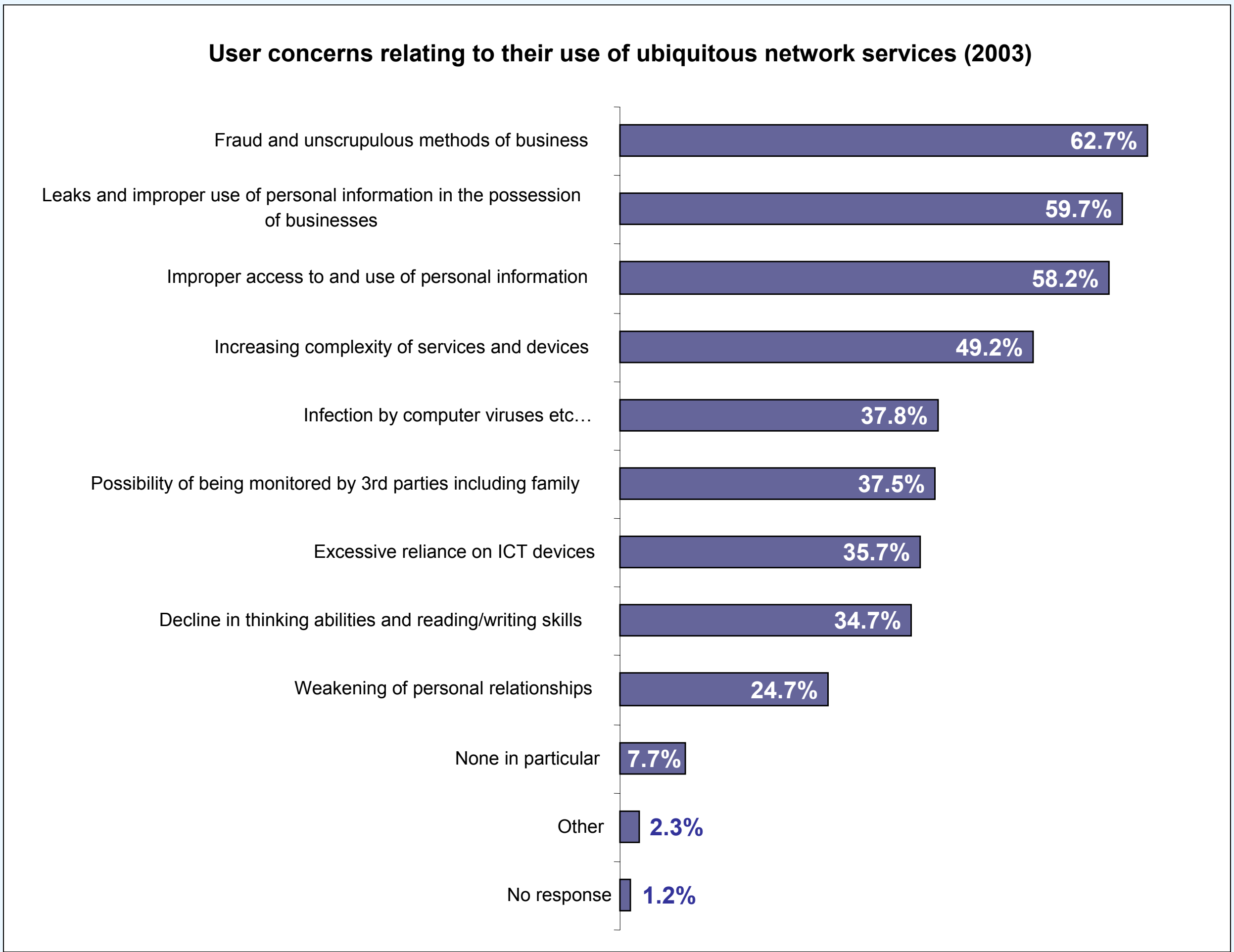
In addition, the MIC and METI have made and disclosed a guideline for privacy safeguards for the use of RFID, on the 8th of June 2004. These guidelines focus on the following aspects: user notice, user choice, information disclosure, and access control to personal information. The two ministries are currently carrying out awareness campaigns on these guidelines among relevant organizations and consumers.

6 Conclusion

Japan has long been recognized as a leader in ICT innovation, and is now at the cutting-edge of developments relating to ubiquitous networks and computing.

In the face of a rapidly evolving technological landscape, and in the current economic climate, Japan is actively creating and implementing coherent national e-strategies and "u-strategies". These strategies have enabled the deployment of new infrastructure and innovative services. The diffusion of broadband Internet and mobile networks has been very successful in the country, due primarily to close collaboration between government and industry, and the introduction of new entrants. National competition policy coupled with rapid service innovation has resulted in affordable, flat-rate, and always-on connectivity. Japan is capitalizing on its strengths in mobile handsets and consumer electronics by extending its research and development into areas such as RFID and sensor networks. In order to further stimulate the ubiquitous communication environment, it is keen on promoting the efficient utilization of spectrum, as evidenced by its ongoing evaluation of frequency allocation methods.

Figure 5.2: User concerns in a ubiquitous network society



Source: MIC White paper 2004

Not only is Japan establishing technical and policy measures for the rapid and smooth development of a "ubiquitous network society", but it is also taking a closer look at user concerns and the overall social impact of technology. It is expected that the development of a ubiquitous network society will bring benefits to the economy, help alleviate social problems and, in general, enrich human life. But in order to realize such a vision, citizens must be made aware of their responsibilities and obligations as members of a ubiquitous network society. In this context, ensuring information security and consumer privacy are key concerns, as is the creation of a social framework to ensure that the benefits of the ubiquitous network society are extended equally to all. As such, Japan's holistic view of technology development may provide inspiration to other national and international bodies in their own transitions to the ubiquitous network society.

Endnotes

1 The 2004 case study was written in the context of the ITU New Initiatives Workshop held in Seoul, Republic of Korea, in March 2004. The report, along with other papers and case studies, is available at www.itu.int/futuremobile

2 Documents and information about the ITU Workshop on Ubiquitous Network Societies (April 2005) can be found at www.itu.int/ubiquitous

3 The UNDP's HDI is a composite of key indicators of well-being such as life expectancy, literacy, school enrolment and per capita GDP. See www.://hDrundp.org

4 ITU World Telecommunication Indicators Database.

5 MIC, 2004 White Paper "Building a Ubiquitous Network Society That Spreads Throughout the World", available at www.johotsusintokei.soumu.go.jp/whitepaper/eng/WP2004/2004-index.html

6 IT Strategic Headquarters: www.kantei.go.jp/foreign/policy/it/index_e.html

7 The Basic Law on the formation of an Advanced Information and Telecommunications Network Society: www.kantei.go.jp/foreign/it/it_basiclaw/it_basiclaw.html

8 e-Japan Strategy full text: www.kantei.go.jp/foreign/it/network/0122full_e.html

9 e-Japan Priority Policy Program summary: www.kantei.go.jp/foreign/policy/it/0618summary/01_e.html

10 See ITU Internet Reports 2003: The Birth of Broadband, available at www.itu.int/birthofbroadband

11 E-Japan Strategy II.

12 However, an unforeseen effect of all this competition was its negative impact on PHS operators. In October 1997, there were over 7 million PHS subscribers, but in January 2003, the number had dropped to 5.5 million.

13 In 1992, mobile phone subscribers were a mere 1 million.

14 See www.kddi.com/english/corporate/news_release/2003/1022/index.html

15 MIC (formerly MPHPT) Communications Usage Survey 2003.

16 See www.nttdocomo.co.jp/p_s/mzone/home.html (Japanese only).

17 For 5 weeks starting pn 17 November 2003, JR East, Japan Telecom and NTT DoCoMo tested a trial roaming service of Mzone at railway stations, thereby expanding the service to areas not covered by DoCoMo's own WLAN service.

18 See L. Srivastava, *3G Mobile Policy: The Case of Japan,* INFO, vol. 3, no. 6, December 2001.

19 Analysys Consulting, 2003. See www.analysys.com

20 *Ibid.*

21 For more information about the Roppongi Hills district, go to www.roppongihills.com/en/information/index.html

22 To sign up for the service, users can go to www.://r-click.jp/ (Japanese only).

23 See www.://2.pro.tok2.com/~higashi-nagasaki/anti/pintokona.html for pictures and text (Japanese only). See also www.://urawa.cool.ne.jp/vfsarah/kaiten2_pinto.html

24 See ITU, "Ubiquitous Network Societies: The Case of RFID", March 2005, available at www.itu.int/ubiquitous/

25 "Mobile Phone Usage Situation" , Video Research Ltd, September 2002.

26 MIC White Paper 2004.

27 *Ibid.*

28 See www.soumu.go.jp/joho_tsusin/security/index.htm

CHAPTER VIII

UBIQUITOUS NETWORK SOCIETIES:
THE CASE OF THE REPUBLIC OF KOREA

ACKNOWLEDGEMENTS

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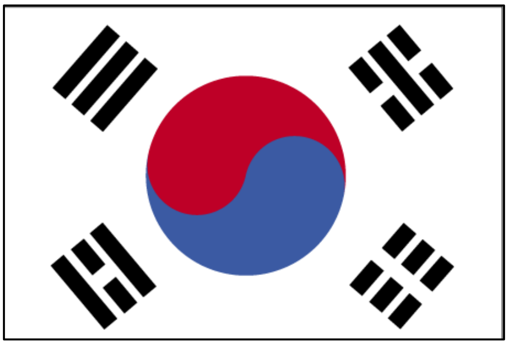
1 INTRODUCTION



The concept of a "ubiquitous network society" implies a world in which information, and the tools to exploit it, are available "anytime, anywhere, by anything and anyone". A ubiquitous network society is thus the logical, long-term outcome of the drive to create Information Societies, as espoused by the World Summit on the Information Society (Geneva 2003 and Tunis 2005).

The Republic of Korea is an appropriate place in which to study ubiquitous network societies. As the twenty-first century gets under way, the Republic of Korea has found itself at the cutting edge of the information revolution. Koreans are taking uncharted steps into a life surrounded by information. For many Koreans, lifestyles already revolve around high-speed information access. Koreans can access information easily from state of the art mobile networks and handsets, the world's most extensive broadband network, or from 25,000 cybercafés located around the country. For younger generations especially, being Korean means being connected.

However, this is just the beginning. Korea's vision of a "ubiquitous dreamworld"[1] (see Box 1.1) is set to continue to change the way that Koreans access and use information. This new "unified" network promises to change Korea's information society, drastically increasing the amount of information Koreans can access at any time.

Korea provides an excellent example for a study of the mobile information society, simply because its success as one of the world leaders in information and communication technologies is little short of phenomenal. The country has evolved from utter decimation at the end of the Korean War to being one of the world's most high-tech economies. Korea has the highest level of broadband penetration in the world; more than 70 per cent of households are connected to the Internet via high-speed lines. Korea is also one of the leaders in mobile phone technologies. It was among the first countries in the world to offer IMT-2000 (or 3G) services.

Box 1.1: What is the ubiquitous network society?
Korea's vision of a Ubiquitous Dreamworld

As the different background papers and case studies prepared for ITU's New Initiatives Workshop on Ubiquitous Network Societies show, the concepts and definitions of what constitutes "ubiquitous" vary between countries, and between different disciplines; sometimes subtly, sometimes significantly. Korea's own short-hand definition of ubiquitous is "Anytime, anywhere, any device, any service, all security". From the Latin root, Korea defines the concept as meaning 'existing everywhere' or 'existing everywhere and all the time, simultaneously. It refers to an environment that anybody can use at anytime, anywhere through computers and network. In such an environment, the transition from wired to wireless networks is seamless.

1.1 About the report

This analysis forms part of the background research for the Ubiquitous Network Society workshop, held in Geneva, Switzerland in April 2005. It was updated and revised from an earlier study carried out in 2004. The Korean case study is just one of four case studies that will explore the nature of the ubiquitous network society. The other three case studies cover Italy, Japan, and Singapore. In addition, thematic background papers look at the impact of the Ubiquitous Network Society on the traditional telecommunication industry, its implications for consumer privacy and a case study of radio frequency identification (RFID).

This ITU New Initiatives workshop serves as a forum for telecommunication policy-makers, national regulators, private sector participants, and academics to discuss the implications of a mobile information society. This particular workshop is intended also to provide input for the Thematic Meeting of the World Summit on the Information Society (WSIS) on “Towards the realization of the ubiquitous network society”, to be organized by MIC Japan, ITU and United Nations University (UNU) in Tokyo, Japan, 16-17 May 2005.

The study is broken into seven sections. Section two introduces broadband in Korea, with information on network deployment, growth in services, and regulatory trends. Section three studies the backdrop to the mobile market with an overview of growth and development, network infrastructure, and government policy. Section four describes current-day mobile services, the evolution of terminals and mobile culture. Section five pulls together the elements of sections two to four to explore the Korean vision of a converged network. It will discuss the blurring of the line between broadband and mobile, how these networks will interact, future end-user services, and the complicated market implications of a converged network. Section six takes the technical and user-focused elements of section four and puts them in the context of the Korean information society. It will look at social factors of the Korean information society, including the benefits and drawbacks of being connected anywhere, anytime. Section six also looks at measures to protect data, and to help users manage mobile information. Section seven, the conclusion, looks at which elements of the Korean experience can be extrapolated to the world, and which may be unique to the peninsula.

1.2 Country profile

1.2.1 Physical characteristics

The Republic of Korea is on a peninsula that lies between China to the West, Japan to the East, and the Democratic People’s Republic of Korea to the North (also commonly known as North Korea). The Republic of Korea’s only land border is to the North along the 38th parallel. Its land mass is 99,000 square kilometres, making it slightly smaller than Cuba, Iceland, and Guatemala and slightly larger than Hungary, Portugal and Jordan. Korea’s population in 2002 was 48.2 million with a population density of 490 inhabitants per square kilometre (see Figure 1.1).

Figure 1.1: Korea at a glance

Republic of Korea	
Geography	
Coordinates	37 00 N, 127 30 E
Area	98'480 sq km
Density (inhab per km2)	493
Terrain	Hills, mountains, wide costal plains
Population (July 2004 est.)	
Total	48.598 million
Growth rate	0.62%
Life expectancy	
Women	79.5
Men	72.0
Median age	33.2
Economy (GDP, 2003 est.)	
Total (PPP)	US$ 857.8 billion
Per capita (PPP)	US$ 17'650
Growth rate	3.1%
Language	
Official	Korean
Studied widely	English

Source: Official sources, including World Factbook.

1.2.2 Social characteristics

The past 100 years have been turbulent for the Korean peninsula but the country has proven tenacious, rebuilding the economy from virtual decimation to attain the leading role it has today in the information society. The Korean peninsula was annexed by Japan for 35 years in 1910 as a Japanese colony, until the autonomy of Korea was regained in 1945 at the end of World War II. The peninsula was then divided into two sections, the north backed by the former USSR and the south backed by the United States. The Korean War broke out in 1950 and lasted until a cease-fire was signed in 1953, leaving the country in utter ruins. In 50 years, Korea has rebuilt its county and economy to the 16th largest in the world, despite being only the 26th largest in terms of population.

This economic growth has been described as "phenomenal" and "a miracle" due to the movement from one extreme level to another. In 1960, Korea had a per capita income of less then USD 100. However, during the next forty years, Korea's average annual growth rate was 8 per cent, growing the economy to reach a per capita income of USD 17'800 (based on purchasing power parities), pushing Korea into the World Bank classification of a high-income economy.

"Bballi Bballi"

While the "Korean miracle" has been the topic of much study in the academic press, Koreans would be quick to explain that Korea's phenomenal success can be summed up by the simple Korean phrase, "*bballi bballi*", literally "hurry hurry". Korea's moniker "Land of the morning calm" gives a misleading impression. Koreans work extremely hard and have sacrificed to develop into a high-income country in a mere 50 years. This *bballi bballi* mentality permeates through all aspects of Korean life, including telecommunications. Koreans work extremely long hours and have one of the longest working weeks (5.5 days) in the industrialized world. Koreans will not be content and relax, until they become the leading IT economy in the entire world, it seeMs If their growth in the past can be an indication, they are certainly on the right track.

1.3 Historical perspective

Korea's telecommunication history began in August 1885 when a telegraph line was installed between Seoul and Incheon. The first telephone lines were installed in 1902 and the first automatic exchange introduced in 1935. Korea joined the International Telecommunication Union (ITU) in 1952. By the end of the 1980s, Korea had achieved virtually achieved universal service. Korea signed the World Trade Organization (WTO) Agreement on Basic Telecommunication Services that became effective in November 1997, committing the country to further liberalization of its telecommunication sector.

The nation's historical operator is Korea Telecom Corporation (KT). It began as the government-owned Korea Telecom Authority. Its statute was changed in 1989 allowing it to be privatized, and in November 1993 the Government began selling its shares in the company. Ten additional share sales ensued over the next decade with the final one in May 2002, just ahead of the World Cup, when the Government fully divested itself of the company.

Box 1.2: Korea's wise investment in information promotion
How revenues from spectrum licences and taxes on operators are re-invested in telecommunications

Spectrum auctions and licences have been very successful around the world at swelling the coffers of governments. However, these funds are usually put into the Government's general budget and used to fund non-telecommunication related projects. The Korean Government recognized early on that these funds could be strategically reinvested in the telecommunications sector as a way to help Korea become a world leader in ICTs. The fees from spectrum licences were pooled together into a government fund called the "Information Promotion Fund".

In addition to one-time deposits from spectrum auctions, the Government keeps a steady flow of new money flowing into the fund by requiring operators to pay a fee that amounts to 0.8 per cent of their revenue into the fund.

The fund, in total, holds around USD 5 billion and disperses around USD 500 million each year on projects to help encourage access to information. The research projects fall into three main categories:

1. Upgrading infrastructure;
2. Pioneering research (ETRI, NCA, IITA)
3. Building and maintaining internal government networks.

These investments have produced phenomenal results in Korea, including establishing its position as the world's broadband leader. The Korean example shows how careful use of spectrum fees can help boost overall connectivity in the society, to the benefit of the industry rather than as a tax upon it.

Source: NCA.

The Ministry of Information and Communications (MIC) is responsible for telecommunications and broadcasting policy and regulation. This mandate also extends to certain areas of information technology. The MIC is active in promoting and developing the communication industry in Korea. One tool it has had at its disposal is requiring telecommunication operators to contribute to government programmes for industry development. In contrast to many other countries, this money and funds from spectrum auctions are then reinvested in the telecommunication sector instead of being transferred to other areas of government (see Box 1.2).

1.3.1 Developing the backbone

Korea's telecommunications success is partially attributable to the Government successfully targeting key industries. In 1993, the Office of Information Planning identified a nationwide fibre backbone as vital for Korea's economic development. Rather than funding the backbone completely, the Government put up grant money and then agreed to become a tenant on the line, so as to ensure sufficient demand. The backbone was the first national, high-speed backbone of its kind throughout the world. While other economies had used public funds to develop backbone networks between universities (e.g. the United States High-Performance Computer Network Initiative or the European Union's TEN project), Korea was the first to target government offices around the country as the landing spots for the connections.

The rollout for the 10-year plan was assigned to KT and Dacom, which built the fibre ATM backbone that now spans the country. The Government continues to lease lines on the fibre that connect government offices such as post offices and provincial headquarters. Post offices around the country are connected via the secure fibre backbone and users are able to send and receive funds securely. Postal accounts make up 25 per cent of bank accounts throughout the country.

The Government's initial investment of USD 1 billion has paid off with the private sector completing the rest of the network at a total expense of USD 50 billion. The Korean experience has shown that the government can play a key role in network provision by becoming an anchor tenant on the line, a strategy being used by other leading broadband economies, such as Canada.

1.3.2 Educating users

In addition, some of Korea's current success in telecommunications can be tied to a government project that trained people in IT skills. In total, over 10 million people were given IT training and have subsequently become more savvy technology users and buyers (see Box 1.3).

Box 1.3: Educating out of the Asian financial crisis
How widespread ICT education has helped fuel Korea's growth

The Asian financial crisis, in 1997-98, was particularly difficult for the Republic of Korea. The value of the Korean Won dropped substantially and Korea was forced to request financial assistance from the International Monetary Fund (IMF). However, the crisis was also a turning point for the Information Society in Korea.

In response to the crisis and the IMF conditions for aid, many Koreans lost their employment during restructuring. The Korean Government decided to create a programme that would give these unemployed people IT training. At the time, the Government decided it would create a programme that would give IT training to 200'000 women outside the workforce. However, the demand for the programme far exceeded the Government's expectations. Three million women applied for the programme, which was eventually extended to include IT training for men. Post offices and vocational institutions were opened for free IT classes. In total, over 10 million people – roughly a quarter of the Korean population – received IT training by way of government programmes or institutes with government certification.

The effort produced astonishing results. Koreans who went through the training are much more likely to participate in the information economy. They are more prone to be Internet users, subscribe to broadband, use the mobile Internet on their phone, and shop online.

Source: Former MIC Minister Yang Seung-taik.

1.4 ICT Statistics

Some of Korea's impressive ICT statistics are given in Figure 1.2. Mobile phone penetration overtook fixed-lines as long ago as 1999 and in 2003, for the first time, fixed lines actually began to decline. Korea is now in the unusual situation, almost unique in the world, of having more Internet users and PCs than fixed telephone lines. The mobile phone population continues to grow, adding a further 1.25 million users during 2003. Broadband also continues its expansion with a further one million broadband users being added in 2003. A dramatic example of the expanded use of increasingly higher bandwidth services is the fact that Korea's international Internet bandwidth more than doubled during 2003, suggesting a return to growth rates not witnessed elsewhere since the dot.com bubble burst. Sections two and three will examine both the broadband and mobile markets in more detail.

Figure 1.2: Korea's ICT statistics
A snapshot of the ICT industry in Korea

Republic of Korea (2003)	
Mobile Telephones	
Penetration rate	69.12
Total	33'591'760
Growth Rate, 00-03	7.80%
Fixed Lines	
Penetration rate	47.07
Total	22'877'020
Growth rate. '00-03	1.42%

Republic of Korea (2003)	
Internet	
Users	29'220'000
Users per 100	60.13
Intl. bandwidth (Mbps)	37'069
PCs	26'741'000
Broadband	
Total subscribers	11'179'121
Subs per 100 inhab	23.0

Source: ITU World Telecommunication Indicators Database.

2 BROADBAND

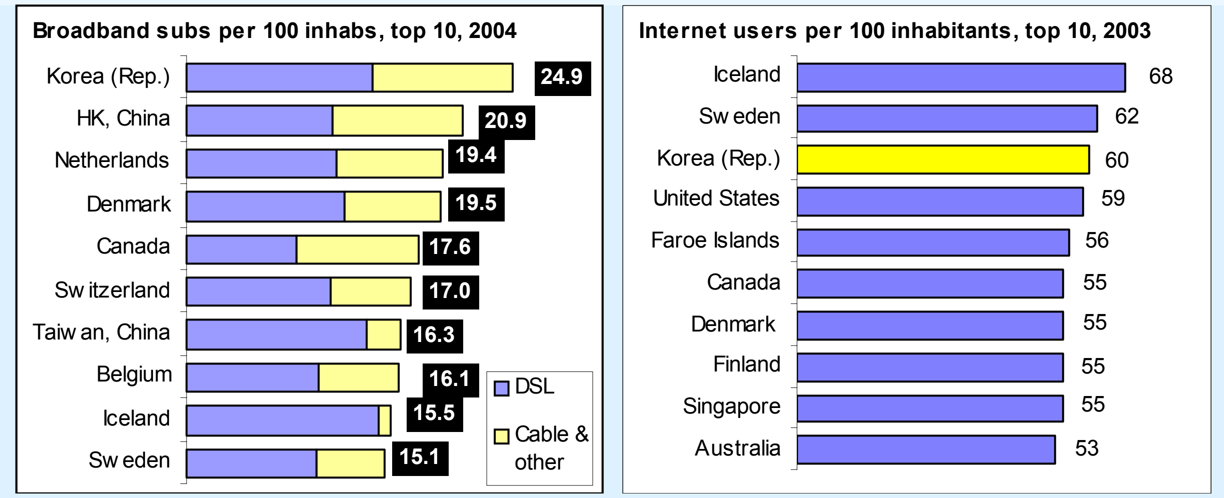
2.1 Level of network deployment

Korea is the world's broadband leader by a large margin. In 2004, Korea had 24.9 broadband subscribers per 100 inhabitants (see Figure 2.1, upper charts). This equates to more than three-quarters of all households subscribed to broadband[2]. In addition to the world's highest broadband penetration rate, Koreans have some of the cheapest and fastest residential connections in the world at the lowest prices. ADSL broadband connections at 2 Mbit/s are on offer at less than USD 25 per month while even VDSL broadband connections, at 20-40 Mbit/s, cost consumers less than USD 50 a month (see Figure 2.1, lower charts). This extraordinary position is the result of several key factors, especially the level of competition, government involvement and geography.

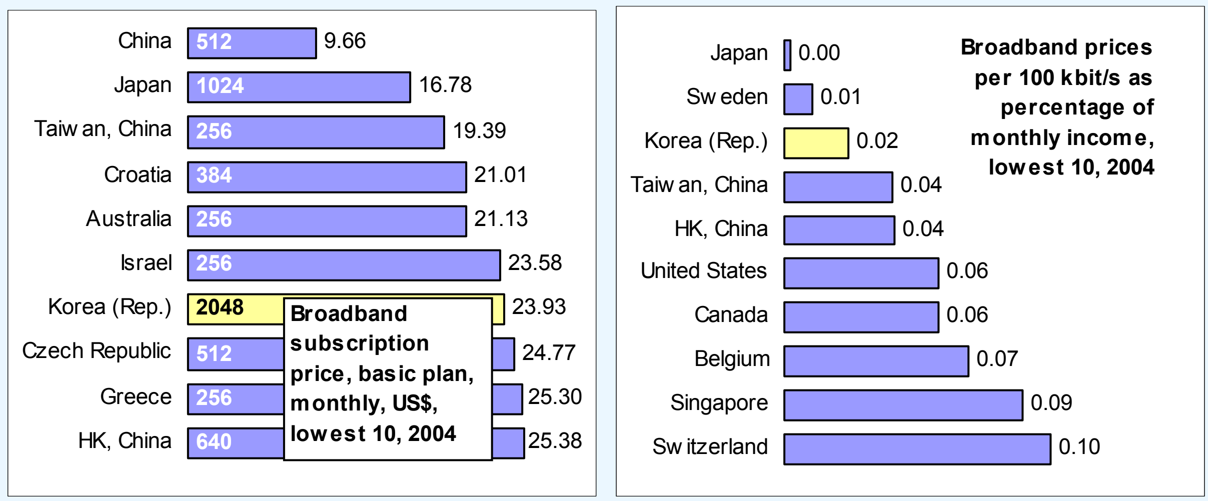
Broadband Internet services were launched in Korea in July 1998 by the cable provider Thrunet. In April 1999, Hanaro entered the broadband market by offering the world's first ADSL service. Hanaro had been a competitive fixed line telephony provider but ran into several obstacles in extending its market share against the incumbent, KT. There was no number portability at the time and users going back to KT from Hanaro were forced to pay large reconnection fees. Facing these fixed line problems, Hanaro changed its strategy from a focus on fixed-line telephony to broadband. This strategic move was particularly successful given KT's reluctance to deploy ADSL due to its high investment in IDSN. However, when the success of the ADSL service became apparent, KT quickly responded and began offering its own service in June 1999[3].

Figure 2.1: Korea as a world broadband leader

Korea leads the world in broadband subscribers per 100 and is third in the number of Internet users



Korea also offers some of the lowest and most cost effective broadband tariffs in the world, July 2004



Source: ITU World Telecommunication Indicators Database, and ITU Internet Reports 2004, The Portable Internet.

In 2005, the broadband networks in Korea are extensive and most households have access to two or more technologies to subscribe to broadband. ADSL is available to 90 per cent of homes with cable television networks passing around 60 per cent of households. In addition to these core technologies, Koreans often also have access to apartment LAN technology (essentially Ethernet wiring in the building connected to the ISP via fibre), wireless local loop, and satellite connections – each of which have extensive coverage.

Currently VDSL speeds of 20-40 Mbit/s are available to many Koreans at just under USD 50 a month with average speeds in the country at 4 Mbit/s. However, the Government plans on having 20 Mbit/s connections available to all homes by 2006. The speed is important because it represents the speed necessary to view high-quality HDTV signals. The 20 Mbit/s speeds are only a starting point for Korea's broadband vision. In the near future, VDSL speeds are expected to reach 50+ Mbit/s. Hybrid fibre/coax connections will be able to reach 30 Mbit/s. By 2010, Korea plans to have between 50-100 Mbit/s available to all homes. These goals may seem optimistic but may very well become a reality given the tremendous growth of Korean broadband that has taken place in the space of just over five years. One implication is that, despite the continuing improvement in performance and capacity of mobile communications networks, fixed line networks may continue to have the edge for some years to come.

2.1.1 How has Korea achieved this success?

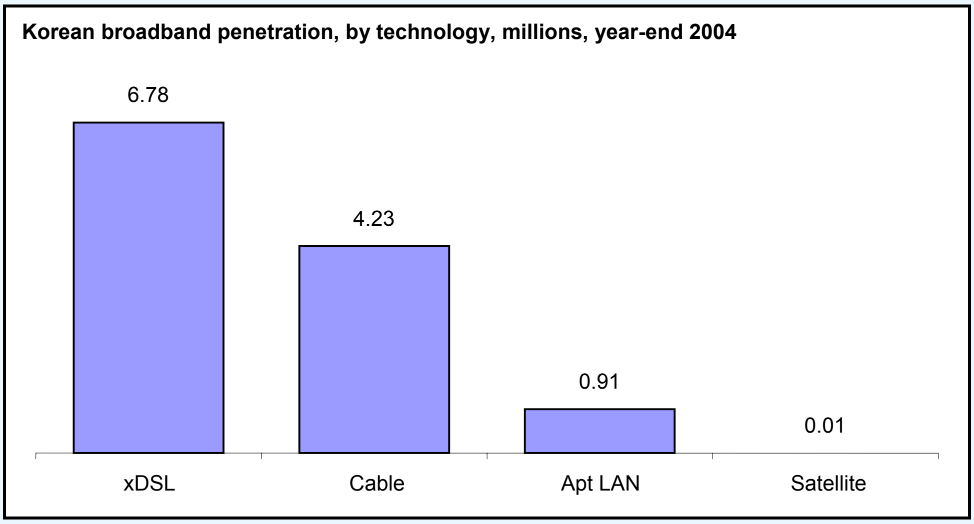
Korea's exceptional broadband success is due to several factors, some of which may be specific to Korea and others that can be replicated by policy-makers in other economies. Each of the key factors – competition, government involvement, and geography – are discussed below.

2.1.2 Competition

Korea's competitive situation will play a major role in helping the Government reach its ambitious goals for universal, high-speed broadband access. While many countries have competition at the level of services providers, Korea is one of the few that also have real competition at the infrastructure level too. Koreans can choose among multiple providers on each technology and there are multiple technologies available to most homes. In addition, Korea has one of the world's only examples of true facilities-based competition, a situation where side-by-side networks compete against each other using the same technology.

Currently, Koreans have many technology options for broadband in most areas of the country. The most popular connection technology is xDSL (different flavours of Digital Subscriber Line), accounting for 57 per cent of broadband subscriptions. Cable connections make up 35 per cent of connections, while apartment LAN and wireless technologies cover 8 per cent of subscribed homes (see Figure 2.2). Although broadband via cable modems was the first to be offered in Korea, ADSL has now overtaken cable, despite the later start, because of its much more extensive installed network. This strong inter-modal competition has brought down prices and introduced technologies that can serve remote areas.

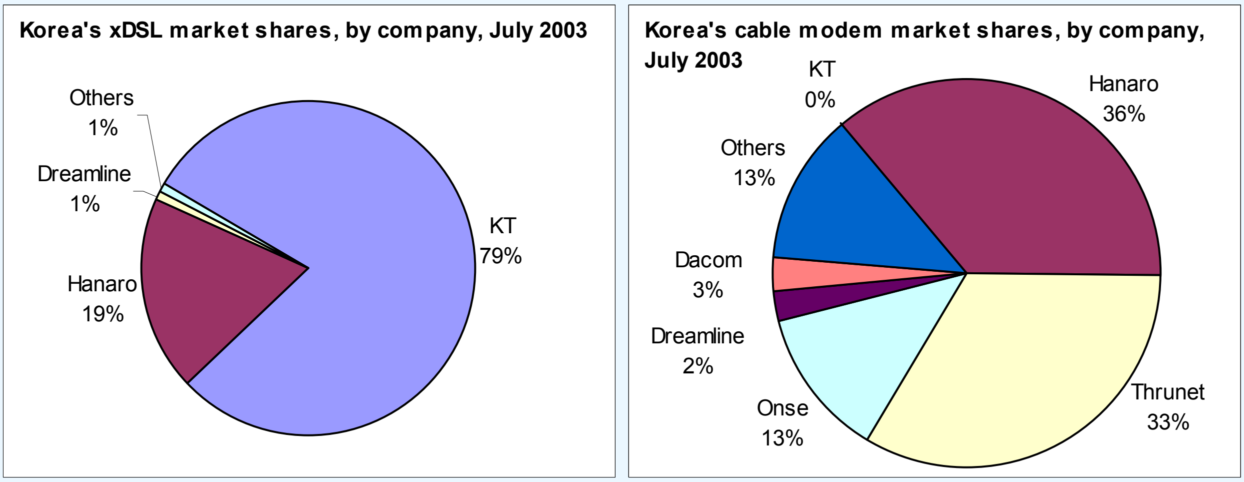
Figure 2.2: Korea's broadband subscriptions, by technology
Koreans have a solid choice of technologies to choose from when subscribing to broadband



Source: MIC Korea "White paper 2003: Broadband IT Korea".

Inter-modal competition in Korea is different from many other economies because a single carrier may offer broadband service over a wide range of technologies. Hanaro, for example, offers broadband over five different technologies: xDSL, cable modem, apartment LAN, LMDS (B-WLL) and wireless LAN. The incumbent, KT, offers access over 5 different technologies: xDSL, apartment LAN, wireless LAN, satellite and WiBro.

Figure 2.3: Fierce inter-modal and same-technology competition
Breakdown of market share, by technology



Source: International Cooperation Agency for Korea IT.

The number of technology options available from a single provider (e.g. Hanaro) might cause concern in other economies since broadband rollout is often delayed, by conflicts of interest, in economies where telecommunication operators own cable companies (e.g., in Scandinavia). However, the Korean example is different for several reasons. First, the competitive market is mature with extensive networks over many technologies. Second, open access on broadband networks allows any carrier to provide service over other types of networks. A carrier such as Hanaro has open access to KT's unbundled loop, as well as Thrunet's extensive cable network. This allows Hanaro to provide service nationwide and over multiple technologies, even if it does not have a physical network presence in the area.

Intermodal competition in Korea is fierce and users have many choices available to them (see Figure 2.3). While xDSL and cable technologies make up the brunt of connections, wireless technologies will have a much more pronounced roll in the future. KT's Nespot (WLAN) service has built an extensive Wi-Fi access network around the country and continues to grow (see Box 2.1). Also, new wireless data technologies are in the planning phase that should allow seamless data connectivity and movement throughout the country. These are discussed in Chapter 4.

Box 2.1: Wi-Fi connectivity across Korea
How KT's NESPOT service is quickly making broadband portable

KT's NESPOT service offers wireless LAN access (Wi-Fi) in 10'000 areas around the country. Wi-Fi access points are located in areas such as universities, hotels, exhibition halls and other public areas. In addition, NESPOT subscribers around the country have their own Wi-Fi access points at home, which extend the reach of the overall wireless network. KT expects the network to grow quickly as more and more users join and become nodes.

There are several ways to access the NESPOT network in Korea. First, KT's xDSL (Megapass) subscribers pay an extra USD 8.40 (10'000 W) a month for unlimited NETSPOT usage at home and from any of the country's access points. Non-KT subscriber, travellers, and others can also pay by the minute or hour to access the network where there is coverage. A wide variety of tariffs and packages are available. For instance, the basic hourly rate is 3'000 Won (USD 3.00), while the cost of a monthly subscription starts at 32'500 Won (USD 32.30)

Source: KT.

In addition to competition among technology, there is also strong competition within individual technologies (e.g. multiple xDSL providers). KT and Hanaro are the main players in the xDSL market. Hanaro was the first Internet service provider (ISP) in the world to offer DSL services and had an early lead on KT due to KT's reluctance to reverse its strategy of investment in ISDN. However, as soon as KT realized the threat from Hanaro, it quickly changed tack and has now overtaken Hanaro's xDSL in terms of DSL subscribers.

As of July 2003, KT had 79 per cent share of the ADSL market although competition from Hanaro is keeping the pressure on for faster speeds and lower prices (see Box 2.2).

