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CONNECTIVITY, OPENNESS AND VULNERABILITY: CHALLENGES FACING REGULATORS

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1. Introduction

Huge strides in penetration of ICT services have been made over the last decade. There have been particularly strong gains in the availability and uptake of voice services using mobile networks due to the lower cost of deploying mobile networks and competition in prices and services in the vast majority of countries.[1] According to the ITU, the number of Internet users worldwide more than tripled between 2000 and 2008. In developing countries, the increase was tenfold.[2] Continued growth is widely anticipated.[3]

Moving beyond these gains, it has become more important than ever to achieve more extensive, and even ubiquitous, availability of advanced ICT services in order to address the digital divide and reap the trans-sector benefits of network effects, or network externalities.

While the digital divide has narrowed significantly for voice services, it is widening between and within societies in the areas that have a major impact on innovation in economic development such as access to and usage of high speed connectivity and computer processing. Increasing numbers of people engage in and benefit from advanced ICT services while others advance slowly or even remain stuck, lacking access to or the ability to use such services. As much as 76% of world population did not use the Internet in 2008.[4] This problem confronts both developing and developed economies. In any country, the more that relationships between individuals and Government and providers of products and services are handled online, the greater the risk of social exclusion.

As ICT services advance, the divide also deepens, becoming more difficult for those on the wrong side of it to cross. The more that Government and business are conducted and communities develop online, the more serious become the implications of a substantial portion of the population not having access or not using ICT services for basic purposes. For example, the higher the percentage of jobs that

are advertised online, the harder it will be for those who do not have access to or are not comfortable with ICT services to find jobs.

The positive externalities of ubiquitous ICT connectivity, particularly broadband, i.e., high speed Internet access, are as abundant as they are varied. They fuel demand for products and services and so contribute to economic growth.[5] ICT drives productivity improvements,[6] enables an economy to run to a fuller measure of its capacity, improves efficiency in the allocation of goods and services, and enables higher quality products and services.[7] And the benefits from ICT are trans-sector, permitting major innovations and efficiency gains in healthcare, education, finance, agriculture and numerous other sectors. Smart grid electricity networks – powered by ICT – may improve efficiency of energy consumption, improving prospects for dealing with some of mankind's largest challenges.

It is also increasingly recognized that ICT offers a platform for a new phenomenon of connectedness – changes to ways information is created and shared which are producing an economic and social transformation. The successful Web 2.0 methods of Wikipedia and social networks are now being translated to economic production. Companies increasingly use distributed co-creation to improve their innovations in technology, design, marketing, sales and numerous other areas – notwithstanding uncertainties over how intellectual property rights may be kept within the boundaries of the corporation.[8] User participation in innovation is contributing significantly, enabled increasingly by ICT platforms.[9] Written, video and audio content is increasingly generated from a variety of sources, including users, extending these trends into culture, entertainment, politics and other areas.

Coupled with information technology, high speed network access offers a multiplier effect, taking society to a new level of connectedness. The creativity of connected minds using open networks and their ability to solve problems makes it a high priority to ensure that such connectedness itself is made possible.[10]

The more networks are ubiquitous and the more open they are, however, the more vulnerabilities the ICT sector and its users face. Some vulnerabilities arise through economic structure, such as vulnerabilities of new entrants in markets in which one or more other service providers have significant market power (SMP). At the customer end of the value chain, other vulnerabilities include threats to privacy, loss of control over data and child protection concerns. Entire systems are vulnerable to cybersecurity and cybercrime threats.

This paper discusses the challenges faced by ICT regulators in light of these developments. Regulators are typically charged with implementing and administering a large number of policies and processes, including in relation to licensing, interconnection, network access, competition policy, price regulation, dispute resolution, consumer protection and universal service or access. They are typically (though not always) established with some separation from both political bodies and service providers. They are granted certain powers over service providers and physical resources such as radio spectrum, and are expected to ensure that the behaviour of service providers serves certain public policy goals established explicitly or implicitly derivable from law.

Inasmuch as regulators are needed because without them service provider behaviour might not alone serve such public policy goals, regulators are essentially charged with anticipating and addressing problems of market failure. They have a variety of tools or levers available to them to accomplish this, including the ability to create positive and negative incentives through rights and obligations in licenses, regulations and decisions on disputes.

The scale of the telecommunications sector, its significance as a platform for communication, its importance as a source of public funding and its monopoly history (which in most countries remains a dominating feature) inevitably place the regulator in a politicized environment. Regulators need effective legal power and reliable information and the ability to understand it if they are to carry out their roles. A discussion of challenges facing regulators might include a variety of matters, such as for example:

- **financial challenges** concerning the adequacy of their funding to carry out their mandates;
- **information challenges** arising from asymmetry of information, for example for the purpose of cost-related price regulation, and understanding and monitoring rapid technological change and introduction of new services;
- **technical challenges**, such as in monitoring and testing spectrum and equipment use as well as quality of service;
- **economics challenges**, particularly understanding and defining markets for the purposes of determining the level of competition and whether and what regulation is required;
- **legal challenges** arising from inadequate powers to introduce regulations and decisions, and resistance from some sector participants to change; and
- **political challenges** to their ability to implement their statutory mandates in a transparent, professional and impartial manner.

As is the case with many things in telecommunications regulation, the matters listed above are all interrelated.[11] To provide context to the discussion and enable some organization of the challenges regulators face, section 2 describes three dimensions of network architecture and ICT usage which are changing the nature of the sector. These include the open platform based architecture of the Internet, the shake-up of network technologies and management, and the redistribution on the network of where computer processing and content production occur.

In light of these developments, section 3 discusses the triple act – which each regulator must perform in the specific context of its own jurisdiction – of providing regulatory conditions that:

- attract substantial investment with a goal of **significantly increasing connectivity to high speed networks**;

- judge and set the appropriate level of **openness of networks and ICT**; and

- ensure protective **safeguards for the vulnerabilities** of networks and their wholesale and retail users arising from the open nature of networks and devices, and the distribution of computing functions across the network.

A constant theme that arises concerns coping with a rapidly changing sector and the repeated importance of reevaluating and reconsidering the regulatory framework – while at the same time providing a level of predictability that maintains confidence of investors sufficient to attract very large amounts of long term investment. Section 4 concludes by offering observations on the importance of regulators looking to the context of the wider ICT sector, and on how a steady commitment to an inclusive and open manner of regulation can fortify a regulator in dealing with its many challenges.

2. Network revolutions

The architecture of telecommunications networks and services is undergoing a revolution, and the initial challenge facing regulators is to understand the nature of this revolution. This can be understood in three dimensions, each of which – and together – have major implications for thinking about the regulation of telecommunications:

- the emergence of a network architecture understandable in terms of a stack of horizontal layers;
- a shake-up of network technologies and network management; and
- a major redistribution of computing functions and content production across the network.

Understanding these dimensions and their trends allows regulators to identify and analyze problems, for example where the major costs are in installing networks, where and how innovation and competition in services are most likely to occur, and where market failure is most likely to hinder the ICT sector. Understanding such problems enables regulators to tailor solutions that fit.

2.1 Platform-based architectures

IP-based networks have been introduced pervasively in many developed countries. Developing countries are also showing strong trends of the shift to IP-based networks. Kanartel, Sudan's fixed line competitor to incumbent Sudatel, for example, operates an all-IP network. This trend is likely to continue, as regulators in many developing countries now focus not only on increasing geographical network coverage (often mobile) and access to basic services, but on ensuring that the networks are IP-based.

The sweeping change in transmission technology from a circuit switched to a packet switched architecture using the IP/TCP suite has changed – and continues to change – the way that networks are viewed in terms of network design, service provision and regulation.[12]

Circuit switched networks integrate the information technology required for services in the physical network design. Calls are routed through a tree of central and local exchanges to establish dedicated

connections. Terminal devices such as phones and faxes were a function of that design, “dumb terminals” that offered limited creative processing power. The network transport system therefore effectively determines what can be done by the network’s users. The owner and operator of the network therefore controls what services can be offered.

The pioneering impact of the Internet lay in its features of “layering” and the “end-to-end argument.” [13] In IP-based networks, the logical layer riding “on top of” the physical infrastructure and equipment is comprised of several modular protocols, sometimes described as a stack of horizontal functional layers.[14] The modularity of the protocols makes it considerably easier to change the network for different purposes without threatening the system as a whole. As a result, an IP-based network is by design open to any number of uses. In turn, while retaining significant network management control, the network operator has less control over the purposes for which the network is used.

The end-to-end argument seeks the best allocation of functions in a distributed system. In effect, it results in requiring key information technology functions to be implemented as close as possible to the computers and other devices sending and receiving the packets across the network.[15] It has been described as the basis of the “dumb network,”[16] with the network transporting the signals and the intelligence carried out at each end. A key feature is that packets are sent separately by various routes according to network efficiency and then reassembled at the other end.

In contrast to the limited range of services that circuit switched networks could carry, protocol layering or modularity made possible a huge, perhaps infinite variety of applications which could be carried across the common platform of the IP/TCP (IP based) suite. Added to this, the end-to-end argument placed the power to write the code that constitutes applications in the hands of applications designers.[17] The network became multi-purpose with potential for creativity beyond imagining.

Beneath this logical layer of the network is the physical network infrastructure across which it rides, simply described in terms of active infrastructure and the passive infrastructure:

- The active infrastructure comprises the electronic equipment that carries the signals, such as lit fibre, DSL, node switches, satellites, radio network controller, and so on.
- The active infrastructure is installed on or in passive infrastructure, such as ducts, towers, poles, buildings and power supplies.

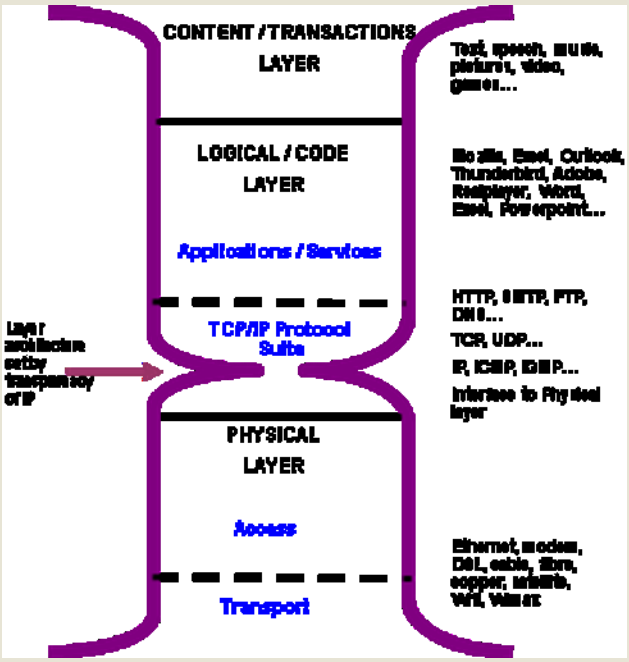
Above, across the IP based platform, computers and devices can communicate with one another using a vast number of different applications for a vast number of different purposes, some of which are commercial and some of which are not. Using these applications, providers offer electronic communications products such as voice calls, voicemail, email, messaging and numerous others, some of which are effectively becoming substitutes for circuit switched telecommunication service providers.[18]

The innovation unleashed by placing the power over coding the network[19] with the applications developers has been extraordinary. It confers on the network a quality of “openness,” i.e., the availability of the network to use by applications created and operated by persons other than the network owner and operator. This embeds an operating principle often referred to as “innovation

without permission." Fundamentally, the sharing by the network operator of control over what the network can be used for with its users has produced a revolution in the way in which services are provided. All services in effect become applications run on the computers and devices at the ends of the network, whether offered to retail customers as such or not.

The ubiquitous employment of the IP platform has, then, changed the way the overall network functions, and is understood and visualized. The hourglass image below illustrates the layers of the network described above.

Figure 1: Network layer model



Source: Yochai Benkler, Richard Whitt and others (modified by the author)

The IP-based network now defies the historical silos of voice telecommunications, data telecommunications, enhanced or value added services, as well as whether the network is fixed or wireless. For instance, in many countries now, Skype calls are available on mobile handsets.

As illustrated in section 3, the benefits for regulators in understanding network architecture, particularly the Internet's modular structure, are chiefly in understanding different economic and market realities at the various levels of the network in order to set regulatory conditions that will encourage investment, apply an informed competition policy and maintain a platform for innovation. Understanding changing network architecture informs regulators' understanding of different economic barriers to entry, numbers of potential providers active at each level, and consequent implications for applying competition policy and economic regulation.[20]

2.2 The shake-up of network technologies and management

The ongoing evolution and rapid uptake of wireless access technologies is combined with increasing investment in high speed wireline access. In addition, as discussed in this section, there are signs that certain network elements and processes are undergoing a process of unbundling and consolidation.

