The dawn of a new era?

Imagine a future in which not only people, but also things, are connected and contactable. This is far from science fiction — the day may come when virtually every item (from remote controls to razors) will be tracked using tiny radio transmitters, or tagged with embedded hyperlinks.

The term "ubiquitous computing" was coined in 1991 by the late computer scientist, Mark Weiser. He had this vision of a world in which technologies "weave themselves into the fabric of everyday life until they are indistinguishable from it". Early signs of how such pervasive technologies might impact society can already be gleaned from the use of mobile phones today, widely celebrated for their "ubiquity" and pervasiveness.

The notion of "ubiquitous communications" has been receiving increasing attention over the last two or three years. No one can deny that technology has already permeated most aspects of human life. Mobile phones and the Internet—the biggest success stories our industry has ever seen—are only the beginning. The next stage in "always-on" communications seems to be the appearance of new ubiquitous technologies and networks, such as radio frequency identification (RFID), that promise a world of networked and interconnected devices providing relevant content and information to users whose location is no longer restricted. This is the vision of communications "anywhere, anytime, by anyone and anything".

It is often argued that the beginning of a new technological development is the right time to consider its effects, social and otherwise. New technologies ought to be studied early in this context, both in national and international forums. In this regard, the workshop on "Ubiquitous Network Societies", hosted by ITU in Geneva from 6 to 8 April 2005, was an important international forum to exchange information and provide guidance as to how regulators, policy-makers, operators, technologists, journalists and individual citizens should respond to the challenges raised by the increasingly pervasive, ubiquitous nature of information and communication technologies (ICT).

Siemens

The day may not be far off when it will be possible to control all home communications and automation systems by using a single wearable device that recognizes voice commands...

The workshop was the fifteenth in the series of expert meetings conducted under the ITU's New Initiatives Programme. Some 40 experts participated in the event, 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.*

* Three background papers were prepared for discussion at the workshop: "Ubiquitous Network Societies: Their impact on the telecommunication industry" written by Professor Elgar Fleisch, University of St-Gallen (Switzerland) "Ubiquitous Network Societies: The case of RFID" written by Lara Srivastava (SPU/ITU) "Privacy and Ubiquitous Network Societies written by Gordon Gow, London School of Economics and Political Science. All workshop documents, including country-specific case studies on Italy, Singapore, Japan and the Republic of Korea are available at www.itu.int/ubiquitous.

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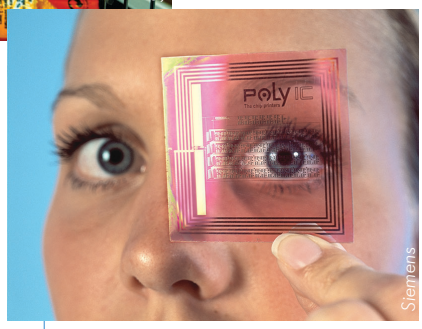
RFID chips made of plastic. These "intelligent tags" should eventually make it possible to differentiate between individual product items



Siemens

According to the workshop, the term "ubiquitous network societies" 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 RFID chips available at less than USD 0.05, mobile phones at USD 20 and computers at USD 200.

However, the business case for implementing longer-term visions of ubiquitous network societies 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.

Broad definitions of ubiquitous network societies 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 ubiquitous network societies, at present the best developed is RFID (both passive and active). 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.

Country case studies

Italy, Japan, the Republic of Korea and Singapore were selected for case studies, as early adopters of third-generation (3G) mobile and ubiquitous technologies in their regions. While much activity, particularly in Europe and the United States, has concentrated on RFID technologies in the context of product management or a replacement for universal product codes (the familiar bar codes), the Asia-Pacific vision of "ubiquitous" is much broader. A glimpse of what a future ubiquitous networking environment might look like is the communications environment portrayed in the film "Minority Report" (albeit a somewhat negative one).