One of the key elements behind the fierce competition over the same types of technology is open access. Many economies have unbundled the local loop, with varying success. However, Korea has gone a step further by also unbundling the cable loop. This has allowed competitors to take unbundled lines from the incumbent operators to provide competitive service. The effect has been astounding on penetration, prices, and speed.

Box 2.2: The rise of a strong broadband competitor: Hanaro

In many economies around the world, incumbents dominate in broadband. This is especially true in Europe where incumbents dominate the DSL market[4]. In addition, the incumbent generally supplied the remaining DSL lines, either by wholesale or through local loop unbundling. The Korean experience is different and demonstrates the possibilities for genuine infrastructure competition.

KT still has a large portion of the DSL market, with a 79 per cent market share in July 2003, but Hanaro also has a strong showing in DSL, in addition to having the largest market share for cable modem connections.

The Korean Government realized that the country needed a second, competitive carrier in order for competition to flourish. With government encouragement, several of Korea's conglomerates or *chaebol* jointly formed Hanaro as a strong competitor to the incumbent KT.

This strong financial backing has been a large benefit to the broadband market. First, Hanaro had enough financial support to build out its own infrastructure in many parts of the country. Hanaro runs fibre connections to the basements of large apartment buildings and business districts, alongside similar lines from KT. In apartment complexes, these multiple fibre connections are terminated in the main distribution frame (MDF) room and the final meters of broadband are delivered over high-speed VDSL. Hanaro has targeted apartment complexes with more than 200 apartments as potential subscribers. In areas where Hanaro hasn't been able to justify a second network outlay, it can simply use unbundled lines from KT (xDSL) or Thrunet (cable). Hanaro initially bid also for a WiBro licence, but later withdrew when the first payment became due, citing increased competition in the fixed-line broadband market.

True facilities-based competition has had an astounding effect on the market. It has effectively lowered prices below, and raised speeds above, those available almost any other economy. This is because profit margins are squeezed by the low prices and broadband providers are forced to compete on speeds and services (see Box 2.3).

2.1.3 Government involvement

The Korean Government has been very successful at fostering certain industries that it deems "strategic". The Government makes small, strategic investments that evolve into much larger investments from the private sector. Examples include becoming an anchor tenant of the fibre backbone throughout the country and the new push to make Korea the leading world IT economy by 2010. The Korean Government was also instrumental in encouraging the formation of Hanaro, as a strong competitor to KT. This has been a huge boon for the broadband industry and the high competition is a major factor behind Korea's high penetration rates.

More recently, the Government has promoted different schemes designed to allow Korea to take a leadership role in emerging technologies, notably the "U-Korea" programme, the "Broadband IT Korea Vision 2007" and the IT 839 Strategy. These are discussed further in chapter five.

2.1.4 Geography

A thriving competitive market and keen government participation have helped propel Korea to the world leading position in broadband. However, Korea's geography and demographics have also played a key role in its success. 47 per cent of Koreans live in apartment complexes and roughly 93 per cent of all households are within 4 km of a telephone exchange[5].

As most Koreans live in apartments or multi-dwelling units (MDU), telecommunication firms have less distance to travel and money to recoup for traversing and connecting the last mile. In Korea, most apartment complexes consist of multiple 15-storey buildings with a central telecommunications exchange, or main distribution frame (MDF). Telecommunication service providers terminate their lines in the MDF and the telephone network from the MDF to individual apartments is privately owned and operated by the apartment complex. This creates a positive incentive to a competitive telecommunication provider such as Hanaro because by installing one fibre optic line to the MDF, it can offer services to uses in the complex without having to pay KT for use of the unbundled local loop. As a result, Hanaro has built an extensive fibre network to apartment complexes with at least 200 potential customers.

Korea's broadband success is often attributed to these three main factors: competition, active government involvement, and geography. Indeed these have laid the foundation for a highly developed network. However, the main reason for the success of broadband in Korea is the high-quality broadband services that Koreans enjoy.

2.2 Growth of broadband services

Korean broadband services fall into several main categories: information retrieval, e-commerce/e-banking and entertainment. The traditional Korean culture has adopted and embraced the way broadband and Internet connectivity can provide near-instantaneous access to information.

The World Wide Web is the foundation for a vast amount of information in Korea. Koreans often look to the Web first for everyday information such phone numbers, traffic information, and driving directions. This type of web-research is common in many parts of the world. What makes Korea unique is the sheer number of users connected and the positive development incentives to content providers. With 70 per cent of households connected, most businesses find it worthwhile to include vast information about their company on the Web.

E-commerce is also a huge driver for broadband adoption. For much e-commerce, the high broadband speeds in Korea don't play as key a selling point as always-on connectivity. In 2002, nearly 75 per cent of stock trades were done online. While both men and women trade stocks online, it has been the vast number of Korean "housewives" trading shares that has helped increase broadband penetration. This translates into higher online times; Koreans spend an average of 16 hours online a week, compared with 10 hours for Americans and four hours in the UK. This is only possible because the vast majority of Korean users have flat-rate, always-on subscriptions rather than volume or duration-based tariff options.

Information retrieval and e-commerce, while important drivers, are not the favourite use of broadband in Korea. That distinguished title goes to e-entertainment. Koreans use their broadband connections for online gaming, video on demand, and video chat services.

2.2.1 Gaming

In Korea, online gaming is centred around the "PC Bang" or PC Room. PC Bangs are cybercafés dotted around the country and offer broadband access and gaming for around 1'000 Won (USD 1) an hour. While the cybercafés are also commonly used for e-mail and other web browsing, they are mostly used as online game havens. This may be surprising given Korea's high household penetration rates for broadband. However, parents generally subscribe to broadband to help their children's studies, not for playing Starcraft during all hours of the night. This has created a niche market for PC Bangs throughout the country. In addition, using the computers in a PC Bang is a social event. Often PC Bangs will have love-seat style chairs where couples can each be on a computer but still sitting close to one another.

The Korean love affair with online gaming seems to be an interesting evolution. Until recently, gaming had a strong stigma attached to it. However, this started to change with the introduction of multi-user games (MUGs) and Role-Playing Games (RPGs). Instead of these games being considered antisocial, they offered a way for Koreans to interact with each other through the games. The fast broadband networks in the country allowed for users to play games against one another with almost no delay from network congestion. Key games such as Starcraft and Lineage drove the growth of the Korean online gaming industry.

Korean online gaming firms are hoping their new products will be able to take a larger percentage of the 32 billion dollar computer games industry (hardware and software)[6]. The broadband gaming world in Korea is now dominated by massively multi-player online role-playing games or MMORPGs. These games form entire fantasy economies where players meet, interact, and even battle against one another using avatars. One of the key reasons these games have been a huge success in Korea is they offer the ability for groups of players to form alliances with others in clans and groups. This *camaraderie* helps keep online gamers less isolated. In fact, one of the main selling points of Korean games is they include more opportunities for players to interact and chat online than other popular games such as Everquest. Some of the more popular online games in Korea are ArchLord offered by Hangame (www.hangame.com), Kangjin soccer, offered by Netmarble (www.netmarble.net) and Lineage offered by NCsoft (www.ncsoft.co.kr)[7]. The size of the Korean Online gaming industry in 2003 was estimated as almost 600 billion Won (around USD 600 million), with 30 per cent year-on-year growth.

2.2.2 Multimedia

Korea's high penetration rates have given incentives to online multimedia distributors to create content and make it available over the web, either through the computer monitor or connected directly to a television. Several companies, like Daum (www.://movie.daum.net/) the leading Korean Internet portal, provide movies on demand to users in DVD quality. Korea's traditional terrestrial television broadcasters also make their programs available on the web. Users can watch the programs for free in real-time using their computer or pay a small fee (usually 300 Won) to watch a programme from the archive. The archive has been a particularly popular way for Koreans to follow their favourite dramas. A similar strategy is now being pursued for providing video entertainment to mobile handsets.

Terrestrial broadcasters and portals currently deliver video-on-demand services but they are not the only players in town. Its-TV.com (www.its-tv.com/) is an interactive video provider that offers films and music videos to consumers at 4 Mbit/s speeds. The company uses set-top boxes on top of the television that receive their signals over a broadband Internet connection. The service is becoming popular because of the high quality films and the ability to watch overseas content including CNN and StarTV, a popular service among Koreans learning English.

Broadband Internet providers are also looking into ways to offer quality-added video services to their offerings. Hanaro started a trial service in June 2003 that is IP based and connects directly to the TV through a set-top box. KT currently offers video-on-demand to its ADSL Megapass subscribers for 1'000-2'000 Won (USD 1-2) a movie under the brand name Homemedia (www.://homemedia.megapass.net). At any given time, there are 400+ movies available for streaming to users on the network. KT was able to work out a revenue sharing model with film distributors where the film distributor receives a minimum guarantee plus a percentage of profits. KT is planning on having more than 1'000 films available soon.

2.2.3 Multimedia: Audio

Koreans use their broadband connections to listen to CD-quality audio over the web. Shoutcast.com, a vast directory of streaming MP3 sites lists Mulkulcast.com (a Korean home-spun radio station) often as the most popular MP3 streaming site in the world. What makes the feat even more impressive is the streams are all in Korean with Korean pop music, and therefore restricted to the relatively small global population of Korean speakers.

2.2.4 Customer service

Korea's service sector is known for its attention to customers and this extends to broadband for several reasons. First, the level of competition in Korea is so high that providers know if they don't retain a customer, another provider will pick them up right away. Second, the expectations for customer service are very high in Korean culture (see Box 2.3).

2.3 Regulatory trends

The regulatory environment in Korea, as mentioned earlier, has allowed for exceptional growth in broadband penetration and service offerings. Open access policies have allowed competitive carriers to use equipment on other carriers and lowered prices. The mixture of both traditional telephone and cable data unbundling has been a key element in boosting the strength of Korea's competitive carriers.

In addition, the Korean Government has maintained regulatory control over Internet exchanges, in an effort to offer better connectivity to all competitors. Currently there are three private Internet exchanges and one non-profit exchange.

Box 2.3: The incredible customer service of Korean broadband providers
When your computer isn't working, call the broadband provider

Koreans demand impeccable customer service. Koreans never have to serve themselves at petrol stations and receive gifts (including extended auto insurance coverage for a week after purchasing petrol) just for choosing one filling station over another. Broadband providers, like petrol stations, have found improving customer service to be a successful method for attracting users.

Koreans who want to sign up for broadband can place a call to the broadband provider in the morning and will be connected within 24 hours, and often before the end of the same day. The providers know that if they don't connect users quickly, another competitor will.

In addition to fast hook-ups, and free multimedia access (comics, anime, movies, ebooks etc), Korean broadband firms are also offering computer repair services to users. As an example, Hanaro offers a PC repair service and online remote services for free to its subscribers. If a user's computer breaks down, Hanaro can run remote diagnostic programs to see what is the problem. Then, it will send out a technician to help repair the computer if necessary.

This high level of customer service is an attempt to build brand loyalty that in turn will help Hanaro and other broadband providers sell other value-added services via their portals.

2.3.1 Universal broadband access

KT was originally a government owned incumbent until 1993 when the Government started selling shares. This process was finally completed in 2002 with the Government selling its final stake in the company. However, as a condition of complete privatization, KT has to deliver broadband to all villages in the country (e.g., universal service for broadband). The threshold for broadband is considered to be 1 Mbit/s or higher. Other economies have *talked about* universal access for broadband but Korea is one of the first to implement it and is definitely the closest to bringing it to fruition.

2.4 Conclusions

Korean broadband penetration leads the world, its speeds are among the fastest, and its subscription charges are among the lowest in the world. This success is a result of many factors including, a fiercely competitive market structure, key government involvement, and geography. More than 75 per cent of Korean households have a broadband connection and some think the market is near saturation level. This makes Korea a fertile proving ground for broadband services, since no other economy is close to its penetration level. While Korean broadband experience clearly has elements unique to Korea, other economies can borrow competition policies and lessons on successful government involvement from Korean broadband.

Widespread, low-cost, high-performance broadband coverage is essential to the realization of ubiquitous network societies because it provides a platform to support the development of other services. But broadband alone would not be sufficient, because the concept of ubiquity is based on the ability to shift from one location (and from one network) to another, seamlessly. For that, it is necessary to have broadband-quality performance on the mobile networks too; the topic of the next chapter.

3 Mobile communications

Misplacing a mobile phone is traumatic for Koreans. That's because when a Korean loses their handset, they have lost much more than their phone; they have potentially lost their web browser, game console, electronic wallet, house keys, video camera, still camera, MP3 player, and organizer all in one. To Koreans, their mobile handsets often represent their digital connection to friends, family and the world.

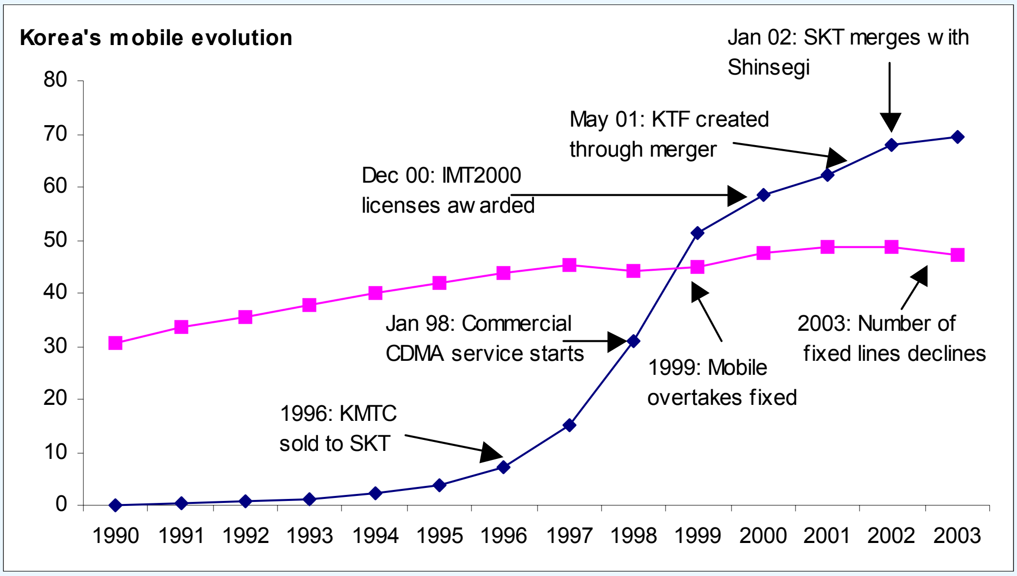
The Koreans mobile market is fascinating because Korea is a world mobile leader on many fronts. First, Korean mobile operators were among the first operators in the world to offer third-generation mobile (3G, or more correctly IMT-2000) services. Korea has also been the world-leading mobile market offering CDMA services. In addition, Korean handset manufacturers Samsung and LG have the world's third and fifth largest market shares respectively, and are constantly receiving accolades for their phone design and innovative features.

It makes sense, therefore, to look deeper into the Korean mobile market as a way to understand the Korean ubiquitous network society. What types of user services, network architectures, mobile policies and business plans have made this success possible? This section will examine the path Korea has followed to achieve this success. The section will first look at the history of the Korean mobile market, with special detail on Korea's fast mobile growth. Next, the section will look at the three leading mobile operators and their networks. This will be followed by a section detailing some of the services that have been introduced and embraced by Korean users, including a section on the cutting-edge terminals, produced in Korea, that make these services possible. Finally, the last section of the section will explain some of the key mobile policy decisions that have served as a foundation for Korea's mobile market.

3.1 Overview of mobile

The mobile market in Korea is one of the most advanced in the world and boasts nearly 100 per cent coverage across the peninsula. Korea's mobile penetration rate in 2003 was 69.4, compared with a fixed penetration rate of 47.2 subscribers per 100 inhabitants. Selected highlights of Korea's mobile growth are given in Figure 3.1.

Figure 3.1: Korea's rapid mobile growth, 1990-2003



Source: ITU World Telecommunication Indicators Database and ITU research.

The evolution of mobile telephony in Korea has gone through several distinct phases.

- **1984-1994**. Analogue cellular services started in Korean in 1984 by Korea Mobile Telecommunications Service (KMTS), a subsidiary of Korea Telecom. During the 11-year period between 1984-1994, KMTS enjoyed a monopoly in the provision of cellular services. The period saw relatively slow mobile penetration growth and by 1995, cellular penetration had only reached two subscribers per 100 inhabitants, one of the lowest levels among the advanced Asia-Pacific economies. In 1994, KMTS was sold to the SK group and is now does business under the name of SK Telecom (SKT).
- **1995-2000**. The six-year period between 1995 and 2002 marks Korea's strong CDMA years. Digital CDMA voice services (IS-95A) were launched in January 1996. From this period on, penetration grew rapidly to cross the symbolic 50 lines per 100 inhabitants. Few countries have transformed

their mobile communication sectors so rapidly. During this period, four new operators entered the market, each using CDMA technology: Sinsegi Telecom operated at (800 MHz) while Korea Telecom Freetel (Now KTF), LG Telecom, and Hansol (later M.Com) became Personal Communication Services (PCS) operators at 1.8 GHz. October 2000 marked the transition from CDMA(IS-95A) to CDMA2000 1x and the launch of CDMA2000 1x in October 2000 (although commercial services only arrived a few months later).

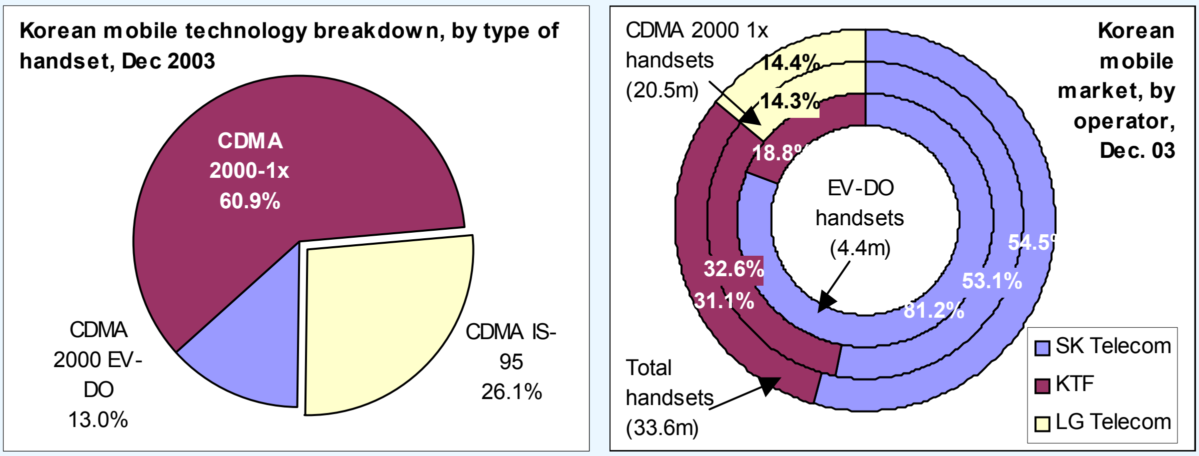
- **2001 to date**. The period coving the last few years corresponds with somewhat slower growth in the number of mobile voice subscribers, as the market approaches saturation (only 2.1 per cent between 2002 and 2003). Instead the focus has shifted to the development of mobile data applications. CDMA2000 1X mobile data services were launched in October 2000, CMDA2000 1x EV-DO in May 2002 and services in the IMT-2000 2.1 GHz band were licensed in December 2000 for launch in 2004. More recently, WiBro services have been licensed with a view to introducing more competition in the market. Two of the three available WiBro licences were won by fixed-line operators (KT and Hanaro) while the third went to an established mobile operator (SKT). Thus, even though no "new" operators entered the market, the licensing process should help to accelerate both competition and convergence between fixed and mobile networks. Push-to-talk services have also been launched in early 2005. This period also has seen a consolidation in the number of operators, with SK Telecom acquiring Shinsegi and KT Freetel acquiring Hansol to become KTF.

3.1.1 Mobile overtakes fixed

Mobile subscribers in Korea first outnumbered fixed line subscribers as long ago as 1999 (see Figure 3.1). Korea was one of the first 15 economies worldwide to make the transition. In 2003, Korea commenced on another significant transition as fixed lines fell in number by 380'000. The number of fixed lines had fallen slightly also in 1997, but that was due to the effects of the Asian Financial Crisis and was quickly reversed. This time the fall in fixed lines is not due to economic factors but rather because mobile phones are increasingly being seen as substitutable for fixed lines, and an increasing number of households are choosing to have only a mobile connection (or perhaps a mobile phone and broadband over cable modems). However, it is too early to tell whether this downturn marks a decisive trend, or just a blip.

Figure 3.2: Breakdown of the Korean mobile market, December 2003

More than 70 per cent of Korean handsets use CDMA2000 1x and EV-DO technology with SK Telecom dominating the market



Source: International Cooperation Agency for Korea IT.

3.1.2 SKT

SK Telecom (SKT) is the largest mobile operator in Korea, with a market share of 54.3 per cent as of September 2003[8] and profits of USD 1.66 billion (1.94 trillion won) from USD 8.13 billion (9.52 trillion Won) in revenues at the end of 2003[9]. SKT was the first mobile operator in Korea, offering analogue services under its former name, KMTS. SKT was also the first to launch digital CDMA services in 1996. SKT is considered the dominant mobile operator and thus has its prices regulated by the Ministry of Information and Communication (MIC). In January 2002, it completed the takeover of Shinsegi Telecom, its leading competitor in the CDMA 800 MHz field. In order to satisfy MIC requirements for allowing the acquisition, SK Telecom had to reduce its combined market share to below 50 per cent. SKT was able to accomplish this by *demarketing* (getting rid of their least profitable subscribers and not advertising for new ones). However, it has subsequently grown beyond the 50 per cent mark again (see Figure 3.2).

SKT was the first in the world to offer mobile data services over its standard CDMA network (IS-95). In October 2000, it launched its CDMA2000 1x service under the brand name “Nate.” In January 2002, it commercialized its CDMA2000 1x EV-DO (1x evolution, data optimized) service with great success. As of December 2003, it had 16.4 million mobile Internet handsets with 13.2 million of those subscribing to *Nate*[10].

In addition to its CDMA2000 licence in the 800 MHz range, SKT has a W-CDMA licence in the 2 GHz band and is set to launch limited service in early 2004. It also won a WiBro licence in 2005.

3.1.3 KTF

KTF is the second largest mobile network operator in Korea and had a market share of 31.5 per cent as of September 2003. At the end of the fiscal year 2003, KTF reported a net profit of USD 348 million (407 billion won) on revenues of USD 4.33 billion (5.08 trillion won). KTF, like SK Telecom, has its roots in Korea Telecom, which owns a 40 per cent stake in the company. This came about through KT FreeTel, which merged with M.Com (now KTM.com) in May 2001. KTF has a CDMA licence to operate in the 1’800 MHz band. In addition KTF has a W-CDMA licence in the 2 GHz range and is expected to roll out limited service in early 2004 in parts of Seoul. KTF currently has all types of CDMA networks currently in use, A/B networks, 2000 1x, EV-DO and EV-DV.

3.1.4 LG Telecom

LG Telecom is the third mobile operator in the country and operates in the 1’800 MHz range with a PCS licence. It is the smallest of the three mobile carriers with a 14.2 per cent market share as of September 2003. LG Telecom, like SK telecom, is one component of a much larger conglomerate, or *chaebol.* SK Telecom is a member of the SK group of companies whileLG Telecom belongs to LG (formerly Lucky-Goldstar). LG Telecom is the smallest mobile operator and has struggled to win market share, despite a sister company in the *chaebol,* LG Electronics, being the worlds 5th leading manufacturer of mobile handsets (see Table 4.1).

While SKT and KTF both successfully bid for W-CDMA licences, LG Telecom instead was awarded another CDMA2000 licence in the 1 GHz range, which may ultimately prove more interesting.

LG Telecom makes use of its sister companies to distribute and sell its services. These include gas stations and supermarkets, much like similar marketing strategies used by SKT.

3.2 Network

Korea’s mobile network is based on CDMA technologies jointly developed by ETRI and Qualcomm. All three Korean operators use CDMA, although at different frequencies. Network coverage is excellent and universal for all three carriers throughout the country. The only differences in coverage are the type of CDMA technology available. SKT’s coverage is the most advanced, with almost all areas served with CDMA2000 1x EV-DO.

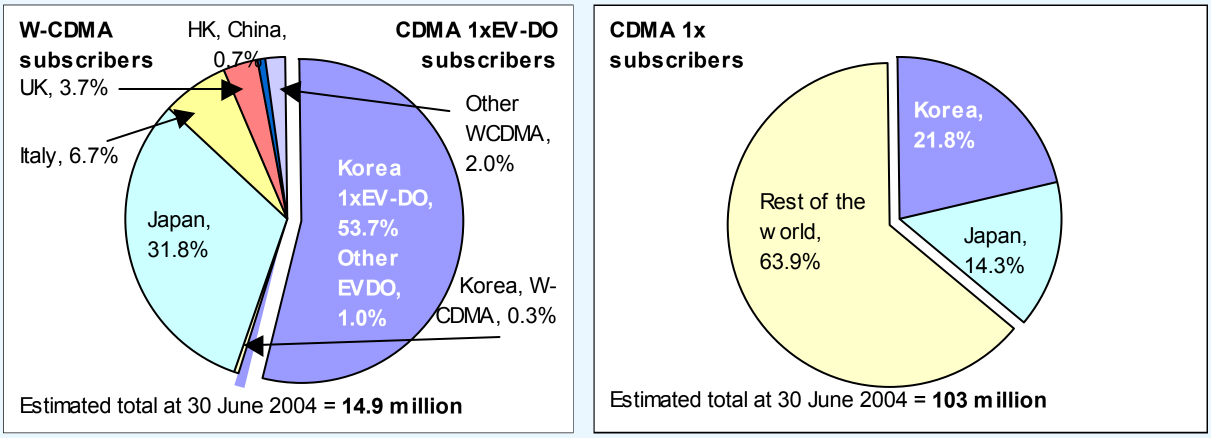
Korea’s embracing of CDMA technologies has meant network upgrades have been relatively simple when compared to countries with only GSM networks. Older CDMA (IS-95) networks (cdmaOne) were first upgraded to CDMA2000 1x, and more recently are being upgraded again to CDMA2000 1x EV-DO and EV-DV (see Table 3.1). This has made the transition from second to third generation services much faster for Korea than other countries since no new extensive network infrastructure needed to be built. Korea and Japan currently dominate the 3G market worldwide (see Figure 3.3).

Table 3.1: CDMA development in Korea

	Speed	*Adopted in Korea*
CDMA (IS-95)	*13.5 kbit/s*	*Jan 1996*
CDMA2000 1x	*153 kbit/s – 307 kbit/s*	*Oct 2000*
CDMA2000 1x EV-DO (evolution data only)	*700 kbit/s – 2 Mbit/s*	*Jan 2002*
CDMA2000 1x EV-DV (evolution data and voice)	*3.1 Mbit/s*	*2004*

Figure 3.3: Korea and Japan dominate the 3G market worldwide

Breakdown, by country, of 3G subscribers worldwide at 30 June 2004, broken down by technology



Source: "ITU Internet Reports 2004: The Portable Internet", drawing upon ITU World Telecommunication Indicators Database, www.3Gnewsroom.co.uk, www.3Gtoday.com

Korea's original CDMA licences were awarded via a beauty contest with SKT receiving a licence in the 800 MHz range and LGT and KFT receiving allocations in the 1'800 MHz frequency. Korea held auctions for two W-CDMA licences in 2000 with all three mobile providers bidding for the two available licences. At the same time, the Ministry accepted bids for additional CDMA2000 licences, with only Hanaro Telecom bidding.

The Ministry accepted the bids of SKT and KTF for W-CDMA licences. Each was required to pay nearly USD 1 billion for their licence. In order to sweeten the prospect of CDMA2000 licences, the Government allowed providers to choose preferred spectrum and offered favourable loan rates for build outs in rural areas[11]. While LG Telecom was unsuccessful in its bid for a W-CDMA licence, it later purchased a second CDMA2000 licence for roughly USD 100 million (1.3 trillion Won), a mere tenth of the amount spent on W-CDMA.

The auctioning of W-CDMA, CDMA2000 and WiBro licences highlights a key dilemma faced by Korean policy-makers. Each technology is seen as vital to a different segment of the Korean market. The Korean Government is interested in developing a domestic network using the same standard as a large part of the rest of the world. This makes it much easier for domestic manufacturers to sell domestically produced phones abroad, increasing the worldwide mobile market share of Samsung and LG. For that reason, Korean companies such as Samsung are also heavily invested in building W-CDMA cell towers, which will be sold around the world.

However, Korea is the world leader in CDMA technology and CDMA2000 1x has achieved much of its success in the 3G market due to the fact that it is a relatively simple upgrade from CDMA IS-95 (whereas W-CDMA requires GSM operators to build new network). In addition, the Korean Government receives royalties from all CDMA2000 handsets sold in Korea because of pioneering work done by the Government research institute, ETRI (see Box 3.1).

Box 3.1: ETRI and the development of CDMA technologies

Koreans were offered their first analogue mobile phone service in 1984, Advanced Mobile Phone Service (AMPS). The network was built using infrastructure and mobile terminals from large US telecommunication firMs In 1988, Korea successfully hosted the Olympic Games and the momentum from the event helped shift the Government's view of telecommunications from a technology they needed to control to one they could exploit economically.

Korean network operators were looking to upgrade their networks to digital technologies and most of the world was looking towards a promising technology from Europe, GSM. The research branch of the Ministry of Information and Communication, Korea's Electronics and Telecommunications Research Institute (ETRI), was given the task of coming up with a new mobile technology that could be implemented in Korea and help spur economic growth.

After careful research, ETRI decided that CDMA technology made more efficient use of the radio spectrum and represented the best possibility for Korea mobile telephony. CDMA technology wasn't new as it was originally developed in the 1940s as a military technology to mask conversations. The technology was important to the military because instead of sending all data over one frequency that could easily be eavesdropped, CDMA breaks up the data into small pieces that are spread over the frequency band in a pre-defined (but pseudo-random) manner. Receiving devices must know the "frequency hopping pattern" in order to correctly decipher the data.

Qualcomm, a small corporation in the US at the time, owned seven key CDMA patents and ETRI quickly stuck a deal and went to work with Qualcomm developing and perfecting the technology. ETRI and Qualcomm decided on a profit sharing deal where 80 per cent of licensing profits from CDMA phone sales in Korea would go to Qualcomm. The other 20 per cent would belong to ETRI.

The partnership was probably more successful than either of the parties would have initially imagined. Korea was able to launch the world's first commercial CDMA service in January 1996 in increase its penetration rate from 3 users per 100 in 1995 to 68 per 100 in 2002. The success has also helped Korea become one of the world's few 3G countries. Qualcomm has also benefited by rocketing to becoming a global telecommunications powerhouse.

ETRI is expected to collect royalties worth an estimated USD 200 million by the year 2008 for its share of the technology. Royalty payments received so far have strategically re-invested in developing other key technologies.

Source: www.://times.hankooki.com/lpage/tech/200304/kt2003043017080611790.htm and interviews.

The third technology licensed in 2005, WiBro, is important because it provides a logical migration path for those fixed line operators that are seeing their core business decline and need to be able to exploit the potential convergence between fixed and mobile networks that the ubiquitous network society offers. Korea's home-grown WiBro technology also offers an alternative to the more international WiMAX standard, in a manner which is similar to the way in which CDMA offers a local alternative to GSM. However, the export potential of WiBro is, as yet, unproven.

These three, often contradictory, policy objectives pose problems to Korean mobile promoters. Rather than choosing one technology, the Government has instead decided to attempt to have three co-existing networks running three types of technologies. The risk of this policy is that, in the effort to standardize with the rest of the world, Korea operators may confuse their own consumers.

3.2.1 IMT-2000

Currently, there are two main IMT-2000 technologies in Korea, CDMA2000 and W-CDMA. Both offer relatively high-speed data transfer for small amounts of data at reasonable cost. Currently CDMA2000-1x EV-DV offers maximum speeds of 5.2 Mbit/s while proposed W-CDMA HSDPA networks could theoretically deliver between 8-14 Mbit/s.

In many other economies, third-generation mobile services (IMT-2000) have been slower to materialize due to a collapse in telecommunication investment and exorbitant auction fees paid by operators. Korea's initial choice of CMDA2000 made network upgrades much easier but the future of IMT-2000 in Korea is still not clear.

When industry players and governments met to formulate the IMT-2000 standard it was seen as visionary and represented the future of mobile telecommunications. What was not apparent at the time was how fast the industry would advance before these networks would materialize. Only now has the world started rolling out 3G, and usually only in limited areas. However, the CDMA technologies preferred by the Koreans have continued to grow in speed to the point they are as fast, or faster than other 3G networks such as W-CDMA being built around the world at great expense. This represents a large dilemma for Korean operators SKT and KTF that have purchased the licences.

Each of the operators bid USD 1 billion for W-CDMA licences, but have since perhaps been hesitating to build out extensive networks given the huge expense in building a new network from scratch. Instead, operators may be more interested in upgrading their CDMA2000 networks. Many analysts and industry observers are expecting only limited rollouts in densely-populated areas as a way for operators to fulfill their timetable obligations.

IMT-2000 was originally seen as a sort of "broadband for mobiles". However, Koreans are increasingly looking to a new frequency band for wireless Internet access, 2.3 GHz, the Portable Internet. This concept is explained in more detail in section four.

The key question is whether users will be willing to pay as much for data as they pay for voice. If not, the limited speeds and bandwidth of W-CDMA make it best suited for voice and medium-speed data applications. The dilemma is that voice and medium-speed data is already handled very well by existing CDMA2000 networks.

Korean handset manufacturers are covering their bets by building dual-band and dual-mode handsets that operate on both CDMA and W-CDMA networks.

3.2.2 Beyond IMT-2000

While much of the attention in the mobile world has been focused on ensuring smooth and profitable 3G rollouts, Korean operators and policy-makers have already begun preparing for life "beyond IMT-2000"[12]. These new networks have been defined to include New Mobile Access, IMT-2000, IMT-2000 enhancement[13] and high speed wireless LAN[14], which can provide seamless access, are always on, and work in an IPv6 environment.

Korean research is being led by ETRI, which has started developing wireless LANs capable of delivering 500 Mbit/s in the 5GHz frequency band as well as other core WLAN technologies at 60 GHz offering very high-speed 1 Gbit/s services. There is also strong interest in continuing work with IEEE 802.11n technologies in an effort to enhance international cooperation and standardization activities[15].

One promising new technology which has recently been licensed in Korea is the portable Internet or "WiBro". This is further discussed in Box 3.2 and chapters four and five. Developers are promising eventual speeds of the wireless Internet based, all IP infrastructure to reach 30-50 Mbit/s to slow-moving users.

Box 3.2: Licensing WiBro

Korea's homegrown version of the portable Internet is called "WiBro". The term is short for "wireless broadband" or alternatively "wide broad Internet", but it also carries connotations of being "Wi-Fi's little brother". WiBro occupies a similar space to that of WiMAX (IEEE802.16e), but with a crucial difference, namely that it permits handover between cells, making it usable in moving vehicles. Speeds on offer are around 1 Mbit/s, with service available over a radius of 50 km from a base station (making it relatively economic to establish a network) and available to vehicles moving at up to 60 km per hour. As such, WiBro could be positioned as a cheap, data-intesive version of 3G cellular, and/or as a lower bandwidth but higher-mobility version of Wi-Fi[16].

Korea's decision to push ahead with licensing WiBro has not been without criticism. Some have accused MIC Korea of pushing the technology to market before the standard (WiMAX) is ready and thereby, implicitly, locking out foreign investors. Nevertheless, as with Korea's courageous decision on CDMA in the early 1990s, establishing Korea as a test bed for WiBro will allow Korean operators and vendors to steal a march on the emerging portable Internet industry. Possibly as a sop to this criticism, the Ministry has undertaken to introduce a Mobile Virtual Network Operator (MVNO) once WiBro reaches five million subscribers[17].

The spectrum allocated for WiBro is 100 MHz between 2.3 and 2.4 GHz. Three licences were awarded with each of the three bidders paying between 117 billion and 125.8 billion Won (USD 117-126m)[18]. The winning bidders were SK Telecom, the dominant mobile operator, plus the two fixed-line operators, KT and Hanaro Telecom, though Hanaro later withdrew, when the first payment became due. WiBro can be seen as a precursor to increasing fixed-mobile convergence, and as a possible way for fixed-line operators to win back some of the market they have lost to the mobile operators (e.g., among those households that now have a mobile phone but no fixed-line telephone).

Source: ITU, MIC Korea.

3.3 Mobile policy

Researchers cannot study the success of IT in Korea without first examining the role of targeted government policy and technology promotion. While many factors contributed to Korea's current mobile success, government policy decisions early in the 1990s have played a major role in shaping the industry.