2.2.1 Diversifying access network technologies

The use of wireless access – whether "fixed wireless" or mobile – for telephone calls was only the beginning of the major growth of wireless technology. Wireless access networks are fast becoming available for access to the Internet. WiFi connections are already widely available, and continue to increase whether as a paying service or as a free feature bundled with another service. Wireless access networks have become an important means of providing broadband access in many countries using various fixed wireless technologies, sometimes permitting "nomadic" usage. While facing challenges, technologies such as WiMax are anticipated to increase prevalent bandwidth. IMT-2000 (3G) networks offer mobile Internet access with seamless handover among cells allowing a fuller "mobile" experience. And recent tests demonstrate the technical viability of Long Term Evolution (LTE) technology, with rollout anticipated in the coming years.

Where it is available, the signs are that consumer uptake of 3G mobile broadband is very rapid.[21] In countries where disposable incomes available for telecommunications services do not justify extensive wireline access networks, wireless technology has become the dominant form of retail telecommunications services, particularly in Africa.

The realization is still growing that the radio spectrum offers an extensive – and as yet still relatively unexploited – raw material for telecommunications, and not only for developing countries. Countries worldwide are making larger amounts of radio spectrum available as they refarm spectrum from inefficient uses towards more productive purposes. Historical top-down approaches to spectrum management are changing to ensure that the market – through demand for services and the potential of technologies – drives efficient use of radio spectrum. Numerous countries use auctions for granting spectrum rights not only to generate revenue but importantly to bring an economic discipline to bear on the spectrum usage, and as a protocol for transparent assignment. Several countries such as Belgium, Georgia, New Zealand and the UK treat spectrum rights as tradable after the original acquisition of a licence. Even without spectrum trading, efficient use of radio spectrum is increasingly the focus of regulators, for example as they consider the various ways of pricing spectrum such as administrative incentive pricing based on the opportunity cost of the next best alternative technology available.

Different technologies offer different advantages and disadvantages, with a trade-off among mobility and agility for one part, quality of service and bandwidth for another, and cost as a third. Wireless local and personal area networks (WLANs and PANs) using the IEEE802.16e technologies offer high speed data services but persisting authentication, authorization and accounting challenges keep them nomadic rather than mobile. The planning and control of UMTS and GPRS networks makes them more reliable in minimizing interference and managing capacity, and their cellular handover provides

mobility. LTE is anticipated to offer more efficient use of radio networks, reduced latency, better mobility and higher bandwidth, and promises convergence between networks originating in the GSM and CDMA families of technologies.

End user devices are increasingly wireless. Just as higher speed networks are enabling the redistribution of computer processing, major advances in device design has allowed greater use of wireless networks. With laptops, smartphones, game consoles, reading devices and netbooks increasingly substitutable for a growing number of functions, the market in devices is converging. Laptops become mobile communication devices by using dongles and data cards to connect to 3G networks. Major computing manufacturers are entering the market in smartphones,[22] which are capable of running a respectably and increasingly wide range of applications – many designed and offered by persons other than the service provider or the device manufacturer – on operating system platforms. The increasing availability of web-based applications to retail customers – cloud computing – which operate on and store data remotely reduces the burden on customer devices, some of which can offer significant broadband access with little more than a browser.

Mobile devices increasingly allow connection both to the macro cells of the mobile network as well as the micro cells of local area networks. A few mobile service providers are beginning to allow Skype VoIP calls from mobile handsets connected to home and business WiFi systems,[23] although most mobile service providers block this functionality.[24]

At the same time on the wireline side, fiber optics offer major capacity advantages and so is useful for aggregated transport in the core and metropolitan networks. In their core and metropolitan networks, both cost reductions and volume and bandwidth demands of mobile Internet services are leading operators to rely upon wireline fibre backhaul providers to carry their aggregated traffic instead of managing their own traditional microwave backhaul transmission. In some cases, backhaul is contracted through an interconnection agreement, for example as in Sudan. In others, the mobile operators outsource the backhaul between base stations to the fixed line operator.[25]

Of course, the fiber optic network is not merely a backhaul transport technology. Indeed, a widespread effort is beginning to spread the use of fiber optics throughout as much of the access network as possible.[26] One of the main debates among telecommunications policy makers and businesses in a number of OECD countries today concerns ensuring investment in fiber to the node, the home, the building, the premises, the cabinet or the curb (FTTx) and the creation of next generation access networks (NGN or NGA). Some countries, such as France and The Netherlands, have advanced further than others but the overall trend is towards increasing fiber deployment. The same debate is occurring in countries with less developed infrastructure and economies, except that it focuses on developing fiber in the core network – national and regional backbones – while relying upon wireless technology for access to users.[27]

At the same time, several competing technologies provide bandwidth sufficient for the provision of broadband access (depending of course on the adopted definition of broadband). Digital subscriber line (xDSL), cable modem systems and broadband over powerline (BPL) each contain costs by relying upon

existing networks, i.e., twisted copper pair of the traditional phone lines, fiber-coax cable TV networks, and the power lines, respectively. None of these matches fiber optic cable for bandwidth and reliability but where networks already exist some have cost and coverage advantages at least in the short and medium term.

2.2.2 Different technologies for different needs

Driven by a combination of customer demand, network capacity and economic efficiencies, then, telecommunications traffic is increasingly finding its way onto the technologies that suit its needs at the core, metropolitan and access parts of the network – notwithstanding that this involves using networks run by operators other than the provider having the relationship with the customer.

Different uses require different bandwidths, and thus different types of networks. Video, including high definition video conference and HDTV, is generally likely to require fiber for simultaneous use of multiple devices in the same location. Voice calls on the other hand require relatively low bandwidth but are delay-sensitive, and thus can be provided over basic cellular networks.[28]

Customers increasingly have to make explicit choices of network technology according to his or her need and the context. He or she might use a Blackberry to send an email rather than log on to a hotel WiFi network with high charges, might use an airport's WiFi network for transmitting large files or surfing the Internet rather than using a 3G network with high usage charges, but will rely upon the 3G service when in a car or on a train. Such decisions are of course also influenced by factors such as international voice and data roaming rates, but the general trend is towards more efficient use of networks according to user needs.

Applications are beginning to become available that automate some of such selection processes, such as Google Voice, which begins indirect unbundling of numbers from service providers and devices. Calls to an allocated number are directed to any one of several selected devices and networks at the preset choice of the user recipient. The service also permits management of calls from the various devices under the single Google Voice number.

In time, and in a more fully converged fixed-mobile environment, service providers and device manufacturers may build such preferences and efficiencies into the devices themselves. Users can be expected to make such choices according to the most efficient means of meeting their needs. Over time, service providers and device manufacturers may allow users to employ their personal applications and content seamlessly across a single service platform on one or several devices regardless of the access network used for connectivity – an access network which may be selected and changed by the device according to the given context, user profile and available network. Early signs of the development of such "personal networks" [29] are visible where a mobile phone contract is used as the billing mechanism (prepaid or postpaid) for logging on to another operator's Wifi connection.[30]

The emerging network architecture is one in which the users, and their relationship providers, have greater choice to select the network they require according to their needs for a given situation: mobile

or not, high or low bandwidth requirements, delay-sensitive (e.g real time voice or video or not) or not, and degree of cost sensitivity. Realizing the potential efficiency gains will depend upon interconnection and openness of the networks, as discussed in section 3.

2.2.3 Unbundling and consolidation in network management

Where providers are subject to competitive pressure, they can be expected to seek out efficiency gains. There is increasing consolidation of such assets under common or separate management, opening an opportunity for a new market in passive infrastructure provision. Mobile service providers, for example, have increasingly contracted with one another to share towers, base stations and even radio access networks.[31]

At the active network infrastructure and wholesale services layers, significant consolidation is occurring through outsourcing of backhaul traffic. Most regulators are taking the position that such sharing, even among a limited number of providers in a sector with high barriers to entry, does not undermine competition, but set guidelines as to the limits of such consolidation.[32] Regulators can encourage cost reduction through market-led initiatives such as mentioned above by taking a clear position, on which investors may rely, of a presumption against regulatory control unless likely or actual harm to competition is shown.

Box 1: Pressures for efficiency are leading the unbundling and outsourcing of network operations

Trends in the unbundling of network operations are illustrated by the outsourcing during 2009 to Ericsson of Sprint Nextel's US and Vodafone UK's network operations, and to Nokia of Orange's network operations in Spain. These introduced deeper levels of outsourcing to the developed economies that had hitherto been seen primarily in less developed markets for example such as Brazil, China, India, Hong Kong and Saudi Arabia where Ericsson provided outsourcing services.[33] Managed services, i.e., large outsourcing arrangements between licensed service providers and network operators, are increasing globally – a sort of reverse version of the mobile virtual network operator (MVNO) model. The Sprint-Ericsson deal demonstrates the blurring between service providers and manufacturers, as Ericsson assumes responsibilities which in many countries would be reserved for the licensed mobile provider.[34]

Source: Author

These changes indicate a fundamental shift in the view of what is core and what is not core in a telecommunications operator's business. They inevitably and similarly have fundamental repercussions for regulators' licensing regimes. The wave of mobile network operator licenses issued over the last 10-15 years includes a large number of licenses which permit outsourcing but never contemplated subcontracting key licensed functions on such a scale. Provided that concerns are met regarding security over the critical infrastructure of national networks, regulators increasingly have to rethink licensing to ensure that their own legacy legal instruments do not act as barriers to the functioning of market dynamics.

2.3 The redistribution of computer processing and content production

Together with the availability of greater network capacity, the employment of the IP platform in the network's logical layer has opened the possibility for a substantial redistribution of computing functions across the network. This can be illustrated by two trends, each seemingly opposite to the other:

- a decentralization of information technology, and consequently innovation, to users at the edge of the network; and
- a greater centralization of computer processing and storage in data centres.

2.3.1 Decentralization

Historically, communications devices have been two-way and closed, configured for a given network (e.g., PSTN or GSM). Entertainment devices have been closed and predominantly one-way, receiving broadcast, cable or satellite video and radio content. Computing devices have offered operating systems providing open platforms but with minimal communications functionality.

Year by year, microchips have rapidly increased in speed and reduced in size and the quality and power consumption of screens has been transformed at the small portable and large monitor ends of the scale.[35] The capital cost of computer processing has in turn rapidly declined. As a result, significant computer processing capacity is widely available on a proliferation of computer processing devices, and can be integrated with communication devices, resulting in a convergence between computer processing and communications (e.g., PCs, laptops, smart phones and netbooks).

This has also made it financially possible for individuals, families and small enterprises to create and manage information, knowledge and culture for an unlimited range of business, personal and other motives.[36] This appears to satisfy a latent demand across human society, as illustrated by the trend in maturing markets away from passive experience of centrally provided communications (such as television) to engaged use of ICT for an exponentially increasing number of purposes.

The predominant pattern has been for the newer devices to have a quality of openness using a similar sort of layers structure as the IP platform provides the Internet. The passive casing of a laptop encloses the active computing elements. Across these runs an operating system, whether Microsoft Windows, Linux or now Google Chrome (on PCs) and Google Android (on mobile devices). The operating system acts as a common platform for employing or creating any number of software applications, whether for email, word processing, image editing or otherwise. Apple computers and devices have been the exception, with a proprietary operating system supporting a larger number of proprietary applications, although these too are increasingly open. This design of computers and devices establishes "generativity" [37] unleashing human society's apparently tremendous potential for creativity and innovation.

The combination of these developments with the architecture of the Internet described above allows this human potential to be networked, producing new forms of human interaction and information production, whether for commercial, financial, logistical, gaming, entertainment, emotive or other reasons and purposes.[38] Various types of networks result, from social networks to distributed computing, also known as grid computing. In the latter case, networking, harnessing and combining the unused capacity of computer processors in widely distributed PCs belonging to millions of individual volunteers established the most powerful supercomputer in the world. Participants offered their computers' spare capacity while idle for the use of a University of California at Berkely project for the

purpose of analysing huge amounts of radio signals from space in the search for extra-terrestrial intelligence.[39] In 2004, seti@home's cumulative processing capacity of such distributed computers exceeded that of the most powerful supercomputer at the time, IBM's Blue Gene/L.[40]

Distributed computing models are employed commercially by banks (HSBC), car makers (BMW), computer manufacturers (Hewlett Packard, IBM), mobile device manufacturers (Ericsson) and other manufacturers (Unilever).[41] Notwithstanding its impeded launch, the most famous example remains the computer processors harnessed by the CERN nuclear research facility's Large Hadron Collidor in Geneva, Switzerland (which is scheduled for relaunch around the date of this paper).

A huge redistribution of computer processing functions across populations, businesses and science is underway, facilitated by the reduced capital cost of computing, the increased speed of computer processors and – crucially – the existence of high speed networks for carriage of signals among them.[42]

As a result, an extraordinary revolution has occurred in the production and distribution of content. The low capital costs of digital cameras and computers and now mobile devices has allowed individuals to create, distribute and receive written, audio and video content on a vast scale. Classic centrally distributed media industry structures of TV and radio broadcast, films, music, newspapers – and, within the last year or two, books – are challenged by the peer-to-peer structure of the Internet and possibility of distributed innovation. The development of distributed multi-media applications such as YouTube as well as Facebook, MySpace, Twitter and numerous other social networking applications, have had a huge social, economic and to some degree political impact. Usage of such web services is increasing demand for greater investment in connectivity. As discussed further in section 3.3, these developments are also creating new challenges for regulators in identifying lines of responsibility for protecting against the many vulnerabilities that arise from the nature of freely distributed and uncontrolled content and threats from digital transfer to intellectual property.[43]

2.3.2 Centralization

At the same time, a trend is developing towards centralization of computing, of which cloud computing is the most touted example. The availability of high bandwidth enables the unbundling of three traditionally linked aspects of information technology:

- computer processing,
- storage, and
- display/interface.