Japan defines the ubiquitous network society 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 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.

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. RFID chips have been used in road pricing since 1998, and there is 100 per cent penetration of vehicles in the country. 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.

Smarter homes, smarter people?

The Republic of 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 highlights new growth engines for a ubiquitous ICT environment.

An important market segment emerging in technology-savvy environments in the country 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 reordering of food items, contactless security systems and wireless sensors (e.g. for lights), and smart laundry machines (that determine treatment required for different fabrics).

If homes seem to be getting smarter, so too are people, with the help of portable smart devices. An example of this is the "smart watch system" that helps people remember to take their essential items with them when leaving the house, or a public place (see box *Watch this RFID*).

Watch this RFID: a step towards 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, wallets and glasses.

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, for example, home, car or office. 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, http://www.eurekalert.org/pub_releases/2004-10/uow-awt100604.php

What migration path?

For some experts at the workshop, the migration path to ubiquitous network societies 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.

A word of caution

At the workshop, ITU Secretary-General, Yoshio Utsumi, underlined that: "While it may be tempting to focus only on the wonders of the new technology, we must also acknowledge the need for consumer safeguards. It will be important to consider, for instance, how long service providers should retain information about users' calls, messages and location. And while tiny radio tags may be helping retail businesses track inventory, it is crucial to discuss whether these will continue to be active after purchase and if so, what kind of information will be collected and how it will be distributed."

The development of social norms is yet another sphere that demands attention. "ICTs are meant to save us time and to promote and facilitate intercommunication. But we should ask ourselves whether social practices are developing hand-in-hand with technological development, and what policies may be required to discourage the growth of any undesirable side-effects, such as a loss of privacy, or a sense of technological alienation", Mr Utsumi also said.

In many ways, this workshop has prepared the ground for the World Summit on the Information Society's Thematic Meeting: "Towards the realization of a ubiquitous network society". This meeting will be organized jointly by the Japanese Government, ITU and the United Nations University and will be held in Tokyo on 16 and 17 May 2005. ■

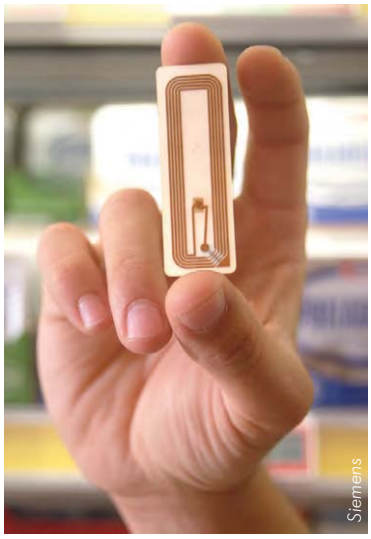
ITU 050024/photos.com

Radio Frequency Identification (RFID)

Though not a new concept, radio frequency identification is being seen as an enabler of the "Internet of things". RFID enables the automated collection of product, time, place and transaction information. An RFID system consists of two main components: a transponder to carry data (e.g. a tag), which is located on the object to be identified and an interrogator (or reader) to read the transmitted data (e.g. on a device that is handheld or embedded in a wall). Many readers are fitted with an additional interface (i.e., middleware) to enable them to forward the data received to another system, such as a personal computer or robot control system. Most tags are no bigger than a grain of sand (see photo), and are typically encapsulated inside a glass or plastic module.

Though there are early examples of ubiquitous technologies and their applications, such as the mobile phone, the vision of access "anytime, anywhere, by anyone and anything" is still limited by the 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 tyres to razor-blades. 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.

However, the absence of new international standards is hindering the uptake of RFID-based applications.



An RFID tag

Continuing fragmentation in standards setting in this area may mean that organizations will incur higher costs to ensure compatibility with multiple systems. Participants in the ITU workshop on "Ubiquitous Network Societies" in April 2005 called for concerted efforts to encourage global harmonization of RFID standards and their interoperability to stimulate smooth and rapid technological growth in the field. This holds true particularly for the harmonization of frequency use and communication protocols which vary across regions.