Korea's ascension as a leading telecommunication economy arguably didn't start until 1991 when the country started one of its most successful IT research to date, the commercialization of CDMA. The technology, originally developed by Qualcomm, was put into commercial use for the first time in the world by a Korean consortium consisting of ETRI, Samsung, LG, Hyundai, SKT and Maxon. Korea's early success with CDMA mobile communication has been a key factor in helping spur the country's 16 billion strong sales of mobile handsets in 2003. CDMA was thus a turning point for Korea in its progress to its leading mobile communication and ICT position (see Box 3.3).

Korean government policy has also played another key role in the success of Korea's mobile market through fostering extensive competition. Initially, the government allocated three PCS[19] licences and two cellular licences (SK Telecom and Shinsegi) in the mobile market that had previously been dominated by KMT. The high level of competition among the five (now consolidated to three) operators has kept prices comparatively low and voice quality high. It has also forced Korea's mobile operators to compete on innovative value-added services. Korea's handset manufacturers have also helped maintain market competition by quickly integrating new service offerings into hardware designs of new phones.

Forward-looking government policies have been extremely successful at targeting key industries and technologies for development. At the same time, government policies have also focused on training the population on how to use these new, cutting edge technologies.

Box 3.3: Difficult decisions surrounding early CDMA adoption

The Korean Government's decision to focus on CDMA technologies has been one of its most visionary but also most controversial decisions in the Korean ICT sector. Although Korea has been more successful in selling CDMA as an "international" standard that, say, the Japanese PDC and PHS standards or the US-led TDMA standards, it is still not achieved the worldwide acceptance of GSM. Nevertheless, as the world starts the transition from second to third generation mobile standards, Korea is now well-placed and the decision to go with CDMA seems quite visionary, Nevertheless, policy-makers were faced with difficult choices and risks in the early 1990s in regards to unproven CDMA technology.

At the time, Korea was a heavy user of TDMA technology and a switch to CDMA represented a huge risk for an immature mobile market. The volatile debates over the use of TDMA or CDMA technologies came to an end in late 1993 when the US Telecommunication Industry Association (TIA) recognized CDMA as an IS-95 standard, paving the way for its use in Korea.

While CDMA technology had been used in military projects, the new technology had never been adapted for commercial use and was widely considered unproven. Korea benefited from this uncertainty because it forced Qualcomm to be less restrictive on the use of its intellectual property and opened up favourable licensing options for Korea.

The Korean Government promoted the research and development necessary to commercialize the technology in two parts. ETRI and Qualcomm took charge of switch design, prototype development and base transceiver station (BTS) design while the designated handset manufacturers developed new mobile handsets and switching systeMs During the development, the ministry laid out a specific time schedule to shorten the CDMA development cycle. All together, the initiatives were well-organized and extremely successful, allowing SK Telecom and Shinsegi to roll out the first CDMA commercial service in the world in 1996.

Currently, CDMA2000 technologies represent a major mobile presence in the world with networks available throughout Asia and the Americas. As large Asian countries such as China, India, and Japan have developed networks, CDMA users worldwide have grown from 0.3 per cent of all mobile users in 1996 to 14 per cent in 2004, representing more than 240 million subscribers around the world.

Source: MIC, CDMA Development Group.

3.3.1 Policy decisions

As mentioned above, one of the greatest dilemmas in Korean mobile policy rests, to a large extent, with the mobile operators and how they will make use of their W-CDMA licences. The Government put coverage obligations in place as conditions of the auctions and providers will have to adhere to them. What is unclear is how much further the providers are willing to go with their networks. Essentially, if new technologies such as the portable Internet (WiBro) are used mainly for data, then carriers will use CDMA2000 1x and W-CDMA networks to carry the bulk of their voice traffic.

3.3.2 Subsidized handsets

Korea's original quick take-up of mobile handsets can partially be attributed to a government policy on handset subsidies. When CDMA IS95A networks were introduced in 1995, the handsets were very expensive and many Koreans would not have been able to afford buying them outright. This was especially important because the combination of high-priced handsets and new technology created a high risk for consumers buying new terminals.

As a result, the Korean Government instituted a policy where mobile providers were allowed to lock subscribers into two-year, exclusive contracts in exchange for giving the handsets away for free to subscribers. In addition, the Government kept the maximum price providers were allowed to charge per-minute high enough that mobile carriers could earn sufficient revenues to pay the manufacturers for the handsets. The price-per-minute was initially around USD 0.17 (200 Won) per minute, with current prices much lower at USD 0.07 (80 Won) a minute. By giving out free handsets, Korean mobile operators were also able to buy phones in bulk, thus reducing their per-unit costs. This combination proved an immediate success in Korea and was part of a much larger plan to export CDMA technologies to the region and around the world.

While the handset subsidization scheme worked wonders for Korea's mobile penetration rate, the Fair Competition Board eventually ruled that the subsidies would have to end. As a result, Korean mobile carriers are no longer allowed to subsidize handsets in order to attract users, though has proved hard to prove whether or not cross-subsidies are continuing. Removal of subsidies does not appear to have caused a major problem, even though the mobile market is approaching "saturation" as users seem willing to pay large sums to upgrade their phones with the newest features. This is strikingly evident in the high turnover rate at which Korean mobile users upgrade their handsets.

While the subsidization of CDMA phones is over, some are calling for the re-introduction of the program, this time to help spur W-CDMA adoption. The question Korean policy-makers are facing though is how strongly they should push the W-CDMA technology. By giving handset subsidies on W-CDMA phones and outlawing them on CDMA2000 handsets, the Government would essentially be promoting one technology at the expense of another. No decisions have been made yet but policy-makers are being very cautious not to cook the golden goose.

3.3.3 The mobile triangle

Certain, individual policy initiatives may have effects on the market but none more so than the underlying relationship between the three main branches of the mobile market: the Government, mobile operators, and electronics manufacturers. East-Asian economies, such as the Republic of Korea and Japan, have often experienced incredible growth rates because of a behind-the-scenes linkage between certain sectors of the economy and the Government. These strong ties have also been criticised as helping spur financial crises, such as Korea went through in 1997.

The mobile triangle is made up of three key players: the Government, the mobile operators, and equipment manufacturers. Together the three parts work collectively to promote the mobile industry, through settling on standards, policies, and business models that can help lead to the best possible outcome for all participants.

This behind-the-scenes relationship has been vital in helping establish common standards and services in the industry. As an example, mobile operators must be in close contact with equipment manufacturers to develop new services that users want. At the same time, the Government plays a role by establishing price controls or paving the way with necessary regulatory changes. The triangle is dynamic with all three elements in constant touch with one another.

These relationships have helped Korea move to the front of developed mobile nations. However, these strong ties between the government, operators, and manufacturers also can create conflicts of interest as is seen with the current debate over what the future rollout of W-CDMA will look like.

3.3.4 WIPI

Another key example of Korea's mobile market triangle is tied to the discussion around WIPI (Wireless Internet Platform for Interoperability), a new virtual platform project that would form the base operating system for new mobile applications. Currently, three players make up the Korean market for virtual platforMs These are Korean-based Sinji soft with it's GVM platform, Qualcomm with BREW, and Sun Microsystems with JAVA. Currently, each mobile provider in Korea uses a different platform but providers such as SKT are preparing to open their networks to multiple platforMs

3.3.5 Number portability

MIC has introduced a type of asymmetric regulation in the mobile market, with the dominant operator SKT subject to different regulations than other operators. One area where this has been apparent is number portability, which was introduced at the beginning of 2004. In the first phase, users were only able to take their numbers with them when they moved *away* from SKT to other providers. It will not work in the other direction. This is an effort to protect against a mass exodus from the other providers to SKT's more comprehensive network. The project provoked a high level of interest, with 122'800 subscribers moving from SKT to KTF and another 75'600 migrating from SKT to LG Telecom, all within the first month of availability.

The term "number portability" is a bit of a misnomer for the system in place in Korea. For mobile users, the policy means they can keep their old numbers but subscribe to rate plans from other providers. In reality, users never actually leave their original network. An SKT subscriber who wishes to switch to KTF will still communicate via SKT's mobile towers. However, the user will be charged the KTF rates. The user stays on the SKT network but KTF is put in control of the account. Then, the two providers, in this case SKT and KFT, work out payment for use of the network based on interconnection rates.

3.4 Conclusion

The Korean mobile market is extremely dynamic with operators, handset manufacturers and the Government working to ensure that Korea remains a world mobile leader. Koreans enjoy services on their fast, 3G networks that are unavailable in many countries. Korea's advanced mobile networks and world-class handset manufacturers have also been a key factor in Korea's burgeoning mobile gaming and mobile server industries.

While the Korean mobile network is one of the leading networks in the world, it will not remain in its current form for long. Korea's mobile and broadband networks are quickly moving together towards a broadband converged network, one where fast, mobile data is available anywhere at anytime.

4 THE MOBILE MARKETPLACE

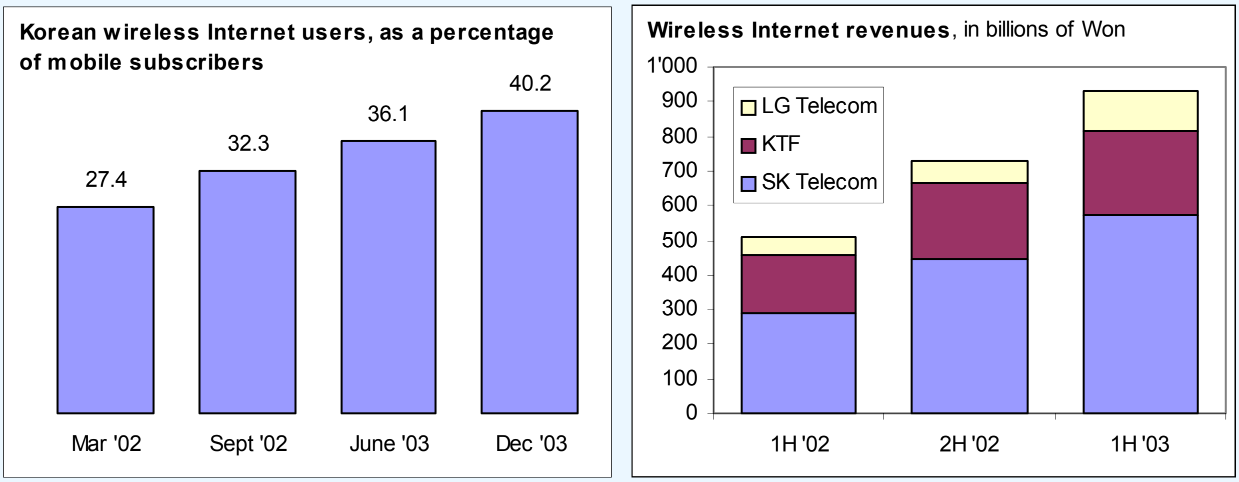
4.1 Services and applications

While the mobile networks play a key role in Korea's high mobile penetration rates, it is the services on the network that attract Korean users. Some of the most popular and newest service offerings are discussed below and include wireless Internet, multimedia, m-commerce and mobile gaming.

4.1.1 Wireless Internet

Given Korea's broadband penetration rate, it would be easy to assume that Koreans wouldn't have a pressing need for Internet access on their mobile phones. However, Korean's thirst for information makes them high mobile Internet users, despite having broadband access at home and most likely at work. More than 93 per cent of Korean mobile users have access to wireless Internet services, and they generated almost USD1 billion in the first half of 2003 from doing so (Figure 4.1).

Figure 4.1: The wireless Internet is alive and well in Korea
Korean wireless Internet users as a percentage of all mobile subscribers and wireless Internet revenues.



Note: The methodology for measuring Korean wireless Internet users is based on usage within the last six months. Some 93.5 per cent of mobile handsets are equipped for data usage. In the right chart, one billion Won is approximately equivalent to USD 1 million at March 2005 exchange rates.

Source: KRNIC and Internet Statistics Information Systems (left chart). MIC (right chart).

The wireless Internet is most popular among an interesting demographic group, junior high school students. Students in general use the wireless Internet more than the general public. Indeed, junior high school students have grown up learning on the Internet and face a nearly non-existent learning curve looking up information on a mobile device. This has promising implications for the Korean information society. A whole generation of Internet users will be accustomed to pulling Internet information via their mobile phones.

Koreans use the mobile Internet mostly to search for quick, but important pieces of information. Examples include looking up information on a movie theatre (address and movies playing) or finding a listing of restaurants in a particular area by the type of food that they serve.

4.1.2 M-Commerce

Koreans can use their mobile phones to pay for everything from coffee at a coffee shops, snacks at convenience stores, and large purchases at department stores, either in person or online. The Korean version of m-commerce refers to financial transactions taking place on- and off-line, via mobile terminals. Mobile phones on Korean CDMA networks don't use a SIM card, as on GSM networks, that could be used to store credit card information. Therefore, mobile phone manufacturers, at the request of mobile operators, have built in smart-chip slots on phones that can be used for specialized services. Information from these chips is transmitted in two ways, either via the IR port on the top of the phone or by using radio frequencies. In order to facilitate mobile commerce, credit card companies and mobile network carriers formed an alliance and began issuing credit cards into the subscribers' handsets. One of the tangible benefits is that the service can be used as soon as the credit card company issues the wireless credit card to the phone, immediately after the credit check.

All three mobile operators in Korea have m-commerce services. SKT's "Moneta" service has over 1 million subscribers, KTF's "K-merce" service has over 500'000, and LG Telecom's "Zoop" is also quickly expanding its services. There are more than 470'000 locations nationwide that will accept m-payments[20] (see Box 4.1 for information on SKT's m-commerce solution, Moneta).

Box 4.1: Paying for everything via mobile phone

How mobile phone may make credit cards a thing of the past in Korea

When Koreans stop in for snacks at the neighbourhood convenience store, they don't need to bring any money with them. All they need is their m-commerce enabled mobile phone. SK Telecom's Moneta service has more than 470'000 terminals around the country that will accept payments via RFID chips embedded in mobile phones. Users simply wave their phone in front of the Moneta receiver placed next to the cash register (see image). The purchase is then assigned to the mobile user.

Users can also use their mobile phones to pay for public transit. They simply scan their mobile phone over the receiver and the money is debited

One reason that Moneta has been so successful is because Moneta terminals were first installed in another branch of SK's businesses, petrol stations.

4.1.3 Mobile banking

In addition to point of sale transactions over mobile phones, operators have introduced mobile banking services to subscribers. SKT's Network Money (NeMo) service takes advantage of multifunctional smart chips to store online banking information securely and allow users to make payments to others over their mobile phones. The end of the month in Korea is usually a very busy time at banks when users queue up to make payments. However, with mobile online banking, users can transfer money through mobile settlement banks in a near, real-time transaction.

Mobile phones have become one of the favourite methods for making payments, as is shown by the doubling of mobile banking transactions between 2002 and 2003. In December 2003, Korean mobile users checked their balances, or made a banking transaction, 2.56 million times. That is more than double the amount in December 2002 of 1.1 million[21].

4.1.4 Video services

Video services over mobile phones have been a huge success in Korea. Perhaps *too* successful in fact. Initial video-on-demand offerings by SKT were so popular that the mobile network ground to a near halt in 2003 with the huge amounts of traffic when the service was initially offered without volume limitations

SKT experiences with video services over mobile networks have provided a lesson for all operators in Korea. Video may still end up being a huge mobile driver but it will be in a different form. Rather than users accessing video on demand, mobile phone manufacturers have built terminals with miniature television tuners in them. This allows mobile subscribers to watch terrestrial broadcasts on their phones, regardless of how close they are to a traditional TV. Since the tuners pick up over-the-air signals there are no bandwidth or other charges to users (see Box 4.2).

While video-on-demand has long been seen as a "killer application" for mobiles and broadband, it may not become a reality until there is a substantial leap in bandwidth and streaming capacity, and/or compression technology. While mobile networks may struggle with limited bandwidth, mobile phone manufacturers are already looking towards a different model of video provision. They are embracing the digital media broadcasting (DMB) as a way of delivering video to mobile devices. With DMB, a mobile phone or PDA essentially becomes a receiver for satellite subscription television. Just like home satellite dish users, mobile phone and PDA users will be able to subscribe to services and watch broadcast programs on the move. Service providers are planning on offering a flat-rate service due to the simple economies of "broadcast" television. DMB will be one of the key movements towards convergence of mobile and broadcasting towards "ubiquitous" networks, which can be accessed "*anytime, anywhere, by anyone, from any device*".

Box 4.2: TV on a mobile phone

There is no more need to miss out on a favourite programme when stuck on public transportation

Koreans are big fans of television programmes and many people follow their favourite singing stars on the evening variety shows on a regular basis. It makes sense then that Korean's would be interested in watching their favourite shows while away from a standard television set. The major broadcasters already show their programming over the Internet but a new generations of phones is bringing over-the-air television reception to the handset.

For instance, Samsung's SCH-X80 has a built-in TV tuner that receives TV broadcasts directly from terrestrial towers free of charge. While the world waits for a video-on-demand model to be worked out for mobile data, Koreans can already be watch their favourite programmes via mobile phone

Source: www.etechkorea.info/articles/20030616001.php

4.1.5 Mobile gaming

Most of the mobile world passes time tapping SMS messages but Koreans are playing games, lots of them. At any time of the day on the subway in Seoul, Koreans of all ages quietly tap away at their phones. Mobile gaming is becoming a major source of revenue for Korean mobile operators. In September 2002, operator revenues from mobile gaming surpassed that from ringtones and screensavers.

Users download games from their mobile operator's game portal into the memory of their mobile phone. Games are typically 120 K and common phones can store at least 10 games at a time. The games are essentially mini-applications that run on a "game platform" on the mobile phone operating system. The most popular mobile game in Korea is a "business game" called *Boong-o Bbang Tycoon*. *Boong-o Bbang* are fish-shaped pastries that are available all over Korea from street vendors. In the mobile game, users run a *Boong-o Bbang* business, deciding how many "fish" to make and when to produce them. Since the fish must always stay hot, the user must make well-timed decisions in order to make money in the game. *Boong-o Bbang Tycoon* and other mobile games cost an average of 2000 Won (USD 2). In addition to the cost of the download, users must pay "packet fees" to the mobile provider for Internet usage of around 600 Won (60 US cents).

Each mobile operator in Korea uses a different game platform so game manufacturers create the game once (usually in C or C++) and then "port it" to each of the different game platforMs SKT runs a Korean game platform "GVM" from SinjiSoft. KTF uses "Brew" from Qualcomm, while LG uses "Java" from Sun MicrosysteMs The Korean Government has been interested in harmonizing the platforms across providers by requiring them to use a government-sponsored version called WIPI (Wireless Internet Platform for Interoperability).

Online games have turned out to be a success for the entire mobile value chain, with all segments of the market taking a share. An example is SKT's arrangement with content providers and its game platform provider. When a user purchases an online game, 85 per cent of the revenue goes to the content creator or provider (e.g. Com2Us). Next, 5 per cent of the revenue goes to license the game platform (e.g. SinjiSoft). Finally, SKT takes a 10 per cent share to cover costs of hosting, and promoting the games on its portal. In addition, SKT bills users separately for data charges incurred through downloading the game.

One of the reasons Korean gaming has become so popular is the game providers are Korean and can cater to local tastes and culture. One of the most popular games for female subscribers is "Go-Stop", traditionally a very popular Korean card game among older Korean men that has found a new niche.

Interestingly, mobile game usage is equal among men and women. What is different is the *type* of games they download. Women prefer more "casual" games while men prefer more "action" games. Whatever the genre, more games are appearing for Koreans every day since a typical game takes only three months to develop.

The majority of mobile games on the market are individual games. However, mobile operators have requested more role-playing games (RPG) from game developers as a way to boost revenues. Individual games are only downloaded once generating only a one-time payment to the operator. However, RPGs typically require a connection to the network to interact with other players, providing a lucrative stream of revenues to mobile operators. That creates dilemma for mobile RPGs. Game developers are hesitant to develop more RPGs because they don't sell well – due to the high data costs of playing them. They realize the games would be much more popular if flat-rate connections were available. Operators, on the other hand, don't want to move to a flat-rate data plan for gaming as it would cannibalise the revenues of extreme gamers who are currently willing to pay high costs to play.

4.1.6 Music

Music is deeply engrained in Korean culture. Koreans love to sing and music touches Korean's daily lives. It is therefore fitting that new technologies embrace music as a way to promote their services. Korean phone manufacturers were among the first to introduce polyphonic ring tones to give a more pure musical sound to mobile phones. Korean phones can reproduce 64 phonics (or different notes) at one time and this is now setting the standard for the rest of the world as Korean-manufactured handsets become more popular (see Table 4.1).

Korean content providers are making good use of the improved technology in several ways. Noraebang (Karaoke) programs and associated music files are among the most popular downloads.

Korean operators have also built new music services into interesting business ideas. While ringtones change the way a mobile phone rings to the subscriber, new services allow Korean subscribers to change their "connection tone", how their phone rings to the *caller*. That means instead of hearing the traditional telephone "ring-ring", the caller can actually hear an audio clip such as music or simple narrations. The Korean company DANAL provides connection tones for all three mobile providers under the names Coloring for SKT, Feeling for LGT, and Ring4U for KTF.

In addition to changing how the phone rings for the caller, new mobile services can also play music softly in the background while users talk.

4.1.7 Other services

The mobile Internet, multimedia services and games are only a part of the total services available to Korean mobile subscribers. Several other interesting applications are becoming popular among users. These include:

- *Mobile call caching*. New services available from Korean mobile providers allow subscribers to receive an SMS of all missed calls while their mobile phone was turned off or out of reach of the network. Traditional call logs were compiled at the handset level, meaning that if the handset were powered off or off the network, the list of callers could not be provided. However, a Korean mobile server provider, FeelingK has built a system that transfers call information at the server level to mobile users when their phones reinitiate contact with the network.
- *E-lottery.* Another popular mobile service in Korea is the lottery. Instead of buying lottery tickets from the local store, Koreans are able to play the lottery online. This has been a huge boon for mobile operators with operators taking a percentage of all tickets purchased via mobile handsets. The ease of play has greatly increased user participation in the lottery, with several groups claiming it is fuelling gambling addiction.
- *E-books.* Korea's Confucian emphasis on education can help explain the importance of books in Korean society. It is therefore natural to see books as a popular download for mobile users. Koreans can download e-books onto their mobile phones for a typical price of USD 6 (7,000 Won), representing a discount of nearly 40 per cent off the cover price for the paper version. The book's text can be read straight from a mobile phone. Com2Us is one e-book provider and shares revenues

with Booktopia, the collective licensing scheme. Some 60 per cent of the revenues go to the authors through the collective scheme while the remaining 40 per cent stays with Com2Us.

4.2 Terminals

One of the key reasons new services have become so popular in Korea are the high-tech terminals produced by Korean manufacturers and quickly put into circulation by Korean mobile providers. Korea is well known for its flashy, cutting-edge terminals produced by the leading manufacturers Samsung and LG.

Korea's large domestic market has allowed Korean manufacturers to gain expertise and economies of scale sufficient to expand quickly into world markets. Korea's mobile handset operators have been able to leverage their technological know-how in CDMA to also become leaders in GSM technology, even though there are no GSM networks in Korea. Samsung and LG produce both CDMA and GSM handsets, with the GSM terminals built exclusively for exportation. Samsung is the world's number two manufacturer of GSM phones, just behind Nokia. Like LG, currently in fifth place worldwide, it has increased market share recently (see Table 4.1). Korea also has several other handset manufacturers including Telson, and Hyundai/Curitel, although they have yet to gain a significant market share.

There are several interesting trends in the Korean handset market. First, the distinction between mobile phone and personal digital assistant (PDA) is fading as the two devices converge. Second, handsets are becoming larger to include more features and bigger displays after a long spell of shrinking sizes. Third, users are upgrading their handsets ever more. Some estimates indicate that users upgrade their handsets every eight or nine months[22].

Table 4.1: Worldwide mobile handset sales to end-users, 3Q 2004
With the growing market share of Korean manufacturers highlighted

Company	3Q 2004 Sales (thousands)	3Q 04 Market Share (%)	3Q 03 Market Share (%)
Nokia	51’695	30.9%	34.2%
Samsung	**22’981**	**13.8%**	**11.2%**
Motorola	22’393	13.4^	14.7%
Siemens	12’758	7.6%	9.1%
LG	**11’142**	**6.7%**	**5.3%**
Sony Ericsson	10’683	6.4%	5.3%
Others	35’417	21.2%	20.2%
Total Market	167’070	100.0%	100.0%

Source: Gartner, www.://www4.gartner.com/press_releases/asset_115121_11.html

4.3 Conclusions

One thing that has become clear in the Korean market for mobile phones, is that users are demanding more from their phones – in terms of services and applications – and are willing to settle for larger sizes as an exchange for functionality. As the number of features increase, the number of devices Koreans must carry falls. As a result, many are predicting that devices with extensive functionality (like the Samsung MIT 400) will be the wave of the future.

It is also clear that the Korean marketplace has shown remarkable responsiveness to users’ appetite for services to be accessible on the move. This is what makes the quest for ubiquitous networks such as tempting prospect. The role of the Government policies in promoting a vibrant environment for operators, service providers and manufacturers is also an inextricable part of the mobile-friendly marketplace that today exists in the country.

5 TOWARDS UBIQUITOUS, CONVERGED NETWORKS

5.1 The Korean vision: The "Broadband Converged Network"

The boundary line that formerly distinguished Korea's highly developed broadband and mobile networks is fading. In one direction, broadband connections are becoming mobile with extensive Wi-Fi (e.g. KT's Nespot) and soon WiBro networks. At the same time, mobile phone technologies are starting to reach broadband-type speeds, as EV-DO comes more widely available and as W-CDMA services are launched. Convergence is nigh and the new Korean network will likely be one of the first of its kind in the entire world. Convergence will mean that Koreans have seamless access to fast, robust information wherever they happen to be in the country.

As a result of Korea's leading role as an Information Society, it is important to understand the nature and implications of this newly converging network. Other developed countries will likely be following the lead of Korea, implementing everything from Korean equipment (hardware components and handsets), to policy lessons pulled from the Korean experience. This section will examine the Korean vision of a ubiquitous converged network and how that vision is currently becoming a reality. It will also look at particular government programmes designed to promote this vision (see Figure 5.3).

5.1.1 What is a broadband converged network?

The Korean mobile and broadband networks, while both very advanced, have evolved separately and are quite different in their composition, network architecture, and business models. Therefore, it should be no surprise that there is no "exact" picture of what the future network will look like. The Korean model has had to be dynamic to reflect the merger of two very dynamic Korean telecommunication sectors. Even the official name of the new network has undergone a series of transformations, currently settling on "Broadband Converged Network" (see Box 5.1).

Korea's National Computerization Agency (NCA) has defined the BCN as

> "*A next-generation integrated network that is accessible anywhere without any connectivity problems while offering top-class security for quality streaming of broadband multimedia services in an info-communications environment that embodies the convergence of fixed line and wireless networks.*"[23]

The complex nature of NCA's definition mimics the inherent complexity of a converged network; it is more than simply a merger between broadband and mobile technologies. The converged network will also include terrestrial and satellite video broadcasting (TV). The BCN should be one massive, fast IP network connecting users to all kinds of information and should, at the same time, be able to adapt and integrate other new forms of information easily (see Figure 5.1).

Combining so many different information sources together creates many technological and political challenges. This section will first spell out what the ubiquitous, converged is likely to look and what services will be available with when completed. Next, the section will look at the technical issues of how these networks can interact with one another. The final section will look at policy implications of a converged network and what the Korean Government has done to facilitate the development of the ubiquitous network society.

In order to fully understand the BCN, it is important to understand where different network elements fall into place in the wider scheme of "total connectivity." The BCN is being touted as one massive IP network to which Koreans can connect from a wide range of terminals and from nearly all locations (see Figure 5.1). In order for society to achieve the goal of total connectivity, the network must use many different technologies, some of which are more suited to certain environments than others. In essence, different services and activities are optimally provided by different types of connectivity, and the BCN should leverage each technology's comparative advantage. For example, video streaming of movies to a household is best done over the broadband, wired network while mobile telephony in the subway may be most efficient over the existing mobile networks. The key is then ensuring that each of the disparate networks can communicate with each other and pass traffic between themselves via IP.

Network-specific services (e.g. SMS) should move away from being solely a mobile technology and should be accessible via any IP-enabled terminal. This creates the need for new network architecture. The BCN will demand an entirely different type of network plan that involves building a third type of data service.

Box 5.1: What's in a (converged network) name
The difficultly of naming an ever-changing network.

The Korean Government has been planning for a converged network for a long time but has remained flexible enough to incorporate modifications as the process develops. One place where this dynamic has been apparent has been the naming of the new converged network. Currently the official name is "Broadband Converged Network" but it has gone through an evolution reflecting developments in the mobile and broadband sectors.

1. **Next-Generation Network (NGN)**

The first phase of planning was focussed on building a "next-generation network", by developing both the mobile and broadband markets. Policy-makers envisioned this next-generation network eventually meshing mobile and broadband technologies but the name seemed to put less emphasis on a future convergence than on upgrading existing mobile and broadband networks separately. The two parts, while similar, would still need to develop under their own, specific plans. NGN has latterly come to be widely used within ITU-T circles as a focus for future standardization work.

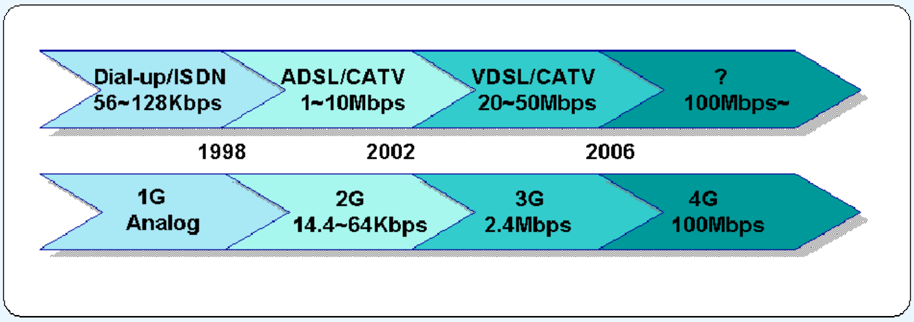
2. **Next-Generation Converged Network (NGCN)**

As mobile and broadband technologies were developing at such a rapid pace, it became apparent that the vision of convergence could happen sooner than some had expected. This gave way to a stronger focus on the "convergence" of the future network, a focus that has only become stronger over time. When policy-makers use the word **convergence** they are referring to a move towards **a single large network**.

3. **Broadband Converged Network (BCN)**

Korea's mobile network is one of the leading networks in the world but its broadband network is by far, the most developed in the entire world. It is, therefore, natural that the converged Korean network should have an emphasis on broadband, to show off its strongest assets. This is reflected in the newest iteration of the network's name. It was also the title of a recent ITU/MIC symposium, held on 3 March 2004[24]. A possible timeline for achieving the BCN is indicated in the Figure below:

Box Figure 5.1: Korea's BCN timeline



4. **Beyond the BCN: IT 839 Strategy**

Perhaps conscious of the impossibility of capturing so many complex concepts in a single overloaded phrase, MIC Korea has positioned the BCN as one of three "infrastructures" supporting the so-called IT839 Strategy (see Section 5.4 and Figure 5.3).

Regardless of the current or final name decided for the converged ubiquitous network, the transformation is continuing at a rapid pace. Whatever the final name, the network should be a world-class telecommunications infrastructure connecting Koreans to information everywhere, from anywhere.

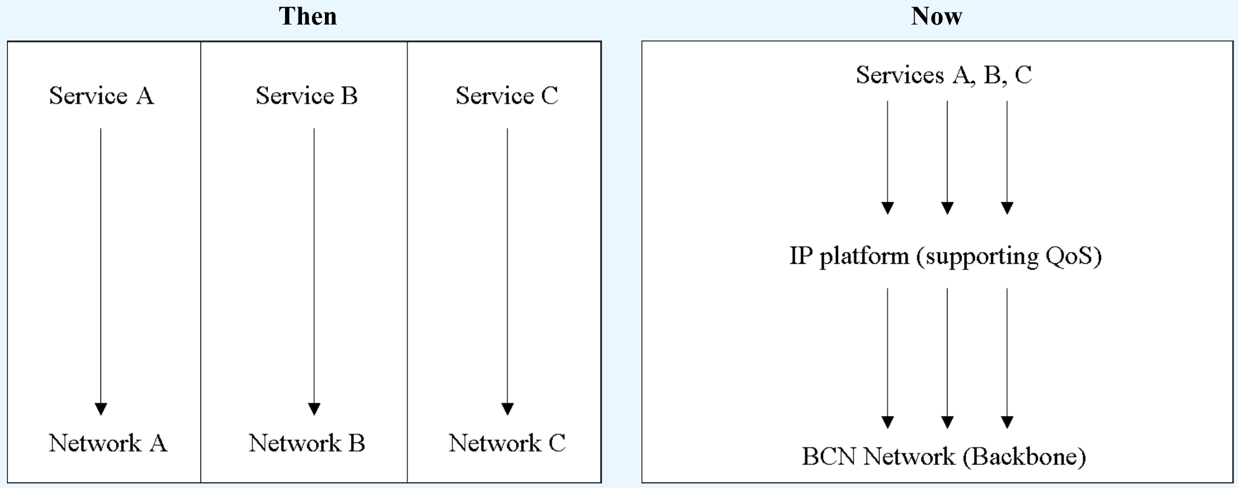
Source: ITU/NCA.

5.2 Korea's revolutionary network plan: The Portable Internet

In many countries, mobile operators have envisioned being able to encroach on the fixed-line broadband market through their 3G and eventually 4G offerings. Likewise, broadband providers have been eyeing mobile data provision, until now the domain of mobile carriers, by using WLAN technologies such as Wi-Fi. However, neither broadband nor mobile operators are perfectly suited for offering fast, mobile data. Broadband networks are too stationary since Wi-Fi and other WLAN technologies ranges are short and there is no effective handoff ability. This makes it less effective for use in moving vehicles. Mobile networks, on the other hand, don't have enough bandwidth to offer truly high-speed, broadband-type connectivity, as was highlighted by SK Telecom's experiment with video-on-demand on its CDMA network.

Figure 5.1:The move towards one network, many services

The Korean vision of the BCN can be broken down into "then and now" network services. In the left image, different services are each provided by different providers on their own networks. BCN will change this and combine all networks into one large IP network. Then, the same services will be available to all users, over IP, regardless of from which part of the network they connect. As an example, users could configure their Internet enabled refrigerator via broadband, their mobile phone, a PDA, or any other connected terminal



Source: KT and ITU.

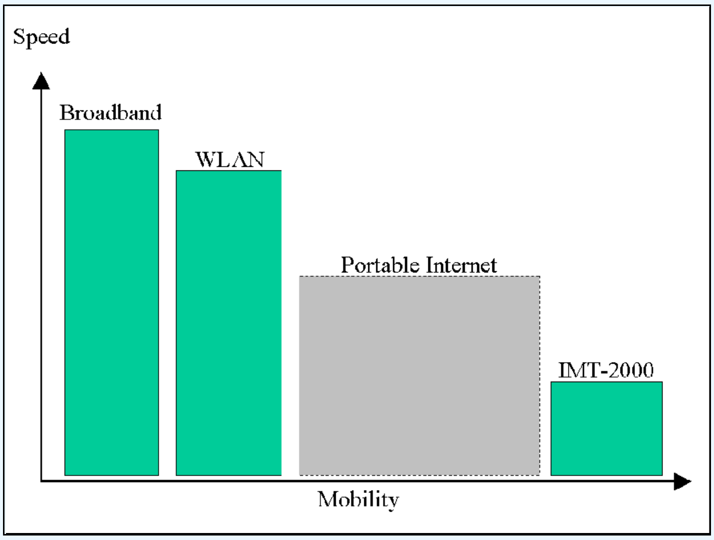
Korea's policy-makers, broadband providers, and mobile operators have therefore come up with a plan to develop a new data network that is more efficient at offering mobile data than either broadband or mobile. This plan is called WiBro, or "the Portable Internet". The Portable Internet is a technology that fits well between WLAN and IMT-2000 in terms of mobility and speed (see Figure 5.2, left). It would offer a 1 Mbit/s connection to users for a flat monthly fee. The three licensed operators have not said how much they will charge but industry watchers assume the prices will be about USD 15 per month, for flat-rate access[25].

The strategies of the three licensed operators for the 2.3 GHz plan vary:

- KT, for example, has already introduced a "seamless" offering through its Nespot Swing, a bundled package that where users can roam between its own Wi-Fi hotspots and its competitors' CDMA2000 1x EVDO networks, when out of Wi-Fi range. WiBro will allow them to take this latter traffic onto their own network;
- The Portable Internet promises to further expand SKT's network in a more cost-effective manner than relying on CDMA alone. Because of their limited bandwidth availability, CDMA networks are only cost effective for voice and non data-intensive applications.
- For Hanaro Telecom, WiBro offered a chance to fight back against its loss of market share and traffic to mobile operators, as well as a chance to become a "mobile" operator itself. However, once the first payment was due, it decided to relinquish its licence and focus on the fixed-line broadband market[26].