These can now be carried on in different locations. Thus a user may access a central data center to carry out computer processing on data that is stored remotely elsewhere, while viewing the data and processing results on a screen in a third place.[44]

The construction of large data centers by companies such as Amazon, IBM, Google, Microsoft and the provision of cloud services by these companies and others such as Salesforce.com are effecting fundamental changes to the provision of applications and services from a distance. The ability of cloud

providers to offer on-demand, scalable computing resources (whether as software-as-a-service (SaaS), platform-as-a-service (PaaS) or infrastructure-as-a-service (IaaS) or otherwise) offers economies of scale in information technology to the rest of the economy.[45]

Box 2: Cloud computing is on the rise with Government and corporate customers

The benefits of shifting computing functions to cloud providers are increasingly employed, for example in the United States:

- corporate versions of simple long-existing services like hosted email, e.g., the adoption by Washington D.C., and more recently the City of Los Angeles, of Google Apps to host their email systems;[46]
- standardized customer processes, e.g., Dell's sales, marketing and customer relations management and Citibank's global wealth management system; or
- complex, tailored computer processing, e.g., the US Census Bureau's use of Salesforce's SaaS in connection with the 2010 decennial census, or NASA's use of the NEBULA cloud computing for collaboration and public in-put, and education and outreach programs.[47]

Source: Author

Data centers are not being built only in developed economies. For example, IBM has built a data center in Egypt for Telecom Egypt (dubbed the "big green") and has data centers in India and other developing countries. Developing countries might reap particular benefits from the revolution in information technology once connection speeds are sufficient to carry data for complex computing tasks. Cloud computing may enable economically viable scaling development models such as microfinance for example where loan transaction costs present scaling challenges. Treatment of disease and disaster recovery coordination may also benefit from lower cost scalable computing.[48]

Made possible by telecommunications networks which can carry data at high speeds, a substantial shift of computer processing to centralized locations is underway. Illustrating the scale of the potential import of these changes underway, some have referred to the centralized provision of computing by server farms as a utility analogous to the shift from local generators to national electricity grids.[49] While cloud computing centralizes and consolidates data processing for efficiency purposes, storage is also becoming more innovative and efficient, again driven by network transmission capacity.[50]

It is not only companies that are traditionally associated with information technology that are becoming cloud providers. In the United States in 2009, telecommunications operators such as Verizon introduced Verizon Computing-as-a-Service (CaaS) and AT&T launched AT&T Synaptic Storage, an on-demand web-based data storage service.

While cloud computing and other developments may not satisfy the heady aspirations of some,[51] its advent signifies an underlying trend which is both consistent with and indeed inextricably linked with the wider distribution of computing functions mentioned earlier. What is occurring is essentially a constant redistribution of computer processing and storage across the network to optimize efficient utilization of computing and transmission resources.[52]

These developments result in a blurring of the boundary between information technology and telecommunications and creates questions regarding the regulation of cloud-based services that are

substitutable for traditional regulated telecommunications services. They increase the tensions between regulatory distinctions used in many countries between "telecommunications" services (typically regulated) on the one hand and "enhanced" or "value added" services (typically lightly regulated or unregulated) on the other.[53] The limits of the network are less clear today than the relative equilibrium reached with the traditional PSTN.

3. Challenges facing regulators

This section discusses the key challenges facing regulators worldwide in light of the changes occurring in the ICT sector described in sections 1 and 2:

- the economic and social value of **connectivity** to increasingly high speed networks for ever larger segments of the population, businesses and Governments makes this a clear priority for regulators;

- the nature of current ICT technologies creates challenges for regulators in judging and setting the appropriate level of **openness** in the ICT sector that will achieve innovative and efficient use without undermining operational integrity or investment incentives; and

- the increasing dependence of populations on connectivity to open networks creates various types of **vulnerability** that represent significant challenges for regulators.

3.1 Connectivity

The stage of high speed network development reached by countries varies. Some such as Japan, the Republic of Korea and The Netherlands have extensive penetration of high speed broadband access. Others lack IP-based access networks and in many cases core networks too, severely constraining connectivity for their businesses and populations. Regardless of the stage of development of networks, generating investment in ubiquitous high speed IP-based networks has risen high up the priority list for all regulators. Such networks are increasingly recognized as a central plank in any economic policy.

The more developed economies have substantial backbone capacity, partly as a result of investments made at the end of 1990s. But even these anticipate congestion problems with the expected uptake of higher speed services. They are focusing increasingly on spreading fiber optics throughout the networks as far as is economically viable towards the customer. Where it is not economically viable, they rely upon other high speed wireline and wireless access technologies.[54] Many developing economies still lack high speed IP backbones and international bandwidth capacity required as a basis for offering high speed connectivity, and thus are focusing on enhancing investment and competition in core networks and international submarine and overland cable connections.[55] Their focus is on wireless broadband technologies for customer access to the fixed network's points of presence.

The cost of network deployment is large for several reasons. The network effects that make deployment economically viable require a measure of coverage ubiquity. A few trunk lines here and WiFi hotspots there do not make a connected society. It has become generally recognized that substantial

barriers to investment are found in the cost of deploying the lower horizontal layers (see section 2) of the wireline and wireless networks, some in the passive and some in the active infrastructure layers. The high proportion of costs that are fixed rather than variable renders investment significantly more vulnerable to the take up of access subscriptions by customers, greatly increasing the risk to investors. [56]

On the wireline side, deployment is particularly expensive, particularly where it is greenfield and there are no existing ducts and conduits for installation, or even rights of way. On the wireless side, individual mobile network base stations may not be hugely expensive but greater usage of high bandwidth increases congestion, requiring greater transmission capacity. With limited spectrum bandwidth available for individual band-specific network technologies (GPRS, UMTS, WiFi, etc.), more base stations may be needed to ensure quality of service that meets the national wireless broadband vision embedded in licence obligations – which in turn increases the cost of deployment.

Higher speed wireless traffic in turn requires aggregation and transport on backhaul networks. The higher the volume and bandwidth usage of wireless devices, the greater the capacity of such backhaul networks must be, and the closer to the base stations they must run. Microwave frequencies, used for backhaul transport of voice traffic, are not sufficient to carry substantial broadband traffic. Thus broadband wireless network development necessarily requires accompanying wireline investment in fibre optic backbones unless such wireline networks are already in place – which they often are not.

In all these situations, the common challenge all regulators face is to attract the large scale investment required to advance networks to the next stage of development from where they are now, both in terms of improved speed and coverage.[57] The problem of providing for ubiquitous availability and use of ICT as a platform for economic growth and innovation is in significant part one of universal access and the digital divide within countries. Addressing this involves setting in motion a virtuous circle whereby increasing demand justifies investment in networks and ICT equipment and devices, and the availability of connectivity and devices in turn fuels demand.

This section discusses key challenge facing regulators of improving connectivity, exploring:

- increasing competition to drive network build out;
- optimizing use of the key public resource of radio spectrum
- exploiting property assets, public and private;
- addressing infrastructure investment gaps resulting from persistent market failure; and
- handling the role of Government in the sector.

3.1.1 Competition for connectivity

Attracting investment requires providing attractive investment conditions, which depend in significant part on the regulatory framework allowing investors to enter the market and compete on a

fair basis. As a threshold matter, investors will seek to recover their costs and make a return on investment that is commensurate with the risk involved and better than alternative opportunities available to them.

Competition at the physical infrastructure layer of networks has proven to be a valuable means of driving penetration of services. For instance, mobile service providers routinely compete on the basis of the geographic coverage of their networks – first for voice and now for Internet services. Competition can lead to innovations in expanding coverage, both in network design and in generating usage to justify investment. For example, in countries where lack of electrical power supply constrained the recharging of mobile phone batteries, and thus held back usage, the mobile operators offer a battery recharge service at points of sale of prepaid call units and solar chargers – enabling operators to extend their networks further.[58]

At the other end of the retail market, hundreds of local ISPs and broadband access providers in Romania and Bulgaria – which to the surprise of some have among the highest broadband quality scores in the world[59] – engaged in a race for the market, stringing fiber optic cables across buildings and to their customer homes, contributing to these countries' high broadband access rates. Regulators need to ensure that licensing regimes and network buildout approval schemes do not overly restrict distributed competition initiatives while respecting environmental and planning laws.

The diversification of access technologies today discussed in section 2.2.1 is demonstrating that not only is competition among providers of the same service beneficial, but inter-modal competition is also driving improved access to higher speed and services. At a basic level, this includes competition between PSTN and mobile networks for voice traffic. It also includes competition between services integrated in the networks and applications which are run over the Internet (such as Skype and chat), increasing the tension between the silo structured market and the horizontal network model described in section 2.1.

The challenge facing regulators is to ensure that competition serves the aim of improving connectivity to the greatest extent possible. As discussed further in section 3.2, this involves setting an appropriate degree of openness in terms of market entry and open functioning of the market, including effective competition and access to open platforms.

3.1.2 Optimizing use of radio spectrum

Since the public interest is served by lowering the costs of network deployment, public authorities can take a lead by making spectrum, a key medium, available in a manner that attracts large and efficient investment in networks and services. Radio spectrum is a valuable, and in many places crucial, means of extending the network to users where the cost of laying infrastructure would exceed what is economically viable, and for offering services with the feature of mobility. If the experience of the mobile sector's growth in voice services over the last ten or fifteen years offers any indication, competition in mobile broadband may be expected to reduce prices and increase penetration and usage.

Mobile broadband is already enjoying very high growth in usage,[60] significantly driven by the development of Internet-capable devices.[61]

Many regulators have taken major steps to make more spectrum available for narrow band and broadband connectivity. Between licensing frequencies available for 3G GSM/UMTS, WiMax and now "4th generation" LTE,[62] and ensuring that frequencies used for WiFi do not require licenses, the last 10 years have seen a huge shift towards wireless means of communications. Making available more radio spectrum, particularly low band spectrum which permits higher quality of service over longer distances, can facilitate mobile broadband growth.

Significant amounts of radio spectrum that are expected to be useful for telecommunications purposes are being liberalized through digitalization of TV. This represents the latest wave of digitalization of communications carried out over recent decades – first digitalization of fixed networks, then mobile networks and now broadcasting. The radio spectrum anticipated from this process – the "digital dividend" – includes spectrum in bands that are expected to be useful for broadband purposes. Still, the cost of replacing equipment and the complexity of such a spectrum refarming exercise means that many countries will not benefit from this for years to come. It also often creates tensions between official institutions responsible for the broadcasting sector and telecommunications regulators, the latter of which in many countries have authority over the country's radio spectrum management but not broadcasting.

Further, the radio spectrum is in many countries still managed under a "command and control" approach, a legacy from early government monopolization of the radio spectrum including for military purposes. Proposals for decentralized methods of management have ranged from treating spectrum under a tradable property rights regime,[63] on an "open access" basis,[64] and as a "commons,"[65] i.e., as an asset available for use by all on common terms like a public park. These have not been adopted significantly but various initiatives are allowing market forces to influence the allocation of spectrum.

Box 3: Radio spectrum is being liberalized in various ways[66]

Liberalization of radio spectrum has included:

- initial public offerings by the State of the right to use frequencies for certain periods;
- relaxation in controls over transfers and consolidations of licensees (and thus indirectly spectrum rights);
- some steps to permit secondary trading of spectrum rights (including sale, buy-back, leasing and mortgage schemes), allowing licensees to aggregate spectrum to meet their needs according to capacity and technology usually for a given period of time, and inversely to transfer spectrum rights to other entities when they expect to make more profitable use of it;[67] and
- use of spectrum on a commons (typically unlicensed) basis, typically limited according to the radio magnetic power of the radio devices to protect against risk of interference; the vision of an "Internet of Things", i.e., devices connected to devices in homes, offices and other premises, may provide demand for more unlicensed spectrum, the value of which is anticipated to be large.[68]

Source: Author

Spectrum is often shared for point-to-point and point-to-multi-point microwave links for trunking and backhaul, e.g., in the 6, 7 and 8 GHz bands. Apart from MVNO arrangements, most regulators license access network radio spectrum on an exclusive basis. Technological neutrality is often encouraged in order to ensure that investors are free to select the technology they believe offers the best combination of effectiveness and cost in using the radio spectrum. Still, since deciding to license a certain band of radio spectrum is associated with industry standards, there are few truly technology neutral regulatory decisions.