In North America, the biggest regional player in RFID today, there are standards such as Global Tag (GTAG), American National Standard Institute's "NCITS-T6 256-1999". 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. The European case is more complex, because there is less uniform use of frequencies.

Data formats for RFID tags, or electronic product codes, on the other hand, have benefited from international collaboration through organizations such as Auto-ID Centre, now EPCGlobal, and Ubiquitous ID Centre. For example, the main focus of the EPCGlobal is the standardization of the data format embedded in the RFID tag or label.

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). Near-term growth in RFID use will continue to be driven by business applications with consumer applications growing in the mid- to long-term. The firm Frost and Sullivan predicts revenue growth of USD 11.7 billion for RFID systems by 2010 from its estimates of USD 1.7 billion in 2003.

Table 1: RFID in the ultra high frequency (UHF) bands
Current status

Frequency band	Details
433.5 – 434.5 MHz	ISM (industrial, scientific and medical) band implemented in Europe, and under consideration, by Japan and the Republic of 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 for additional frequency range, increasing spectrum bands 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 finalized).
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). FCC rules define operation within the bands 2.4–2.48 GHz and 5.72–5.85 GHz (the super high frequency band).

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

RFID and spectrum issues

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) typically between 125–134 MHz, high frequency (HF) in the 13.56 MHz band and ultra high frequency, or UHF (see Table 1).

Typical LF applications include access control, animal tracking, vehicle immobilization, healthcare, authentication and point-of-sale applications. HF applications include smart cards and shelves for item-level tracking, library tracking, patient monitoring, product authentication and the tracking of airline baggage. UHF bands are highly suited to supply chain RFID applications due to the greater range for transmission of data. They are also widely used for toll collection systems on highways, manufacturing applications, and parking lot access control.

The use of RFID in the UHF band is not harmonized across regions. 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 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 communication systems, and a public wireless network for disaster prevention. But now, the Ministry of Internal Affairs and Communications (MIC) has opened up the 950–956 MHz band for RFID trials.

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. Governments and international organizations are aiming to minimize differences between regions, and to ensure that sufficient spectrum is available for RFID applications. ■

Source for the articles on pages 14–18: "*Ubiquitous Network Societies —The case of RFID*" (see www.itu.int/ubiquitous/Papers/RFID%20background%20paper.pdf).

ITU 050025/photos.com

RFID applications

Science fiction or fact?

Some of the applications described in this article may seem far-fetched, but the line between science fiction and fact is blurring. Though individual consumers may not always be aware of it, they have been exposed to RFID in action: on toll roads, in offices, theme parks and libraries. From sports events to retail shopping, small RFID tags are increasingly being used. Bio-medical applications too include RFIDs that contain identity information and which can be implanted or injected into the body. Pharmaceutical companies are beginning to use RFID tags on bottles to fight counterfeiting and theft of their drugs.

Transportation

Public transport, toll collection and contactless payment cards are some of the RFID applications that are gaining momentum. RFID was first deployed for collecting fares on toll highways. Electronic fare management systems using RFID have been fairly successful 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 RFID contactless smart card for fare collection.

Radio that cab fare

Taxis, mobile phones and RFID in Tokyo

In Tokyo, taxi drivers are 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 and deduct the requisite amount. All mobile phones used in the trial had to 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. — *Japan Corporate News and RFID Journal*, October 2004.

RFID to combat counterfeit drugs

The sale of counterfeit drugs is said to be plaguing the drug industry—and driving it to adopt item-level use of radio-frequency identification technology. 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 to 10 per cent in the developed world are counterfeit.