The portable Internet has several advantages over WLAN and IMT-2000 for delivering data. While Wi-Fi is limited to a range of roughly 100 meters, WiBro will be accessible in a 1 km radius around a base station and be accessible at speeds around 60 km/h (see Figure 5.2, right). WiMAX will be accessible over a much greater range, though probably not from fast-moving vehicles. Mobile carriers are especially interested in Portable Internet technologies because of their significant investment in cell towers throughout the country that can quickly be leveraged to offer Portable Internet. This upgrade can be effectuated simply by adding a second set of radios on the towers.

Figure 5.2: Portable Internet technologies, including WiBro, could fill the speed and mobility gap



WiBro at a glance	
General	
Frequency:	2.3 GHz
Licenses:	3 awarded (Feb 2005)
Bandwidth	
Per user:	1-2 Mbit/s
Total:	100 MHz
Maximum accessible speed for users:	
Practical:	60 km/hour
Theoretical:	250 km/hour
Pricing estimates	
Monthly unlimited use:	Flat rate, est. 15 USD

Source: "ITU Internet Reports 2004: The Portable Internet", available from www.itu.int/portableinternet.

Portable Internet technologies, as envisioned, could handle the a majority of mobile data traffic while voice calls will be routed over the existing CDMA, and W-CDMA networks. This plan leverages the comparative advantages of each technology and allows Koreans an effective way to have fast data access everywhere.

However, Portable Internet technologies can also, relatively simply, accommodate voice over IP traffic streams, and in this sense would compete more directly with existing mobile networks. In this sense, the fixed-line operators, like KT and Hanaro, are positioning themselves to offer services, like KT's "One-Phone", which provides users with a telephone with a unique number that can be used on both fixed and mobile networks, and will automatically route via whichever link is cheapest for a particular call (e.g., jumping onto a fixed-line network via a Bluetooth, Wi-Fi, WiBro, WiMAX, 3G or 2G interface)

Korean handset manufacturers are also interested in portable Internet technologies as a stimulus for their products. Manufacturers such as Samsung and LG will build multi-band phones that work on a variety of networks. Future mobile handsets, like KT's "One Phone"[27] may have the ability to access the different types of networks: CDMA2000 1X, W-CDMA, Wi-Fi, and portable Internet technologies. Both Samsung and LG make it clear that the technology for building these multifaceted handsets is currently available but they are simply waiting for word on how the network will evolve before building in portable Internet functionality.

While the different telecommunication entities in Korea may agree on a need for the portable Internet in Korea, there is less harmonization in the actual design of the network. Korea's ETRI has developed a plan for the Portable Internet known as HPI, while other groups are pushing for slightly different standards. The final decision on the makeup of the portable Internet should be made in 2004.

5.3 Digital media broadcasting (DMB)

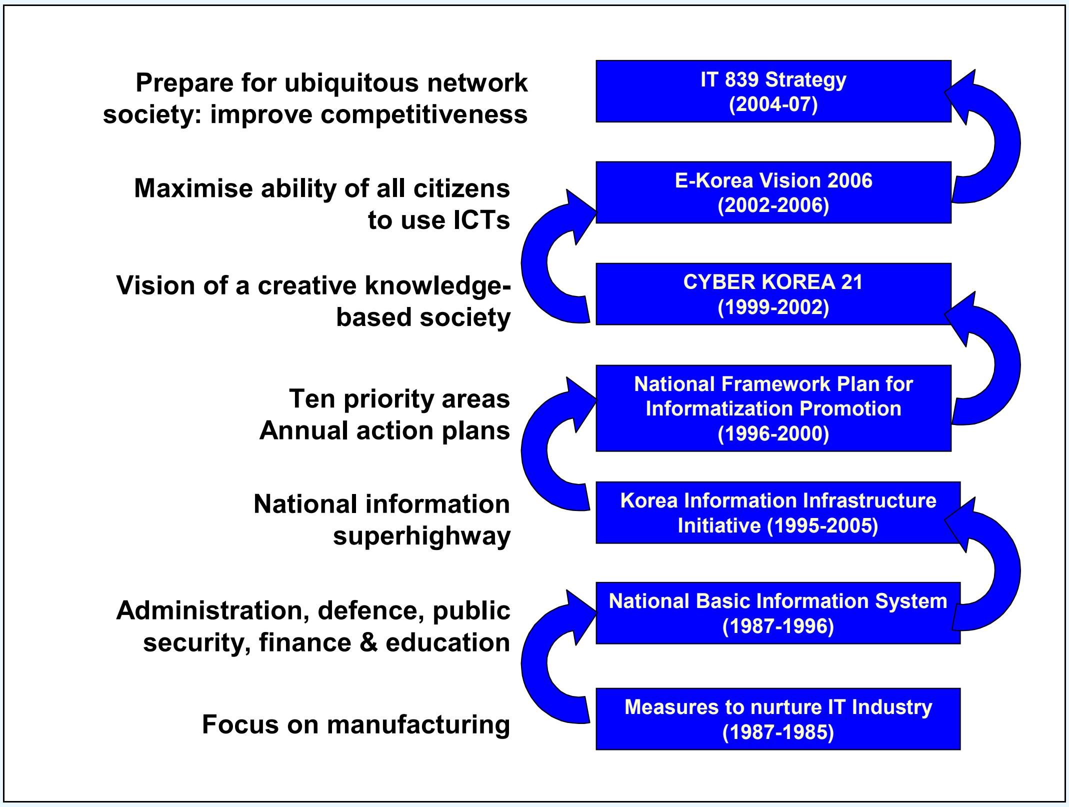
While portable Internet technologies address the need for cheaper mobile data, Korea's broadband converged network will also include a video component known as Digital Media Broadcasting (DMB)[28]. DMB is satellite television for a mobile phone and addresses an inefficiency inherent in video-on-demand (VoD). VoD has often been cited as a potential "killer application" for broadband and mobile users. The predictions of VoD success have not appeared as of yet though because of a number of problems with the underlying economics of video-on-demand distribution and with the lack of compelling content. Terrestrial, satellite, and cable television use one single stream of a channel to service all subscribers in a given area, making effective use of limited bandwidth. VoD is inefficient because each individual subscriber requires a separate stream from the server. The inefficiencies are obvious when many subscribers are watching the same programme but still require a channel of bandwidth for each. This bandwidth problem will persist until either compression technologies improve drastically or available bandwidth explodes.

In the meantime, Korean policy-makers and telecommunication providers have found a cost-effective and efficient way to bring video to mobile users; they will broadcast it. Mobile handset manufactures are building satellite television receivers into their new mobile phones as a cost-effective way for Koreans to watch their favourite programmes on the go. DMB pricing plans are flat rate, with costs in the USD 20 range per month for unlimited viewing. Flat rate pricing makes sense when the incremental costs of increasing the number of viewers are essentially zero. While users will be stuck to a certain time schedule, policy-makers are not worried about insufficient demand.

Digital satellite television services have been a huge success around the world, partially because technology has increased the number of channels available to subscribers. Digital satellite television compresses signals to allow for a large number of channels to subscribers. It is not uncommon for subscribers to have several hundred channels available with their subscription in some parts of the world. But the business case for moving this content also onto mobile phone handsets is still unproven. DMB in Korea would allow for subscribers to watch these programs on their DMB-equipped mobile phone or PDA.

Figure 5.3: Government Push

Two decades of programmes designed to prepare Korea for today's ubiquitous network society



Source: ITU, adapted from MIC Korea

5.4 IT 839 Strategy

An important component of Korea's critical path for achieving a ubiquitous network society ("U-Korea"), and for sustaining industrial competitiveness is the so-called "IT 839 Strategy"[29]. The name comes from the targeted industrial sectors (see Table 5.1). The goals of the strategy are intended to "open the era of

USD 20'000 GDP per capita" (in 2003, Korea's GDP per capita was USD 17'650, measured in purchasing power parities). In 2004, the employment generated by these industrial sectors was 1.28 million and projected to grow to 1.44 million by 2007. More dramatically, it is projected that the value of Korea's exports from these sectors will increase from USD 75 billion in 2004 to USD 110 billion.

Although discredited elsewhere, the policy of "picking winners" through technology assessment is alive and well in Korea, and is being promoted through a partnership between government and the private sector. The strategy contains both specific actions to be undertaken in 2005 and measurable mid-to-long term goals. For instance, for the Home Network Service, the aim is to encompass 1.5 million homes in 2005 and ten million by 2010. The strategy sets specific targets also for Korea's international competitiveness, such as achieving a minimum 5 per cent global market share in RFID chips by 2007 or being the second largest global producer of embedded software by 2010.

The technologies and sectors chosen underpin the achievement of the ubiquitous network society. This is particularly evident in the case of the three highlighted infrastructures. The case of the BcN is described above. Korea aims to have the world's first fully-integrated BcN by 2010, serving some 20 million users at speeds of 50-100 Mbit/s. The U-Sensor network is intended to connect RFID chips and U-Sensors to the BcN and to create an "internet of things" by 2010. It is projected that a U-Sensor test centre will be established in 2005 and that chip prices will be below 10 US cents per chip by 2007. Similarly, the development of an all IPv6 network by 2010 is essential to this vision. Korea's allocation of IPv4 addresses is expected to be depleted by 2006. IPv6 will be implemented straight away in pilot projects, such as WiBro and home networking.

Table 5.1: The components of IT 839
The industrial sectors making up Korea's IT 839 Strategy

8 services	3 infrastructures	9 new growth engines
• WiBro Service • DMB Service • Home Network Service • Telematics Service • RFID based Service • W-CDMA Service • Terrestrial Digital TV • Internet Telephony (VoIP)	• Broadband Convergence Network (BcN) • Ubiquitous Sensor Network (USN) • Next-Generation Internet Protocol (IPv6)	• Next-Generation Mobile Communications • Digital TV • Home Network • IT System on Chip • Next-Generation PC • Embedded Software • Digital Contents • Telematics • Intelligent Service Robot

Source: MIC Korea, "U-Korea: IT 839 Strategy", at: www.mic.go.kr/eng/res/res_pub_it839.jsp

5.5 Technical issues

Merging separate broadband, mobile, and video networks is a daunting task and there are several technical issues that need to be resolved for the BcN to function smoothly. These include mobile gateways, IPv6, and ENUM. Some of these have been or are currently being deployed while others are in planning stages.

5.5.1 Mobile gateways

One key element of a converged network is the ability of all devices to talk to each other on the network. This has been difficult in the past due to the closed architecture of mobile networks[30]. However, the Korean Government quickly realized that mobile devices needed to be able to access Internet content while Internet terminals should also have access to data on the mobile networks. Gateways play a key role in the merging of mobile and broadband networks in Korea. A Gateway is networking hardware that passes information back and forth between different, privately owned networks. Gateways are an integral part of broadband backbones because they “piece together” all the smaller networks to form the Internet. Mobile-broadband network gateways have been much more difficult to put into place because of resistance from mobile providers that have preferred to keep control over content on their networks.

Currently, wireless data users in Korea must use a special prefix (e.g. 1501) to access the Internet from a mobile phone. However, the Government has recently initiated a mobile exchange, similar to Internet exchanges that pass Internet traffic from one network to another. The Government has mandated the use of the exchange by all carriers, as a way to push quickly towards a single network (see Box 5.2). What remains to be worked out is an accounting method for paying for traffic exchange. In the traditional Internet, large “Tier 1” carriers usually pass information back and forth without charge for other Tier 1 operators, since traffic flows work out to be roughly equal, in and out of the networks. However, the higher costs of data traffic on mobile networks will make the ultimate decision on how to pay for traffic a much more difficult issue for the regulator and businesses to work out.

A common exchange will also change the way content is delivered to mobile users. Content providers were commonly pressured to offer exclusive services to just one carrier. A common fixed-mobile gateway would be more efficient because it allows mobile users to freely access content on the Internet and open the way for mobile content competition.

MIC recognized this reluctance on the part of mobile operators to open their networks and mandated the installation of mobile gateways from operators. In August 2003, MIC authorized SKT’s proposed gateway plan and will required SKT to open the gateway to both wired and wireless carriers as well as portals and other content providers. The goal of the project is to create competition in mobile Internet content. An Internet portal could create mobile content that could be used on any of the three mobile networks.

Box 5.2: The Korean Government’s mandate on mobile gateways

Internet portal and content providers will soon be able to offer their services directly to Korean mobile subscribers over the mobile Internet. MIC has mandated the opening of mobile gateways to facilitate network traffic between the fixed and mobile networks in an effort to expand mobile content provision. Many of the terms between mobile network owners and those wishing to use the network are predefined by the ministry. Examples include:

1. Portal and content providers shall request initial access to the network at least one month before the intended date of connection.

2. Portal and content providers shall be verified on the harmfulness of their content from verification organization, like content associations, which are designated by mobile carriers.

3. Payment to a mobile carrier’s billing service may be fixed at between 5 to 10 per cent of the total information fee, based on mutual consultation between parties. To avoid customer complaints on information fees, portal and content providers will be verified on charged and collected information fees from “independent billing verification organizations” as designated by the three mobile carriers.

4. Portal and content providers may be provided with information on wireless Internet platforms (WAP GW, billing system, linked standards, etc.), which is essential in the production and distribution of content and services from mobile carriers.

5. Portal and content providers may be provided with information on the specifications of the user’s handsets (e.g. colour displays and 4/16/64 polyphonic tones) so that the content provider may offer market-specific content and services to its users.

Source: *ICA*.

5.5.2 IPv6

Koreans envision a broadband converged network where all appliances will be controllable from a wireless phone or Internet terminal. However, this futuristic vision of connectivity will require specific addresses for each device on the network. As noted above, the current Internet addressing scheme “IPv4” may suffer from a shortage of addresses as from 2006, at least if every refrigerator and other electronic device is going to be attached to the Internet. IPv6 is an upgrade to the current IP addressing system on the Internet and Korea is one of its largest supporters. In January 2004, Korea and the European Union signed an agreement to work together to develop applications and services based on addressing system[31].

There is some debate as to how pressing the need is to upgrade the existing IPv4 system. However, Korea is quickly on track to connect a wide variety of home appliances to the web (see section six for more information). Korea's efforts with IPv6 are especially pertinent given Korea's historical production of consumer appliances. (e.g. LG, Samsung, Daewoo). It may be unwise to underestimate the speed at which appliances will require unique addresses, or their number.

5.5.3 ENUM

On a converged network, mobile phone users will need an effective way to "call" someone who uses an Internet phone (e.g. Voice over IP). VoIP users often don't have phone numbers and instead are contacted via an IP address or some other alphanumeric format, such as that used by Skype. The phone network and Internet need an effective way to share directories in order to pass calls back and forth. One solution under consideration in Korea is ENUM (named after the technical standardization working group on electronic numbering). ENUM is a method to merge the addressing system on the Public Switched Telephone Network (PSTN) with that of an IP network by "mapping" a telephone number into a typical Uniform Resource Locator (URL). ENUM could help lay the foundation of the Korean BcN by combining two different directory structures, the domain name system (DNS) and the PSTN numbering system, as defined in the ITU-T Recommendation E.164.

The Korean Government has started several successful ENUM trials. A successful internal ENUM trial in July of 2003 has led to a public trial capable of handing over 100,000 users.

5.5.4 Building the BCN: Technology vs. business models

Several issues need to be worked out before the BCN will become a reality. Interestingly, some of Korea's leading telecommunication firms believe the biggest difficulties with the BCN will not be tied to technology, but rather to business models. The technology to move users seamlessly from one network to another is already in place with KT demonstrating Nespot Swing as a viable solution. However, the mechanism for making interconnection payments between respective infrastructures is much more difficult and a process that will take some time to work out.

A particular problem arises in inter-working networks based on flat-rate pricing structure (such as DSL broadband networks) with those based on per-minute or per message charges, such as the mobile phone network. It is likely that the former will prevail, and this is likely to generate considerable resistance, especially among cellular mobile operators. For that reason, portable Internet technologies, such as Wi-Fi, WiMAX and WiBro may offer an easier integration path than cellular networks for the BcN.

5.5.5 Dual-use devices

One area where Koreans will quickly see convergence is in mobile phones. KT is working on development of a "One Phone" network that can be used as a cordless phone at home and a mobile phone outside. The mobile phone will attach to a home or office network via Bluetooth, when in range. This allows it to make use of cheaper tariffs that may be available via a land-line provider. Eventually, the phone could also be used to make calls via VoIP at home or at the office. When users leave the Bluetooth range, the handset becomes a mobile terminal capable of using KTF's extensive CDMA2000 network.

The evolution towards dual-use devices seems natural and offers an initial step towards integration of the two types of telephony. Of particular interest is the use of Bluetooth instead of its 2.4 GHz compatriot, Wi-Fi. Network designers chose to limit the range of the radio technology in order to increase battery life. In addition, the new Bluetooth standard incorporates quality of service (QoS), something missing in Wi-Fi but important for continuous voice communication. Perhaps, too, the fear that a voice call that interfaces with the network via Wi-Fi would continue its journey via the Internet rather than via the PSTN is another reason for reluctance to promote Wi-Fi.

Network operators have already built similar services into their product lines. Large groups including corporations and universities can make special arrangements with mobile operators to have all calls between users in a certain cell free (like a PABX). This cell can be located in a building or on a campus. Once outside the cell, users then are charged normal mobile phone rates (see Box 5.3). The success of the service depends crucially on having a single phone number that can be accessed, irrespective of location.

5.5.6 RFID and Sensor Technology

Another area where ubiquitous technologies are evolving fast is in radio frequency identification (RFID) and universal sensor networks (USN). Research in these field is being coordinated by ETRI[32]. In 2004, the Korean government allocated spectrum for RFID/USN in four bands:

- 135 khz, mainly for access control applications (e.g., smart key passes);
- 13.56 MHz, for smart cards and inventory management;
- 433.67-434.17 MHz, where applications include inventory management and tire pressure sensors;
- 908.5-914 MHz, for applications in the logistics and distribution fields.

RFID and USN are identified respectively as a key service and infrastructure for the IT839 Strategy. To this end, six pilot programmes have been launched within Korea's public sector as a testbed for these technologies:

- Sept. '04 – May '05, Government procurement management using RFIDs;
- Sept. '04 – April '05, Ammunition management using RFIDs by the Ministry of National Defence;
- Sept. '04 – April '05, import/export logistics infrastructure using RFIDs, by the Ministry of Commerce Industry and Energy;
- Sept. '04 – April '05, an imported beef tracing service using RFIDs, launched by the national veterinary research and quarantine service;
- Sept. '04 – April '05, an airport baggage tracking service, by Korea Airports Consortium;
- Dec. '04 – August '05, an RFID-based harbour efficiency improvement scheme, launched by the Ministry of Maritime Affairs and Fisheries.

A similar range of pilot programmes have been launched in the private sector, including in wholesale and retail, medical and parking applications.

5.6 Policy implications

Korea's move towards a ubiquitous network based around the BcN has several important policy implications, including how voice traffic will be regulated, which operators are allowed to own which networks, and interconnection rates. The success of the BcN will likely rest, to a large extent, on the policy decisions made now.

5.6.1 Voice

In a converged network, there may less economic incentive to have extensive overlapping areas of network coverage. It is predicted that the BCN will economically reward telecommunication carriers specifically for concentrating service in the areas where they have the clear advantage. With the advent of the portable Internet as a cheaper alternative for mobile data, IMT-2000 networks may lose their competitiveness in terms of providing mobile data, a key selling point of 3G technologies. This will be compounded if the portable Internet includes flat rate pricing for data, eventually leaving CDMA networks transporting mainly voice.

However, if one mobile network is better at handling data than another, the distinction between data and voice could become trivial. As has been shown by the explosive growth of voice over IP, data traffic tends to find its way to cheaper transport channels. Handset manufacturers could include voice over IP software on their terminals that could bypass the CDMA network completely for a monthly flat rate. This leaves the Government in the awkward position of deciding whether to regulate different types of data traffic flowing over the new network; a decision most regulators would prefer to avoid.

Box 5.3: Samsung's converged fixed and mobile phones
Internal calls are free within the building but are charged at 3G network rates outside.

At Samsung headquarters in downtown Seoul, every desk has a wired, landline phone, even though they aren't necessary. Samsung is taking advantage of a new trend in business mobile technology offered by Korean mobile providers: mobile handsets that become part of the Wireless Private Branch eXchange (W-PBX) inside company buildings. Company-issued mobile phones attach to the internal Samsung network while inside the headquarters and switch to the regular CDMA network when outdoors.

This new and interesting business model in Korea essentially installs a mobile cell inside the building. All calls that stay on the same local cell (in the building) are free and are not billed to the users. Internal calls are patched through the company PABX so users only need to type the last four digits of the phone number to reach another employee.

Mobile operators are betting that the business model will increase revenues. First, by signing up companies to the plan, the mobile carrier effectively wins all that company's employees to its service. Second, as users become more accustomed to doing business via the mobile phone instead of a desktop model, carriers are hoping that more business will eventually take place out on the CDMA network, where users are still billed.

There is a certain psychology to the usage of different networks: because fixed-line telephone tariffs were traditionally cheaper than using a mobile, calls made over that network are longer in average duration. By giving users the same phone for use on both mobile and fixed-line networks, mobile carriers are hoping that the loquacious habits of fixed-line users will spread (perhaps sub-consciously) to their usage of the mobile network.

Source: Samsung, SKT.

The regulatory implications for voice traffic will be significant. Traditional regulatory schemes involving universal voice service may be different on a large data network. With VoIP, voice calls are handled alongside other data. It becomes difficult for regulators to apply different regulations to voice than to other data on the network.

In October 2004, the Korean Government allocated "070" as a prefix code for VoIP numbers. This will be an important step since it allows users on any IP device to make and receive calls. Instead of using separate prefixes for mobile and fixed line phones, VoIP prefixes would be device independent. This means that a user on the road would be able to be reached via VoIP on their PDA via the portable Internet, but the same call could also reach them at home via their broadband connection and a VoIP application. According to some estimates, VoIP traffic is growing by 40 per cent per year in Korea[33].

VoIP also introduces other complications to current regulatory schemes. Currently, KT and SKT are considered the dominant providers in the fixed line and mobile markets respectively. However, in a BcN, the market definition is likely to expand. KT and SKT could become closer substitutes to one another and the Ministry must necessarily reconsider what is defined as "dominant".

5.6.2 Universal service requirements

Universal service requirements have long been a staple of voice telecommunication policy but have been relatively rare in data service provision. Korea is one of only a few countries to mandate universal service requirements for broadband, something many other countries are watching closely. The Korean Government sold its final *tranche* of shares in KT in 2002 on the condition that KT would be required to offer broadband to remote villages. At the time, broadband was determined to be a 1 Mbit/s connection.

The Korean trend is to move more towards requiring universal data services, rather than one specific data technology such as voice. Regulators are hoping that if an area is covered by broadband data, voice service becomes a given.

In a truly "converged" network, there should be no differentiation between the type of technology used to access the network. In reality, universal service coverage covering simply "data provision" may not be sufficient for outlying areas. The Korean vision of the BcN employs four separate technologies to "fill the gaps" of high-speed coverage. Users in highly populated areas such as Seoul could very likely have access to all four technologies at any given moment. However, users in outlying regions (e.g. some of Korea's outlying islands) will only have limited access to one to two of the four networks. Universal service requirements will therefore need to be explicit about what types of data coverage may be required and if one or two technologies will be sufficient.

5.6.3 Competition policy

Another area that Korean policy-makers must address is competition policy. Current competition policy disallows the ownership of more than one type of network. This may hinder development of the BcN. Competition issues will arise over what kind of networks operators are allowed to own. With broadband, WLAN, the Portable Internet, and mobile networks all offering data services via different technologies, Korean policy-makers must decide if operators will be able to own all four types of network or whether there should be certain limitations.

5.6.4 Interconnection rates

Data should be able to flow freely over the BcN, regardless of where the data request originates and where it ends. The behind-the-scenes transfer will likely happen over several networks, owned possibly by several providers. Good interconnection policy will be vital to ensure that the system works as planned.

The difficultly in setting interconnection rates for a BcN begins with the different cost structures for different networks. Mobile networks have the highest costs per packet of transferred data while high-speed broadband fibre-optic networks incur near zero costs per packet. Mobile operators will need to be compensated more for data use on their networks than fixed line broadband providers. Interconnection rates will also form a key part of any future business models.

In conclusion, consumers will most likely benefit from the introduction of another competing network. The costs of mobile data transmission should fall considerably as the new network offers large increases in data efficiency. Also, services on each of the four disparate networks may also improve as broadband providers, mobile operators, and Wi-Fi service providers can put more emphasis on specializing their products, rather than spending to vastly increase the reach of their network. Finally, as these networks converge, users will likely subscribe to one "network" data service that connects then regardless of location. Movement between the "different" networks should become seamless and opaque to users as the handoff technology improves. Indeed users will access "one network" via different, seamless technologies.

6 THE KOREAN UBIQUITOUS NETWORK SOCIETY

Koreans can be said to be swimming in information. The amount of information available to Koreans at any time of any day from anywhere can be overwhelming. Smart phones, PC Bangs, and even broadband-equipped restaurants all constantly beckon Koreans to keep in touch with information. This vast access to information seems to go hand-in-hand with Korea's *bbali bbali* culture. Everything is a rush to be more productive and save time. Mobile networks, both current and in planning, have greatly expanded productivity and freed up more time for Koreans to work. However, *bbali bbali* also has some drawbacks. In Korean society, people often cannot (or do not) take time to relax, disconnect, and enjoy. Even leisure activities, like gaming, are taken at a frantic pace.

Korea's burgeoning of information has both benefits and drawbacks. The success of Korea's ubiquitous network society will, to a great extent, depend on the resulting balance. As a result, Korea mobile users, policy-makers and telecommunication providers are working on finding a healthy amount of connectivity. What is clear is that Koreans will need a way to "unplug" from information when they want.

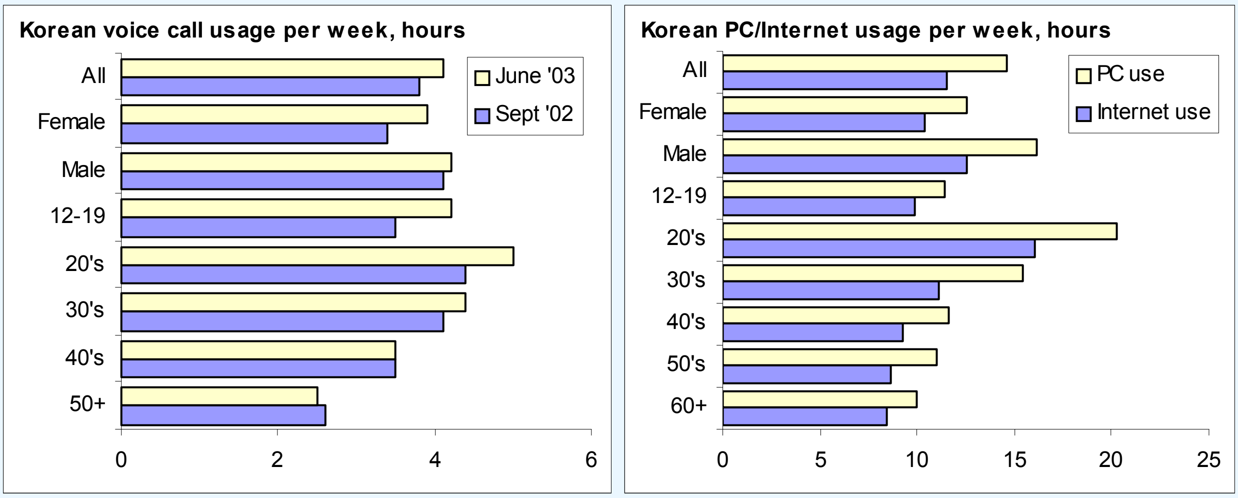
This section will look at some of the social factors affecting the development of the ubiquitous network society in Korea. First, it will look at the possible benefits to users, the economy, and service providers. Second, the section will examine a few of the drawbacks and pitfalls of living in the Korean ubiquitous network n society, along with programmes and plans to overcome them. Third, the section will examine a few ways Korean culture has changed and adapted to the new society. Finally, the section will attempt to look forward to how the ubiquitous network society will change in the next few years.

6.1 Social benefits

6.1.1 Anytime, anywhere

Seoul's *DongDaeMun* market is a good example of how Koreans function at all hours of the day. The market's busiest hours are between 11 PM and 5 AM in the morning. Restaurants are all open, sidewalks packed, and traffic jams common at 3 AM. For shoppers, *DongDaeMun* is a clothing paradise and it reflects the constant, always-on attitude of Koreans[34]. Much like the *DongDaeMun* market, the mobile information society in Korea is always open, always busy, and there is always something to do.

Figure 6.1: Mobile, PC and Internet usage in Korea
Koreans use their mobile phones an average of 4.1 hours per week and use PCs for around 14.6 hours per week



Source: KRNIC and NIDA.

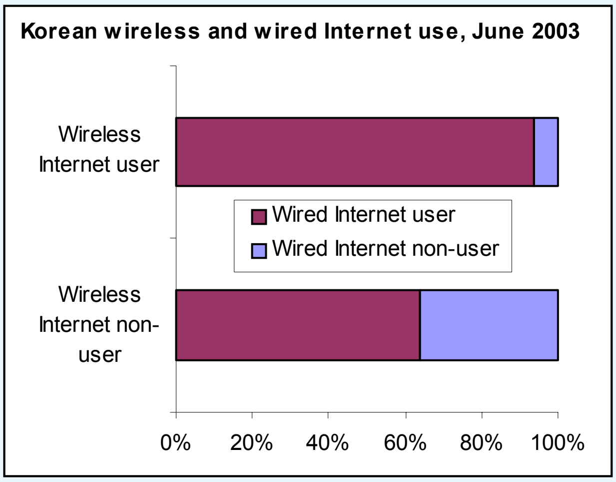
Koreans apply the same vigour to shopping in the middle of the night at *DongDaeMoon* as to mobile connectivity. Koreans are heavy mobile users with a typical user making 4.1 hours of calls a week, roughly 1'000 minutes a month (see Figure 6.1). In addition, the average mobile user also sends 42 SMS messages a week (6 per day, 168 a month). People in their 20's make the most phone calls while teenagers are the heaviest SMS users, far outpacing any other segment of the market.

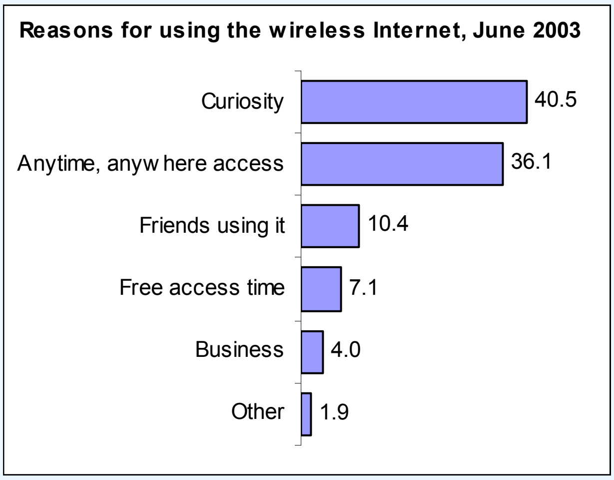
Similarly, Koreans use computers, on average, around 14 hours 36 minutes per week, of which 11 hours 30 minutes (almost 80 per cent) is online. Again, it is 20 year olds that are the most intensive users of both PCs and the Internet. Those in the 30-39 year bracket have the greatest offline use of computers while 12-19 year olds seem to be online most of the time that they use the computer.

This high correlation among Korean wired and wireless users highlights the complementary relationship among the two access technologies. Some 93.8 per cent of mobile Internet users also use the wired Internet. However, of those that do not use the wireless Internet, only 63.8 per cent use the wired Internet such as broadband (see Figure 6.2, left). This is an important and key aspect for the Korean mobile information society, highlighting the important role that a converged network will play.

Korean operators have been generally successful at convincing subscribers to try out mobile wireless services (see Figure 6.2, right). When users were asked the reasons they used the mobile Internet, in June 2003, 41 per cent stated it was out of curiosity. Anytime, anywhere access was the second-most stated reason with 36.1 per cent of respondents. One interesting point is that business use was ranked relatively low, with only 4 per cent of respondents stating it was their reason for using the mobile Internet. This seems to show how, in the initial stages at least, the mobile Internet is more about staying connected with friends and family, than more traditional business use. This largely parallels experiences with fixed-line broadband, where residential use, rather than business use, has initially driven the market.

Figure 6.2: Wireless Internet use
The complementary relationship between the wired and wireless Internet





Source: KRNIC.

6.1.2 Mobile handsets as the information gateway to the home

Korean mobile operators and handset manufacturers envision a society where mobile phones replace keys, wallets, credit cards, as well as function as the control for all the user's appliances. Many of these services are already available in Korea with several mobile operators offering home networking and application control over their 3G networks. One of the most advanced services is SK Telecom's *Nate* service that can interact and control networked appliances from afar (see Box 6.1)

Mobile handsets play a vital role in this vision of an intelligent home network. This network will enable a household of appliances to be controlled remotely via a mobile phone or over another IP connected device. The Korean Government hopes to have 10 million homes with intelligent networks by the year 2007; roughly 61 per cent of all households in the country[35].

MIC has determined that intelligent home networks should play a key role in the Government's overall ICT strategy and will target the industry with USD 213 million (249.3 billion Won) of investment from 2004 until 2007. In addition, the Government is assembling a set of initiatives to set the foundation for intelligent networks. These include developing a home network platform that combines communications, broadcast video, and gaming.

In July 2003, the Government started a one-year test project to develop a home network platform based around the Linux operating system. Linux was chosen in order to avoid the expensive licensing fees of proprietary operating systeMs ETRI is currently working on developing the platform and testing it for use. The Government's targeted investment in intelligent home networks will also establish an RFID research centre, as well as helping to establish RFID, sensor networks, and the BCN.

Korea's telecommunication manufacturers are also involved in developing intelligent home network systeMs Samsung and LG are creating network-ready appliances, along with complementary technologies such as power line communications (PLC) for connecting the appliances to the network, middleware, and microchips.

There is immense interest in being able to control all devices in a home via a mobile phone. However, the vision is not entirely clear on how users will make the best use of this networked environment. RFID chips on food packaging in the refrigerator are commonly used as an example. Users would be able to remotely check which foods they were out of via their mobile phone. Other examples have shown that the air conditioning in an apartment could be turned on and off.

The problem with these examples is that while they are both convenient uses, the benefits may not be able to outweigh some of the privacy issues and costs associated the service. This may delay rollout until a secure network that people trust has evolved; and that may take time.

Box 6.1: Controlling home applications via mobile phone
When Korean mobile phones become a very long-range remote control for household appliances

If Samsung has its way, soon mobile phones will act as a remote control for all household appliances. Koreans will be able to check to see if they left the iron on while at a movie theatre with friends. Samsung has a strong interest in the technology as both a manufacturer of household appliances (e.g. air-conditioners, refrigerators) and telecommunication handsets.

Each home appliance is equipped with a network card that allows it to communicate through the power lines of the home. A server, called a "home gateway" controls all communications with appliances by receiving requests from a mobile phone or the Internet and passing the information to each of the appliances. Users would be able to securely control the devices in their homes via any available Internet connection. This would include mobile phone, PDA, or broadband Internet connection.

In order to test the technology, Samsung built the technology into a new apartment complex (construction is another branch of the Samsung Conglomerate), the Tower Palace. Devices throughout each apartment are controllable via a mobile phone. Residents can control a wide range of appliances, including the air-conditioner, the refrigerator, the washer/dryer, and the electric gas stove.

SK Telecom is currently offering a service to *Nate* subscribers that allows people to leave video messages when they ring a doorbell and the *Nate* subscriber is not at home. If no one answers the door, the doorbell system uses its integrated camera to record a video message that is then delivered over SK Telecom's EV-DO network. The service also allows users to press a button on the remote handset to unlock the door if they choose. This could be particularly handy to let a friend in the door when they do not have a key.

Sources: www.sktelecom.com/english/cyberpr/pr_center/exhibitions/ and
www.samsung.com/HomeNetwork/SAMSUNGhomevita/Achievements/Pilot.htm

6.1.3 Post PC

Korean's are looking forward to the next generation of mobile computing devices, sometimes called "Post PCs". Two categories of Post PC products are of particular interest to the mobile information society in Korea: portable and wearable. These devices can be a PDA or tablet, or special watches and clothing. What may set these devices apart from PC's and PDAs as we know them is the user input method. The mobile Internet has long been constrained by a good method for inputting information. Users have had to rely on either tapping letters or writing them by hand on PDAs and voice recognition software has not advanced to the point that it can reliably be used to enter information. However, Samsung has been working on a solution to this dilemma and has recently released what it claims to be the world's first wearable mouse[36].