The challenge regulators face is to ensure that radio spectrum is made available in a manner that ensures its optimal exploitation,[69] taking into account the experience that such use – and operators – may change with developments in technology and markets, including dealing with competition concerns.[70] In addition to allocation and assignment, optimal exploitation of radio spectrum is significantly influenced by spectrum pricing. Spectrum pricing may serve various purposes, including:

- serving fiscal and derivative political goals;
- ensuring a fair return on private use of a public asset through charging economic rent; and
- rationing a scarce resource to ensure (i) efficient spectrum use, (ii) ensure the highest value use of the spectrum and/or (iii) ensure a fair and transparent method of spectrum allocation.[71]

Policy for pricing mechanisms in many countries has not been developed, probably in part due to the complex economic and technical analysis involved in pricing according to consistent theories. Pricing methods often involve a mixture of mechanisms that depend on perceived demand for, value of and risk of congestion in the spectrum, and of course political pressures. These include upfront auctions, installment payments,[72] fixed charges (whether one-off or recurring periodically), revenue sharing obligations and administrative incentive pricing (i.e., basing the price on a calculation of the opportunity cost value of the spectrum). Better tailored pricing mechanisms are likely to reduce economic barriers to efficient usage of the spectrum.

The radio frequencies and bandwidth an operator is allowed to use have a significant impact on its costs, the distances it can serve and the capacity of its network. Capacity is likely to become an ever more important competitive factor in the provision of wireless broadband. The pressure of broadband usage on capacity and the need to manage mobile network traffic is intensifying the debate today about wireless network neutrality in the United States.[73] It will be important for regulators to ensure that their allocation and assignment methods and associated pricing do not distort the market and hinder the potential of telecommunications but rather facilitate the efficient use of a valuable national resource.

3.1.3 Exploiting property assets

Whether used in combination with spectrum (e.g., for backhaul) or as an alternative means of access, wireline networks remain crucial to developing high speed connectivity. From the perspective of

horizontal network layers, there is increasing focus on the costs of the passive layer of the network. For example, various studies have found that between 65–80% of the cost of rolling out fiber networks to the premises consists of civil works.[74] Thus, "any policy which can reduce the costs of civil works would provide an important impetus to stimulating the roll-out of fiber."[75]

3.1.3.1 Public property and administrative procedures

Given the high cost of civil works, access to publicly owned real property can greatly reduce the cost of network deployment, particularly horizontal corridors such as rights of way (e.g., roads, rail, power and gas lines), existing public duct systems and even existing, redundant dark or lit fiber (e.g., used by national power companies).[76] Numerous innovations are being tried, including use of the public sewer systems.[77]

Much depends on the facilitating legislation. In Canada, service providers may enter on and break up any highway or other public place for the purpose of constructing, maintaining or operating its transmission lines.[78] German service providers may use public roads, paths, squares, bridges and waterways to deploy telecommunications lines without charge.[79] In the United States, the National Telecommunications and Information Administration facilitates access of service providers to a wide range of public properties. Many developing countries struggle with the lack of a clear real property rights regime, particularly in the absence of land registers. Regulators can nevertheless facilitate negotiations with those who lay claim to land. Legislation enacted in 2009 in the Bahamas and Solomon Islands provide innovative approaches to securing access to private and customary land for telecommunications purposes.[80]

A major impediment to the lack of exploitation of public resources appears to be lack of initiative and coordination across government bodies and barriers to approval. Regulators can do much to take a lead in this regard. The Lebanese Telecommunications Regulatory Authority recently published a study identifying legal barriers to use of public properties, including rights of way. It has proposed a decree to remove such barriers, establish application and approval procedures, and set out pricing principles for implementation by government bodies. The TRA expects it to be a cornerstone of its new broadband policy.[81] Such studies and legislative initiatives may lead to significant improvement in the exploitation of public assets in support of ICT services.

Network investment can be advanced by greater exploitation of existing institutional and community assets, particularly those that may both serve as demand drivers as well as locations for resale, such as schools, libraries, hospitals, community centers and other public facilities. Even without major legal or financial powers, regulators can act as facilitators of such initiatives, coordinating the process of identifying the facilities and introducing relevant parties. The creation of one-stop shops for collecting key information and channelling applications and approvals can accelerate the identification of investment opportunities and deployment of networks.

3.1.3.2 Passive telecommunications infrastructure and other private properties

The cost of civil works is increasing focus on access to ducts that are privately owned by service providers, including interest in the requirement for a "reference duct offer," introduced in Portugal[82] and currently being considered in the UK which recently carried out a major study of the country's duct system[83] and in Lebanon where the ducts are still in the public domain. France's regulator ARCEP in 2008 reached the conclusion, accepted by the European Commission, that the provision of access to ducts was a "relevant market" for the purpose of analyzing market analysis and determined France Telecom as having significant market power in such market, and applied access obligations as a reasonable and proportionate remedy.[84]

Some countries' regulators and municipalities require coordinated planning for civil works to avoid repeated disruption and duplicated cost among operators. Some have considered ambitious mandatory planning requirements involving industry committees established by the regulator.[85] These face concerns about the managerial nature of such regulation as well as the loss of stealth as a competitive strategy and the "lowest common denominator" drag on operators' competitive incentives to be first to install infrastructure in an area. Australia's access regime provides for operators planning to install infrastructure to notify other operators and requires some negotiation with those who are interested in participating, an interesting compromise.[86] In some countries, the operators themselves have taken the initiative to coordinate planning, such as the UK's Mobile Operators Association.[87]

The nature of passive infrastructure makes it important that regulators look beyond just obligations on telecommunications network operators to broader questions of how costs of deployment may be reduced given the types of property being used. An increasing number of countries (for example Bahrain this year) are engaging building development and landlord associations to ensure optimal use of their rights of way, ducts and in-building cabling to facilitate investment and competition.[88] In some cases, such as Sweden building developers and landlords are recognizing the benefits of securing high speed networks, including increased property value, charging higher rent, customer lock-in and building management systems.

In the active network infrastructure and wholesale services layers, regulators have adopted a variety of remedies on the basis of significant market power for dealing with cost barriers to new entry, including mandating non-discriminatory provision of leased lines and various forms of local loop unbundling. These are having varied degrees of success and while they may increase the level of competition do not guarantee investment in new high speed network infrastructure.

3.1.4 Addressing persisting market failure gaps

Even with competition and good use of public resources of radio spectrum and real property, the costs involved in making substantial advances in connectivity can remain a significant barrier to rapid investment from private sector investors.[89] Most countries still face the problem – in varying degrees depending on a country's geographic distribution of business and wealth and its topology – of reaching uneconomic areas with networks which are costly to deploy.

Notwithstanding the benefits of competition discussed above in section 3.1.1.1, the introduction of competition weakens the traditional basis of internal cross-subsidies which in the past were paid for from higher margins in wealthier areas which were used to pay for below-cost provision in rural and low income areas. Over time, competition may drive coverage beyond more economically attractive areas, but the likelihood of "cherry picking" gives the advantage to operators who enjoy higher margins from high revenue areas without the pressure of lower or negative margins from lower income areas. Rapid nationwide rollout of high speed network infrastructure in many countries requires a clear regulatory plan to attract investment and ensure that the benefits of competition are made widely available.

Regulators have to work through the dilemma of identifying where competition is unlikely to be an effective driver of increased penetration of higher speed network access for the population, and whether (and if so, where) alternatively aggregation and consolidation of networks and services may be necessary to provide a robust revenue base for substantial levels of investment. The question is how to address the bottlenecks to extending higher speeds networks.

A now common approach to the loss of the internal cross-subsidy within a national operator is to extend this traditional method so as to draw funding from a wider number of sector participants through universal access charges that supply a fund that may be used for reverse subsidy auctions. Other geographic-focused solutions include region-specific approaches to licensing, exemptions from license and spectrum fees, encouraging partnerships among operators, and coupling profitable areas with rural areas in licenses.

Universal service funds raise particular challenges for regulators since collecting funds inevitably attracts interest and changes incentives. The political dimension and scale of such funds in many cases necessitates additional supervision, sometimes in the creation of cross-sector participant committees and sometimes involving politicians. Ensuring the application of funds is consistent with the rest of the regulatory regime and does not distort investment incentives is also important.

Changing definitions of services can raise concerns about which entities should be required to contribute, particularly with the effects of convergence.[90] A significant risk that must be addressed in universal service fund mechanisms is the central management of such funds, including the inefficiencies, distorted incentives, political pressures and even corruption that often accompany any major centrally managed funding. These can be mitigated to some degree through competitive bids, such as are now common. Some countries' legislation, such as Fiji's Telecommunications Decree, include arrangements allowing local communities to propose projects, thereby distributing the opportunity for taking the initiative – and thus innovation – more widely than its more common place at the center.

3.1.5 Dealing with Government as investor

The importance of improved connectivity to economic growth and social cohesion necessarily make increasing penetration and speed of networks a key element of national economic policy making. The last two decades of telecommunications reform in most countries have pursued these goals through reducing the direct role of Government in the sector. Government has been increasingly separated from

service provision and network investment and operation through privatization. Policy making and regulation have in turn been separated through the establishment of independent regulatory authorities, with Ministers focused on higher level policy development and regulators charged with executing regulatory mandates established by law. Investment risk has thus been better aligned with network operation and service provision decisions, within a context of stable regulatory environment.

Recent years, however, are increasing the tensions between the areas of policy, regulation and operation. Of course, in many countries, Governments remained significantly invested in the sector as part owner of the national operator.[91] But as shown in Box 4, there are now signs that the importance of high speed networks to national economic policy in some wealthier countries is leading to increasing Government involvement through financial investment and public private partnership arrangements (PPPs) – in some cases driven by stimulus funding.[92] The most ambitious of these is the Australian Government's A$43 billion (about USD 37 billion) plan to build out FTTH and subsequently privatize a large portion of the network.

Box 4: Recent public funding commitments for next generation broadband networks

Country	Announcement	Total investment (USD million)	Investment per capita (USD)
Australia	2009	3,300[93]	159
Germany	2009	200	2
Greece	2008	1,030	92
Ireland	2009	110	25
Republic of Korea	2009	890	18
Malaysia	2008	720	27
New Zealand	2009	840	205
Portugal	2009	1,060	100
Singapore	2008	710	154
USA	2009	7,200	24

Source: Booz & Company, "Digital Highways: The Role of Government In 21st-Century Infrastructure" 2009

Governments are planning and implementing a variety of means of intervention both on the demand and the supply side. The Republic of Korea, for example, has stimulated demand through a classification system for buildings according to their broadband speeds. Both the Japanese and Republic of Korea governments have, for example, provided substantial subsidies, with significant results.[94] Singapore's example is now well known.[95] Other countries have seen significant initiatives at the municipal level, including Norway and Sweden for example.[96] In Europe, the majority of FTTH/B projects are led by municipalities and power utilities. [97]

Decisions by countries' or municipal Governments to invest public money in telecommunication networks, while likely to boost connectivity significantly, give rise to significant regulatory issues that are important to resolve. The worldwide trend towards privatization over the last two decades has been driven in part by the rationale that excessive Government ownership or interests in national telecommunications providers risks a misalignment of investment planning, risk and reward, with

resulting inefficiencies. Where Government funding is provided in a multi-operator market, there are significant risks that any competitors may be adversely affected by the subsidy element. This may create distortions in competition and investment incentives of other providers, "crowding out" private investment.

For this reason, in Europe, the European Commission recently published guidelines on how restrictions on State aid should apply to rapid deployment of broadband networks. The Commission has categorized situations into:

- "white areas," where broadband is not currently available and there are no plans by private investors to roll out such infrastructure in the near future, in which case State aid will generally be permitted;

- "black areas," where at least two broadband network providers are present and there is facilities-based competition, and so where State aid for rolling out additional broadband networks will be viewed negatively; and

- "grey areas," where a broadband operator is present and further analysis is needed to assess the adequacy of market conditions, the existing network access offer, entry barriers and inability of existing regulatory remedies to overcome such factors.

The Commission required various safeguards to avoid potential adverse consequences, including ensuring that State aid is only provided:

- where in the absence of private investments, a public service network is necessary to ensure universal coverage;

- compensation is granted only to deploy the network in the unprofitable areas; and

- the network is open to all service providers. [98]

The European approach, then, focuses on maintaining competitive dynamic in the market and addressing specific market failure. Whether it suffices to bring about the sea change of major investment claimed by some to be necessary to achieve the transformative effects of ubiquitous high speed networks will remain to be seen. While the European approach seeks to maintain a continuity of regulation through the application of competition policy principles, the larger scale investments particularly in Australasia introduce a new level of politicization of the sector. This creates unique challenges for regulators, who have to cope with substantial changes to the structure of the sector and their legislative mandates.

3.2 Openness

The sweeping introduction of competition across the world's telecommunications markets may be seen in a wider context of greater openness in the economic management of the ICT sector. Openness is

used in various ways, but generally in contrast to exclusivity and to refer to unconstrained access to and use of commonly available platforms. This comprises for example:

- openness of systems and markets to newcomers and fairness of treatment among participants;
- the degree of interoperability, i.e., how much systems should be required to allow information to be transferred and used across organizations, networks and components;
- the degree to which proprietary offerings should be either permitted and encouraged, regulated to require mandatory access and non-discrimination obligations, or even prevented; and
- the degree to which processes which determine development of the sector are transparent and consensus-oriented, are not controlled by a narrow set of interests but permit a range of interested parties to participate, and whose results are made widely accessible.