By using RFID tags on bottles of medication destined for pharmacies and drug stores, the pharmaceutical industry hopes to better detect counterfeit drugs. In July 2004, a group of pharmaceutical manufacturers in the United States announced that they were working with distributors and retailers on an experiment dubbed "Project Jumpstart" to attach RFID tags to individual bottles of drugs.

In addition to tracking fake drugs, tagged bottles can serve to prevent theft, as well as to manage recalled and outdated medication. It is estimated that inventory worth USD 40 billion is lost or stolen somewhere along the pharmaceutical supply chain every year.

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.

The Food and Drug Administration issued a report in early 2004 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. — *InformationWeek of 26 July 2004.*

Security and access control

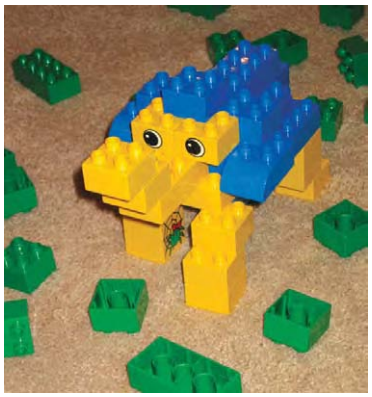
RFID technology is being used to control access to restricted areas, and to enhance security in laboratories, schools and airports. Many employee identification cards already use RFID technology to allow staff to enter and exit office buildings. For example, the security programme of the Canadian Air Transport Authority (CATSA) 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.

The Rikkyo Primary School in Tokyo (Japan) carried out a trial of active RFID tags in September 2004 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 metres, students do not have to stop at designated checkpoints. Some schools in North America too have gone down this path. One example is the Enterprise Charter School in Buffalo (New York), which deployed an RFID smart label system from Texas Instruments in 2003. The system, in addition to controlling access to the school campus, is also being used to identify and secure assets such as library books and laptop computers.

Personal safety: RFID helps parents keep a tab on their children

As tags are location-sensitive, public leisure parks such as Legoland in Denmark are using RFID 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.

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



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

Parents and guardians wishing to locate separated or missing children can use their mobile phones to send a text message to an application known as "kidspotter". The application then returns a text message stating the details of the child's last location in the park. — *Network World, 3 May 2004, Vol. 21, Issue 18.*

Tagging the ancient… and new

Libraries are opting for RFID technology to automate the loan and return of their materials. 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).

The Vatican Library, containing a 40-million piece collection of books and manuscripts, began deploying RFID in 2003. About 30 000 books had been tagged as of October 2004.

Vatican Library deploys RFID

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. — *CNN.Com,* 14 October 2004.

In the Netherlands, publishing companies like NBD Biblion, which sells 2.7 million books to Dutch libraries annually (80 per cent of the national market), began tagging all of its books in September 2004. In Tokyo, the Roppongi Hills Library has been tagging its books since 2003.

RFID and the mobile phone

Mobile phones can serve as an important platform for users to communicate with smart objects and open up possibilities for location-based services. In March 2004, Nokia introduced the "Nokia RFID Kit", a GSM phone with RFID reading capability for supply-chain applications. 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. Nokia is developing the RFID consumer phone jointly with Verisign.

Sports and leisure

High-speed RFID

Tracking 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 tied onto the runner's shoe. 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).

In April 2004, when some 33 000 runners competed in the London

marathon, their positions could be tracked and recorded by electronic tags attached to their shoes. Friends and family of competitors were able to follow their progress by signing up to a short message service (SMS) that sends the positions of athletes as they make their way around the course. Special mats were positioned every 5km 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. — *ITU Internet Reports 2004: The Portable Internet (www.itu.int/portableinternet).*

■ **In Switzerland,** RFID is used widely in ski-passes to provide access control and an easy mechanism for payment. Hands-free access systems using RFID for ski lifts have been in use for some time now. Remote-operated

gates equipped with readers can detect a valid ski-pass and open automatically, resulting in shorter queues for skiers. The credit-card sized RFID-enabled ski-pass can also be used to locate skiers (in cases of injury) or children.