6.1.4 Telematics

Korean's are keenly interested in "telematics", which is a terms they use to describe a merger of technologies: the automobile and mobile communications. Telematic services include a mobile communication device (e.g. a PDA or mobile phone) and a GPS to pinpoint location. The result is a system that can receive up-to-date traffic information, transmit information on specific businesses in the car's area, conduct remote diagnosis of car troubles and report accidents[37]. The Korean Government has declared that the car will become the "third Internet arena" and will help with the development of terminals, and the establishment of a telematics traffic information centre that will deliver real-time traffic information.

The private sector has also been investing in telematics with several Korean car manufacturers already building the system into their new models. Renault-Samsung has started installing Samsung's SM5 telematic technology in its vehicles. Hyundai Kia's luxury vehicles, the Grandeur XG, EF Sonata, and the Regal are also now sold with telematics systems preinstalled. This year, the manufacturers will include telematics equipment as standard features on mid-range cars as well.

Mobile, and even fixed line operators, are looking for telematics to be a boon for business. The country's three mobile operators, SKT, KTF and LGT have all declared their entry into telematics with fixed-line provider KT also announcing telematic plans (see Box 6.2).

6.1.5 Location-based services

The key component that makes location-based services possible in Korea is the Global Positioning System (GPS). Even now, Korean's have a wide variety of location-based services available to them. Currently, SKT's *Nate* subscribers can subscribe to a system where a user's position is given via GPS on their mobile phone with maps and information about the area updated over the CDMA network. Users can find directions using voice commands or by moving through a set of menus on the phone.

Box 6.2: Gas with your handset
How LBS services direct Korean drivers to the best petrol bargains

Drivers need not panic when their cars run low on fuel and they are in unfamiliar areas of the city. Instead of pulling over into the nearest petrol station for fuel, LBS subscribers will be able to press a button on their mobile phone and receive a list of prices of gas stations within a 1.5 kilometre radius of their exact position. Once a low price is selected, the mobile phone displays exact driving directions to the nearest filling station, car wash, or parking lot. A car requiring 30 litres of petrol could save up to USD 2.50 (3'000 Won) by using the service.

Source: www.etnews.co.kr/

The Korean Government has designated LBS as a next-generation strategic export item that will precede CDMA. The Government successfully launched several LBS pilot projects throughout the country in the fields of emergency rescue aid, disaster management, and car navigation systems (see Box 6.3).

The evolution of telematics in Korea promises to make a large difference in the life of Koreans. One area this will be especially noticeable is in traffic in Seoul. It is not uncommon for Koreans to have televisions mounted next to the driver's seat of a car so they have something to watch during traffic jams common throughout the day. However, a well-functioning telematics system could help ease some traffic congestion by delivering precise data to drives that would lead them to less-congested roads.

Box 6.3: How LBS on mobile phones save lives in Korea

Korean fire-fighting and rescue services are making use of LBS to reach people faster in cases of emergency. Certain mobile phones are equipped with an emergency button that can send out a distress call including the location of the person in need of help. Rescue services receive the message and are then guided to the distressed via car navigation systems built-in to emergency vehicles. In addition to simple road navigation, the 3G mobile network updates the navigation with up-to-the-minute traffic conditions in order to plot the most efficient route.

The benefits of the LBS system are obvious. People can get emergency rescue services from fire or crime scenes without elaborating their exact position. This is seen as an especially important project for the aging population in Korea who benefit from the independence they receive from being able to continue living on their own and knowing help is but the push of a button away.

Source: KADO.

6.2 Social drawbacks – the Korean experience

The ubiquitous information society is exciting for Koreans and they have found efficient uses for the technology. However, the benefits are not without costs. As mentioned before, Koreans sometimes have a difficult time separating themselves from work and the mobile technologies have future increased the amount of time Koreans are attached to their jobs. In addition, the vast amount of information available to Koreans has raised some alarms about how to maintain privacy. Finally, the Korean ubiquitous information society may have negative social effects on human interaction.

6.2.1 The meaning of teleworking in Korea

Korea has the most extensive broadband network in the world, along with one of the leading mobile networks. It would therefore seem fitting that Korean would be an optimal testbed for teleworking. However, the idea of working from home has not gained much acceptance in Korean culture. It is vital for workers to be physically present in the office each day, usually in view of, or calling distance from, their boss. Korean workers traditionally stay in the office until the boss has gone home, often very late at night. Instead of using teleworking as a substitute for commuting into work, it has become a complement, allowing them to attend to work even after they've gone home for the day.

Several years ago, employees might stay late at the office but would have time to themselves once they left. Now, they are always in contact via their mobile phones. Surprisingly, Korean firms don't supply mobile phones to their employees but rather expect them to bring, and use, their personal mobile phones to work.

6.2.2 Security in the ubiquitous network society

As Korean mobile devices are becoming commonly used to aggregate a wide range of devices such as keys and wallets, the issue of security in the ubiquitous network society is more important. Losing a mobile phone in the early days of mobile communication usually resulted only in the lost cost of the handset, since the mobile operator could quickly shut off the service. However, with the current mobile phones in Korea, users may be losing a lot more.

Instead of simply losing a terminal, users may lose smart cards with banking information, their credit cards, the keys to their house, and their public transportation pass. Operators have been good at building safeguards into the system that allow Koreans to quickly cancel services but even so, the risks are great for Koreans. In addition, replacing all the services lost in one fell swoop is a long and arduous task. Mobile phones already account for a increasing number of thefts in countries around the world. Even more alarming, many of the victims are youth with mobile phones. In the UK, estimates say two-thirds of the monthly 10,000 mobile phone theft victims are between the ages of 13-16 years old[38]. In Korea, stolen phones are usually reprogrammed and sold. While having a mobile phone stolen and others calls billed to a user's account may be costly, the potential for harm is much worse as both phones and thieves become more sophisticated.

6.3 Korea's information society

Koreans may be more trusting about how their data is used than users in other developed economies. While there can be no concrete proof of such a broad statement, the rate of adoption of technologies such as m-commerce, m-banking, and m-brokerages imply that Koreans may adopt these services more readily than users in other economies. M-commerce services have been slow to unfold outside of Asia for many reasons, but privacy concerns of users have been tantamount. Many western users will not adopt a technology until their fears have been assuaged.

Koreans, on the other hand, appear to have a stronger sense of community trust in their institutions to protect their data. This has allowed Korea to become a leader in general m-commerce while other economies languish.

While Korean's may be more trusting of their institutions and the safeguards in place, this does not imply that Korean mobile operators, handset manufacturers and commercial establishment do not make security a high priority. Phone manufacturers are starting to implement fingerprint and voice recognition into the mobile phones as a way to make them more secure for users. Biometric technologies increase the cost of a mobile phone significantly but are seen as necessary to prevent abuse of m-commerce.

6.3.1 Privacy

Korea's CDMA networks, by technological design, are fairly secure due to their use of spread spectrum technologies. However, as the networks become more saturated with data and users, the small potential for abuse increases. Korean users will need to be diligent with their handsets and Korean network operators must continually implement cutting-edge security into the networks to protect users' privacy.

Recently Korean equipment manufacturers have been asked to help solve a privacy issue inherent with new mobile phones, unauthorized photographs. Almost all new Korean mobile phones contain small cameras that can be used to take photos where traditional cameras would have been detected and banned. In response, Korean handset manufacturers have included new safety precautions to ensure people know when a picture is being taken (see Box 6.4).

Box 6.4: Stopping a peep with a beep.
How Korean mobile phone manufacturers have added "clicking" sounds to mobile camera phones to help solve the problem of unauthorized photography

Korean's love the hot sauna baths (*mok yok tang*) around the country. Men and women always bathe and soak separately in a peaceful Korean ritual of moving between saunas, hot, medium, and cold pools. However, the serenity of the "*mok yok*" experience has been shattered by mobile phone users surreptitiously sneaking in their phones and taking pictures of unsuspecting bathers in the nude. In a recent case, a woman used her camera phone to snap pictures of naked women in the *mok yok tang* and then sold them to a popular website.

In response to public outcry, the MIC has required mobile handset manufacturers to equip new mobile camera phones with a non-mutable click that sounds every time a picture is taken. The new phones make a sound of at least 65 decibels when a picture is taken. An estimated 4 million camera-equipped mobile phones were sold in the country in 2003.

Source: "Korea: Beeping Prevents Peeping" at: www.wired.com/news/technology/0,1282,61197,00.html

6.3.2 Cultural changes

In some instances, mobile technologies have been used to strengthen already existing norms in Korea. This includes workers using mobile phones to work longer hours and to stay more connected than before. However, in other areas, mobile phones have completely changed elements of Korean culture. An example is the traditionally silent, tranquil subway has become vibrant and loud with people talking on mobile phones and playing mobile games.

One of the most striking cultural elements of Korea's mobile information society is how people are willing to share their mobile phones with others to make telephone calls. In most countries of the world, mobile calling is restricted to necessary communication because per-minute tariffs are so expensive. Users will often choose to send a cheaper SMS messages than make a voice call on a mobile network. Even friends hesitate to ask friends if they can borrow a mobile phone to make a call.

In Korea, MIC has kept the cost of voice communication low by negotiating a local tariff ceiling of USD 0.07 a minute (80 Won). This low price, plus Korean's Confucian traditions have created an environment where people are willing to let friends, relatives, and even perfect strangers on the street borrow their phones to make a quick call.

Avatars

Korean culture has also changed drastically with the growing popularity of avatars. Avatars are cartoon representations of people that are used in virtual chat worlds and on mobile phones as screen savers. Different from traditional chat programs where users employ only a small picture or cartoon to represent themselves, avatar users communicate in virtual worlds. One of the most popular avatar sites is Neowiz's "SayClub" that has over 20 million subscribers, equivalent to nearly half the population of Korea.

What makes the avatar phenomenon so interesting is how much users are willing to pay to outfit their avatar with clothing and accessories. When a user signs up to a virtual world, their avatar comes only with underwear. Each additional item of clothing or accessory much be purchased and applied to the avatar. Users can buy designer avatar clothing, with licensing fees being paid to actual trademark owners such as Gucci. This has led to situations where Korean avatar owners spend more money on clothing for their avatar than they do for themselves. Daewoo Securities has estimated that the avatar market in Korea to be worth USD 114 million in 2004, up from USD 64 million the year before[39].

The avatar phenomenon, in some ways, seems to be a logical extension of Korea's history with group dating for young singles as a way to meet other people. By using avatars in virtual worlds, users often feel freer to open up, talk, and interact with each other. Indeed, often these avatar relationships can blossom into real-world relationships for users. However, some have questioned whether the avatar phenomenon is going to be a net positive for Korea. Some believe that avatar worlds are simply expensive "fantasy lands" that push users further into isolative behaviour.

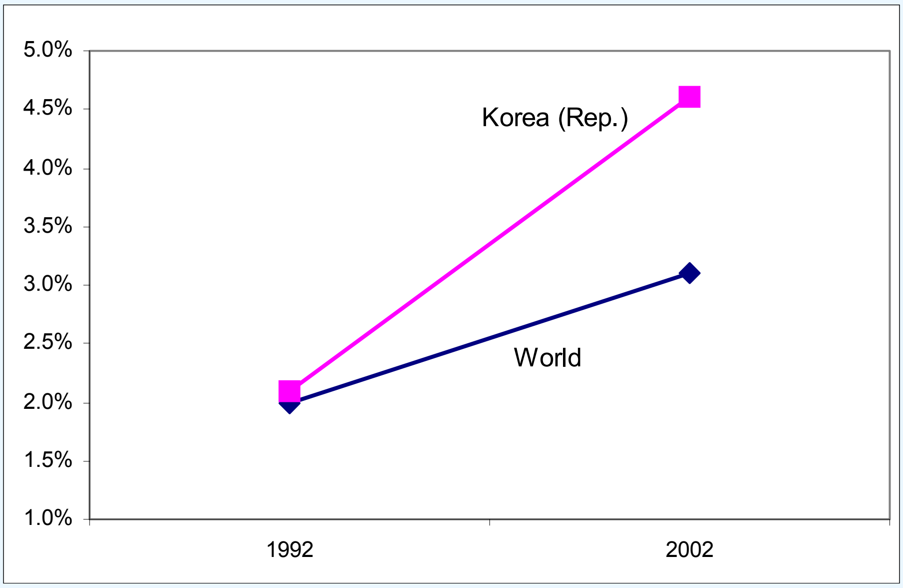
7 CONCLUSIONS

Electronic information, available from anywhere, at anytime and from any device, has become a staple of Korean life and studying the Korean model can give insights to how mobile information services will evolve in other countries around the world. There are several elements of the Korean experience that can be replicated and other elements that are specific to Korea. This section looks at certain key lessons policy-makers can draw from the Korean experience.

As has been discussed in this paper, much of Korea's success as a ubiquitous network society can be attributed to keen investments in ICT education by the Government. Money collected from mobile spectrum allocations were strategically reinvested in ICT promotion rather than being simply put into the government's general fund. This has helped Korea catapult to a world leader in ICT by creating a vast, ICT-savvy consumer base that has fueled Korea's tremendous growth. Other economies would be wise to consider following the Korean model of strategic re-investment of telecommunication funds.

One illustration of Korea's success over the last decade or so is the extent to which it has increased the level of spending on telecommunications as a percentage of GDP, where it has grown to be almost twice the global average by 2002 (see Figure 7.1). Given the fierce competition in the services market, it is unlikely that this results from higher prices. Rather, it is a reflection of the increased choice that Korean consumers enjoy, with high-speed Internet services, both on fixed-line and mobile platforms, having been rolled out in Korea well ahead of other countries.

Figure 7.1: Korea's success as an information-based economy
Spending on telecommunication services as a percentage of Gross Domestic Product, Korea and the world, 1992-2002



Source: ITU World Telecommunication Indicators Database.

Korea also offers the world an excellent example of telecommunication competition. Korea's world-leading broadband position is strongly tied to the level of competition between broadband providers. The mobile market is also strongly competitive with three highly developed networks. Policy-makers in other economies might usefully examine what elements of Korean government policy have contributed to Korea's vibrant market competition.

As the world looks forward to an increasingly converged network environment, Korea's broadband converged network may represent a model for similar networks around the world. While other economies may not be as far towards true convergence as Korea, policy-makers in all countries should look at the policies Korea is currently developing. These include key policies such as creating mobile exchanges, implementing technologies like IPv6 and ENUM, and looking forward to how operators of the future will need to be regulated (e.g. ownership restrictions for different types of networks). Korea’s initial experiences with these policies will foreshadow future decisions for regulators and policy-makers around the world.

Another area that may bring unexpected dividends to other economies is in the field of mobile Internet technologies. One of the most important policy decisions for the Korean mobile information society involves the development of the “Portable Internet”. The Portable Internet would work on mobile phones and allow users to browse the Internet, stream audio and video, and have video conversations.

While the Portable Internet will play a key role in the Korean ubiquitous network society, developing economies could reap its largest benefits. The Portable Internet could bring Internet connectivity to the developing world the same way mobile phones have brought voice. Policy-makers around the world, especially in developing economies, could usefully examine the evolution of the Portable Internet in Korea as a way to spread broadband data to the world’s mobile phone users.

Even where the negative aspects of the proliferation of mobile and Internet technologies are concerned, Korea has some interesting lessons to pass on. Policy-makers in Korea have already been addressing issues such as Internet addiction and mobile SPAM that have only just started to appear in other countries around the world. Advanced mobile markets such as Korea and Japan are forced to make groundbreaking policy and social decisions without any other country examples to follow. What is clear is that many of the problems showing up in leading mobile information societies now will begin to appear in other economies around the world. This allows policy-makers around the world a glimpse of what is to come, allowing them better time to plan and prepare.

One area where this will be especially important is privacy and data protection. As the mobile phone becomes the payment method of choice in Korea, consumers will demand better and more secure protection of their data. Korea's mobile leading work with mobile payment systems can offer a foundation for other mobile operators and banks that are moving into m-commerce. At the least, Korea's early lead with mobile applications such as banking and m-wallets can provide researchers with excellent case studies for new service implementations in their own economies.

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Korea is on the cutting edge of the ubiquitous network society and nations around the world are watching as Korea's highly-developed Internet and mobile networks move towards convergence. As the network evolves, so do its users. Koreans have quickly adopted and integrated mobile and Internet technologies into their lifestyle. In fact, life in Korea has become a life surrounded by information. Users of all ages are taking advantage of quick, easy access to information and using technology to increase their productivity.

At the same time, Korean's are faced with both positive and negative elements of the mobile information society. While the Korean information society is moving into uncharted area, the main players involved are taking great care to help protect information and make the information society a safe place. No one knows exactly what the future ubiquitous network society will look like, but Koreans are on the verge of making it a reality.

Endnotes

1 The term "ubiquitous dreamworld" comes from a special permanent exhibition on ubiquitous network societies staged at the premises of the Korean Ministry of Information and Communication, in Seoul, see: www.ubiquitousdream.or.kr/

2 ITU World Telecommunication Indicators Database.

3 See ITU Korean IT Case Study at: www.itu.int/ITU-D/ict/cs/korea/material/CS_KOR.pdf

4 See the ETCA news release on the "Local Loop Unbundling scorecard" at: www.ectaportal.com/html/index.php?pgd=regulatory_article&sc=3&rec=1839

5 See "South Korea: Living Laboratory for Broadband" at: www.broadbandhomecentral.com/report/backissues/Report0301_4.html

6 See "Invaders from the land of broadband", Dec 11, 2003, www.economist.com/business/displayStory.cfm?story_id=2287063

7 See "Online Game Special", in IT Korea, March 2004 issue, pp 51-69.

8 IT Korea, November 2003 (Issue 4), International Cooperation Agency for Korea IT.

9 See World Markets Telecoms Daily, "South Korea: SK, KTF Reveal Contrasting Fortunes in Q4 2003 " February 2, 2004.

10 IT Korea, November 2003 (Issue 4), page 100, International Cooperation Agency for Korea IT.

11 See "Korea eases 3G auction rules" at: www.3gnewsroom.com/3g_news/jan_01/news_0209.shtml

12 Future services are expected to allow for 100 Mbit/s in high-speed vehicles while providing up to 1Gbit/s at walking speed by 2010.

13 ITU-R defines IMT-2000 enhancement as a multimedia service delivering 10 Mbit/s under fast moving conditions.

14 High Speed Wireless LAN will provide multimedia information at 500 Mbit/s – 1 Gbit/s for laptop computers or PDAs with 100 m radius.

15 See MIC Internal Report, "Wireless Mobile Telecommunications Industry Promotion Plan," September 2003.

16 For a primer on WiBro, see the presentation from Samsung at: www.itu.int/ITU-D/imt-2000/documents/Busan/Session3_Yoon.pdf. For more background on the general concept of "portable Internet technologies", see "ITU Internet Reports 2004: The Portable Internet", 220pp, Geneva, available at www.itu.int/portableinternet

17 See: *Three Operators picked for home grown Portable Internet service*, at: www.mic.go.kr/index.jsp, on 10 March 2005.

18 Ibid, on 16 February 2005.

19 PCS represents CDMA service in the 1.8 GHz frequency band.

20 Welcome to e-Korea, Korea Agency for Digital Opportunity and Promotion, page 38.

21 See "Mobile banking transactions doubled in 2003" at: www.koreaherald.co.kr/SITE/data/html_dir/2004/01/28/200401280037.asp

22 See "Samsung's Golden Touch" at www.samsung.com/mea/english/news-040102a.htm.

23 Shin Sang-Chul, " IT Infrastructure for Tomorrow with Korean Experience", October 2003, IST 2003.

24 ITU/MIC Korea Symposium "Towards the realisation of the broadband convergence network", held on 3 March 2004, Seoul. For more information, see: www.ica.or.kr/en/itu-en/ITU_6.asp

25 See "Wiring Korea – Competition heats up for 2.3 GHz mobile Internet" at: www.times.hankooki.com/lpage/tech/200306/kt2003060818544410840.htm

26 See "Hanaro Pulls Out of WiBro", in Red Herring, 26 April 2005, see: www.redherring.com/article.aspx?a=11890

27 See Korea Times Article at: www.times.hankooki.com/lpage/tech/200406/kt2004061618183911800.htm

28 DMB is the version of mobile broadcasting favoured by MIC. However, industry players may have their own names for competing, but similar technologies. These include PSMB, and BCMCS.

29 For a description of the IT 839 strategy, see: www.mic.go.kr/eng/res/res_pub_it839.jsp

30 Mobile networks have traditionally been closed from public traffic, unlike the public Internet, because of differences in its inherent cost structure. Internet backbone networks can handle data at very low cost. In contrast, the bandwidth allotted to mobile carriers is much more scarce and is thus also more expensive. However, as networks converge, the two networks need to be able to freely pass information back and forth, regardless of differences in cost.

31 See "EU teams with Korea on IPv6 development" at: www.news.zdnet.co.uk/communications/networks/0,39020345,39119162,00.htm

32 For more information, see Sewon Oh, "RFID/USN technology in Korea", presentation made at ITU's "New Initiatives Workshop on Ubiquitous Network Societies", 6-8 April 2005, Geneva, at: www.itu.int/osg/spu/ni/ubiquitous/Presentations/2_oh_RFID.pdf

33 See: www.pulverblog.pulver.com/archives/001221.html, citing an article in The Korea Herald, October 2004.

34 The DongDaeMun market even has its own website: www.dongdaemun.com

35 See IT Korea, January 2004 (Issue 5) at: www.ica.or.kr/en/journal_read.asp?board_seq=250&seq=948&page=1

36 See: The Korea Times: Samsung Develops World's First Wearable 'Mouse' at: www.times.hankooki.com/lpage/biz/200312/kt2003122417420911910.htm

37 See IT Korea, January 2004 (Issue 5), page 35 at: www.ica.or.kr/en/journal_read.asp?board_seq=250&seq=948&page=1

38 See "Safeguarding your mobile phone" from the Metropolitan Police at: www.met.police.uk/crimeprevention/phone.htm

39 See "Is Another Bubble About to Pop in Korea?" at: www.businessweek.com/magazine/content/03_39/b3851157_mz033.htm

CHAPTER IX

UBIQUITOUS NETWORK SOCIETIES:
THE CASE OF SINGAPORE

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The ubiquitous network societies case studies programme is managed by Lara Srivastava <lara.srivastava@itu.int>, under the direction of Tim Kelly <tim.kelly@itu.int>. Other country case studies on Ubiquitous Network Societies (Italy, Japan and Korea), as well as three background papers can be found at www.itu.int/ubiquitous

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UBIQUITOUS NETWORK SOCIETIES: THE CASE OF SINGAPORE

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Ubiquitous Network Societies: The Case of Singapore

1 Introduction

In 2004/05, Singapore was selected as one of four SPU case studies to be conducted on the topic of Ubiquitous Network Societies. Although a number of factors went into this decision, the most significant was the clear presence of elements critical for the healthy development of a ubiquitous network society. These include an omnipresent high-speed network (both fixed-line and wireless), applications and services that leverage on their pervasive nature, a nurturing policy and regulatory environment and a population receptive to technology.

At the time of writing this report, 74 per cent of all households in Singapore owned one or more personal computers. Internet access was enjoyed by 65 per cent of all households with two out of three accessing the Internet through broadband. About 83 per cent of all companies in Singapore used a computer with 76 per cent of all companies having Internet access. Mobile phone penetration in Singapore reached a high of 92 per cent in 2004.

1.1 Scope and outline of the report

This report aims to provide a concise description of Singapore's development as a ubiquitous network society. Chapter one provides a brief introduction to the country, which is followed by an overview of the ICT sector. Chapter two goes on to describe the institutions and highlight the national ICT strategies, policies and programmes that currently guide the country in its course towards developing a ubiquitous network society.

Chapter three looks at Singapore's fixed and mobile communications networks, the building blocks of a ubiquitous network environment. The chapter describes their genesis; their expansion; their market characteristics; and the policies and strategies that have fostered their development.

Chapter four describes the development and deployment of new technologies, applications and services that leverage increasingly on the ubiquitous nature of communications networks in Singapore. In particular, the chapter will focus on the use of technologies such as RFID across the different sectors of the economy and society. It also goes on to discusses some of the challenges that stand in the way of realizing the vision of a ubiquitous network society. Chapter six focuses on the social aspects of a ubiquitous network society.

1.2 Country background

1.2.1 Geography and demographics

Singapore has a land area of 699 square kilometers and consists of a group of islands, dominated by a main island, on which the population is concentrated. The country is located just off the southern tip of the Malay Peninsula and is linked to Malaysia, its northern neighbor, by two bridges across the Johore Strait. The closest island grouping of its southern neighbor, Indonesia is located just across the Singapore Strait. Singapore's strategic position at the crossroads of multiple trading routes has defined its unique history and economic development. These particularities coupled with its relatively small size, however, give its population a heightened sense of political and economic isolation and vulnerability. Singapore is a trading and business hub reliant on good relations with its neighbors and trading partners for its economic success and political stability.

In 2004, the population of Singapore was estimated at 4.2 million, of which 3.5 million were Singapore residents. About 77 per cent of the country is of Chinese descent, the result of several waves of immigration. The Malay population makes up about 14 percent of the country while another 8 percent is composed of descendants of immigrants from the Indian subcontinent, many of them Tamils from southern India. A core precept of government policy is the equal treatment and acknowledgment of all cultural and ethnic backgrounds. Chinese (Mandarin), Malay, Tamil, and English are recognized as official languages, with English serving as the predominant idiom in business and government.

1.2.2 Human development

In the 2004 United Nations Development Programme's Human Development Index (HDI), Singapore was ranked twenty-fifth among the 177 countries surveyed. The HDI is a calculation based on a variety of factors, including wealth, health, education and quality of life. Singapore has the highest HDI in Southeast Asia and is second only to Japan in Asia.

1.2.3 Political economy

With a small domestic market, few natural resources, and a strategic location in Southeast Asia, Singapore developed primarily as a trading nation. It leads Southeast Asia in exports and imports, per capita. According to 2004 World Bank rankings, its gross domestic product (GDP) per capita ranks twenty-ninth in the world, at USD 21’230.

The Singapore government plays an active role in planning and coordinating all major aspects of economic life in the country. It not only proactively works to ensure a favorable climate for business and technology development through numerous and varied programs, it also provides direct financial support for critical industries. This policy is based on the concern that the relatively small size of Singapore’s domestic market might not provide sufficient market-based incentives for growth of healthy industries. The government provides direct financial support, predominantly through two methods: the holding of indirect equity stakes – often amounting to controlling interests – in domestic companies; and the provision of grants and subsidies for companies engaging in technology and service innovation. Since 1974, the government has utilized a holding company to channel its capital investments into the Singapore economy. Temasek Holdings Ltd., which is wholly owned by the government, has substantial holdings in most economic sectors, including transportation, energy, banking, shipping, diversified energy, real estate, and ICTs.

1.3 ICT market overview

1.3.1 Basic indicators

Basic ICT indicators for Singapore are set out in Table 1.1. As in most industrialized nations, the growth of overall telephone density in Singapore has slowed considerably as saturation points are reached. Although mobile subscriptions have increased steadily over the past few years, subscriber growth rates are beginning to slow. At the same time, fixed line numbers have also started a slow decline. The number of mobile subscriptions overtook the number of fixed lines in July 2000.

Table 1.1: Basic ICT indicators for Singapore

	1999	2000	2001	2002	2003
Main telephone lines (000s)	1’876	1’946	1’947	1’927	1’889
Main lines per 100 inhabitants	47.49	48.45	47.14	46.29	45.03
Internet users per 100 inhabitants	24.05	32.36	41.15	50.44	50.88
Mobile phone subscribers (000s)	1’630	2’747	2’991	3’312	3’577
Mobile phone subscribers per 100 inhabitants	41.28	68.38	72.42	79.56	85.25
Percentage of homes with a Personal Computer	58.90	61.00	63.90	68.40	73.70

Source: ITU World Telecommunication Indicators Database.

1.3.2 Market structure

Singaporeans enjoy easy and widespread access to advanced telecommunication networks and services. This has been made possible due to the country's small size, its considerable wealth and the government's emphasis on ICT (or "infocomm" in the Singaporean context) sector development. Nevertheless, Singapore's small market size also acts as a constraint on the level of competition possible at the network facilities level. Singapore generated an estimated USD3.6 billion in telecommunication revenues in 2003.

In April 2000, Singapore liberalized its telecommunications market fully, allowing competition in all telecommunications markets and lifting all limits on direct and indirect foreign equity investment in Singaporean operators. In March 2005, there were 35 Facilities-Based Operator (FBO) licensees that owned their own facilities and more than 700 Service-Based Operator (SBO) licensees that provided telecommunications services over third-party networks. Key FBOs include:

- *Singapore Telecommunications Ltd. (SingTel)* is the country's incumbent operator. It was corporatized in 1992 and partially privatized in 1993. Temasek Holdings, the Singapore government's holding company, currently owns 63 per cent of SingTel. In 2004, SingTel continued to dominate the telecommunications sector with a 99 per cent fixed line market share and a 41 per cent share of mobile subscribers. Its competitors, however, have made strong gains in the mobile segment with SingTel's market share falling by more than 5 per cent in the preceding year. At the end of June 2004, SingTel's subscriber base included 1.9 million fixed-line subscribers and 1.5 million wireless subscribers. It also boasted a broadband subscriber base of 268,000, or a 60 per cent share of the market.
- *StarHub* is Singapore's second-largest telecommunications operator, having launched its fixed line and mobile services on 1 April 2000 when the market was liberalized. StarHub's main shareholders are Singapore Technologies Telemedia (wholly owned by Temasek Holdings), NTT Communications Corporation and Media Corporation of Singapore. Following its merger with Singapore Cable Vision (SCV) in 2001, StarHub acquired a two-way Hybrid Fibre Coaxial (HFC) network that covers 99 per cent of homes in Singapore. At the end of June 2004, the operator had 1 million mobile subscribers, 393,000 residential cable TV customers, 150'000 retail broadband subscribers and 18'000 business subscribers for its fixed services.
- *Mobile One (M1)* is the country's second mobile licensee. It was formed in 1994 and launched paging and mobile services in April 1997 when SingTel's monopoly over those markets expired. Its major shareholders include Keppel Telecoms and Singapore Press Holdings Multimedia. At end-June 2004, M1 had 1.1 million mobile subscribers.

2 ICT POLICY AND STRATEGY

2.1 Sector reform history

Singapore has undergone three distinct phases of ICT sector reform. In 1992, Singapore Telecommunications (SingTel) was corporatized. During the process, regulatory and operational functions were separated with the reconstitution of the Telecommunications Authority of Singapore (TAS) as the sector regulator. Reflecting the government's proactive approach to industry development, the mandate of TAS included not only regulation but also the promotion of the telecommunications industry in Singapore. During the mid to late 1990s, TAS was the agency that implemented the phased introduction of competition through the licensing of services that were progressively liberalized.

During this period, SingTel was operating under a licence that included exclusive rights to provide public basic domestic and international telecom services until 31 March 2007. Although SingTel was also authorized to provide mobile cellular services, the government acted to introduce competition in the mobile cellular sector in May 1995 with the licensing of Mobile One (M1) as the country's second mobile licensee.

As the pace of liberalization in global telecommunications markets accelerated during the mid-to-late 1990s, however, Singapore felt pressure to keep pace with other East Asian states. In April 1996, the government kicked off a second phase of liberalization, announcing that it would accelerate the start of full competition in the telecommunications sector to April 2002. In the process, SingTel's exclusivity period was also reduced by seven years, to 1 April 2000, with plans to introduce a measure of limited competition by licensing an additional fixed-line licensee, StarHub.

Before StarHub could enter the market, however, Singapore had embarked on the third phase of liberalization, accelerating the date for full competition from 1 April 2002 to 1 April 2000. On that date, Singapore opened all its telecommunications markets to competition[1]. It was clear that the main impetus for accelerating liberalization was the perception that Singapore risked falling behind its rivals in its effort to become the regional info-communications hub. Hong Kong, China, for example, had already moved forward with full liberalization earlier.

At the same time that the government was moving to open its markets, a number of different government agencies – including TAS, the National Computer Board (NCB)[2], the Economic Development Board (EDB) and the then Singapore Broadcasting Authority (SBA) developed overlapping responsibilities with regard to ICT promotion, regulation and development. As a result, legislation was tabled to create a single, focused agency that would combine all government promotional and regulatory efforts involving the converging communications industries. The Info-Communications Development Authority of Singapore Act of 1999 officially disbanded TAS and the NCB, creating one new statutory board, the Info-Communications Development Authority (IDA). IDA was legally constituted on 1 December 1999.

2.2 Legislation and regulation

Telecommunications Act

The Telecommunications Act of 1999 (The Telecoms Act), passed by Parliament in tandem with the IDA Act, provides much of the legal basis for IDA's actions as industry promoter and market regulator.

The Telecoms Act empowers IDA with the right to provide all telecommunications services within Singapore and gives it the authority to transfer that right to operators through its power to issue licences. IDA also may attach conditions to licences, and it can modify those conditions. In general, there are two categories of licences for the provision of telecommunication services in Singapore: (1) Facilities-Based Operator (FBO) licences and (2) Services-Based Operator (SBO) permits. The FBO licence is always an individual licence, while the SBO may be an individual licence, or for some services, a class licence[3].

FBO licences are required, in general, for any kind of network infrastructure build-out and operation. This includes international and domestic fixed wire transmission, public cellular mobile networks and switching facilities such as international gateways. Other than for spectrum scarcity reasons, there is no limit on the number of licences that can be issued for services in Singapore. Whenever spectrum limits are an issue, licences may be distributed through a selection or auction process.

Certain SBO licences are distributed on an individual basis such as international simple resale (ISR), virtual private network (VPN) services, Internet access, Internet exchange services and mobile virtual networks (MVNOs). Other services provided over the public switched telephone network and the Internet are subject to a class licence. These would include simple resale of public switched telephony, international callback services, Internet-based voice (VoIP) or international calling card services.

Apart from licensing, the Telecoms Act also gives IDA three general options through which it can implement regulations. IDA can issue:

- "Codes of practice" and "standards of performance" that apply to all licensees offering services;
- "Directions" to specific licensees, instructing them to alter their behavior and giving them a time limit for compliance; and
- "Advisory guidelines".

For example, the *Code of Practice for Competition in the Provision of Telecommunications Services* was drafted as the blueprint for IDA's regulation of the telecommunications industry in Singapore. It lays the foundation for interconnection and consumer protection as well as applies the principle of asymmetrical regulation to ensure a level playing field.

IDA also has the authority to allocate radiocommunications spectrum for both public sector and private sector uses. IDA collaborates with the Media Development Authority (MDA), the broadcast regulator, for the latter to assign frequencies to broadcasters after IDA has decided on the national spectrum allocation for broadcasting service and cleared the technical operation for broadcast transmitters.

Beyond policy and regulation, IDA is also tasked to promote the development of info-communications within Singapore. In general, its promotional activities can be grouped into three categories: (1) Outreach to residents and companies to promote the use of information and networking technologies; (2) promotion and development of Singapore's info-communications industry itself; and (3) outreach beyond Singapore's borders to stimulate investment and provide an outlet for exports. IDA pursues these, in part, through organized and well-funded programs to proactively subsidize and sponsor the development and adoption of new technologies, applications, services and business models. Initiatives and promotional activities range from technology fairs and expositions to providing seed money for research and development efforts.

Electronic Transactions Act

The Electronic Transactions Act was enacted in July 1998 to create the legislative framework for electronic transactions in Singapore. It provides for the legal recognition and usage of electronic signatures and electronic records, and also covers the duties of certification authorities, duties of subscribers and the regulation of certification authorities. The Act follows closely the UNCITRAL Model Law on Electronic Commerce, which sets the framework for electronic laws in many countries. It addresses the following issues:

- *Commercial code for e-commerce transactions*

  The Act defines the rights and obligations of the transacting parties. It also addresses the legal aspects of electronic contracts, use of digital signatures and concerns for authentication and non-repudiation.

- *Use of electronic applications for public sector*

  The Act contains an omnibus provision through which government departments and statutory boards can accept electronic filings without having to amend their respective Acts. It also allows public bodies to issue permits and licences electronically.

- *Liability of network service providers*

  Realizing that it is impractical for network service providers to check all the content to which they provide access, the Act specifies that network service providers will not be subject to criminal or civil liability for such third-party material, in relation to which they are merely the host.

- *Provision for a Public Key Infrastructure (PKI)*

  Singapore has been developing a Public Key Infrastructure as a foundation for a trusted and secure environment in electronic commerce. In line with the PKI development, the Act provides for the appointment of a Controller of Certification Authorities (CCA) to enable regulations to be made for the licensing of certification authorities (CAs), including recognition of foreign CAs.