Box 5: Open systems may exist at various layers of the network

Examples of open systems include:

- physical and logical interconnection of telecommunication networks (particularly the peering arrangements of the Internet, but also traditional interconnection of PSTNs and mobile networks too), allowing greater efficiency gains to the totality of networks and richer levels of communications as increasing numbers of connections are made possible among providers, users and other participants;
- non-discriminatory access to infrastructure and wholesale services, providing a platform for many service and applications providers to compete and offer services;
- devices which can host any application, which can connect to different network providers using different modalities (e.g., GSM, UMTS, WiFi), and so which can be used for multiple purposes not limited by a single provider;
- inclusive standard setting bodies such as the ITU's Telecommunication Standardization Sector (ITU-T), the European Telecommunications Standards Institute (ETSI), the Internet Engineering Task Force (IETF), the International Organization for Standardization (ISO) and the World Wide Web Consortium (W3C);
- open-source software, a software copyright licensing system which ensures that there are no limits on the royalty-free, non-discriminatory redistribution of the licensed software, provides source code to facilitate its incremental development derived from it;[99]
- Creative Commons content copyright licensing, which "provides free licenses and other legal tools to mark creative work with the freedom the creator wants it to carry, so others can share, remix, use commercially, or any combination thereof.and user-generated content websites;"[100] and
- social networking websites (such as Facebook, MySpace and LinkedIn) and collaborative content creation websites such as Wikipedia, which enable participants to communicate, create and share content and information with each other in a variety of ways, intensifying the social capital created by the interconnection of networks.

Source: Author

These issues cross multiple domains and disciplines, and many are the subject of extensive controversy. The chief benefit of open systems is in the permission they allow for innovation and competition, ensuring that power is not over-centralized. A key question regulators repeatedly face is the degree of openness they should impose in the ICT sector – how they should adjust and influence the

prevailing system of incentives which affect the behaviour of network operators and service and applications providers. [101]

This section explores the challenges regulators face when:

- seeking to establish an open market and maintain its openness by policing fair competition and market dominance;
- considering whether to impose openness – particularly of networks – in order to increase competition and innovation across shared platforms; and
- ensuring open processes in the development of industry standards.

3.2.1 Open markets

The benefits of open market competition for the ICT sector were mentioned above in section 3.1.1. The stance a regulator takes on what kind of market structure is to be allowed to develop and how open it will be will, inherently, have a major impact on the functioning of that market. Regulators have to consider the optimal approach to facilitating market entry through the authorisation regime, both by the number of service providers allowed into the market and the rights and obligations applicable to them in licences or regulations. In dealing with service providers in the market, regulators also face challenges in applying competition policy, addressing areas of actual or anticipated market failure and supporting market initiatives. The key responsibility of a regulator is to understand how best to structure the framework of incentives within which service providers operate in order to derive the benefits from investment and competition.

3.2.1.1 Optimizing open market entry

A significant number of regulators have adopted open authorization regimes, which either make an unlimited number of licenses very easily available or require only a notification to the regulator and no approval to commence business.

In still the majority of countries worldwide, however, telecommunications services are provided and networks are operated under licenses rather than open authorization regimes. Two aspects of this create tricky problems for regulators:

- Licensing regimes are typically based on a presumption that services and networks are forbidden unless a person has a license. The market is closed and market entry is the exception to be granted by the regulator. This creates a risk of the regulator itself becoming a bottleneck if it does not issue enough licenses.

- Licenses are typically limited to defined activities (specified services that may be provided and networks that may be operated), have set durations and sometimes have hefty acquisition fees. These factors risk creating significant legacy rigidities that impede valuable investment and the competitive dynamic of the market.

Regulators, then, face the challenge of ensuring sufficiently open and flexible licensing regimes to allow investment and competition. Thus more and more countries are adopting universal licenses (which permit any services and networks) and open authorization regimes. The transition of key rights and obligations from provider-specific licenses to regulation – *ex ante* and *ex post* – is necessarily bumpy and regulators face challenges in minimizing disputes in the process.

Despite general recognition of the benefits of universal and open licensing, three factors still pull in the opposite direction. First, in many countries, the benefits of more flexible licensing regimes must still be weighed against investors' need for certainty of their rights. Particularly in countries where the legal and administrative system does not yet guarantee regulation under a reliable "rule of law," investors typically seek clearly defined rights for a set period of time. This often means providing lengthy licenses on which investors may rely in case of disputes with the Government and regulator. As discussed further in section 4, the challenge for regulators in such countries is to provide the certainty required without creating greater problems for the regulatory regime in the future.

Secondly, notwithstanding open market, any country needs a mechanism for controlling use of publicly owned physical resources, i.e., radio spectrum and public property. A simple means of controlling and rationing use of such resources is through licensing. Such permissions can of course be separated from service provider licenses (i.e., to spectrum licenses and public property approvals without any link to networks and services). In practice, however, the benefits of a one stop shop have meant that in many countries, at least as concerns radio spectrum, the right to provide a service has been combined with the right to use the physical resource.

Thirdly, almost all regulators take the view that at least certain dimensions of the market require a limited number of sector participants, which is most easily controlled through a licensing regime. It is generally recognized that the potential for competition to produce ubiquitous coverage is limited by the large cost of rolling out networks. Thus in the mobile sector, there are arguments for restricting entry to the market because (putting technical arguments based on the need for spectrum aside) an industry structure with a smaller number of players would provide substantial reductions to the cost of serving subscribers.[102]

Similar arguments apply in the wireline sector, particularly in relation to installing FTTP. In addition, where capacity is very large, as it is with fiber optic technology, the attractiveness of rolling out redundant network infrastructure declines (except to maintain competitive pressure on pricing and quality of service, and to provide network redundancy for security purposes). There is a tendency towards "natural monopoly" type thinking by regulators for passive (and sometimes active) network infrastructure in given geographic areas and in some countries even nationally. Fiber networks are increasingly regarded as a crucial national electronic infrastructure utility, a genuine information transport "highway" the economies of scale of which likely require a single supplier to aggregate traffic to ensure the level of efficiency that makes them affordable. This thinking emphasizes the substantial trans-sector externalities that a society can expect to gain from having ubiquitous high speed

connectivity, externalities which are not priced into individual telecommunications operators' business plans.

The problem for regulators in designing open market entry conditions lies in the difficulty of predicting how the market will develop using new technologies, particularly the uptake and profitability of broadband network access. Regulators are caught in a cross-fire of policy and economic arguments that high speed networks will be profitable as the entire economy shifts gear and usage rises exponentially, and counterarguments that demand remains unsure and the transformative effects on productivity unproven. The contrasts between the vision of a transformative leap forward and incremental change are starker than ever.

3.1.1.2 Policing the open functioning of the market

As competition in markets has developed, so has the sophistication of understanding competition problems, and correspondingly so has regulation tailored to address such problems. Still, regulators face major challenges in keeping multi-operator markets open, i.e., policing competition. These challenges include defining the relevant markets in which the level of competition is to be assessed, and identifying dominance or significant market power (SMP, often defined as meaning a level of power enabling a provider to behave to an appreciable extent independently of competitors and customers) and competition abuses in such markets.

As experience has grown of anticompetitive behaviour, the propensity for dominant providers to engage in it and the harm caused if they do, countries have also legislated against specific activities carried out by providers that have been identified as dominant, i.e., "*ex post*" regulation of anticompetitive practices.[103]

Abuses of market power, of course, can only be addressed when – if it is proven – they have occurred. They can be so serious and establishing that an abuse of market power has occurred can take so long that the remedy comes too late – the harm to competition is done. For this reason, legislation typically provides for regulations that will prevent such abuses occurring in the first place. This involves placing "*ex ante*" obligations or restrictions on dominant providers, such as requiring them to provide a minimum interconnection offer, controlling their wholesale prices and conditions offered to other providers, requiring them to make their facilities available to other providers, and where there is inadequate competition at the retail level, controlling their retail prices and quality of service.

Thus regulators face considerable challenges in determining the balance between *ex ante* and *ex post* regulation. New entrants often press for greater *ex ante* regulation of incumbent operators, who in turn may argue that matters should be dealt with more by *ex post* regulation. The risk with *ex ante* regulation is that, like licenses (which in effect are another form of ex ante regulation), the boat risks being beached as the tide turns. In some markets, for example the African or Caribbean mobile markets,[104] very rapid change to market structure challenges regulators' abilities as new entrants quickly overtake incumbents while the regulatory regime struggles to update its analysis of the market and change prior regulatory obligations.

The challenge for regulators is to be agile enough to ensure that *ex ante* regulation does not overly burden the operators. Many countries still apply controls on retail prices in competitive mobile sectors without explanation. The flexibility to change regulation where it no longer suits the facts on the ground is, then, just as important as getting it right the first time. In the European Union, and an increasing number of laws worldwide in developing and developed countries, [105] there is a requirement to ensure that the obligations – remedies – are specific, relevant and proportionate to the problems they are designed to address.[106]

3.1.1.3 Preventing market foreclosure due to dominance

An essential part of both *ex ante* and *ex post* approaches to regulation involves identifying which providers are dominant and which are not. Dominance is commonly understood as referring to a level of power in a market that renders the entity effectively immune to the actions of others, such as suppliers and customers. Such power inheres the ability to close down markets and undermine the benefits of open competition.

Identifying dominance, then, enables the regulator and providers to know which operators are subject to the abuses of dominance provisions and specifically targeted regulatory obligations. The use of dominance as a threshold trigger for various regulatory obligations is useful for various reasons:

- It involves a presumption of lighter regulatory treatment unless dominance is shown to exist, thus placing the emphasis on market forces rather than regulation to drive the improvements in telecommunications services.

- It focuses on the underlying sources of problems that arise in competition, which as explained above arise from dominance.

- Once dominance is established, regulatory obligations can be applied fairly automatically without extensive further consideration.

The benefits of using a dominance test include the now fairly extensive jurisprudence available internationally regarding the meaning and application of such tests. Furthermore, dominance zooms in the analysis to the precise market failure problem that has to be addressed in regulation. It requires detailed fact gathering and complex economic analysis. The regulator has to analyze a common set of factors for every defined relevant market, including market growth and market shares, future potential market shares, barriers to entry and expansion, economies of scale and scope, countervailing buyer power and access to capital markets.[107]

In turn, competition policy and law have developed tests to identify what markets authorities ought to look at when considering whether a producer or service provider has reached a position of dominance. Practice in developed markets has developed a well known test for defining relevant markets, commonly known as the Small but Significant Non-Transitory Increase in Price (SSNIP) or “hypothetical monopoly” test. This test originates from competition law and policy applied more

broadly across economies where it was necessary (e.g., for merger or acquisition approval or to deal with allegations of abuses of dominance) to identify what segment of the country's entire economy was being considered.[108]

The market developments described in section 2 of this paper are making the carrying out of tests of relevant markets and market power increasingly challenging for regulators, particularly given the convergence of wireline and wireline services, and the convergence of applications and services. The increasing availability of high speed connectivity, combined with the horizontal layering structure of the network created by the IP/TCP suite, greatly accelerates the impact of convergence, which in turn increases the complexity of competition analysis.

Box 6: Competition analysis in a converging market is a complex exercise

The revenue base of network-delivered services is changing significantly. Advertising is an increasingly large source of revenues. A September 2009 report for the Internet Advertising Bureau showed that advertising online in the UK exceeded advertising spent on TV.[109] Telecommunications companies whose primary source of revenues has long been voice services increasingly anticipate that video on demand (VoD) and high definition TV (HDTV) will become the core of the fixed line business with voice calling offered as a bundled component.[110]

As content becomes increasingly important in attracting advertising and Pay TV revenues, new competition concerns arise between the network layers described in section 2.1. For example, in the UK, broadband providers BT and Virgin Media and others complained against BSkyB for not permitting them to use its "premium content," in this case sports and blockbuster movies, for distribution on their networks. UK regulator Ofcom has found that such content constitutes its own wholesale market, and that Sky is dominant in such market.

Ofcom also found that Sky is using this dominance in an "upstream market" to favour its own distribution platforms over those of competing platforms of cable, digital terrestrial television (DTT) and IPTV.[111] The finding was that dominance in one layer (content) is being used for anticompetitive purposes in another layer (transport). The case has taken three years and thousands of pages of consultation documents and as of the date of this paper, is not complete.

Source: Author

In many countries, the inadequacy of the economic and legal resources and information available to analyze such factors is a huge challenge for regulators and indeed creates a substantial risk for regulation. If providers pursue aggressive competition into the regulatory process and the courts, they may make a dispute a forum for argument over wide ranging international sources of complex economic theory and its correct or incorrect application by the regulator. Providers are also likely to challenge, rightly or wrongly, over whether the regulator has taken into account all pieces of information that should be taken into account in the economic analysis.