■ **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. — *San Jose Business Journal.*

Implantable chips

RFID has its privileges for VIP patrons

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 containig information on a VIP patron.

How does VeriChip work? 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 the registry confirms the data, the appropriate benefits become available to the VIPs.

The United States Food and Drug Administration has approved the use of VeriChip in hospitals. — *ITU Internet Reports 2004: The Portable Internet (www.itu.int/portableinternet).*

Challenges

The privacy paradox

Will society be under more surveillance?

Privacy is a central issue in the 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 networked devices hold for current social norms and values concerning privacy and surveillance.

Data protection and consumer privacy

A number of consumers and privacy advocates have voiced concern over the growing adoption of services based on radio frequency identification (RFID) technology. Given the capacity of RFID to track things and people, and to record a wide array of information, consumer advocates remain concerned about the potential risks RFID poses to individual freedoms and privacy protection. RFID critics argue that stores, corporations and governments could eventually use RFID to spy on individuals by accessing information on tags embedded in their clothing or other personal items.

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". The statement called for a full assessment to be conducted on the impact of RFID technology.

The BBC News technology website recently reported on a consumer study indicating that a majority of people in the United Kingdom have serious privacy concerns related to RFID tags, believing that these tags can be read from a distance and thereby exposing them to unwanted surveillance. But 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.

In some countries, RFID chips in ID cards and passports have been proposed as a way of improving security and streamlining procedures at airports. Human rights advocates are particularly concerned that biometric passports will facilitate global surveillance and lead to misuse or abuse of information. For example, how much of the identifying information will RFID chips contain, and will that data be secure from hackers? This is a public policy question, and some governments are now looking at ways to secure the data on the tag before introducing RFID chips in passports.

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, according to the ITU workshop held in April 2005 on "Ubiquitous Network Societies".

Participants in the workshop raised specific challenges related to privacy in ubiquitous network societies 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.

The workshop recalled that privacy is widely recognized as a shared set of common values, and in many countries it is recognized 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.

At the same time, the workshop 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. Resolving these issues will have a fundamental impact on the trust and confidence that consumers and citizens place in ubiquitous network societies.

In the specific context of data protection, the workshop concluded that 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.

Challenges for the telecommunication industry

The ubiquitous nature of information and communications will have a significant impact on the telecommunication landscape and current business practices. 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 and item-level tagging. Operators are expecting greater revenue growth from data services than from voice services, on both fixed and mobile networks.

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 cannibalisation 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 Wi-MAX, Wi-Fi or the Republic of 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 the Republic of 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

The different types of service underlying ubiquitous network societies 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, Working Party 8F of the Radiocommunication Sector (ITU–R) is working on the spectrum requirements of services beyond IMT-2000 (3G), with a typical radio interface of 100–1000 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 radiocommunication conference. For RFID applications, various spectrum allocations and power limitations have been agreed in different regions — for instance, 902–928 MHz, 2.4 watts of effective radiated power (ERP) in the United States but 868–870 MHz, 0.5 watt 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.

New spectrum requirements for ubiquitous network societies 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 licence-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 an application-specific basis or on a technology neutral one.

Government policy and regulatory issues are important considerations as ubiquitous network societies 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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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.

The interplay between technological ubiquity, human behaviour and socialization

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.

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.

One 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 ubiquitous network societies. 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.

Another 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 ubiquitous network societies and whether these are consistent with agreed values and ethical norms.

Shaping ubiquity in the developing world

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 WalMart, 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 workforce-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

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 and allocation of IPv6 addresses. 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.

Sources: "Privacy and Ubiquitous Network societies," "Ubiquitous Network Societies: The case of Radio Frequency Identification," and extracts from the Chairman's reports from the workshop on "Ubiquitous Network Societies", held in Geneva from 6 to 8 April 2005 (see www.itu.int/ubiquitous).