Computer Misuse Act

The amended Computer Misuse Act was enacted in June 1998 to deal with new potential abuses of computer systems in a networked environment. The amended Act takes a more nuanced approach to provide for enhanced penalties proportionate to the different levels of potential and actual harm caused. It also addresses new potential computer abuses such as denial or interruption of computer services and unauthorized disclosure of access codes.

2.3 National strategies

The government of Singapore has traditionally taken an active role in the development of the nation’s ICT sector. From the early 80s, the Singapore government has methodically designed and implemented a succession of national plans and strategies to guide the nation on its ICT development path (see Box 2.1).

Box 2.1: National strategies
1980 to the present

Reflective of the changing technological, business and social climate, Singapore has progressed through five distinct national IT plans over 25 years.

National Computerisation Plan (1980-1985). One of the key objectives of the National Computerisation Plan was to computerize the major functions in every government ministry. Directed at improving public administration through the effective use of IT, the effort focused on automating traditional work functions, reducing paperwork and escalating the deployment of IT in the Public Service.

National IT Plan (1986-1991). The focus then shifted to the provision of one-stop services through cross-agency linkages. A significant number of public services were developed in the direction of the 'One-Stop, Non-Stop' strategy by using IT to automate and integrate traditional manual administrative processes.

IT2000 (1992-1999). The IT2000 masterplan was launched to position Singapore as a global IT hub. Building on the National IT Plan, the expanded focus included construction of a nationwide broadband network, the development of common network services (e.g. directories, billing, security authentication), the forging of international alliances with industry leaders in Japan, Europe and the US and the establishment of a policy and legal framework on issues such as intellectual property rights and computer crime. In the public sector, the Internet was introduced as a new delivery channel providing both information and transaction-based services to the public.

Infocomm 21 (2000-2003). Spurred by the convergence of telecoms and IT, the Infocomm 21 blueprint was launched in 2000 to develop Singapore into a global infocomm capital with a thriving and prosperous e-economy and a pervasive and infocomm-savvy e-society. The plan involved multiple strategic thrusts that included: developing the ICT industry, promoting e-business practices and applications, delivering more government services online, expanding access to ICT to the population, nurturing ICT talent and creating a pro-competitive ICT policy environment.

Connected Singapore (2003- present). The current blueprint continues to build on the Infocomm 21 plan but with a different focus. It sees infocomm as a key enabler, to create new business opportunities, consumer value and cultural experiences.

Source: Adapted from IDA

In 2003, IDA launched its current national strategy, "Connected Singapore". Essentially a re-visioning exercise of the previous national strategy, the current strategy takes cognizance of the need for Singapore to develop new sources of growth, including new areas involving creative inputs, like design and the arts. Instead of developing infocomm for its own sake, the vision sees infocomm as a key enabler, aimed at increasing the productivity and efficiency of individuals, organizations and businesses. Under this vision, infocomm technology is also regarded as a catalyst for the creation of new business opportunities, consumer value and cultural experiences.

IDA currently implements a wide range of programmes under four key strategies to bring about the realization of the Connected Singapore vision:

- *Infocomm for Connectivity, Creativity and Collaboration* aims to place infocomm products and services into the hands of everyone by developing an infocomm infrastructure for pervasive and secure access; encouraging the development and use of infocomm applications and services; and promoting infocomm literacy.
- *Digital Exchange* aims to develop Singapore as a leading global digital distribution and trading centre. IDA currently focuses on developing end-to-end infrastructure that integrates the processes of digital production, management, localization, archival and secure distribution. This infrastructure in turn is aimed at supporting a wide range of businesses such as online gaming, digital publishing and software distribution.
- *Engine of Growth* aims to grow new economic activities and job creation in infocomm by focusing on the development of five key industry clusters: value added mobile services, infrastructure for wireless and wireless networks, multimedia processing and management, web services and portals and security and trust infrastructure.
- *Agent for Change* aims to help businesses and government agencies use infocomm to achieve higher levels of efficiency in delivering their products. This involves reengineering key business clusters

and government services through deploying common infrastructure and standards, redesigning business processes and encouraging the use of technologies and applications that improve linkages between the government, companies and consumers.

With the 3-year Connected Singapore lifecycle ending in 2006, IDA is currently embarking on a new strategic visioning and planning exercise to develop the next national strategy termed iN2015.

It is useful to note that despite the ostensible differences seen in the couching of each successive national strategy, the Singapore government's efforts to promote infocomm development have been characterized by progressive evolution as opposed to disruptive revolution. To a large extent national strategies preserve continuity in infocomm development while serving as a catalyst for further renewal. A large number of established programmes continue from one national strategy to the next, as do established institutional structures. Institutional reorganization and the lapsing of established programmes are not generally timed to match the unveiling of a new national strategy.

At the same time, it is also important to realize that the introduction of each national strategy is not designed to be static nor does it exist as an exclusive self-contained policy guide. On a periodic basis, complementary strategies and policies are introduced during the lifespan of a national strategy to reinforce, refresh, and occasionally refocus its basic tenets.

2.4 Infocomm Technology Roadmap (ITR)

Alongside the development of national ICT strategies, IDA also embarks on periodic technology visioning exercises in order to identify key technology enablers and technology market trends. Referred to as Infocomm Technology Roadmaps (ITR), IDA is currently in its 5th cycle, having released its 10-year Infocomm Technology Roadmap 5 (ITR5) in March 2005 (see Box 2.2).

Box 2.2: Highlights from Infocomm Technology Roadmap 5 (ITR5)

ITR5 forecasts the following broad trends:

1. The computing wave

By 2015, the PC as we know it today will 'disappear' and computer mainframes will be accessible via revolutionized devices infused with nanotechnology. Computers will be so small that they will be embedded in everyday devices, and computing will be further revolutionized by innovations including Grid Computing, Peer-to-Peer technology, Service-Oriented Architecture such as Web Services, and software agent technologies.

2. The communications wave

Experts anticipate that the world will be covered by optical fiber providing an almost unlimited capacity to transport data anywhere around the world. Its low-cost deployment will result in unlimited bandwidth subscription, and this fabric of network connectivity will mean broadband will be available everywhere where the service is needed. It is also predicted that Internet Protocol (IP) will become the unifying platform, providing high levels of end-to-end quality of service and security.

3. The sentient wave

The confluence of the first two waves will result in intelligent devices that can sense and interact with one another. Countries will exploit these to build nationwide sensor networks, like chemical and biosensors, to operate around the clock, detecting a wide range of potential homeland threats. Smart systems will also be deployed for various purposes. For example, smart systems will be set up to advance eldercare, sensing and reminding elderly patients at home to take their medication.

Source: IDA

2.5 "Wired with Wireless" programme

Initiated in October 2000 under the Infocomm 21 plan and reprised by the Connected Singapore blueprint, IDA's Wired with Wireless programme is the organization's main launch pad for major initiatives to develop the country's wireless value chain – from infrastructure to content.

Under the programme, IDA collaborates with industry to identify, develop and launch key projects with industry-wide impact. This collaboration largely takes the form of pilot and trial projects that are designed to foster thought leadership; market access development; manpower and technology development; infrastructure & product development; and industry and consumer adoption in five key areas: machine to machine communications (M2M), wireless multimedia and messaging, location based services, mobile commerce and wireless enterprise. Key ongoing initiatives under the programme include the following:

In October 2000, the *Pilot and Trial Hotspots (PATH) Initiative* was launched as a SGD 78 million government grant programme aimed at accelerating the development of innovative infocomm infrastructure, applications and products. The programme supports projects proposed by companies and organizations that are registered and operational within Singapore. Originally targeted at developing the five key wireless areas listed above, this initiative was subsequently expanded to include other innovative infocomm technology areas prioritized by IDA.

Under the PATH initiative, IDA uses a *Call for Collaboration (CFC)* mechanism to promote industry partnerships in the development of infocomm solutions and applications. Under this process, CFCs are issued to interested industry players for proposals to collaborate with one another in the development of pilot and trial projects that can benefit the entire industry as a whole. IDA support in the form of grants and other incentives are used as an enticement. The list of Wired with Wireless CFCs that have been issued include:

- Mobile Payment Systems CFC
- Mobile Workforce Solutions CFC
- Wireless Java Solutions CFC
- Pervasive Wireless Access CFC
- Location-Based Services CFC
- Smart Airport & Passenger Travel CFC

Some of the applications and services that have been developed as a result of these CFCs are described in greater detail in the chapters below.

Besides facilitating infocomm companies to develop and implement their solutions through pilots and trials, IDA also has a Market Development (MADE) initiative that was set up to help accelerate a company's foray into potential markets. The initiative supports market research activities such as test marketing, as well as showcases and promotes innovative products through joint promotional activities.

In keeping with the leadership role played by the government in industry development, IDA has also set up a *Wireless Technology Alliance (WTA)* to encourage the transfer of wireless technology skills and expertise among local wireless industry players. Designed as an industry forum, its goal is to match make industry players that occupy different tiers on the wireless value chain. For example, the partnerships that the initiative has brokered include the establishment of the Java Wireless Competency Centre, which brings together IDA, Sun Microsystems and the Institute for Infocomm Research for the purpose of Java research and training.

Reflecting the holistic approach to wireless development, the Wired with Wireless programme also incorporates elements of skills development and awareness building. With the aim of seeding talent and increasing exposure to the wireless industry among the youth in Singapore, IDA has facilitated the setting up of *Mobile Clubs* in secondary schools and junior colleges. Mobile Clubs are the product of partnerships between interested schools and a wireless industry sponsor(s) who works with the school to provide wireless training and industry exposure. Mobile club activities may include the development of basic logos and ring tones for mobile phones. More advanced students may be given an introduction to Wireless Access Protocol (WAP) and Java tools to program their own games and applications. Currently mobile clubs have been established in five schools on the island.

3 Building blocks of a ubiquitous network

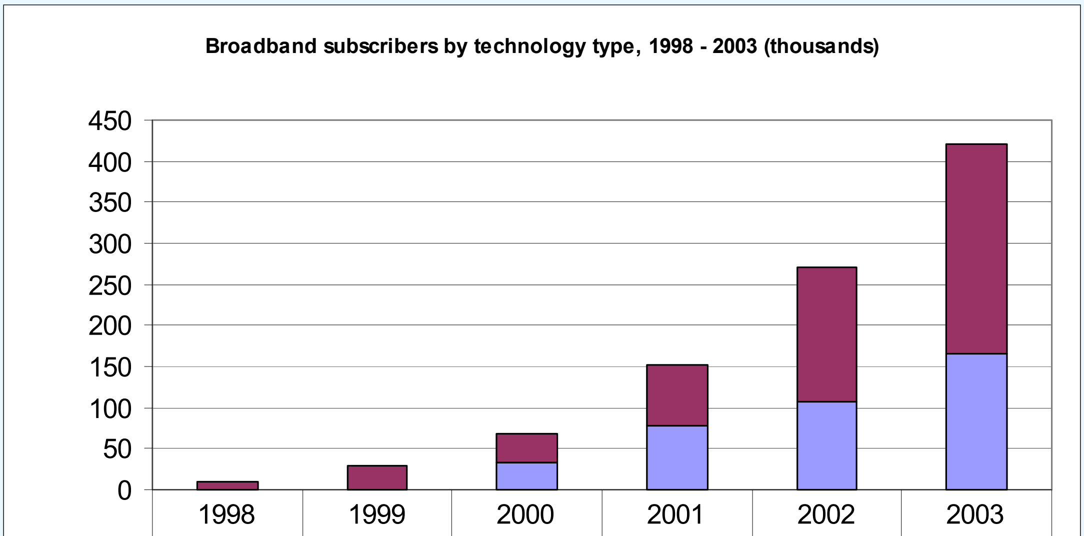
3.1 Fixed-line broadband

In 1992, under the IT2000 master plan, planning began for the building of a national information infrastructure (NII) to support the applications it proposed. The construction of a high-speed nationwide broadband network was envisioned as the cornerstone of the NII. In 1996, 1-Net Singapore, an industry consortium led predominantly by government-linked companies, was formed to build, own and operate the core Asynchronous Transfer Mode (ATM) backbone network for Singapore ONE. Singapore ONE was to comprise two distinct but integrated levels. The first was a broadband infrastructure level of high-capacity networks and switches. The second was a level of advanced applications and services that took advantage of the infrastructure's high-speed and high-capacity capabilities. Construction on the 622 Mbit/s nationwide fiber optic network lasted till June 1998 when it was commercially launched, making Singapore the first in the world to have a nationwide broadband network covering 99 per cent of the entire country.

Retail residential broadband access is now mainly supplied through three providers: SingTel, using ADSL technology, StarHub, using cable modem technology and Pacific Internet, a local ISP that uses a combination of SingTel's and StarHub's unbundled last mile infrastructure (see Figure 3.1). According to IDA statistics, at the end of 2004 Singapore had 512'400 broadband subscribers and a household broadband penetration rate of 42.3 per cent.

Singapore's model of broadband promotion and growth has attracted a mix of admiration and criticism. An absence of effective competition and the lack of compelling broadband content resulted in low adoption rates in the first few years following its launch. To a large extent, government user subsidies played a much larger role in boosting adoption in the early years than commercial demand. Despite initial setbacks, however, Singapore ONE nevertheless served successfully as the centerpiece of the country's commitment to technological advancement, perking industry interest in the sector. Over the past few years, with more competition, lower prices and a wider range of services, the Singapore ONE has achieved the results hoped for by its original architects, albeit a little later than envisaged. The construction of the Singapore ONE nationwide broadband network was clearly an enterprise ahead of its time.

Figure 3.1: Broadband in Singapore
Broadband subscribers by technology type, 1998 - 2003 (thousands)



	1998	1999	2000	2001	2002	2003
DSL	10	30	36	73	162	256
Cable	0	0	33	78	108	165

Source: ITU Telecommunication Indicators Database

3.2 Wireless broadband

3.2.1 Wireless broadband access (WBA)

With close to complete fixed-line broadband network coverage in Singapore, the option of using wireless technologies to deliver fixed-wireless broadband access has not been commercially popular among the major operators[4]. Nevertheless, in a renewed bid to introduce greater facilities based competition into the broadband market segment, IDA announced the intended release of spectrum for wireless broadband access (WBA) in the 2.3 GHz and 2.5 GHz frequency bands, which were earlier earmarked for technology and business model trials in Singapore. IDA will divide the spectrum into 25 lots, with most companies allowed to bid for up to the six lots that ensure island wide coverage. Market incumbents StarHub and SingTel, however, will be limited to only four lots each, in an attempt to encourage new market entrants. Successful bidders for the 2.5 GHz band will have to offer public wireless broadband services within 18 months of the licence being issued, while those working on the 2.3 GHz band will be given 36 months due to the limited amount of equipment

In order to preserve operator flexibility, IDA has announced that it will not impose requirements on carrier technology or provider interoperability. Unlike 3G licensees, mobile broadband providers can also opt to roll out services in a limited area rather than nationwide. Depending on the technology deployed by operators, WBA services may eventually be accessible from either fixed points or mobile devices. But due to a commitment IDA made during the 3G spectrum auctions, successful bidders of the WBA spectrum will not be allowed to deploy any technologies belonging to the IMT2000 family of 3G standards prior to 1 January 2006. Acknowledging that the line between 3G services and mobile WBA services are blurred, IDA employs a “fixed” versus “mobile” distinction as the key differentiating factor between the two services. As a result, WBA operators will not be allowed to offer mobile or restricted mobile services at vehicular speeds above 10 km/hour before 1 January 2006, a speed limit based on definitions introduced by an ITU-R recommendation on IMT-2000 technologies[5]. After 31 December 2005, subject to licensing requirements, WBA operators will be allowed to offer any type of broadband wireless service, fixed and/or mobile.

Industry response to the announcement has been mixed with potential new market entrants applauding the decision to limit spectrum allocated to the market incumbents. Nevertheless, operators have also raised concerns regarding the timing of the auctions. With the emergence of different technologies offering different capabilities and harnessing different frequencies, some carriers are waiting for a single global standard to emerge.

One possible standard that is currently being monitored by IDA and operators is WiMax, based on IEEE's 802.16 standard, which many expect to be largely deployed in the 3.5 GHz band. IDA is currently studying the possibility of issuing 3.5 GHz spectrum for the provision of WBA services. Currently, the 3.5 GHz band is heavily used in Singapore for fixed-satellite services.

As a whole, industry interest in providing WBA services in Singapore appears strong with interested operators having commenced WBA trials. M1, for example, announced in November 2004 that it had started technical trials of wireless broadband systems that allow access speeds of more than 1 Mbit/s. These include technologies based on FDD (paired spectrum), TDD and UMTS TDD.

3.2.2 Wireless Local Area Networks (WLAN)

In 2004, there were more than 8 public WLAN service providers that extended service coverage to more than 600 public hotspots in Singapore. While this represents a WLAN density of one hotspot per square kilometer in Singapore, hotspot coverage is concentrated largely in commercial areas that attract high volumes of human traffic such as in the airport and in shopping malls.

Currently, SingTel boasts coverage of more than 200 hotspots across the island. These are mostly centered on popular food and beverage outlets such as Starbucks and Burger King, as well as a variety of country and community clubs. Hotspot access is available to subscribers on a pre and post-paid basis. StarHub entered the WLAN hotspot market with the launch of its largest wireless LAN hotspot at the Suntec City Convention Centre, covering 180,000 square meters. StarHub also currently provides wireless coverage in more than 300 hotspots scattered over the island. In addition to operator-managed hotspots, non-telecommunications related companies have also hosted WLAN hotspots to complement their businesses. McDonalds restaurants, for example, have set up hotspots in over 120 of locations in Singapore in partnership with wireless operators.

Operator figures suggest that the use of WLAN hotspots is increasing. In 2004, for example, SingTel reported a doubling in the number of WLAN minutes used by its subscribers over the previous year. The operator sees more than a hundred thousand minutes of use on average for its WLAN hotspot service every month.

A number of factors have contributed to this growth. On the part of the operators, increases in WLAN hotspot coverage and the introduction of innovative pricing plans that bundle WLAN hotspot services together with residential fixed-line broadband subscriptions and mobile data subscriptions have led to increase hotspot use. More significantly, increase usage also has to be attributed to the increasing popularity of devices that are WLAN enabled. WLAN enabled laptops and PDAs are now increasingly seen as the industry norm.

Spectrum policy

In order to increase the deployment of WLAN networks and boost coverage of WLAN networks, IDA continues to pursue a favorable licence-exempt spectrum policy. In Singapore, licence-exempt WLAN services can be provided in the 2.4 GHz (2400-2483.5 MHz) and 5 GHz (5150-5250 MHz and 5725-5850 MHz) bands. In February 2004, IDA increased the bandwidth for WLAN in the 5 GHz band by making the adjacent 5250-5350 MHz frequency band available for WLAN deployment with a power limit of 200 mW. In October 2004, it increased power output limitations for the 2.4 GHz band from 100 mW to 200 mW in order to allow operators to achieve wider WLAN coverage with less equipment.

Wireless network interworking

In its efforts to support the development of wireless services, applications and technologies, IDA has taken a particular interest in the area of wireless network interworking, a term used to describe seamless user connectivity across multi-operator, multi-platform wireless and wired networks. Currently, different operators provide different services on different fixed-line and wireless networks which are based in turn on different technical standards. This has resulted in multiple but isolated pockets of connectivity. As a result, consumers end up having to subscribe to different operators, receiving different bills, while grappling with the inconvenience of switching networks, such as remembering different passwords for different networks.

Launched in March 2003 under the Wired with Wireless programme, the Wireless Interworking Initiative (WII) is a joint collaboration between IDA and Intel to develop an open and standards-based architecture for cross-operator network roaming, via the interworking of public WLANs, Wireless Wide Area Networks (WWAN) and Wide Area Networks (WAN)[6]. The initiative involves two main components, an interworking study and a series of lab tests.

To date, the WII has released its Public WLAN Interworking Study – Validation Report. This document describes the results of the Interoperability Lab Test which validates the Public WLAN Interworking Reference Architecture developed under the interworking study. It highlights the issues observed across the different PWLAN authentication methods and presents an assessment of these methods. The document also describes a set of recommendations and an architectural blueprint for deploying open, standards-based Public WLAN hotspots (see Box 3.1)[7].

Box 3.1: Wi-Fi roaming services in Singapore public libraries
Read & Roam @ Library

Since March 2004, public libraries in Singapore have offered multi-operator roaming wireless broadband access to their users. The service forms part of a larger arrangement that allows roaming between an alliance of several wireless operators as well as ten institutes of higher learning. Using the open public WLAN architecture validated under the IDA-Intel Wireless Interworking Initiative, the roaming service allows users to log on to WLAN hotspots provided by participating operators just by using the login IDs issued to them by their respective operators.

Source: www.icellnetwork.com

3.3 Mobile

In 1973, tone-paging services were first launched in Singapore as a precursor to the introduction of mobile services. Mobile technology made its debut in Singapore in 1977 with the launch of the country's first mobile telephone system designed to support the use of car phones. This was then followed by the introduction of a cellular mobile radio system that operated on the Advanced Mobile Phone System (AMPS) standard in 1988 by SingTel. A second analogue cellular system based on the Extended Total Access Communication System (ETACs) was then added in 1991. In 1994, digital mobile phone services based on the GSM standard were launched in the 900 MHz frequency band. The next year, a second GSM network was launched in the 1800 MHz frequency band.

Partial liberalization of the domestic mobile and paging markets was introduced in 1997 with the entry of Mobile One (M1) into the market as a competitor to SingTel. M1 was licensed to provide mobile services over both GSM and CDMA. In 2001, however, M1 migrated its approximately 50'000 CDMA users to its GSM network. In April 2000, StarHub joined M1 and SingTel in the mobile market, bringing the number of mobile operators in the market to three (see Table 3.1).

Table 3.1: Mobile technologies deployed in Singapore
Services provided by mobile operators

Operator	2G (Date of launch)	2.5G (Date of launch)	3G (Date of launch)
Mobile One	GSM 900/1800 (April 1997)	GPRS (July 2001)	WCDMA (February 2005)
SingTel	GSM 900/1800 (March 1994)	GPRS/HSCSD (September 2001)	WCDMA (February 2005)
StarHub	GSM 1800 (April 2000)	GPRS (October 2001)	WCDMA (Proposed launch – 1st half of 2005)

Source: Operator data

Mobile penetration

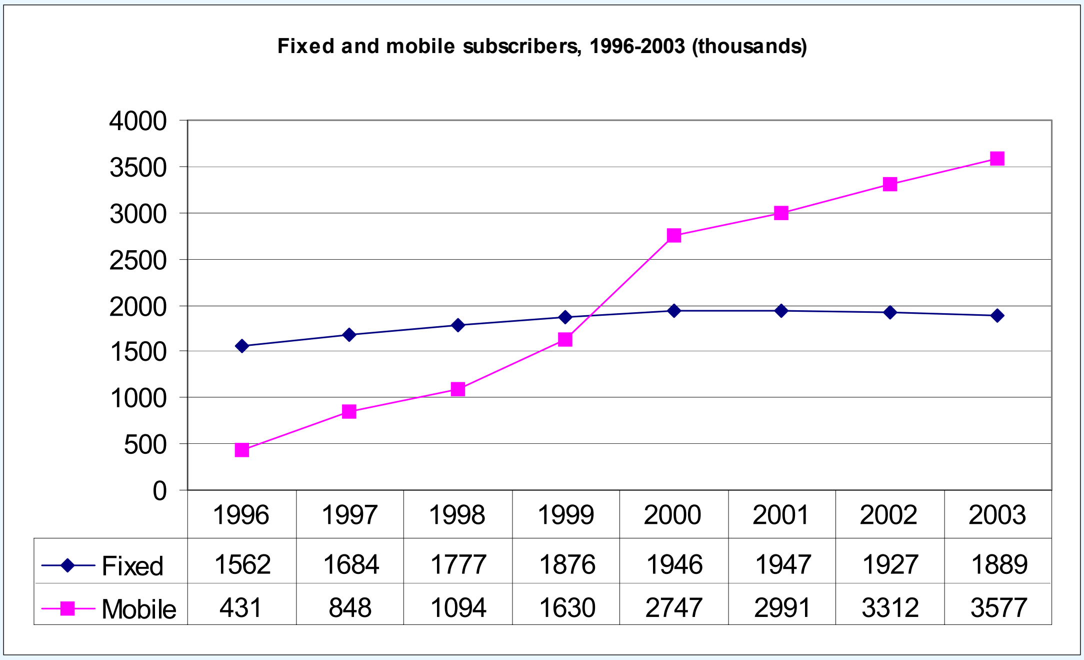
Competition and deregulation accompanied by falling prices accelerated the take up of mobile services in the latter half of the 1990s. Since 2000, the number of mobile subscribers has outnumbered the number of fixed-line subscribers (see Figure 3.2). In January 2005, there were 3'899'600 mobile subscribers in the country, resulting a mobile penetration rate of 92 per cent.

Paging services (numeric and messaging) have suffered greatly as a result of the increased popularity of mobile services. From a peak of 43.9 per cent in May 1998, paging penetration rates fell to a low of 5.6 per cent in September 2003 when M1 announced the closure of its paging business by the year-end. Currently only SingTel continues to provide paging services.

Mobile handsets

Despite the small mobile subscriber base of around 3.8 million mobile subscribers nationwide, the volume of handset sales is Singapore has been substantial. In 2004, 1.73 million mobile handsets were sold, a rise of 14 per cent over the past year. According to market research estimates, Singaporean mobile subscribers replace their mobile handsets on average once every two years. Beyond a desire to possess the latest and the best, analysts point to handset subsidies (which typically accompany post-paid subscriptions of two years), the constant introduction of new models and sharp reductions in handset prices as key drivers of constant handset replacement.

Figure 3.2: Mobile penetration in Singapore (1996 – 2004)
Mobile overtakes fixed in Singapore



Source: ITU Telecommunication Indicators Database

This has important implications on the eventual growth of new applications and services. With short handset replacement cycles guaranteeing the use of the latest handset technologies, new applications and services can be more easily absorbed by subscribers.

Policy and regulation

Mobile number portability is mandated in Singapore. IDA has prohibited operators from charging for number portability since August 2003 and has mandated number portability for Short Messaging Systems (SMS) since October 2003.

In September 2003, IDA introduced a revised allocation procedure for numbering resources. In place of allocating sequential numbers on a first-come-first-served approach, mobile operators were allowed to bid for the number levels they wished to acquire. IDA hopes to achieve greater efficiency, objectivity and transparency by using this method. It stands to reason that as operators are made to pay for the number ranges they seek, they will be more motivated to manage their numbers in a more efficient manner.

There are currently no Mobile Virtual Network Operators (MVNOs) in Singapore. UK mobile provider Virgin Mobile attempted to enter the market as an MVNO in 2001. However, due to a low take–up of its services, it ended its venture within a year.

3.3.1 Mobile data and Internet access

Despite operator efforts to the contrary, the take up of mobile data and Internet access services have been lackluster in Singapore with the exception of SMS messaging. Industry observers point to a number of factors that are likely to be behind the low initial take-up: slow transmission speeds and a general lack of content adapted for mobile use as well high fixed-line Internet and broadband penetration rates and short commuting distances make surfing from the home and the office a preferred choice for most consumers. Currently, the percentage of mobile data and Internet users as a percentage of total mobile subscribers is estimated by IDA to be at 14.6 per cent[8].

Despite the slow initial take-up, the country’s three mobile operators have continued to aggressively promote the development and use of mobile data and Internet access. Given high mobile penetration rates, operators have acknowledged that the scope for quantitative growth to be eked out of the domestic market is severely limited. In response to the market environment, the operators have instead focused on qualitative growth through the promotion of mobile data and Internet access services. For 2003, the three mobile operators reported monthly ARPUs levels of around SGD 15 to 20 for pre-paid customers and SGD 60 to 75 for post-paid customers. Non-voice services accounted for 15 to 18 per cent of ARPU during the same period, an increase of around 1 to 2 per cent over the last year for all operators.

Short Messaging Services (SMS) and Multimedia Messaging Services (MMS)

Since its introduction, Short Messaging Services (SMS) have been an immensely popular communication tool for Singaporean mobile users, particularly among the youth. All operators provide SMS services[9].

In December 2004, 692 million SMS messages were sent, an average of 22 million SMS messages sent daily. In 2004, StarHub reported that each subscriber sent an average of 113 SMS messages each month. Low SMS pricing has been cited a key driver of SMS use in Singapore. In 2004, it cost around SGD0.10 to send an SMS message with a pre-paid subscription and SGD0.05 with a post-paid subscription. Popular subscription plans often bundle the sending of a number of free SMS messages into their pricing.

In March 2002, M1 became the first in Singapore to introduce multimedia messaging services (MMS) with other operators following quickly behind[10]. According to industry estimates, around 12 per cent of Singapore's mobile phone subscribers were active MMS users in 2004. For the large part, operators have cited the increased ownership of MMS capable handsets with built in cameras. Thus far, the usage of MMS has been largely confined to user-created content such as digital images taken on camera-enabled handsets. With picture quality improving rapidly, operators have seen a corresponding increase in MMS usage.

Wireless Access Protocol (WAP)

Mobile Internet access based on Wireless Access Protocol (WAP) was initiated in the first half of 2000. All operators launched their own WAP portals during that period, offering content such as online banking, stock inquiries, news, and sports results.

2.5G

At the same time, mobile operators in Singapore were also developing faster mobile data services to boost GSM's normal data speeds of 9.6 kbit/s. In 1999, M1 introduced the island's first "high-speed" mobile data offering using proprietary technology to achieve speeds of 14.4 kbit/s. In November 2000, M1 launched a pilot higher-speed offering using General Packet Radio Service (GPRS) technology. The following month the operator subsequently became the first in the world to introduce GPRS roaming when it launched the service between itself and PCCW CSL in Hong Kong, China. SingTel currently offers a time-based mobile data service at speeds of up to 38.4 kbit/s using High Speed Circuit Switched Data (HSCSD). It also offers a higher speed volume-based service using GPRS that claims transmission speeds of up to 44 kbit/s. StarHub provides a similar GPRS service.

To date, none of the operators have added higher speed 2.5G technologies to their service offerings, having chosen instead to concentrate on the deployment of their 3G networks. In October 2002, StarHub had to abandon its initial plans to deploy Enhanced Data rate for GSM Evolution (EDGE) technology when it failed to obtain a waiver from IDA's December 2004 deadline for nationwide 3G deployment. In its representations, StarHub argued that by allowing them to deploy of EDGE in fulfillment of their 3G rollout obligations, consumers would be given the choice of an alternative cost-effective high-speed service. In their view, the deployment of EDGE would have been a logical incremental step on the evolutionary path towards 3G deployment.

Market analysis

The take-up of mobile data and Internet access in Singapore thus far appears to be lukewarm in comparison to Japan's popular I-mode service. Nevertheless, operators have continued to take great pains to boost mobile data and Internet access adoption. Given the fact that the vast majority of subscriber handsets now are GPRS enabled and that the migration of 2G users to 3G networks will take place over a period of time, operators have still found it necessary to concentrate also on promoting GPRS use. Promotional activities have typically involved a multi-pronged approach of price reductions, increased content and product bundling. In order to increase returns from data services, SingTel, for example, has bundled GPRS, ADSL broadband and Wi-Fi hotspot access services in one package.

Over the past year, there has been some cause for optimism. Operators point toward two trends that indicate that mobile data and Internet access use is on the rise: an increase in GPRS and MMS traffic and an increase in the contribution of mobile data services to monthly mobile ARPU. For example, GPRS traffic on StarHub's network doubled from 288 Gbytes in December 2003 to 589 Gbytes in December 2004. Similarly, in June 2004, SingTel reported that mobile data contributed 18 per cent of its mobile ARPU as compared to 16 per cent a year ago. As a whole, operators have credited the provision of differentiated content and lifestyle applications and the introduction of an increased range of GPRS enabled handsets onto the market with colour screens and integrated cameras as key factors behind the increasing popularity of mobile data and Internet access use.

3.3.2 Third-generation (3G) mobile

Spectrum rights

In October 2000, IDA announced its procedure for awarding 3G mobile licences, allocating frequencies in the 1900 MHz and 2100 MHz bands for 3G services[11]. Despite industry expectations of a beauty contest, an auction system was used to award four 3G licences. A reserve price was set at SGD 100 million for a licence duration of 20 years. As an incentive for operators to invest in 3G spectrum and the deployment of 3G networks, the government undertook, as part of the auction terms, not to grant any further spectrum rights for 3G mobile communication services before 1 January 2006.

Before the auction date, however, IDA was forced to drastically alter its 3G licensing strategy. At the last minute, the only outside bidder, Sunday Communications Ltd. of Hong Kong, China withdrew from the auction, having failed to submit the required bank guarantee. That left only three bidders, the incumbent Singaporean 2G licensees, as contenders for the licences, negating the need for an auction. As a result, IDA announced on 11 April 2001 that it would simply allow the incumbents to receive the 3G licences in return for a payment of the reserve price.

Industry observers blamed the outcome on the small domestic mobile market – Singapore has only four million residents – and on the worldwide collapse in investor sentiment towards telecommunications and 3G during that period. On the positive side, however, the relatively low licence fee paid coupled with the small geographic area of the country have resulted in lower capital costs for 3G network build-outs in Singapore, particularly in comparison to the capital costs that many major mobile operators have incurred in Europe. As a point of comparison, SingTel's 3G network was built by Ericsson at a cost of SGD 220 million.

It is also interesting to note that the resale of the spectrum rights for 3G licences is allowed, subject to regulatory approval from IDA. Transferred or resold spectrum, however, can only be used for 3G services. IDA approval is subject to an assessment to ensure that the resale is made in accordance with the relevant provisions in the Telecom Competition Code of Practice governing the transfer of licences and consolidation of licensees.

Network deployment

Under the terms of the licences issued, the deadline for nationwide 3G network deployment was set initially for 31 December 2003. This deadline was subsequently postponed to 31 December 2004 as a result of worldwide delays experienced in obtaining the necessary handsets and equipment. Although operators were given a choice of what standards to use – typically Wideband CDMA (WCDMA) or CDMA 2000 – a number of constraints limited operator choice in practice. The particular spectrum bands allocated for 3G services as well as the practicality of following the evolutionary path set for GSM operators resulted in all 3G licensees rolling out networks employing the WCDMA protocol.

On the expiry of the deadline, IDA announced that all three licences had successfully met licence requirements for network rollout. In its evaluation, IDA used the measurement criteria of at least 95 per cent of street-level 3G radio coverage on the island using a signal strength that is greater or equals to minus 100 dBm. Over 200,000 signal strength samples were taken from each operator's networks.

Commercial launch

On 18 February 2005, M1 became the first operator to commercially launch 3G services in Singapore under the straightforward brand name “M1 3G”. M1 was followed in quick succession by SingTel who commercially launched its 3G offering, dubbed “3logy”, the following week on 23 February 2005. StarHub announced plans to commercially launch its 3G services in the first half of 2005.

3G services were marketed aggressively on launch. M1 announced 3G video call airtime charges of SGD 0.40 a minute for incoming and outgoing calls. This was subsequently reduced to SGD 0.15 a minute a month later. At the time of launch, M1 had not revealed charges for 3G data downloads, which were free for its 3G users until the end of March 2005. To further encourage migration to its 3G services, M1 customers were allowed to upgrade to 3G on their current tariff plans by purchasing a 3G handset and switching to a 3G SIM card. It also announced that its 3G users would be able to make international video calls to 12 countries and enjoy 3G roaming in seven countries, with that list expanding over time. A week later, SingTel announced that local video calls would be charged at the same rates as local mobile voice calls – about SGD 0.15 a minute depending on the subscription plan. SingTel announced that it would also treat video call airtime as part of subscribers' free bundled airtime. On the data front, SingTel has priced 3G download charges at 30 per cent less than that charged for the slower GPRS service. Downloading a megabyte of data via 3G costs SGD 3.50, compared to SGD 5 via GPRS. Alongside, SingTel also introduced an unlimited usage data plan at SGD 199 a month. Data charges for subscribers not on an unlimited data plan are capped at SGD 299 a month.

To lure 3G subscribers, M1 and SingTel have offered most of their 3G content free during the launch period. Content already on offer include movie trailers, MP3 downloads, music videos and ‘live’ streaming of news feeds from local free-to-air channel Channel News Asia.

Market analysis

At the end of February 2005, two weeks after the commercial launch of its 3G services, SingTel claimed to have 2000 subscribers subscribed to its 3G services. Conservative industry projections predict that by year-end, the total number of 3G subscribers island wide will likely top 110’000. Hong Kong, China, with a larger market of 7 million inhabitants, counted 220’000 3G subscribers in March 2005, slightly more than one year after the commercial launch of 3G services there.