This presents a significant risk of regulators' assessments and definitions of relevant markets for competition analysis and designations of dominance (and regulatory remedies applied as a result) becoming lightning rods for disputes, tying up regulatory initiatives in the courts without addressing the actual problems that need resolution. In countries where resources are very limited there may nevertheless be little choice but to use relatively blunt regulatory instruments. For example, the

regulator might apply relatively symmetric regulation to interconnection, focus on non-discriminatory interconnection negotiations rather than requiring a reference interconnection offer, regulate prices solely or principally according to international benchmarks, and apply infrastructure access obligations on the basis of a simplified "essential facilities" test.

However, these alternatives to applying competition policy as a basis for regulatory remedies are not particularly satisfying either, and may simply replace arguments over market definition and market power with disputes which are merely proxies for competition policy disputes. The skill required of the regulator is to weigh the importance of careful application of competition policy against the limits of its resources.

3.2.2 Mandating openness

In some cases, such as network interconnection, access to infrastructure and wholesale services, and open devices, regulation has been applied to bring about the desired result. In others, such as open source software, Creative Commons licensing and social networking websites for example, the open systems have emerged without coercive regulation – driven by a variety of motives. And even for business reasons, many companies have endorsed openness to some degree or another in their business models without any or without strong regulatory coercion, often in order to generate further or linked sales or services and sometimes to disrupt prevailing monopolies.

Box 7: In some cases, open systems offer a better business case

Businesses have chosen open systems at many of the layers described in section 2.1:

- At the computer operating system and applications layers, for example, Sun Microsystems and IBM have embraced open source software. The Linux operating system and the Mozilla Firefox browser have become widespread in the mainstream computer market and Google Android is increasingly deployed on mobile devices.
- At the content layer, huge amounts of content are made freely available online by institutions and individuals. Many content providers, particularly newspapers for example, embraced open provision of their proprietary information on the Internet. There are signs now that their dissatisfaction with the current Internet advertising business model (including Google's strong position) is leading to increased charging for content.[112]
- Both the manner of Internet traffic exchange (typically bill & keep and transit agreements) and the logical layer of the Internet itself (described in section 2.1) may be described as relatively open, even if there are limits to such openness due for example to firewalls, network address translation,[113] proprietary protocols in the middle of the network, ISP liability, Government controls in some countries, traffic prioritization, and virtual private networks.
- At the layer of network wholesale services, KPN's CEO Ad Scheepbouwer is credited with perceiving early the benefits of a national network operator opening its network for use by other providers, whether competitors or not – because such open use would increase usage and therefore greater exploitation of network capacity.[114]
- At the layer of physical network infrastructure, tower companies and other voluntary infrastructure management often involve an openness to adding equipment of new network operators or using new technologies.

Source: Author

The challenge regulators face is to consider where openness is particularly valuable and, where it does not arise voluntarily, where intervention is required to mandate it. When considering taking such steps, it is critical for regulators to weigh carefully together:

- the benefits of competition and innovation that are anticipated;

- the operational effects on the functional integrity of the infrastructure, equipment, product, service or process which is to be opened, including in particular changes to control over it; and

- the impact on investment incentives and property rights, and whether the wider distribution of control (e.g., over customer relationships) reduces margins rendering investment in ICT less attractive.

3.2.2.1 Anticipated benefits of competition and innovation

Significant benefits of mandating openness are generally recognized in the context of significant market power over core services, such as in interconnection, access to wholesale services and essential facilities. Some countries are pushing infrastructure openness even further. For example, as is well known, BT Openreach in the UK is committed in its "Undertakings" to functional separation and to offer access to and use of its network on the basis of "equivalence of inputs." British Telecom separated its network asset ownership arrangements and structured its group governance structure to protect against discriminatory behaviour at the network wholesale services layer. While not particularly voluntary (there was significant regulatory pressure from Ofcom), this example of functional separation – along with initiatives in Singapore, Italy, New Zealand, Australia and other countries – exemplify a powerful application of openness policy implemented at the network infrastructure level. At this time, the results of these bolder initiatives remain to be fully understood.

Other cases are clearer. Requiring openness for customer premise equipment has had benefits universally, prising offerings apart, unbundling components that could be opened to competition. In the United States, for example, the US Court of Appeals on the D.C. Circuit's 1956 *Hush-a-Phone* decision[115] and the subsequent 1968 *Carterphone*[116] decision of the US Federal Communication Commission (FCC) famously introduced separation of regulation of the networks and services from terminal devices. This ended AT&T's claim to control over terminal devices and, by requiring AT&T to connect any compliant devices with its network, opened a vibrant market in cordless phones, fax machines, answering machines and other terminal devices.

Since most countries adopted arrangements similar to the FCC's *Carterphone*, devices have been treated as consumer products and, other than some type approval concerns and regular consumer protection, have not been at the forefront of regulatory policy. Today, devices are clearly an important driver of telecommunications traffic, generator of revenues and factor in capturing and defending market share. For example, a large proportion of mobile broadband traffic is driven by the use of iPhones. While competition over the development of the devices themselves is fierce, a positive feedback loop applies since they in turn support the development of the network by the network operator and services by third party applications providers.

The question today is how such principles translate to today's market. In 2007 Skype petitioned the FCC for an extension of the *Carterphone* principles to mobile networks in order to prevent operators

tying mobile devices to the networks,[117] as is the case for example in France, which has laws restricting such tying.[118] The FCC is currently considering these and other "net neutrality" measures.

The debate over such net neutrality issues is led by Canada (which recently issued its decision on the matter)[119] and the United States (the FCC recently issued a consultation process) and ranges across a variety of inter-related topics. It focuses in particular on unreasonable discrimination by ISPs against traffic, particularly where such discrimination results in a degradation in quality received by the user to protect traffic favoured by the ISP. For example, throttling traffic with low tolerance for latency such as real time audio or video may render the signal worthless to the recipient. Requirements that service providers disclose their practices aim at providing greater transparency to users of what they can expect. The debate is highly contentious, billed by some as concerning the very open nature of the Internet itself.

3.2.2.2 Operational realities

Openness often involves a reduction in proprietary control over content, applications, networks and infrastructure. In networks, it typically has significant operational implications. For example, the proposed net neutrality rules in the United States concerning non-discriminatory management of traffic across networks have provoked particular resistance in the mobile sector. Operators have argued that bandwidth constraints on mobile networks, coupled with the difficulty presented by the fact that users move between cells, require more careful management of traffic. Likewise, functional separation involve major changes in the manner in which the network is managed and has been criticized for undermining the operational link between retail services and the networks which serve them, reducing the efficiency of information flow between customer demand and the provider's investments in and operation of its platform for supplying such demand.[120]

Operational realities often produce extensive debate over whether proposed regulations that mandate openness will really even achieve desired results. For example, some policy advocates have suggested embedding the horizontal layered architecture of the Internet as a broadly applicable principle in regulation to guarantee its openness at each level and encourage innovation.[121] The physical, logical and content layers should be kept separate from and transparent to one another, with each layer's problems solved at such layer's level. This has been criticized by others as inaccurately reflecting the development of the Internet, of freezing the evolution of network design, undermining technology neutrality,[122] and of missing the benefit of the Internet's inherent openness to its own continual change and improvement, which should be allowed to evolve with less regulatory control.[123]

The debate mentioned above over network neutrality in Canada and the United States is focusing increasingly on the necessities of network management, including management of congestion, dealing with harmful traffic such as viruses and spam, blocking unlawful content (e.g., child pornography) and transfers of content that infringe copyright. In particular, rapidly rising volumes of broadband traffic on mobile networks places these under strain,[124] with service providers arguing that their networks require careful network management. Similarly, video now represents about a third of all consumer Internet traffic without counting peer-to-peer sharing of video[125] and all forms of video are together expected to

increase to over 90% by 2013.[126] These factors intensify arguments about service providers' needs to manage traffic on their networks.

When considering mandating openness, regulators face the challenge of verifying that operational realities do not prevent the desired outcomes or that regulations will indeed further the desired policy goal.

3.2.2.4 Impact on investment

Mandating openness often affects basic property rights. Property rights in most countries essentially comprise a significant measure of exclusivity over control and usage of an asset. This exclusivity is often constrained by the rights of the State to encroach upon property rights for public purposes in accordance with laws, such as expropriation for national infrastructure (e.g., building roads and railways), environmental protection, divestiture to break up monopolies and other cases. Nevertheless, a key economic rationale for property rights in many countries is the ability to control development and exploitation of the asset and thus to provide an incentive for investment.

A key question regulators need to consider therefore is whether a trade-off arises between attracting investments and mandating openness. Of course, openness that makes competition possible may allow new entrants and new investment into a market (see section 3.1). But the impact on investment may vary, and views differ on where openness will increase or harm the prospects of investment.

Investors and telecommunications providers often seek to persuade regulators not to impose obligations to provide access to their infrastructure or to allow their customers to have access the services of others, for example Internet-based services. The arguments are particularly familiar now in the mobile sector with respect to "walled gardens" (i.e., where a network operator allows customers to receive only or predominantly its proprietary services), tying handsets and traffic prioritization.

The challenge facing regulators is to weigh these arguments in the absence of clear information. Sometimes the lack of information is due to the sheer newness of problems. In countries where regulators' resources are severely constrained, the lack of information is compounded by the difficulty in analyzing such information as is available. It is in these contexts that regulators face the challenge of assessing the various arguments and making decisions that will form the basis of investment over many years.

Box 8: There is extensive debate over mandating open access fiber networks

The debate over the impact of mandating openness on investment may be illustrated in the policy disagreement and resulting dispute between the European Commission and Germany regarding development of Deutsche Telekom's high speed networks and whether the company should be allowed a "regulatory holiday" from access obligations, or whether it should be required to grant bitstream access to new fiber. In 2006, the German legislature had amended the Telecommunications Law establishing a presumption against regulation of "new markets."[127] The law permitted the Federal Network Agency to introduce regulation if the lack of regulation was expected "in the long term impede the development of a sustainable competition-oriented market" but required it to "give particular consideration to the aim of fostering efficient investment in infrastructure and the promotion of innovation."[128] Like the FCC in the United States, the German national regulatory authority decided not to impose access obligations on Deutsche Telekom's new FTTC and VDSL deployments and the European Commission brought enforcement proceedings against Germany for not applying access obligations according to EU law.

Given the sums of money involved, these issues are highly contentious. For example, France Telecom responded to the French regulator ARCEP's announcement earlier this year on required sharing of in-building cabling by freezing investment and threatening not to proceed with fiber deployment. FT's position seems to be softening with a compromise that treats dense urban areas differently from other areas, with only the former being required to install multiple fiber optic lines within the in-building cabling.[129]

Targeting the precise point at which openness should be required can reduce some of the contentiousness around the risk to investment. For example, the Dutch regulator OPTA has explored compromises between the German and EU approaches. Its staff has observed that new, or emerging, markets are often intertwined with existing markets. Rather than apply to new markets those regulatory remedies such as mandatory wholesale services that apply to existing services (which may result in over-regulation) or forbearing from regulation (which may result in under-regulation), regulators should focus on assets used by new technology platforms which are nonreplicable. This means applying ex ante regulation on nonreplicable assets (such as essential facilities), i.e., which a new entrant will not for commercial reasons replicate, and focusing competition law on behaviour in the provision of services over these assets. This may allow longer term certainty for investors in new infrastructure, preserving investment incentives and addressing the risks associated with monopoly fiber investment.[130]

Source: Author

3.2.3 Open processes, standardization and intellectual property

It is not only networks and services that are the subject of openness. Some industry processes have a major impact on the shape of the market that develops. For example, as is evident in the development of GSM, UMTS, WiMax, WiFi and LTE, the development of standards is determinative of technologies that may be used, radio spectrum that will be required and services that will be provided.[131] These standards may not be laws handed down by authorities, but have so much importance in setting market conditions over long periods that they have an implicit quasi-regulatory nature. The manner in which they are developed, then, is a matter of public interest. It is important for regulators to understand their processes and to recognize when they are sufficiently inclusive and transparent to avoid the risk of capture by narrow interest groups, and open enough to encourage innovation.

Many standardization bodies are relatively open. That is not always enough, since individual companies may still control assets which are essential to – and so may block – the development of a standard. An appropriate balance must be found between:

- the incentives to invest in new technologies and exploit them under legal monopoly rights conferred under patent legislation; and

- the need to ensure that industry development is not held hostage to such rights, for example through "patent ambush" whereby a standard is threatened by a patent right holder (or alleged holder).

Various standard setting organizations, such as the Institute of Electrical and Electronics Engineers (IEEE) European Telecommunications Standards Institute (ETSI) for example, seek to resolve these factors by focusing on "essential patents," i.e., patents which would be infringed by the implementation of a particular standard or specification. They will require members to disclose such essential patents and license them on fair, reasonable and non-discriminatory (RAND or FRAND) terms on a reciprocal basis with other members. Despite this, the complexity of new ICT technologies and patent fragmentation means that sometimes thousands of disclosures of essential patents are made together with royalty claims, risking the development of standards as quickly and as successfully as might otherwise be possible.[132]

Competition laws in several countries bolster the voluntary arrangements of standard setting organizations. For example, regulators responsible for competition matters may require patent holders to honor their commitments to license essential patents.[133] And in a case involving the development of mobile phone chips, the US Court of Appeals for the Third Circuit found that deceptive failure to disclose an essential patent during the standardization process and subsequent demands for royalties for essential patents constituted anticompetitive actual or attempted monopolization.[134] Regulators face the challenge of broadening their vision to understand the dimension played by intellectual property rights and standard setting processes.