With its small market and high mobile penetration rate, Singaporean operators are likely to end up cannibalizing their existing 2G subscriber base to fuel growth in 3G subscriptions. While this may not necessarily be a bad outcome, it has nevertheless required operators to balance their strategies in launching 3G services. On the one hand, migrating 2G subscribers to 3G networks is likely to result in a corresponding increase in ARPU. On the other, 3G networks suffer from higher depreciation rates and operating costs that may result in lower returns from 3G networks if ARPU does not increase on migration. Operators acknowledge that there is some possibility of that happening once the novelty of things like videophone calls and the ability to watch multimedia programming on 3G phones wears off. Nevertheless, with operators planning to eventually migrate all their subscribers to 3G networks in the future, the main difference in strategy among operators appears to be the speed with which such migration is encouraged. While industry observers have generally encouraged a gradual migration, Singaporean operators appear to have taken a more aggressive approach. As noted above, SingTel, for example, has priced 3G videophone services at the same level as existing voice calls while also pricing 3G data services at a rate 30 per cent lower than that of its slower GPRS service.

3.3.3 Mobile content

To induce mobile phones use, mobile operators have introduced a wide range of mobile specific content from which subscribers can choose. In offering such services, operators have sought to entice users to move from “dumb” data transmissions, such as e-mail and web browsing to more “intelligent” data transmissions that involve higher priced content and services. Some of these are described here:

Box 3.2: Beauty on call

Singapore Plastic Surgeon and Dermatologist give skin consultations by MMS

When mobile phone subscribers in Singapore have an acne breakout or are down with a rash, they will be able to just snap a picture and send it via MMS to the industry experts. Through a recently launched service, renowned plastic surgeons and dermatologists have offered to give tips on-demand to consumers through MMS in Singapore. For a monthly subscription fee of up to USD 5, consumers can get skincare tips in the form of text, pictures and video via their mobile phones.

The providers of the service have noted that the impending introduction of the service represents a migration from the paternalistic model of health education where doctors dictate standard remedies to one that is more interactive and immediate. MMS treatments can be customized to skin type, age, and hormonal cycle.

Some 8 more industry players are expected to join in the project.

Source: www.iskin.tv

SMS-based services

The birth of a mobile-specific content services market in Singapore can largely be traced back to the introduction of SMS-based applications in the late 1990s. The downloading of ringtones, logos and icons was immensely popular among the youth in Singapore during that period with multiple mobile content providers entering the market.

At the same time, a number of SMS text based messaging services, such as the delivery of news headlines, stock market report, lottery results and horoscopes were introduced into the market. A Chinese business dictionary service was also available for subscribers using Chinese character enabled handsets. Aimed primarily at the adult and business community, these services did not enjoy the same measure of success as those aimed at the youth, such as SMS chat.

Nevertheless, as a testament to their enduring nature, SMS-content services still remain a popular service offering among subscribers today with all mobile operators continuing to offer these services despite the introduction of richer content that take advantage of higher speeds.

Multimedia messaging services (MMS)

Multimedia messaging services (MMS) based services have proved popular with mobile subscribers thanks in part to a number of applications that have been introduced to stimulate its use. Mobile operators currently provide a host of content available through MMS These include video clips of sports and news, real estate brochures and "live" traffic shots taken from webcams set up along major thoroughfares.

Leveraging on the suitability of MMS to deliver images to and from consumers easily, a number of non-operator companies have also introduced a variety of services based on MMS (see Box 3.2).

However, the transmission of user-generated content – pictures and videos – has proved to be the most popular service among MMS subscribers. To boost its popularity, mobile operators have introduced tools and applications to further enhance user experiences with MMS services. Applications such as the Singaporean developed "Muvee" software, for example, allows a subscriber to turn raw video footage taken by a camera phone into a more stylized product. The mobile-based software uses a simple interface that allows the user to edit a video clip by selecting a template that then gets mixed with the video to give it special effects, text and a music soundtrack[12].

Giving a further boost to user generated content development and distribution, Singaporean-based Wireless Intellect Labs (WIL) – a wholly-owned R&D subsidiary of M1 and a product of the Wired with Wireless WTA initiative – has developed and released a system that enables mobile subscribers with an Internet connection and a "webcam" to access the webcam using an MMS-enabled mobile handset. Dubbed Permodia, the system is designed as an easy-to-use application for end users to set up their own content that could then be made available for public or private viewing. Users simply connect a webcam to the Permodia server and access images through operator MMS services. Unlike traditional webcam systems that transmit a continuous stream of data, the system takes pictures only when requested, thus allowing it to use minimal bandwidth. The system also supports motion detection as well as GPRS and Wi-Fi cameras. The Permodia system is available free on a trail basis from the developer's website. Operator charges are levied for MMS transmissions to the subscriber[13].

Multimedia services

With the introduction of higher speed technologies, such as GPRS and 3G, together with the launch of new handsets with color screens and the ability to play music and videos, mobile content offerings became more sophisticated. For example, 3G services on offer include music download services that allow customers to browse, preview, purchase and download CD quality full length tracks, java based news services, and "live" streaming video of news channels.

The two 3G operators have also announced plans to launch a suite of 3G content services in the months following their February 2005 commercial launch. These would include sports and local entertainment TV programming designed specifically for the 3G format, news features, 'live' traffic conditions, music videos and 3G games. SingTel 3G also announced that it would also provide a platform for showcasing self-created content such as movie and video clips by budding local talents, and slices of everyday life captured in video form by customers themselves (e.g. citizen reporter and Singapore's funniest videos). While most of the focus of SingTel's launch was on individuals, the operator announced that it was also working on 3G applications for corporations, such as mobile point-of-sales applications and surveillance applications.

Nevertheless, looking at the pricing plans released by some mobile operators during the recent commercial launch of 3G services, it appears that operators view videophone calls as the "killer" 3G application that will drive the adoption of 3G. Although currently too early to tell whether this will be true, it nevertheless appears that operators will have to make significant adjustments to the service in order to increase its appeal. In its current form, video call quality is poor, largely due to the fact that the video is transmitted through a relatively narrow 64 kbit/s channel. Furthermore, most existing 3G phones tend to use a rather low resolution VGA camera for the video calls. As a result, jerky images, which become even poorer in low light conditions, and lack of lip sync are problems that could potentially put off subscribers once the novelty of the service wears off.

4 TOWARDS A UBIQUITOUS NETWORK SOCIETY

4.1 The Next-Generation I-Hub

In February 2005, IDA unveiled its latest initiative and invited industry feedback on its vision of the Next-Generation I-Hub, a secured, high-speed and ubiquitous network to drive next generation connectivity. By leveraging on the country's strengths in terms of its pervasive communications infrastructure, pro-business policy environment, and plentiful infocomm skilled manpower, the SupraHub envisages the creation of an island wide ubiquitous network in the period running up to 2009.

To realize this vision, IDA intends to direct its efforts along six strategic thrusts:

1. *Infrastructure deployment for a convergent network*

   IDA intends to support the provision of a multi-channel platform that achieves convergence between Wired and Wireless; Data and Voice; and Broadcasting and Telecommunications services. It is considering plans that include developing a favorable IP licensing regime, encouraging IPv6 adoption and investing in fiber to the home (FTTH).

2. Provision of locations sensing network services

IDA plans to promote the deployment of location sensing networks by leveraging on wireless technologies such as WLAN, Cellular, GPS, UWB, and RFID. Potential applications for such networks include telematics, mobile games, supply chain visibility in logistics, and patient tracking in healthcare.

3. Exploring new input/output devices

IDA proposes to promote the search for new Input/Output technologies that can be applied to seamlessly integrate the physical with the electronic. IDA may consider facilitating R&D into new input/output technologies such as voice activated Telematics.

4. Exploring new computing devices

IDA will seek to promote the search for convergent devices that are ecologically integrated for ubiquitous living. IDA may consider supporting potential R&D projects with operators to develop partially or fully integrated portable multimedia devices with new form factors and shapes, and with longer battery lives.

5. Promoting new media software/content/applications with security features

IDA will work closely with other cluster developments in promoting the deployment of suitably secured new media software, content and applications. Potential users include various verticals such as schools, healthcare, logistics, construction, government agencies such as the Police and Civil Defense, insurance and real estate agencies, and the entertainment industry.

6. Promoting industry alliances/collaboration for ubiquitous computing

IDA will take an active role in promoting the formation of industry-led alliances, exchanges, and marketplaces while collaborating with industry to deploy infrastructure for ubiquitous offerings. Potential industry alliances can be forged in the areas of inter-roaming, interoperability and inter-working in a multi-operator, multi-platform environment.

The realization of these trusts will support the strategy imperatives of A: Deploying leading-edge ubiquitous network infrastructure for business and individuals for next generation communications and B: Capturing the R&D IP creation and ubiquitous commerce segments of the international value chain in next-generation communications.

It is important to note that the SupraHub vision is currently at an early stage of conceptualization. At the time of writing the report, the vision was still in the process of being refined and refocused through public consultations and informal meetings with countries that share similar ambitions. Nevertheless, it has been pointed out that the existing strategies, policies and initiatives, such as the Wired with Wireless programme, continue to lead the country on the path toward a ubiquitous network environment.

4.2 Developing the RFID value chain

As a regional logistics hub with a strong manufacturing base, Singapore stands to realize significant benefits by adopting RFID technologies[14]. At the same time, the government and local infocomm companies also see the increasing global interest in RFID technology as a market growth opportunity.

Recognizing the challenges associated with an emerging technology like RFID, such as the lack of international standards, and the limitations Singapore faces, such as the absence of large retailers like Wal-Mart to drive large-scale adoption, IDA decided to adopt a proactive approach to developing the RFID sector. In May 2004, IDA announced that it would invest USD 10 million (USD 5.9m) in a three-year plan to promote the adoption and development of radio frequency identification (RFID) technology along three lines:

- *Alignment of Frequency spectrum and standards for global interoperability;*
- *Building capabilities to develop new intellectual property* by building a robust RFID infrastructure in terms of research and development, skilled manpower, and supporting institutions;

- *Collaboration to catalyze adoption of RFID in key sectors* by using a clustering approach to bring together groups of industry partners, infrastructure service providers and solutions providers to ensure concerted rollout and interoperability.

IDA has taken an aggressive role in accelerating the process of RFID adoption by creating an internal team of RFID evangelists dedicated to the promotion and adoption of RFID technologies. Currently, the team is focused on encouraging and supporting RFID adoption through awareness building and direct assistance in five key sectors: high-tech manufacturing, pharmaceutical manufacturing, consumer packaged goods manufacturing, retail and logistics.

In November 2004, IDA issued a Call-For-Collaboration (CFC) for "RFID for Business Efficiency".

4.2.1 Spectrum policy

Currently, different countries have allocated different radio spectrum frequency bands for RFID applications (e.g. North America – 902-928MHz, Europe/Singapore – 866-869 MHz, Japan/Korea – 950-956MHz). In order to ensure RFID interoperability with Singapore's major export markets – the United States and Europe – IDA realigned its spectrum bands allocated for the deployment of RFID applications. In October 2004, the spectrum for RFID applications in Singapore was set at 866-869 MHz and 923-925 MHz in the UHF bands. The licence-exempt power limit for both bands was also increased from 0.01W to 0.5W, while the power limit for the 923-925 MHz band was increased to 2W for RFID devices only. The 915 MHz frequency, which is widely used in the US for RFID applications, is currently used for GSM services in Singapore.

4.2.2 Research and development (R&D)

As a relatively new technology, R&D on RFID technologies is still on-going in some key areas such global inter-operability of RFID systems, and the reliability of RFID when used in environments with high liquid and metal content. Given the increasing interest in RFID research, IDA hopes to position Singapore as a laboratory for pilot RFID research projects and as a development centre for innovative RFID products and solutions. To date, IDA has implemented plans to assist local and multinational companies in making Singapore a base foe RFID research.

A key element of IDA's strategy will be the establishment of joint research facilities with institutions at the forefront of RFID development, such as MIT's Auto-ID Labs, which played a key role in developing the Electronic Product Code (EPC)[15].

To date, a number of local companies have already taken up the opportunity to do R&D in RFID. For example, Tunity Technologies, a local company specializing in RFID and radio frequency (RF) related systems and solutions, is currently in the process of developing EPC-compliant multifrequency RFID tags that operate in three different RF bands in order to ensure frequency interoperability[16].

Another local company, GT & T Engineering, is developing an intelligent RFID tag that can communicate with other tags so that information can be relayed accurately to the final data collection point. When used in a warehouse management scenario, a tag on one pallet can communicate with the tag on another pallet in order to obtain a meshed network effect. Pallets that are located further away, which previously could not be located, can now be traced for real time monitoring and retrieval.

In addition to establishing research facilities and promoting local R&D, IDA has also strongly encouraged the setting up of an RFID testing centre in Singapore. NOL, APL Logistics and SUN Microsystems have declared that they will be jointly setting up an RFID Testing and Solutions Centre in Singapore, a first in Southeast Asia. It will provide companies with the necessary compliance testing and checks before RFID tagging of the goods. In particular, the Centre will locate the optimal position to place an RFID tag for the most accurate reading for different products. At the same time, the centre will also free up manufacturers from having to do their own tagging.

In September 2004, a Singapore RFID Alliance was formed with the support of IDA. With the aim of transforming itself eventually into an Asia RFID Alliance, it will develop reference architectures, share best practices and align standards. Its current membership includes Hewlett-Packard, Hitachi, Accenture, Port Singapore Authority (PSA) and EPCglobal Inc. among others.

IDA is also currently in the process of encouraging industry to establish RFID registries in Singapore. It is now trying to attract EPCglobal Inc., the leading organization dedicated to the development of industry-driven standards for the EPC, to set up its Asia Pacific headquarters in the country[17].

4.2.3 Skills and training

In order to support the growth of an RFID industry in Singapore, IDA has also undertaken the task of increasing the supply of relevant skill sets. IDA is currently working with a number of relevant organizations and training bodies to accomplish this aim. It is currently working with Institutes of Higher Learning and training providers to develop new courses RFID skills training. The two major state-run universities – National University of Singapore and Nanyang Technological University – are developing courses to provide electrical engineering graduates with specialized RFID knowledge while a local college, Republic Polytechnic, is developing new RFID curricula for students and executive RFID courses for businesses. The college is also conducting a survey to determine industry readiness for EPC, their concerns and gaps. The survey was designed to be used as a tool for the development of government programmes to cater to the industry needs

In addition to educational institutions, the local logistics industry has also introduced executive training in RFID technology. In November 2004, two RFID courses were launched: the first by The Logistics Institute – Asia Pacific in collaboration with Cambridge AutoID Labs; and the second by the Singapore Manufacturers' Federation in collaboration with RFID Focus[18].

4.3 Applications and services for a ubiquitous network environment

4.3.1 Broadband-based applications

Connected homes

With broadband network coverage extending to 99 per cent of all homes and with close to half the households in Singapore subscribing to broadband, a significant market opportunity exists for the development and deployment of innovative home networking applications and equipment. Currently in its infancy in Singapore and around the world, interest in home networking is expected to grow sharply within the next few years. IDC, for example, expects the worldwide installed base of households with a network to grow from 37 million in 2003 to nearly 111 million in 2008.

Inspired by the strong growth potential exhibited in the home networking market, IDA launched its Connected Homes Programme in April 2002 to create a nation-wide test bed environment for the industry to develop, pilot and deploy innovative and integrated end-to-end solutions for homes[19]. Leveraging on the existing Singapore ONE infrastructure and services, the programme also aims to extend the benefits of a Connected Lifestyle to Singaporean homes and communities. There are two main thrusts to the Connected Homes Programme – "Connecting the Home" and "Connecting the Community". The first thrust aims to encourage the development of a suite of solutions connecting a variety of home appliances and communication devices, while "Connecting the Community" is targeted at linking different aspects of the community such as health providers, educational institutions, community groups and businesses.

Following the launch of the programme, IDA issued a Call for Collaboration (CFC) for the first phase – Connecting the Home – to addresses the lack of an integrated home networking solution in the present market. Under the CFC, IDA provided financial support to five consortia comprising content and application providers, network equipment manufacturers, systems integrators, technology providers and broadband service providers in their development and trial of their solutions. Thirty-five new solutions were developed through the CFC with over 400 households involved in the their trial. A number of solutions have been commercialized through deployment in new condominium developments. The solutions developed include integrated data communications and home entertainment, as well as home automation, control and security (see Box x).

Some of these solutions have been commercialized, for example, UniHome's Connected Home solution has been deployed on a modular basis in more than six condominium developments in Singapore. The total project value of these rollouts by UniHome is estimated to be over USD 1.2 million (see Box 4.1).

With the conclusion of the Connecting the Home trials in March 2004, a CFC for the second phase of the Connected Homes project –Connecting the Community – was issued in January 2004 to seek out proposals for integrated IT solutions which can address common community needs. Four consortia were selected in August 2004 and a public trial to test the proposed solutions was scheduled to start in February 2005 involving over 2,500 trial users.

The consortia are made up of 23 companies, ranging from IT solution providers to Citizens Consultative Committees (CCCs), umbrella bodies for grassroots organizations. A total of 24 solutions were presented for trial. These included solutions to address a range of needs, starting from the family to the general community. For example, Golden Years Community consortium offers a suite of services targeted at the middle-aged and senior citizens (aged 50 years and above), offering personalized products and services like healthcare, shopping and travel, to encourage them to lead more active and engaging lifestyles. A key service includes the BioAlert, a device which when strapped onto the body, can detect abnormalities in heartbeat and automatically sends out alerts wirelessly. The readings are transmitted via Bluetooth from the chest strap to a cellphone nearby, which then sends the information to a managed call center. Family members will in turn be alerted once an aged parent or grandparent has his or her blood pressure hitting critical levels.

For the wider community, a solution that enables parents to easily monitor their children's progress in school through SMS and email was also introduced. Other proposed applications benefiting the general community included real-time information alerts via electronic notice boards at common community areas and common terminals for residents to request for services and provide feedback to management councils and property managers, as well as book common facilities and pay for common services.

Connected schools

The use of technology in educational establishments in Singapore has been a long-standing focus of government efforts to build an infocomm savvy society. Schools were one of the first public institutions to be connected to the nationwide broadband infrastructure. In the field of education, technology is seen as playing a dual role, serving as both a pedagogical tool as well as a means of sensitizing students to infocomm technology.

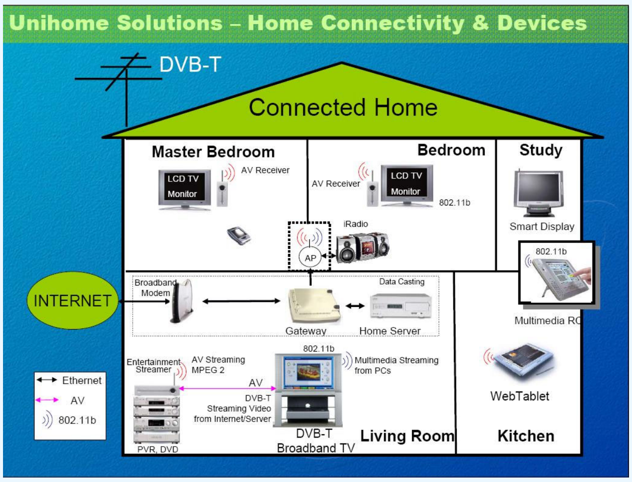
Leveraging on broadband connectivity to schools and the increased availability of wireless solutions, IDA has launched an initiative in partnership with Microsoft Singapore to drive the testing, development, research and showcasing of innovative infocomm technologies in education. In October 2003, the BackPack.NET initiative was launched. A five-year undertaking, it comprises a number of projects aimed at enhancing the learning experience through the use of tablet PCs, 'digital ink' and other emerging infocomm technologies. It also aims at creating a framework for researchers, industry players and schools to develop software and digital content solutions.

Under the first phase of the initiative, cohorts of students in selected schools were equipped with individual tablet PCs that were enabled with wireless connectivity and that contained digitized textbooks. They allow students to communicate with teachers while giving them access to lesson materials and Internet resources anywhere on school grounds. In this way, students are given greater one-to-one teacher access while also allowing teachers to use the application to monitor students work and progress at any time, aiding and encouraging them in their studies by instantly providing feedback. As an example of their use, students are taught to note and share their qualitative observations with other students while conducting a variety of scientific experiments, while during Digital Art sessions, students are taught to draw illustrations and images directly onto the tablet PC screen and then manipulate the images using computer graphic software. Wireless applications also allow students to participate in lessons outside the class while conducting real-time consultations with experts in the subjects.

Box 4.1: Connecting the Tan family home
UniHome's solutions for the Connected Home

During the six-month "Connecting the Home trial", IT professional Lawrence Tan and his wife, Janet, have started their workday mornings with a quick glimpse at iPronto. The wireless web pad – a prototype developed by Philips Electronics – updates the busy 40-somethings on key information that is refreshed every morning before they head for work. Apart from iPronto, the Tans' home was also fitted with a wireless device detachable PC monitor, a home surveillance webcam with motion detection and a DVD/ Hard Disk Drive recorder that can automatically tape TV programmes on a computer hard disk. These devices were connected to an integrated gateway accessed through a home portal that enabled the Tans to remotely access and control them. The complete UniHome solution brings together the following elements:

- *The Home Gateway/Server* – Connects the data, entertainment, home automation and security networks and devices to each other, and to the Internet.
- *The Home Portal* – Provides platform for services and content aggregation. Users enjoy convenient and secure single access point to connected home-related services and also to access and control home devices The portal provides many aggregation tools, e.g. webservices, single-sign-on, payment gateway, messaging gateways, etc. to link up third party service providers. Trial users enjoy video-on-demand, e-learning, SOHO tools, and community services from many service providers via the home portal.
- *A PC Camera Surveillance & Security Service* – Users can monitor their homes from anywhere via broadband or dial-up Internet access. Motion or noise detection can trigger recording and intrusion notification via SMS Additional on-demand viewing via hand phone will be deployed shortly.
- *The Philips Streamium MC-i200* – The world's first broadband Internet micro hi-fi system offers instant access to multiple online music services. It also plays music files store on home PCs.
- *IPronto* – The iPronto enables users to manage digital home devices through an integrated, always on, and simple interface. From any part of the house, users can access entertainment devices or go to a website to instantly to access information.
- *Digital Multi-Media Receiver* -A Wi-Fi enabled audio-video streaming device which allows JPEG/MP3/MPEG-1 contents from the home computer streamed anywhere in the house.
- *TVtoTV link* – Contents from DVD or VCR media can be streamed wirelessly to any other room.
- *DVD/HDD device* – Provides flexibility of freezing terrestrial broadcast at any time through time-shifting TV viewing.
- *DesXcape, Detachable Monitor* – Enables PC to be used anywhere in the home through wireless network.
- *VideoCast* – VideoCast is a new digital service that deploys IP technology to stream content as well as to transfer files onto the PC over a terrestrial platform. For the trial, video streaming of movie trailers, local dramas and sitcoms as well as electronic newspapers, catalogues, and magazines were available for downloaded to the trial user's PC.
- *Digital TV Services* – Digitized versions of current analogue TV channels.



Source: Computer Times and Universal Gateway International (figure)

Preliminary findings taken from the first broad trial have indicated that the use of mobile learning technologies facilitated independent learning while multi media content made schoolwork more interesting. Teachers also found the transition to using tablet PCs for teaching to be relatively smooth.

As part of the initiative, Microsoft Learning Gateways have also been deployed in two schools. The Learning Gateway is an Internet environment that allows students to do and submit their homework online, to participate in group discussions, and to collaboratively work on group projects from different locations all over the country. Teachers are also able to deliver lessons and assessments over the Internet. Applications on the portal help teachers to mark assignments and assessments, allowing them to devote more time to teaching. Parents are also able to track their children's academic progress on the portal on a daily basis.

In March 2005, a BackPack.NET centre was opened at the National Institute of Education (NIE), the national teachers training institute, to showcase and develop the use of innovative technology in education. Technologies on show include a Bio Genetic Laboratory scenario which showcases learning-based technology based on RFID for easy retrieval of up-to-date data; System Modeling Tools to engage pupils in investigative learning; Digital Geography text books where entire book contents are digitized and modified to feature multi-media and collaboration applications, and resource links on the Internet; and applications enabling real-time connections to experts from around the world. The Centre is currently researching and testing new applications for immediate application such as a Composition Automated Testing System whereby teachers can evaluate the students' written proficiency in Chinese language.

Connected Hospitals

Seeking to extend the benefits of network technology to all public sectors, the Singapore government has also embarked on a healthcare initiative aimed at testing and developing the use of infocomm technologies to bring about a patient-centric, seamless, safe and cost effective healthcare system.

Under the Healthcare.NET initiative launched in November 2004, Alexandra Hospital (400-bed general and acute care hospital), IDA and Microsoft Singapore embarked on a series of projects aimed at integrating and upgrading existing legacy systems with innovative technologies such as biometrics, smart cards and RFID[20].

Box 4.2: Mobile data in distribution services
Wireless sales force automation leads to revenue growth and cost savings

Vincent Lim used to have hundreds of numbers stored in his head. As a sales representative of a consumer goods distributor, PSC Corporation, his job was to visit retail outlets and supermarkets to take orders from them. He had to memorize the prices of many individual items as customers often needed to know the prices on the spot. With his company handling over 8,000 different product lines, flipping through his paper files at the customer site would simply be too laborious.

In June 2004, his company transformed the pen and paper sales & ordering manual process into a high-tech sales force automation system. Today, Mr Lim uses an HP iPaq 2210 PDA he needs. At the various retail outlets, he simply inputs the customers' orders into the PDA. The price for each product is listed and the PDA also shows the current inventory level of each item at PSC's warehouse, so he can immediately inform his customer on stock availability and set a date for the goods to be delivered. Previously, he would have had to call or check with the warehouse department on the stock availability and inform the customer later.

He can also inform the customers of the current level of their credit facility, and collect payment on behalf of his company without the need to verify figures with his accounts department. The new order information is transmitted back to the back-end servers at the office in real-time over GPRS to the office.

According to the company, the introduction of a sales force automation system has been a great boon. With the new system, sales representatives have been able to visit 38% more customer outlets. In addition, turnaround time to fulfill the orders has dropped by half. This increase in productivity has led to an increase in revenue by up to about 26% for the first five months after implementing the system (June to Oct 2004) compared to the preceding five months (January to May 2004). Operational costs have also dropped considerably, largely due to substantially lower invoicing errors. The errors have plunged from a 3% average to 0.08%.

Developed by Singaporean software developer Maya Systems Consultants, the new sales force automation system is also providing PSC's management with better understanding of customer's buying patterns as the system generates business analytics and reports.

Source: Adapted from IDA case study

In February 2005, the first phase of the three-year initiative was introduced. Dubbed the Clinical Digital Dashboard, the wireless solution is currently being piloted at the Alexandra Hospital's Department of Emergency Medicine (DEM). Using wireless infrastructure and Tablet PCs staff are now able to register, consult, treat and prescribe medication to patients all at one go.

Alexandra hospital also served as the test-bed for RFID applications in Singapore's efforts to contain the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003. This initiative is described in greater detail below.

4.3.2 Mobile-based applications

The mobile enterprise

As a general trend, increases in mobile data transmission speeds have been matched by increased usage of data transmission applications such as e-mail and web browsing. A host of mobile business solutions such as inventory control, fleet management and similar services that rely on remote database access have also been developed to take advantage of mobile data and Internet access (see Box 4.2).

Location based services

The development of LBS services offered by mobile operators in Singapore have benefited largely from the initiatives undertaken by the Singapore government through the Singapore Land Authority (SLA) and IDA. In May 2002, the SLA issued a call for business collaboration (CFBC) to support the wireless industry in overcoming the high cost of producing quality map information. As a result of the CFBC, the SLA issued LBS Map Content Provision licences to three industry consortia, allowing them to use its comprehensive map content to develop a location-based platform. In February 2003, IDA launched another LBS CFC together with SLA, the Land Transport Authority (LTA), Singapore Tourism Board (STB) and the National Heritage Board (NHB). This initiative was aimed at supporting developers and providers of LBS applications to offer more sophisticated Information and Navigation Services, Resource Management Services, Safety and Emergency Services, Community-based applications and interactive wireless entertainment.

In September 2002, under the Wired with Wireless Wireless Technology Alliance initiative, the Siemens Location Enabling Centre was set up as a test and training centre for the development of LBS applications. The centre offers a comprehensive LIF standard--based Location Based Service (LBS) test environment which brings together the Siemens Location Platform, Siemens Location Enabling Server and GeoToolBox Server and the multi-layered digital Singapore maps from the Singapore Land Authority (SLA).

First introduced by SingTel in March 2001, two out of the three mobile providers in Singapore currently provide location-based services (LBS) to their subscribers. LBS services on offer allow users to receive vicinity-specific information such as the location of nearby supermarkets, cinemas post offices and ATMs Users can further define their search by sub-categories like cuisine types for restaurants and healthcare services by specialization (see Box 4.4). LBS services can also be used to help customers book a taxi and find out which bus services are available nearby. Using an LBS platform developed by Wheresoft, an SLA LBS Map Content Provision licensee, StarHub also offers a "need of the moment" service that provides a proximity search for urgent needs such as the nearest polyclinics, dentists, police and petrol stations, 24-hour shops, etc. The smart proximity search function automatically extends to cover more areas if none is found within the immediate vicinity.

Mobile payments

In May 2001, IDA invited proposals for a Mobile Payments Call for Collaboration under the Wired for Wireless programme. The first in a series of CFCs conducted by IDA, the M-Payments CFC sought to develop a mobile payments infrastructure in Singapore through cross-sector industry collaboration. Five months later, IDA announced the award of the CFC to four consortia to trial five different mobile payment solutions. It supported the venture with grants totaling SGD20 million. Within one and a half years, the consortia successfully deployed the underlying m-payments infrastructure as well as a breadth of mobile payments applications and services. These included the payment of purchase of movie tickets at selected cinemas, the purchase of travel insurance, person-to-person money transfers, and bill and fine payments. The CFC also resulted in Asia Pacific's first Wireless Public Key Infrastructure m-payments trial.

Box 4.3: A tour guide in your pocket
LBS services for the tourist industry in Singapore

Since December 2003, a prepaid location based and real-time information service has been available to travelers visiting Singapore. Offered by SingTel and Landmat, an international mobile content provider, the CitySIM service offers visitors to Singapore tourist information linked automatically to their location, via their mobile phone and prepaid SIM card, which they can purchase on arrival. Information available includes locations of restaurants, banks, nightlife attractions – a personalized "tour guide" on a phone. The service also features a chat service that allows visitors to find, chat and share their experiences with other CitySim users in Singapore.

Users of the service requesting location-based information are guided by menus, which then retrieve the requested information via a SIM-based browser from a central server. CitySim cards are available for purchase at the price of SGD20.

Source: CitySIM at www.citysim-singapore.com/how.htm

Results since then, however, have been disappointing. Two years later after the four consortia launched their m-payment services to the public in March 2003, only two remain, with one subsumed under a larger online payment system. By mid-2004, only 70'000 subscribers had registered for the various m-payment systems despite much higher initial projections.

Industry observers have put forward a number of possible reasons that explain the low adoption rate. Firstly, as originally designed by the consortia, the use of mobile payment services involved a complicated procedure. Subscribers were required to open an account with a participating bank or service before mobile payment services are made possible. A personal ID, an SMS or a certain code was then required to make the actual mobile payment. Secondly, as each consortium operated a different mobile payment system, a subscriber seeking to use the services of a company in a different consortium would require a separate registration and payment procedure. More significantly, mobile payments suffered and continue to siffer from aggressive competition from a wide range of convenient payment methods already available that include online and in person payments through credit cards, debit cards, CashCards and cash.

Although one consortium has started to simplify mobile payments by developing a Java-based application that presents subscribers with a simpler interface, the hurdles of interoperability with other mobile payment systems and competition with other payment methods still remain.

Machine to machine communications (M2M)[21]

Leveraging on wireless technologies and the mobile communications network in Singapore, a number of M2M communications solutions have been introduced for a growing number of applications. These include, for example, remote monitoring, data collection, stock maintenance and configuration of vending machine operations and the remote monitoring of buildings and structures under construction (see Box 4.4). The Land Transport Authority (LTA) is also currently exploring the use of M2M solutions to maintain street lighting operations in Singapore. The system will replace the current labor intensive system of visual inspections of street lighting by providing "live" monitoring alerts of the street lighting systems via PDAs and SMS

Currently, much of the application development activity in M2M in Singapore is centered on RFID and low rate wireless sensor networks which involve product tracking, distribution, monitoring and data collection.

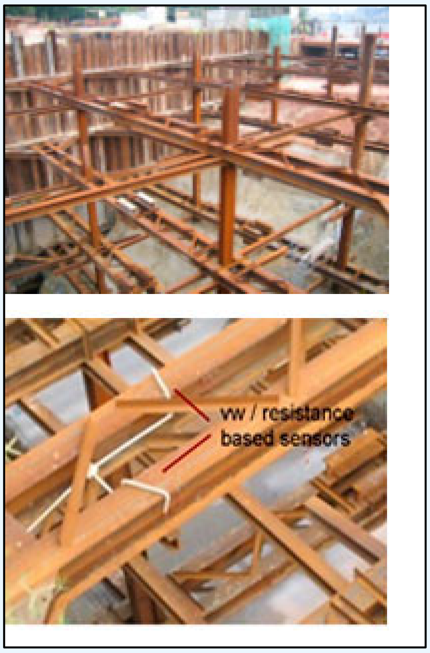
Mobile computing

Currently, mobile handsets and PDAs suffer severe limitations in terms of processing power, limiting the range of software applications that can be run on them. These devises tend to run stripped-down or "lite" versions of full-fledged desktop software applications.

With the aim of realizing a vision of true ubiquitous computing, a Singaporean company undertook the development of an operating system for mobile devices that relies on the increasing amounts of bandwidth available on mobile networks. The MXI operating system developed by Radixs is split into two components – the server side and the device side. 80 per cent of the processing takes place at the server side, which includes running the applications and only 20 per cent takes place at the device level. This way, the hard-core processing can take place at the server level, while the smaller data chunks are transmitted to the wireless device over wireless systems like GPRS, 3G and Wi-Fi. By using the MXI platform, any desktop application developed for the Windows, Java, Linux and Palm environment can work on the mobile device. Users can potentially get full versions of programmes like Microsoft Office and Sun's StarOffice to run on their MXI-enabled mobile devices. In addition, all data is stored on the server side, allowing more games, videos and digital music to be stored by the consumer. Radixs is currently working to licence its patented MXI platform to mobile services providers[22].

Box 4.4: Preventing construction site failures through M2M

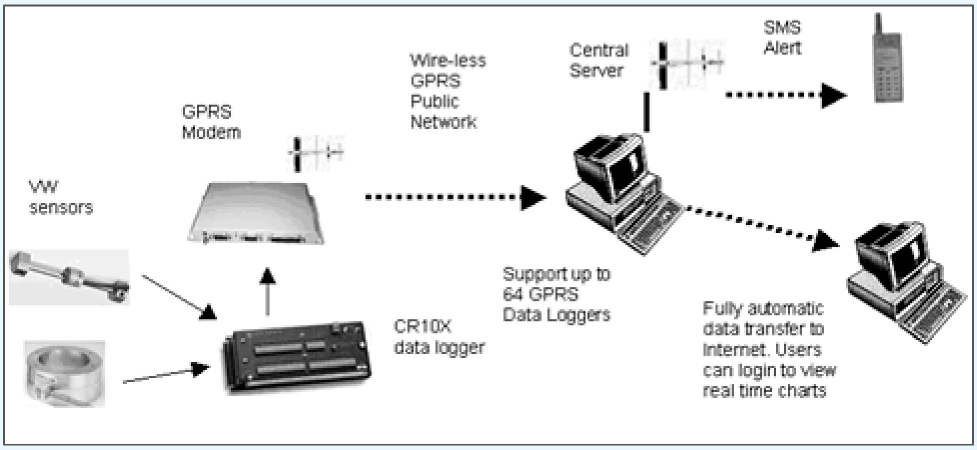
M2M monitoring systems at constructions sites



In the construction industry, there is a recognized need for a continuous monitoring system that provides real-time access to site data and alerts in the event of any signs of structural movement. Currently, construction firms use automatic data loggers to provide reliable and consistent sensor data from project sites. Remote sites use a GSM wireless monitoring system to collect and upload data to a central computer at fixed intervals. The system then sends the data to users in cycles. Although data is captured over extended periods, the cost of conducting continuous GSM online monitoring of sensor readings is prohibitive.

In response to this problem, SysEng, a Singapore based company, developed an eMonitoring Syste, (eMs), a GPRS enabled M2M solution that provides the construction industry with a cost-effective continuous monitoring system. Currently, eMs is used in a number of deep excavation projects in Singapore to monitor strut forces in a temporary retaining system for a cut-and-cover tunnel, such as the on-going Kim Chuan Mass Rapid Transit (MRT) Depot project (see left picture).