3.3 Vulnerability

Just as the combination of connectivity and openness has the extensive benefits described in section 2, it also creates various vulnerabilities, particularly relating to security and consumer protection. There are several types of vulnerability, among which are:

- privacy and data protection;
- emergency services;
- cybersecurity;
- distribution of unlawful content; and
- lawful intercept.

This section closes with a discussion of how regulators may facilitate increased use of self-help resources in coping with certain vulnerabilities.

3.3.1 Privacy and data protection

Privacy is complex and multifaceted, mixing notions of dignity, intrinsic to peace and tranquillity, essential to liberty and democracy and a human right. The many types of privacy-related problems have been organized as follows (Solove's taxonomy):[135]

- information collection (surveillance and interrogation);
- information processing (aggregation, identification, insecurity, secondary use and exclusion);
- information dissemination (breach of confidentiality, disclosure, exposure, increased accessibility, blackmail, appropriation and distortion); and
- invasion (intrusion and decisional interference).

Threats to privacy and data protection have increased hugely as a result of the openness of network communications, the distributed nature of computer processing and storage, and the commercial value of information. Users share extensive information about themselves through electronic communications. Their activities, whether sending emails or chatting, making purchases, sharing photographs of themselves and others, carrying out Internet searches, planning social events, meeting family needs or carrying out business, constitute a picture of themselves. The large amount of data about individuals that is shared may be of interest to businesses seeking to sell products and services, to fiscal authorities seeking to check tax compliance, to Governments wishing to monitor political views, to media companies where there is a good story, and to criminals seeking to abuse information or individuals.

Many countries have established privacy and data protection laws to protect citizens from many of the problems listed above.[136] However, the evolving nature of the ICT sector means that fresh privacy issues are being considered regularly.

Box 9: Privacy protection is constantly being updated as new services develop

The Article 29 EU Data Protection Working Party recently published an opinion on privacy and social network hosted communities and services.[137] It concluded that providers of such services (whether paid for by fee or indirectly through advertising revenue or other means) and even associated applications providers are "data controllers" and so bear responsibilities under the EU Data Protection Directive.[138] They therefore had duties to:

- inform users about the purposes and ways they process personal data and share with third parties;
- offer privacy-friendly default settings;
- provide information and adequate warning to users about privacy risks when they upload data;
- advise users that pictures or information about other individuals, should only be uploaded with the individual's consent.

After an extensive study, Canada's Privacy Commissioner found various complaints against Facebook to be well-founded, including:

- with respect to default privacy settings and advertising (where were resolved); and
- treatment of third-party applications, account deactivation and deletion, accounts of deceased users, and non-users' personal information (where Facebook began to resolve after the proceeding).

Some countries have taken strong measures with regard to hosting of user content. Executives from Google were prosecuted earlier this year for violating Italian privacy law by failing to remove a video of a disabled boy being bullied from the video sharing website, Google Video.[139]

Source: Author

Another example concerns behavioural advertising. A significant part of the Internet's value for advertisers – who fund a large part of online content – is in the ability to provide web advertising to fit the preferences and profiles of users identified from their browsing habits. But as advertising online continues to grow, it becomes more important to offer users with the clear opportunity to preserve their privacy rights. There are signs that behavioural advertising is coming under increasing regulatory pressure. For example, the main US advertising industry associations recently adopted a set of self-regulation principles in a bid to avoid regulation of behavioural advertising by the Federal Trade Commission.[140] Phorm, the behavioural advertising technology firm, recently announced that it was leaving the UK market as it failed to reach agreements with telecommunications operators.[141]

In many countries, various privacy matters are assigned to administrative bodies other than the ICT regulator. Yet the regulator invariably has some responsibilities relating to privacy, particularly where it is a converged regulator dealing with electronic services, broadcasting and information technology. [142] And in many countries, absent specific privacy-related legislation, the ICT regulator may have to lead the way in dealing with privacy as it relates to ICT services, including through license and other regulatory obligations. In discharging whatever legislative mandate is assigned to them, regulators will often face the challenge of finding the appropriate balance between:

- promoting users' access to services through sector investment and growth (which may be significantly boosted by revenues from advertising for example); and
- protecting user's privacy and data.

3.3.2 Emergency and directory services

Developments in network architecture discussed in section 2 have implications for how the ICT sector maintains and develops the provision of social goods which have traditionally been provided by integrated network operators who controlled their own networks, services and customer access. These include:

- provision of emergency services, and
- directory and directory enquiry services.

High speed network access supports multiple services, some or all of which may be provided by persons other than the provider of the physical connection to the user. The less that services are controlled by the network operator, the more difficult it may become to hold it accountable for providing key social goods and protections, some of which were previously provided by network operators. Further, the more that networks are operated by separate core and access network operators, and the more that users rely upon a diversity of access technologies in different locations – none of which may have any relationship to the provider of the service – the more awkward it may become to assign costly responsibilities to any single operator whose margins are under competitive pressure.

The challenge regulators face in all of these areas is to whom, and how, to assign responsibility for these matters in light of who as a practical operational matter has the greatest ability to control the outcome[143] and how the costs of securing such social goods should be fairly apportioned.[144]

3.3.3 Cybersecurity

With the open peer-to-peer design of the Internet based on end-to-end arguments, Governments, companies and individual users face risks from malicious and criminal peers at the other end of the networks. This is resulting in widespread vulnerability to phishing, spam/spim, viruses, computer-related fraud, denial of service attacks, botnet abuses and other offences. Thus while the benefits of ICT adoption have multiplied, so have the risks and dangers associated with their use.

Countries worldwide are increasing their emphasis on enhancing cybersecurity. As an integral part of government, regulators may play a key role in the national cybersecurity effort of many countries. Their broad competencies in the ICT sector, their familiarity with the ICT industry and their expertise in ICT networks and infrastructure naturally position them as key players in the field of cybersecurity.

In a number of countries, regulators have progressively established their role in the rapidly evolving changing field of cybersecurity by building on the clear mandates that they have been given. For example, regulators in many countries have been dealing with the issue of spam as a significant consumer-protection problem and burden on the national ICT infrastructure. Spam can also be a vehicle for generating BOT viruses that can lead to denial-of-service attacks against critical information infrastructures, and so is increasingly recognized as a cybersecurity risk.[145]

A key vulnerability of today's ICT services derives from the ease of anonymity. Regulators are increasingly using device registration as a means of reducing abuses of the ICT infrastructure. For example, Bangladesh, Botswana, Greece, Malaysia, Pakistan and Switzerland require prepaid mobile phone users to register their accounts. In Italy now, Internet cafés and other public access points require customers to register their names.

Nevertheless, the primary challenge facing regulators in the cybersecurity arena is in defining their role, particularly given the association of cybersecurity with national security policy, traditionally the exclusive domain of the military, law enforcement and the intelligence community.[146] In this sensitive area, regulators have to find ways that they can add value to cybersecurity activities and advise on cybersecurity policy without necessarily being the lead institution in the field.

Box 10: There are numerous ways in which regulators can assist in developing cybersecurity

In addition to advancing cybersecurity threats as a consumer protection matter and defining their roles, regulators face challenges in various areas of cybersecurity. In the area of development and implementation of policy, these may include:

- assisting in Government, commercial and public understanding the nature of cybersecurity threats and building broad cross-sector expertise by forging links with other sectors; and
- assisting in development and implementation of national cybersecurity policy frameworks.

Regulators may also assist with the implementation of cybersecurity policy and laws by:

- providing technical training to legislators, prosecutors, the judiciary and law enforcement on the ICT related technical aspects of cybercrime; and
- providing technical assistance in the investigation of cybercrimes.

Regulators' relatively close relationship with and understanding of companies and technologies in the ICT sector puts it in a strong position to contribute through:

- leading or coordinating public-private sector efforts to develop cybersecurity standards, procedures, codes of conduct, etc.;
- mandating or encouraging the adoption of cybersecurity standards, recommended best practices, certification and evaluation schemes; and
- supporting research and development (R&D).

In the area of incident management, the regulator can assume the following roles:

- establishing national cybersecurity incident monitoring facilities; and
- participating in international and regional cybersecurity incident monitoring initiatives.

In the area of readiness assessment regulators can assume the following roles:

- preparing and implementing periodic cybersecurity risk assessments, audits and reviews on a national or a sector-by-sector level; and
- conducting cybersecurity exercises to test readiness and responsiveness.

Source: Author

3.3.4 Lawful intercept

Lawful intercept (wire tapping) on an IP-based network is vastly more complex than on a PSTN. Communications relevant to criminal activity are carried out by a variety of means, such as email, instant messaging, VoIP calls, and website viewing. The routing of individual data packets makes it more challenging to recover a stream of communications. Data encryption raises the barriers to effective monitoring, mostly only to intelligence operations with code cracking capabilities. Deep packet inspection (DPI) has been developed to enable monitoring of multiple internal layers of the Internet, and can be used increasingly for various purposes, including lawful intercept.

Regulators are typically not invited by ministries of the interior, national security and police forces to play a significant role in the practical side of lawful intercept. Nevertheless, the means by which lawful intercept is implemented may often involve regulatory instruments, such as obligations in licenses and regulations requiring ICT service providers to maintain the necessary equipment and facilitate use by authorized officials. With this, regulators may also effectively bear responsibility for deciding whether service providers will bear the costs.

Where regulators do have such a role, a key challenge they face – given their understanding of the ICT sector – is to mediate successfully between the demands of those responsible for national security and policing and the operational and financial realities of service providers. As monitoring and controlling communications for law enforcement purposes has become more complex, so does this challenge.

3.3.5 Distribution of unlawful content

An analogous separation of functions is creating similar questions over responsibility at the content layer, including with respect to:

- censorship (obscenity, child-protection, incitement to violence and other restrictions on free speech), and
- copyright protection.

Mass distribution of media content was traditionally distributed from centralized sources due to the cost of distribution (e.g., broadcasting and printing) and restrictions on the means of communication (e.g., limited use of radio spectrum). The peer-to-peer nature of the Internet and its separation of message from carrier, however, makes it difficult to control the mass viewing or hearing of media content. This is accentuated by the potential variety of geographical locations involved for content creators, websites, servers and end-users customers reading, watching or listening to the content.

Converged regulators – with responsibilities for media distribution as well as ICT services – thus have an extensive task to cope with the many aspects of content. Even regulators which have a more technical and economic market mandate face the challenge of assisting policymakers in identifying who should bear responsibility for making content available and what their responsibility should be.

DPI can also be used for filtering for censorship and copyright protection purposes, drawing the focus to ISPs and online service providers as potential gatekeepers for many of these issues. Thus ISPs have increasingly been allocated responsibilities under copyright protection laws for cutting off users after repeated unlawful peer-to-peer file sharing which have generated recent controversy in the UK and France. In the United States, the Digital Millennium Copyright Act applies severe penalties if the online service provider does not comply with a “take down notice” from a holder of copyright requiring the provider to remove material that violates the copyright.

3.3.6 Facilitating distributed self-help solutions

Advancing key social goods is not only a matter of imposing regulatory obligations. For example, a significant number of cybersecurity problems faced by individual users can be mitigated through adoption of anti-virus and anti-spyware software and firewalls. A large market has grown in this area. As in any market that is still young and not well understood, ICT regulators face the challenge of ensuring that consumers receive adequate disclosure about products they are purchasing.

Another example concerns the complex problems parents face regarding children's access to media content and other online communications which parents consider inappropriate. Given the demand for solutions, a market is developing in this area. Various ratings, labelling systems, and technologies are available to enable parents to manage various devices or different types of content.[147] Regulators can provide a facilitative input in disseminating the large amount of information that is available for self-help resources.[148]

4. Conclusion

The developments described in this paper demonstrate the potential of the ICT sector to innovate and restructure itself beyond the conception of the policy makers and regulators who designed regulatory frameworks. The overall challenge facing regulators is that various assumptions underlying their regulatory frameworks are coming into question. Regulators face the challenge, as much a mental feat as exercise of any expertise, of:

- broadening their perspective to the wider ICT ecosystem;
- struggling in many cases with inadequate legal powers for the complexity of the sector;
- identifying and applying durable regulatory principles;
- coping with regulating a contentious market in rapid transition; and
- applying through regulatory processes an attitude of open mindedness.

4.1 Looking to the wider ICT ecosystem

In most countries, for many years now, the subject of regulation has been telecommunications, typically defined as the transport of electromagnetic signals through one means or another. However, the manner in which computer processing and storage are used is central to many services, corporate and retail, provided over networks. Information technology applications are offered in competition with telecommunications services. Thus while computers and devices in the past were relatively minor technologies at the edge of the network, today they are driving it and determining what it will do.