Using the system, the eMs is connected to arrays of vibrating-wire (VW) or resistance based sensors. It records the data at time intervals. Data acquired is stored and processed in a data logger and sent immediately to a central server via GPRS. An automatic computer system at the central server then uploads the monitored data to dedicated web pages. Monitored values are simultaneously compared with pre-set review levels and SMS alert messages will be sent to users when the values exceed the trigger threshold within 60 seconds. As GPRS costs depend on the amount of data transferred and not on connection time, the automatic data logger is able to connect continuously to the central server without incurring high costs. Data transmitted between logger and server is transmitted in real-time, eliminating connection time delays.



Source: eMs at www.emonitoring-system.com/

4.3.3 RFID-based applications

Road traffic management

Singapore's Electronic Road Pricing System (ERP) is the first in the world to use RFID technology to effectively track and manage road traffic volume at different times of the day. This traffic management tool is effectively an electronic toll system that deducts a prescribed road use fee from a stored value smart card inserted in a RFID based in-vehicle unit (see Box 4.5).

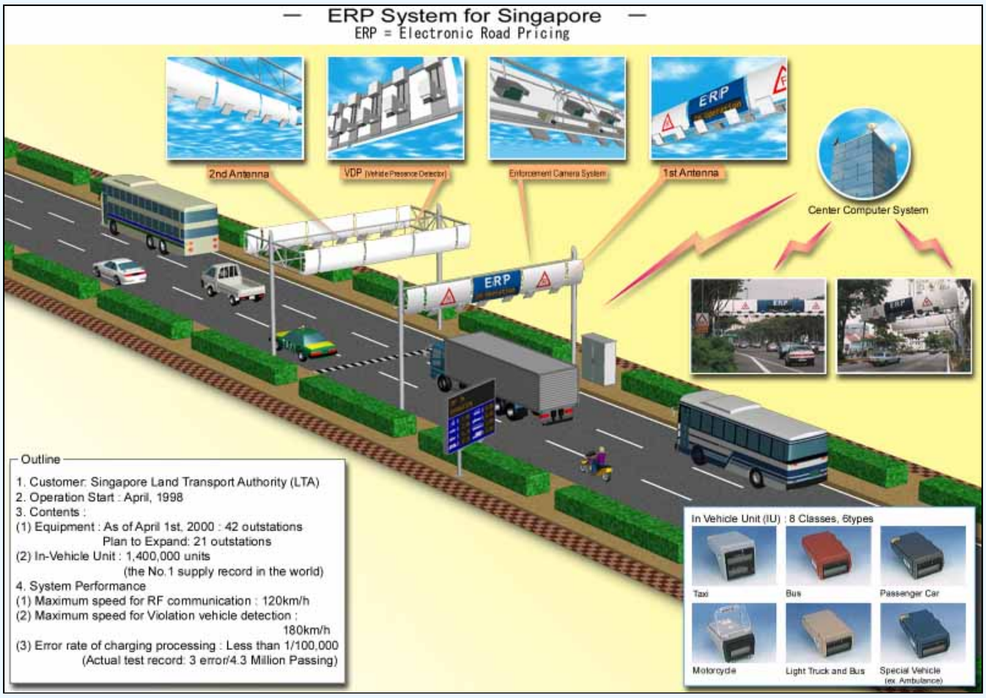
In addition to the ERP system, the LTA also relies on other wireless solutions to manage traffic flows in Singapore. For example, GPS based devices located in taxicabs relay information on traffic speeds back to the central traffic control management system for traffic planning purposes.

Box 4.5: Pay as you use
Singapore's Electronic Road Pricing System

In 1975, Singapore implemented the world's first road pricing scheme to reduce traffic congestion. The scheme was called the Area Licensing Scheme (ALS) and motorists then had to purchase daily or monthly licences to enter the Central Business District or Restricted Zone (RZ) during restricted hours. The scheme was manually run, involving the visual inspection of physical licences displayed on vehicle windscreens by inspectors positioned at entry points into the RZ. It was widely seen as a costly, labor intensive and inflexible process.

In another world's first, an automated electronic road pricing (ERP) system was introduced in 1998 to manage traffic entering the RZ. Under the system, the RZ is surrounded by an electronic boundary demarcated by ERP overhead gantries. All vehicles – except emergency vehicles – have to pay a fee to enter this area from 7:30 am to 7 pm on weekdays. ERP fees vary depending on the time of day and the kind of vehicle driven. In September 1999, the ERP system was extended to some key arterial roads beyond the RZ. The ERP system is based on a pay-as-you-use principle. It uses a dedicated short-range radio communication system to deduct ERP charges from CashCards. These are inserted in the RFID in-vehicle units (IUs) of vehicles before each journey. Each time a unit passes through an ERP gantry when the system is in operation, charges are deducted automatically. All vehicles in Singapore, including motorcycles, have this device installed.

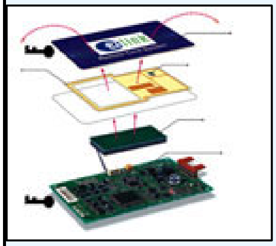
For purposes of traffic management, the LTA periodically reviews the traffic conditions on the expressways and roads where the ERP system is in operation. After each review, ERP rates are adjusted where necessary to minimize congestion on the roads. The ERP system has been effective in maintaining a speed range of 45 to 65 km/h for expressways and 20 to 30 km/h for major roads.



The LTA is currently in the process of planning for the next stage of development of the ERP. Solutions involving the use of GPS and the use of EZ-link contactless RFID cards in place of CashCards are currently under study.

Source: LTA

Box 4.6: Contactless cards



Technology behind the EZ-link card

The EZ-link card is a compact card conforming to ISO/IEC 7816 card dimensions, which is similar to a credit card. The card surface is made of PET and a tamper-proof IC chip and antenna are built into the card. Both the card and the reader communicate using radio wave via wireless communication. The sensing distance between the card and the reader is up to 10 cm. The card itself contains no battery but operates from electromagnetic energy received from the reader. Encryption techniques prevent eavesdropping and fraudulent use. Being contactless, transaction time involving the use of the card is kept to a minimum (approximately 0.2 sec).

Source: : www.ezlink.com.sg

Parking

The use of automated RFID-based parking systems is widespread in Singapore. Leveraging on the ubiquity of in-vehicle RFID units in vehicles in Singapore, a large number of car parks in Singapore, both public and private, are equipped with automatic gates outfitted with RFID readers that can detect the IUs and deduct parking fees from the inserted CashCards. With the RFID-automated system, throughput is increased, attendants are no longer required, and billing and data accuracy has improved.

In addition to controlling access, the RFID systems can also collect parking use data such as how long cars stay parked and how many cars use the car park each month, allowing the parking operators to better evaluate and manage parking capacity.

Public transport

In 2001, the Enhanced Integrated Fare System, better known as the EZ-link card system, replaced the magnetic stored valued farecard system used for public transport in Singapore. A contactless smart card, the EZ-link card was introduced to relieve commuters of the need to remember distance related transport fares payable and to reduce bus boarding times at bus stops (see Box 4.7).

There are currently over 6 million EZ-link cards in circulation with over 4 million financial transactions taking place daily through the system.

Health

During the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003, Singapore hospitals used a specially developed RFID-based Hospital Movement and Tracking System (HMTS) to trace the movements of health care workers, patients and hospital visitors who may have come into contact with infected individuals in hospitals. All visitors and staff who entered specified hospitals were obliged to provide identification and contact details and were then issued a card with an embedded RFID transponder. The active devices continually transmitted RFID signals to readers placed around the facilities, allowing authorities to track and identify the correct visitors and staff for quarantine in the event any patient they came into contact with was infected by SARS.

The incubation period of the SARS virus is 10 days. The system was set up to store information on visitors for 21 days to ensure that information about all the contacts with a probable SARS patient remained available well after the incubation period ends. Hospital staff were able to access the application through a Web-based portal on the hospital's Intranet. If a patient was suspected of having SARS, staff would run an immediate check to find out who came into contact with the patient, in which zones and at what time. The confidential information is deleted from the system after 21 days.

Singapore's Defense Science and Technology Agency (DSTA) developed the system after it received a request from the Ministry of Health to explore ways of tracing contacts within a hospital should there be a suspected SARS case. DSTA evaluated several options, but quickly settled on RFID because of its ability to track people without interrupting operations in the hospital or requiring staff to do much additional work. The system runs off of the hospital's existing local area network and was built with off-the-shelf RFID tags and readers. It was tested before implementation and did not interfere with hospital equipment.

Box 4.7: Speeding up library services

The Electronic Library Materials Management System (EliMS)

Established in 1995, the National Library Board (NLB) is the largest library-managing agency in Singapore with more than 10 million library materials. It oversees the management of the National Library, two regional libraries, 20 community libraries, 28 community children's libraries, as well as libraries belonging to government agencies, schools and private institutions. It manages a library system with one of the highest loan rates in the world with an average of 25 million loans per year.

Under the NLB's traditional manual book loan system, a large number of library staff was needed at the frontline, to stamp books for loans and returns. This resulted in an acute shortage of library staff available to provide value-added services, such as locating library materials for library users, as well as in long queues to borrow and return books. As a result, at the end of the 90s the NLB sought a solution to meet the increasing volume of library loan transactions without increasing its library staff strength.

In 1998 the NLB implemented an RFID system, known as the Electronic Library Management System (ELiMS) to facilitate automatic, multiple object identification, tracking and sorting and data collection. This deployment of RFID technology for public use in a library environment was a world's first. It employed a proprietary system supplied by GemPlus that used embedded RFID chips in books to store information such as a book's title and call number. In 2001, the NLB started to acquire RFID tags based on the ISO 15693 open standard such as the Philips I-code chips. Since 2002, the NLB counted eight million I-code chips out of its 10 million tagged library iteMs The rest of the RFID chips are still from Gemplus, which the NLB will phase out when library items reach the end of their six-year shelf life.

With the implementation of ELiMS, the NLB reported that library checkout times for borrowed materials were reduced by more than 30 minutes to an average of less than 5 minutes with no waiting required for book returns. Stocktaking was also made easier as a trolley fitted with an RFID tag reader is simply pushed pass the shelves in the library to pick up item information. As a result library staff were freed to focus on providing value-added services such as membership and enquiry services. Significantly, the NLB reported that it saved SGD 50 million a year since implementation, mainly in manpower costs, because of its automated borrowing process of scan-and-go at borrowing stations.

Source: See NLB at www.nlb.gov.sg

Libraries

The National Library Board (NLB) of Singapore is the largest RFID technology user in Singapore with over ten million library items tagged. It was also among one of the earliest adopters of RFID technology in the country having started in 1998 when it put RFID tags on books under the Electronic Library Materials Management System (EliMS) that automated a large number of library services (see Box 4.8).

In 2004, the NLB issued a tender to upgrade its library-wide RFID system (excluding RFID tags) in order to provide new services to its members. Some of the new RFID-based services envisioned include a book recommendation service based on a member's borrowing patterns captured by RFID readers and a book pinpointing service that allows members to locate the exact physical location of a book by simply referring to the catalogue on the NLB website or at enquiry kiosks at libraries. With the new RFID system, the NLB also expects to shave two seconds off the present borrowing time and to allow members to return multiple books at one go at book drops.

Homeland Security

Recently, Singapore became the first port in Asia to be selected for the pilot project under the U.S. Container Security Initiative. The initiative aims to prevent the smuggling of weapons of mass destruction into the United States through its seaports by requiring the placement of RFID seals on all containers bound for U.S. seaports. The technology that will be used is based on The U.S. Department of Defense's Total Asset Visibility (TAV) network, a system that was built to improve the tracking and security of shipments from the

U.S. to forces overseas. It features RFID tracking of cargo containers, electronic event-driven alerts, anti-tamper systems, virtual inspections and authenticated audit trails. The TAV network is built on existing U.S. and international standards and on the Universal Data Appliance Protocol (UDAP), which allows open "plug and play" integration of automatic data collection devices, such as RFID and GPS, along with sensors, scanning, and biometric systeMs

The first phase of the initiative's deployment calls for a single system that can secure containers using e-seals, register individual port employees, and authorize roles. The system will capture relevant information and is designed to complement other security initiatives sponsored by the U.S. government.

Logistics and manufacturing

In the area of logistics and manufacturing, a number of Singapore-based companies have adopted RFID technology to meet their specific needs. In the manufacturing sector, for example, Hewlett Packard is currently conducting a trial together with a local supplier and a logistics service provider to achieve full traceability of their server and storage product line.

In the aviation sector, the Airbus Centre located in Singapore was the first outside of Europe to implement an RFID system to keep track of the tools loaned out to aircraft maintenance centers. It is a mandatory requirement by airworthiness authorities for all airlines to track essential data related to aircraft tools, such as historical usage and maintenance, in order to ensure safety. With the use of RFID, Airbus has been able to increase the availability of tools due to a quicker turnaround time made possible by more efficient receiving and issuing processes. The RFID-based system also enabled Airbus to achieve higher data accuracy with automatic data capturing.

In the area of logistics and distribution, RFID systems have been implemented for similar reasons of efficiency. Logistics companies such as Grocery Logistics of Singapore (GLS) and YCH, a local supply chain management company, have sought to improve the tracking of goods and materials through RFID use.

In the agri-veterinary sector, smart tags are becoming more popular for use as ear tags for stock or underskin tags for horses or pets to allow the animals to be traced. In Singapore, the Singapore Article Number Council (SANC) together with the Agri-Food and Veterinary Authority (AVA) use RFID chips to tag endangered wild Arowana fish.[23] This facilitates the export of the cultivated second generation of the Arowana fish from the breeding farMs

Retail

With more than 6 million contactless cards in circulation, the ez-link public transport payment system represents the most widespread RFID-based payment and individual identification system. Beyond public transport payments, the card is also used for a variety of purposes including retail payments, access control management (security), stock management and loyalty and membership programmes. McDonald's Restaurants, for example, allows payment by ez-link cards through card readers setup at its counters. Nevertheless, despite the ubiquity of ez-link cards only a small number of establishments have adopted the system largely due to higher setup costs as compared to established alternatives such as credit cards and ATM cards.

On a smaller scale, motorists in Singapore have been able to purchase petroleum using an RFID-based automated payment system using vehicle-mounted or key mounted transponder tags at all ExxonMobil filling stations since 2001. An RFID reader integrated in the pump reads the unique identification code on the transponder tag that is linked to the customer's payment account for billing purposes.[24]

Conventions and events

As a popular convention venue, Singapore has occasionally used RFID technology to trace delegates at large conferences and conventions in the city. For example, during the Global Entrepolis@Singapore 2003 convention, an enterprise, innovation and technology convention, RFID systems designed by TunityTech were used to track and locate over 10'000 conference delegates. With the RFID tracking system used, it was possible to locate each delegate's real time physical position within the conference venue at Suntec City. Each delegate was given a credit card sized RFID-enabled tag that interfaced with 60 readers placed all around the building to mark their physical location at all times. The RFID locator service was part of a business matching service suite of applications that included a delegate smart search system, an electronic delegate contact list manager, a delegate-to-delegate personal messaging service, and delegate-to-delegate SMS services.

4.4 Policy challenges

4.4.1 Spectrum management

Operating in the context of a small island with a dense population, IDA recognizes the importance of ensuring that spectrum resources are used efficiently to meet the present and future needs of the country. At the same time, IDA also pursues the development of the local infocomm industry in Singapore through its spectrum management policies.

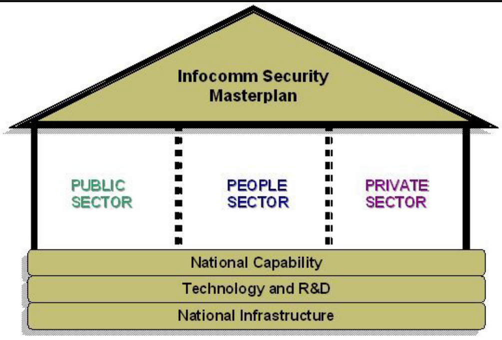
Since its unexpected auction of 3G spectrum – industry observers predicted IDA would adopt a beauty contest mechanism – IDA has clearly stated its adoption of the auction methodology as the mechanism to allocate spectrum. In its stated view, it considers that a market-based allocation approach is more effective in ensuring spectrum optimization by operators. It also is considered an efficient, objective and transparent mechanism. Prior to this change, spectrum was traditionally allocated on an administrative basis and charged on a cost-plus recovery pricing approach.

In addition to the adoption of a market-based allocation mechanism, IDA has also been proactive in facilitating new technology adoption to increase spectrum efficiency and to support the growth of the wireless industry in Singapore. In July 2004, IDA introduced a Market Trial Framework (MTF) to allow companies to assess the commercial potential of new technologies, services or products by charging for their use during a trial period. A market trial licence is valid for six months and renewable for another six months. This supplements IDA's Technical Trial Framework, which allows companies to conduct technical trials of equipment in Singapore. The MTF was used successfully by a number of operators to assess the commercial viability of WBA services before applying for a full-fledged spectrum licence and an operating licence to provide the service.

In its efforts to promote wireless technology research and development, IDA has also paid particular attention to the development of Ultra-Wideband (UWB) technology. In May 2003, it launched a UWB programme aimed at bringing activities surrounding the technology to Singapore. Under the programme, industry interest in UWB is encouraged by the setting up of a UWB-Friendly Zone. Within this designated zone, developers are given significant latitude to experiment with new and innovative UWB technical designs. At the same time, IDA has also made special arrangements to provide lab space and resources on a temporary basis to companies that wish to carry out UWB-related work in the Zone. IDA has also conducted a series of UWB compatibility studies in order to gather data that would form the basis of future rulemaking on the technology in Singapore[25].

4.4.2 Network security

Recognizing the importance of infocomm security, a major effort to boost network security on a national level was initiated by IDA under the guidance of the National Infocomm Security Committee (NISC), a high-level, multi-agency committee that is tasked to formulate policies and strategies for cyber secutiry at the national level[26]. In February 2005, the Infocomm Security Masterplan was launched. It is a strategic roadmap that charts Singapore's national efforts to develop capabilities to prevent cyber security incidents, to protect critical infrastructure from cyber threats, and to respond swiftly to recover from actual attacks. The development of the Masterplan involved industry consultations over a 12-month period and involved a survey of more than 500 companies. The Singapore government has undertaken to invest about SGD 28 million over three years (2005-2007) in the implementation of the Masterplan.



Pictorial Representation of the Masterplan Framework

To be implemented by IDA, the Masterplan is characterized by six areas, three of which focus on securing the people, private and public sectors by raising awareness amongst internet users about cyber threats and the appropriate security measures to take. Key initiatives corresponding to these areas include:

- launching a *National Infocomm Security Awareness Programme* involving a series of public outreach and awareness promotion activities aimed at educating home computer users on adopting security best practices and tools;
- developing a *National Authentication Infrastructure* to support secure online transactions through a trusted identification and authentication framework;
- conducting an *Infocomm Vulnerability Study for National Critical Infrastructure* to assess the adequacy of protection measures installed by network infrastructure owners and operators;
- establishing a *Business Continuity Readiness Assessment Framework* to measure the adequacy of business continuity plans of government agencies; and
- compiling an *Infocomm Security Health Scorecard* to provide an overall assessment of the public sector;

The other three strategic areas of the Masterplan represent thrusts to develop national capability, cultivate technology and R&D and secure national infrastructure. Key initiatives include:

- collaborating with local and foreign research institutes and centers to chart an R&D roadmap for the country;
- establishing a Cyber-Threat Monitoring Center, a round-the-clock facility to analyze and respond to cyber threats, by the second half of 2006; and
- creating training and certification programs for IT security professionals.

Before the launch of the Masterplan, IDA's efforts to reinforce cyber security and trust revolved around a number of initiatives that included the development and promotion of public key infrastructure (PKI) [27] and trust marks, human resource development in the field of cyber security and the development of security standards.

IDA's efforts in the area of PKI have included supporting the creation of a PKI Forum Singapore (PKIFS) in 2001 and spearheading the creation of an Asia PKI Forum in June 2001 to achieve international interoperability[28]. The efforts of the PKIFS have shown positive results with around 20 per cent of large companies in Singapore having adopted PKI as a standalone technology in 2003. More than 40,000 client certificates are in circulation, having been issued by the local public certification authority, Netrust.

In February 2001, the National Trust Council (NTC) – an industry-led committee – was formed to build consumer trust in online transactions. It implemented the 1st nationwide TrustMark Programme, TrustSG, whereby appropriate organizations, such as trade associations, chambers of commerce and businesses were accredited as Authorised Code Owners (ACO). Upon accreditation, ACOs are granted a licence to use the TrustSg seal, and they can thereafter award the TrustSg seal to merchants who adhere to their stringent codes of practice. The TrustSg seal awarded by the ACOs identifies online merchants as e-commerce enterprises that adhere to good e-business practices[29].

IDA has also supported the setting up of a professional body to govern the Infocomm Security profsssion as well as facilitated the offering of training programmes dedicated to developing skills in cyber security. Under its Critical Infocomm Technology Resource Programme (Citrep), infocomm security administration was identified as a strategic skill with around 27 courses on infocomm security on offer[30].

Through the Information Technology Standards Committee (ITSC), IDA has also supported the development of the world's first business continuity and disaster recovery (BC/DR) standards that specify stringent requirements that service providers are required to meet in order for them to provide a trusted operating environment for their end-user companies[31].

5 Social aspects of Singapore's ubiquitous network society

With a mobile penetration rate of over 92 per cent and an island-wide distribution of 6 million RFID enabled contactless EZ-link smart cards, the distribution of networked devices has reached a high level of ubiquity among Singaporeans. Coupled with island-wide mobile network coverage, the vision of always-on ubiquitous connectivity has become a reality in Singapore. Today, connectivity is no longer limited by technology but by social convention and safety concerns, such as in aircraft and in cinemas. Increasingly, even these restrictive boundaries have been pushed back further by new technologies, redefined norms and newly recognized needs (see Box 5.1).

According to a 2004 academic survey "Singapore Youth and their Mobile Lifestyles" that was conducted on the use of mobile communications by Singaporeans aged 15 to 29 years, 68 per cent of the respondents agreed with the statement "I cannot live without my mobile phone".

5.1 New avenues for interaction

The ability to connect to a network at all times and from anywhere has made profound changes to the way individual Singaporeans interact between themselves and with society at large. The use of mobile phones, in particular, has offered Singaporeans new avenues and new forms of interaction and expression.

The use of SMS based services to pursue social interaction on a wide scale, in particular, have been a relatively recent phenomenon in the Singapore context. Charity fund raising by SMS, in particular, has been received with enthusiasm. Supported by all mobile operators, a large majority of publicized charity fund raising events accept donations through SMS According to survey results, 42 per cent of mobile phone using youths have made donations to charitable organizations using SMS services.

Illustrating the growing use of mobile phones to mobilize society, the Singapore government has recently encouraged the use of moblogs – online journals posted through mobile phone – as an alternative avenue for citizens to express opinions on national issues. As a run-up to the National Day celebrations in August 2004, organizers of the national day parade provided mobile users a moblogging platform to post journals online on topics of national concern – from responsible pet ownership to the conservation of Singapore's coastline. Replies to moblogs could be posted online or sent by SMS

On a more intimate level, the introduction of new location-based applications has also changed the way individuals interact. These include location based multiplayer games, which can locate several users within a certain radius and allow them to compete against each other, to Bluetooth based friendship services (see Box 5.2).

Box 5.1: Mobile use in hospitals
Singapore hospitals may allow use of mobile phones

Following a local pilot study indicating into mobile phone use in hospitals, hospitals in Singapore may soon allow mobile phones to be used around the hospital – even in operating theatres.

In July 2004, Tan Tock Seng Hospital, a public health institution, conducted a trial on the use of mobile phones in the hospital environment. The trial involved 500 nurses and 40 doctors in its general surgery department.

The trial found that on average it took four minutes before a doctor returned a page sent to a pager. Delays were typically due to doctors being held up in wards or because they are unable to get to phone lines when they found the time to return the page. The hospital estimated that a doctor wastes over an hour, or some 86 minutes every day on responding through such inefficient communication means. According to the trial, allowing doctors to reply via calls through mobile phones or SMS would reduce those delays drastically.

Besides improving staff communication and efficiency, the trial results also showed that it was safe to use mobile phones in hospital premises. Studies showed that only 4 per cent of medical devices, mainly monitors and ECG equipment, were affected when a mobile phone was in use at one metre away. Sensitive devices like pacemakers were only affected when mobile phones were used within 10 centimetres.

The study is currently ongoing and will be completed in the first half of 2005.

Source: Tan Tock Seng Hospital

Box 5.2: Make new friends with Bluetooth
Mobile users in Singapore make new friends with Bluetooth

Student Gracinia Lim has made new friends thanks to mobile phone software that alerts her to compatible people nearby. She is an early customer of a service in Singapore called BEDD that uses Bluetooth wireless communications to scan strangers' phones for their personal profiles.

Launched in May 2004, users download the BEDD software into a compatible phone, complete a short profile of themselves and include a description of who they want to befriend, or an item they want to buy or sell. The software automatically searches for and exchanges profiles with other BEDD enabled phones that come within a 20-meter (65 ft) radius. Matched users are given each other's contact details. It relies on direct phone-to-phone Bluetooth transmissions without having to go through a central server.

Source: BEDD at www.bedd.com/

5.2 User concerns

While ubiquitous connectivity has created new avenues for social interaction, the same phenomenon has also created new social concerns. Beyond worries over network security discussed in Chapter 4 above, other causes for anxiety include concerns over personal data protection and the opening up of new avenues for mischief.

5.2.1 Privacy and personal data protection

Singapore relies on both a common law tradition as well as statutory provisions to regulate the use of personal data. Under the general common law, confidential information may be protected under a duty of confidence. Personal information is also protected under sector-specific laws such as the Banking Act, Statistics Act, the Official Secrets Act and the Statutory Bodies and Government Companies (Protection of Secrecy) Act. There is however no overarching legislation or regulation for the protection of personal data in Singapore.

In February 2002, the National Internet Advisory Committee (NIAC), a high-level government advisory group on Internet related issues, released a draft "Model Data Protection Code for the Private Sector". Modeled on internationally recognized standards, it is a generic code that contains 11 data protection principles differentiated according to the various stages of data processing: accountability; identifying purposes; consent, limiting collection; limiting use, disclosure and retention; accuracy; safeguards; openness; individual access and correction; challenging commerce and transborder data flows. The Model Code is a voluntary code that is available for adoption by the entire private sector. The NTC, for example, has adopted the Model Code under its TrustSg programme for online businesses.

It may be instructive to highlight that IDA has also issued a set of guidelines to safeguard public interests when Internet Service Providers (ISPs) conduct preventive security scanning exercises to determine whether their subscriber's computers have been infected by Trojan or virus software. The need for such guidelines was highlighted following an incident in May 1999 when SingNet scanned 200'000 subscribers' computers without informing them. The guidelines articulate the importance of accountability and transparency when ISPs conduct scanning exercises. In particular, consent by ISP subscribers should be explicitly obtained before such exercises can be conducted. Scanning activities must be non-intrusive, and the ISP must inform its subscribers on how their privacy will be protected during such activities.

It is also instructive to note that the Singapore government has also found it important to reassure the public over privacy and personal data protection concerns regarding the widespread use of location sensitive RFID based systems that are used to manage traffic flows and public transportation. For example, in order to address personal data protection and privacy concerns regarding the ERP system, the LTA has assured the public that all ERP transaction records are deleted every 24 hours. ERP location sensitive information and vehicle ownership information are also kept in two separate databases. The system is also periodically audited by the Ministry of Home Affairs to ensure personal data protection.

Box 5.3: Are you being watched?
Student films teacher berating classmate

In 2003, a student in a Junior College in Singapore used a PDA to secretly film a classmate being given a sound scolding and later posted the video on the Internet. The postage-stamp-sized, grainy, three-minute video clip, shot on a Sony Clie handheld, showed a somewhat hysterical teacher reprimanding another student before tearing up his homework in front of the class. Several issues were raised in the ensuing nationwide debate – the reasonableness of the teacher's outburst, the student's behavior in filming the incident and his use of the Internet to air the case for public discussion.

While the student and the teacher received counseling on their respective behavior, the incident nevertheless necessitated a review of public policies dealing with the surreptitious use of recording devices in schools and public buildings.

Source: Straits Times

5.2.2 Anti-social and criminal behaviour

While many benefits can accrue to a country with a ubiquitous network, there also exists a darker side to the phenomenon. Old crimes have found new forms using networked devices. The use of SMS messaging to convey hoaxes or obscene and unsavoury messages have occurred periodically in the country. For example, SMS hoaxes such as those promising to give money or prizes if the user forwards the message to a certain number of other users have appeared in Singapore. In a more serious case of unacceptable mobile phone use, a man was charged with the crime of insulting a woman's modesty when he sent 21 obscene SMS messages to a former colleague. The crime carries a punishment of up to one year's imprisonment and a fine.

As a result of a number of reported incidences where camera phones were used to take and circulate obscene photos, camera phone misuse was singled out as a worrying development in 2003. While those cases were prosecuted on the basis of existing laws governing behaviour in public in general, the issue of privacy and the taking of pictures of people in public places without their consent was also raised. While not illegal, the acceptability of such practices is still subject to an ongoing debate in Singapore (see Box 5.3). It may be some cause for concern that in a survey on mobile phone use by youth in Singapore in 2004, 21 per cent of respondents indicated that they had used their camera phones to take pictures of strangers without permission. As a society entering into a new phase of infocomm development, it is clear that Singapore is still searching for its moral and social bearings with regard to the use of new applications and devices.

6 Conclusion

In its desire to forge a ubiquitous network society, Singapore has benefited greatly from the advanced state of development of its fixed line, wireless and mobile networks. This accomplishment owes itself in no small measure to the extensive measures taken by the Singapore government to develop the country's infocomm economy. Its highly pro-active and involved approach to industry development must be considered as the key driver of Singapore's journey to become a ubiquitous network society.

Singapore nevertheless faces significant challenges in its journey, particularly as new technologies and new standards emerge. As a small country, Singapore is limited in terms of market size. As a result, it is often unable to set standards for new technologies, applications and services as they emerge. Nevertheless, despite this constraint, the country has managed to wield a level of influence far greater than its size would otherwise warrant, largely through the efforts it has made to attract pioneering research and development activities in infocomm areas it deems as strategic. Other goals such as the desire to develop a strong local industrial base in the area of innovative ICT technologies will continue to present a challenge to the Singapore government and people. Given the relative success Singapore has realized with its paternalistic approach, it is likely that the country will proceed on a similar path in the development of a Ubiquitous Network Society.

Endnotes

1 Both SingTel and StarHub were compensated for the loss of their exclusive and duopoly guarantees in their service licenses. StarHub was compensated SGD 1.082 billion. SingTel was compensated SD 1.5 billion in 1997 and SGD 859 million in 2000.

2 The National Computer Board (NCB) was created under the National Computer Board Act to promote and develop information technology in Singapore. Its work included high-technology industrial policy.

3 An individual licence is awarded to a company based on a specific application filed by the company and approved by IDA. Such a licence may contain conditions particular to that company and may be modified by the regulator or through an application by the company. Class licences, however, are broad authorizations that apply to any company offering a particular service or set of services. Companies do not need to apply for class licences in order to offer those services. The rules and conditions that apply to each class licence are "gazetted" (published in the official government gazette) and any company that begins to provide that service is presumed to have read, understood and complied with those rules.

4 In June 2002, IDA conducted an auction for the allocation of Local Multipoint Distribution Services (LMDS) spectrum rights. At the auction submission deadline, IDA had not received any initial offers for the auction, forcing it to abandon its plan to award LMDS spectrum. In view of the poor interest shown by industry, IDA did not undertake a similar spectrum offering until February 2005.

5 Under the ITU-R Recommendation M.1034-1 for IMT-2000 3G technologies, the speed for: (a) stationary fixed services is defined at 0 km/h: (b) pedestrian mobile services is defined at up to 10 km/h; (c) typical vehicular services is defined at up to 100 km/h; and (d) high-speed vehicular services is defined at up to 500 km/h.

6 WLAN (Wireless Local Area Network) allows a mobile user to connect to a local area network (LAN) through a wireless (radio) connection (eg: within a building). The IEEE 802.11 family of standards, eg. 802.11b and 802.11a, specifies the technologies for WLANs.
WWAN (Wireless Wide Area Network) uses various devices – land lines, microwave links, and radio waves, to service an area broader than that which can be covered by a WLAN, although typically with lower bandwidth. Examples of WWAN technologies are GPRS, CDMA-2000 and W-CDMA. WWAN technologies are often categorized into "generations" such as 1G, 2G, 3G and 4G.
WAN (Fixed Wide Area Network) is a fixed-line network that extends over a relatively large geographical area and enables broadband IP connectivity to a wide area public network (eg. the Internet). A user connects to the WAN through public access networks with technologies like ADSL and cable modem. The largest WAN is currently the Internet itself.

7 Details of the IDA-Intel Wireless Interworking Initiative and its key findings can be found at www.ida.gov.sg > Technology Department > IDA-Intel Wireless Interworking Initiative.

8 This figure is derived from subscribers who are actually paying for the service and not from the number of data and Internet capable handsets in the market.

9 IDA mandated SMS interoperability between operators in February 2000.

10 In November 2002, IDA mandated interoperability for MMS between operators, a first in Asia.

11 2x60 MHz of paired plus 20 MHz of unpaired 3G spectrum was made available for the auction. This was divided into four blocks – with one block consisting of 2x15 MHz of paired spectrum and 5 MHz of unpaired spectrum, and three blocks consisting of 2X14.8 MHz of paired spectrum and 5 MHz of unpaired spectrum. The specific band plan used was as follows:

Licence	Paired (MHz)	Unpaired (MHz)
A	1920-1935.1/2110.3-2125.1	1914.9-1920
B	1935.1-1950.1/2125.1-2140.1	1909.9-1914.9
C	1950.1-1964.9/2140.1-2154.9	1904.9-1909.9
D	1964.9-1979.7/2154.9-2169.7	1899.9-1904.9

12 See www.muvee.com for more information on the product.

13 See www.wilabs.com for more information on the product.

14 Radio Frequency Identification (RFID) is a wireless system that uses radio frequency communication to automatically identify, track and manage objects, people or animals. The wireless system consists of two main components, a transceiver (RFID reader) and a transponder (RFID tag). Reading and writing distances can vary from a few millimeters to several meters depending on the technology variation used.

15 The Electronic Product Code (EPC) is a standard naming scheme that uniquely identifies and tracks details of physical objects, assemblies and systems, through the entire supply chain. EPC is considered the next evolution of the Universal Product Code (UPC), found as a barcode on most products today. The UPC provides a unique identifier for every product type while the EPC provides true item-level tracking.

16 See www.tunitytech.com/ for more information

17 For more information on the work of EPCglobal Inc. see www.epcglobalinc.org/

18 RFID Focus is a start-up media and RFID resource company. It aims to promote RFID awareness and applications through various channels such as web portals, e-zines, publications, seminars, as well as RFID training programmes.

19 In addition, the Cahners-In-Stat group projected that home networking revenue derived directly from home networking hardware and the incremental value of networking connectivity on entertainment equipment will grow from USD 6.2 million in 2004 to

USD 8.5 million by 2008. The total value of equipment that incorporates a home networking connection will jump from USD 8.3 billion in 2004 to USD 17.1 billion by 2008.

20 More information on the technology applications deployed by Alexandra Hospital can be found at www.alexhospital.com.sg/

21 M2M communications systems allow users to remotely monitor and control key business processes and functions via wireless-enabled devices. Devices connect with other devices to share content such as alerts, supply chain information, digital content, facilitating a seamless flow of data and services.

22 See www.radixs.com/ for more information.

23 All Arowana fish in the natural environment have been classified as endangered species and prohibited from capture and trade.

24 For more information see www.speedpass.com.sg

25 See IDA's Ultra-Wideband (UWB) Programme at www.ida.gov.sg for more details.

26 The NISC was formed to formulate policies and the strategic direction for cyber security at the national level. The high level multi-agency committee comprises representatives from the Ministry of Home Affairs, Ministry of Defence, Ministry of Information, Communication and the Arts, Ministry of Finance, DSO National Labs, and the Defence Science and Technology Agency (DSTA). IDA acts as the secretariat to the Committee.

27 A PKI refers to the whole system of policies, processes and technologies including digital certificates, certificate servers and Certification Authorities (CAs) . A CA is a trusted third party that verifies the identity of an applicant registering for a digital certificate and issues that person a digital certificate binding his or her identity to a public key. It also provides certificate management services such as publications and revocation of digital certificates.

28 For more information on the Singapore PKI Forum and the Asia PKI Forum, see respectively www.pkiforumsingapore.org.sg and www.asia-pkiforum.org/

29 For more information on TrustSG, see www.trustsg.com/

30 See www.nicc.org.sg/ for more information on the Citrep programme.

31 See www.itsc.org.sg/ for more information.

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