Regulators cannot focus narrowly on the service of providing telecommunications services. Today they face the challenge of understanding the wider ICT ecosystem and the evolving symbiotic relationship between computer processing – whether on a server farm on the Island of Malta,[149] on corporate mainframes, on desktops or on smartphones in a user's hands – and the transport of electromagnetic signals, a relationship that is also affected by technological and capacity differences among the diversifying means of transport. The FCC's trilogy of *Computer Inquiries* have wrestled with many of these questions since the 1960s.[150] Today, however, the questions have multiplied and become more complex and spread throughout retail ICT services. And many regulators in the world today are only beginning to struggle with the complexities as the technologies and services reach and spread out in their countries.

Similarly regulators need to understand better the role of manufacturing in the development of technologies and management of networks. The driving importance of standardization and the importance of patents requires regulators to engage with standard setting bodies and processes. In

many countries the courts or a specific competition regulator may have primary responsibility in this area, but for regulators charged with developing access to ICT and innovation in networks and services, it is an important concern.

In these and other ways discussed in this paper, then, the field of vision for regulators is expanding, and the challenge is to understand it and apply regulatory principles that will endure.

4.2 Struggling with inadequate legal mandates

Yet many countries' regulators do not have effective powers to look beyond telecommunications to deal with the wider ICT sector. The changes occurring in the technologies and usage of networks expose regulators to new areas which are traditionally the domain of other Government departments and agencies, and in which regulators' legal mandates are not clear. Similarly, the role of regulators in dealing with cybersecurity in most countries has not been clearly defined, and such matters are often under the powers of a range of other bodies, from national security authorities to consumer agencies. Since most countries have not opted to converge responsibility for media content with responsibility for networks and services, traditional telecommunications regulators may find themselves struggling to address market power problems involving media content, such as described in Box 6 in section 3.1.1.3. Some regulators do not have competition powers, with competition policy being addressed by a different body.

In all of these situations, regulators need to advise policy makers on the problems posed by their lack of broad enough powers, and the potential need for legislation to broaden their mandates. In the meantime, they can only use all means at their disposal to use coordinate activities and share information with other Government departments and agencies.

4.3 Identifying durable regulatory principles

With such complexity, speed of change and uncertainty, it is easy to become captured by one particular perspective. Indeed, various approaches to regulation are constantly jostling for adoption. In significant part, the choices facing regulators are not politically neutral and resolvable by identifying rights answers according to economic theory. Rather, they are about the kind of ICT environment a country wants. Openness along the lines of the design of the IP platform is oriented towards innovation, a key driver of economic growth. Yet one of the most innovative devices, the iPhone, is being successfully marketed in most countries through exclusive, locking arrangements, is driving traffic growth and new mobile Internet services.

In the cacophony of debate over regulatory policy, regulators need to seek and apply durable regulatory policies and principles, i.e., that can be continually brought to bear on the changing market. Many formulations are possible, and might include for example:

- ***competition policy***, applied in a holistic manner to ensure that regulators regard the ICT ecosystem as a whole in defining relevant markets and identifying dominance and abuses of market power;

- ***innovation-oriented regulation***, which seeks to generate opportunities for developing and marketing ideas which may effect key shifts in how ICT is provided and how resources are used, including improving synergies between computing and transport of data;

- ***trans-sector focus***, seeking to ensure through the application and removal of regulation that the multiplier effect of ICT across all sectors are fully realized; and

- ***integral social and economic development***, ensuring that society as a whole advances without irreversible and deepening exclusion.

4.4 Managing transition in a contentious environment

Partly due to introduction over time under varying circumstances, different modalities of service provision (wireline, wireless mobile, fixed wireless, etc.) have in most countries evolved under different regulatory frameworks, including licensing, interconnection and retail price regulation.[151] Likewise, a country's radio spectrum is not a blank slate on which the regulator can design the perfect assignments and allocations, since various government departments (e.g., the military), institutions and companies typically already hold legal rights to use substantial portions of useful radio spectrum.

Regulators today face the challenge of minimizing distortions arising from regulatory treatment of different technologies in order that the most efficient use of resources may be realized. This may require reconsideration of licensing regimes to ensure a level playing field, and likely tends towards unified licensing and even eventually notification and general authorization regimes instead of service licensing. Likewise, NGNs introduce a range of issues for the transition of interconnection regulation for example, including reduced numbers of interconnection points, increased number of potential layers at which interconnection may occur, regulation of interconnection pricing, and others.[152]

Yet there is in most markets a lot at stake in the perpetuation or change of these regulatory frameworks. Investments have been made, and sometimes expensive licenses have been purchased, with some reliance on the continuity of the regulatory regime in place. Legacy rights and obligations may distort competition, or may even be treated as a subject of competition itself as providers use regulatory processes to compete for opportunities and foreclose their competitors. Regulators face the problem of continually migrating from existing regulatory obligations to new ones, together with the resistance of entrenched interests and influences. This requires planning of migration paths for the changes, and dealing with the contentious subjects and disputes that arise.

There is, then, significant weight placed on processes for dealing with disputes among participants in the ICT sector, as well as between such participants and the regulator itself. Regulators find themselves in the hot seat, facing pressures from a variety of interested parties, including Government, large influential network operators, new entrants and other service providers and users – whether individuals, businesses or other organizations.

With the speed of change and constant transition of legacy rights mentioned above, it is inevitable that many regulatory initiatives will be contentious. Effective and efficient resolution of disputes between operators is required where the regulatory regime has not effectively and finally settled uncertainties, which is often next to impossible due to the changing environment and the time and cost of enforcement. In a sense, a large part of any regulator's work – including issuing *ex ante* regulations – is a sort of dispute resolution – i.e., definitively resolving arguments and claims between interested parties.

Box 11: The principles of dispute resolution can inform good regulatory practices

Dispute resolution among service providers is successful where:

- interested parties have an opportunity to present their interests and arguments;
- interested parties also have an opportunity to respond to others' presentations of theirs;
- the regulator considers such presentations carefully and has an opportunity to verify and question;
- the regulator reaches a firm and timely decision where such is required for the sector to develop;
- the regulator provides reasons for its decision based in the law applicable to the sector and under the authority conferred on it; and
- interested parties have an opportunity to request another forum (e.g., a court or another administrative body) to annul or modify the decision if the regulator has stepped out of its powers, acted particularly unreasonably or simply omitted to take into account important information or arguments.

Source: Author

The lessons from dispute resolution can be brought to bear on regulatory process more generally. In the context of dispute resolution, the matter under dispute is specific to the parties, and has often become so adversarial and personal that the regulator must step very carefully if its decision is not to be challenged (and often it will be challenged anyway). But in many ways, the features of successful dispute resolution outlined in Box 11 above are essentially the same as successful consultation process in the development of new regulations. It is critical, then, that regulators bring to the entire regulatory process the same sort of listening ear as they would when arbitrating disputes between service providers.

4.5 Connected networks, open minds

The title of the ITU's 2009 World Telecom Forum, "Open networks, connected minds," encapsulated the major social and economic benefits recognized as emanating from connectivity and open networks.[153] As a result of the trends in network architecture and services discussed in this paper, some of which are more advanced than others in various countries, regulation has become far more complex.

Regulators increasingly need not only the ability to understand engineering and to carry out sound economic and legal analysis, but the mental agility to recognize and adapt to shifting paradigms. They need to be ready to question previous approaches to regulation while nevertheless applying consistent regulatory principles. Regulators face the challenge of judging when market failure requires regulation, and where regulation is no longer required and can be removed. As the impact of regulation endures for many years after regulations are issued and even after they are repealed, regulators face great responsibility to ensure that they maintain minds as open as the Internet itself.

Furthermore, they need processes designed to allow such adaptation, and given the speed of change in the market, on a rapid basis. This requires regulators to be in a constant state of learning, gathering, churning and updating information. It requires regulators to venture ideas and solicit reactions before taking actions that may affect the use of computers and networks by businesses, scientific institutions, hospitals, universities and individuals for years to come. Firm knowledge is necessarily replaced by provisional positions – pending updated analysis.

In this regard, the greater uncertainty regulators which face – about the information before them and the impact of their decisions – must necessarily make regulators both more cautious and more daring at the same time. As a result, consultation processes are now more crucial to successful regulation than ever before to ensure the introduction of new, and removal of old, regulations will have the desired effects. And while recognizing the importance to investment of stable regulatory conditions, regulators need to consider regulatory ideas that are as innovative as the technologies that are their subject – and that are continually arriving.

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[1] The World Bank reports that 90% of developed and developing countries have competition in the mobile sector. See David A. Cieslikowvski, Naomi J. Halewood, Kaoru Kimura and Christine Zhen-Wei Qiang, "Key Trends in ICT Development," in *Information and Communications for Development*, World Bank 2009.

[2] See "Key Trends in ICT Development," *supra* note 1, and .

[3] For example, TeleGeography research predicts by 2013 an increase in the number of broadband subscribers of 72% reaching over 700 million, and an increase in wireless subscriptions increasing by 60% to well over two billion. See http://www.telegeography.com/.

[4] ITU World Telecommunication Indicators database.

[5] "[Econometrics] analysis of 120 countries found that for every 10-percentage-point increase in the penetration of broadband services, there is an increase in economic growth of 1.3 percentage points." Christine Zhen-Wei Qiang, "Telecommunications and Economic Growth", unpublished paper, World Bank 2009, referred to in Mohsen Khalil, Philippe Dongier, and Christine Zhen-Wei Qiang, Paper 1, "Overview," *Information and Communications for Development*, World Bank 2009.

[6] Firms' productivity improvements from broadband are not generally disputed. There is less evidence at this stage regarding the effect on productivity of extremely high speeds as opposed to more basic broadband speeds. See Arthur Grimes, Cleo Ren and Philip Stevens, "The Need for Speed: Impacts of Internet Connectivity on Firm Productivity," *Motu Working Paper* 09-15, Motu Economic and Public Policy Research, October 2009

[7] See generally, Robert D. Atkinson and Andrew S. McKay, "Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution," The Information and Technology and Innovation Foundation, March 2007. See http://ssrn.com/abstract=1004516

[8] See generally, Jacques R. Bughin, Bradford C. Johnson and Andy Miller, McKinsey & Company, "Distributed co-creation: The next wave in innovation," *McKinsey Technology Initiative Perspectives.*

[9] See generally, Eric Von Hippel, *Democratizing Innovation*, Cambridge, MA, MIT Press (2005). Von Hippel's estensive studies, including books, on user contributions to innovation in numerous industries and using today's technologies are available at http://web.mit.edu/evhippel/www/.

[10] See James Surowiecki, *The Widsom of Crowds*, Anchor Books (2005). The wisdom of crowds resulting from openness created by connectivity may be contrasted with "groupthink", i.e., thinking of a group that is not open to critical analysis. See Irving L. Janis, *Victims of Groupthink,* Boston. Houghton Mifflin Company (1972).

[11] For example, a regulator may come under political pressure not to enforce against unlawful spectrum activity and as a result have its funding cut leaving it without technical monitoring equipment necessary to prove the unlawful use in a legal enforcement action. Or lack of information in an interconnection dispute may make it difficult to analyze the market and produce a determination that will stand up to judicial scrutiny.

[12] The TCP/IP suite was one of several protocols suites that were used in the development of the Internet, including Digital Equipment Corporation's DECNet, the Xerox Network Services (XNS) architecture, the Open Systems Interconnection (OSI). The TCP/IP became widely adopted with the establishment of the World Wide Web.

[13] The pioneering work setting this vision out was Vinton G. Cerf and Robert E. Kahn, "A Protocol for Packet Network Intercommunication", *IEEE Trans. On Comms*, Com-22, No. 5 (May 1974).

[14] These are often roughly described as the utility layer, the transport layer, the network protocol layer and the link layer interfacing with the physical network. Put simplistically and abstractly, each layer within the IP/TCP suite deals with its own problems and carries out its own tasks, and interacts with the layers above and below it, allowing it to be modified without changing the other layers. Of course, the reality is more complex than this, since the various layers are not neatly distinct. Application protocols are used as middleware for other applications, many applications may serve one another and carry out more than one of the functions, blurring the boundaries between the various functions. See Richard Bennet, *Designed for Change: End-to-End Arguments, Internet Innovation, and the Net Neutrality Debate*, Information Technology and Innovation Foundation (September 2009), 31. Available at http://www.itif.org/files/2009-designed-for-change.pdf

[15] "The end-to-end arguments suggest that specific application-level functions usually cannot, and preferably should not, be built into the lower levels of the system—the core of the network." David D. Clark & Marjory S. Blumenthal, *Rethinking the Design of the Internet: The End to End Arguments vs. the Brave New World*, Paper Submitted to the TPRC 1 (Aug. 8, 2000).

[16] "In a world of dumb terminals and telephones, networks had to be smart. But in a world of smart terminals, networks have to be dumb." George Gilder, *The Coming of the Fibersphere* (1995), available at http://www.seas.upenn.edu/~gaj1/fiber.html.

[17] Timothy Wu, "Application-Centered Internet Analysis", 85 *Va. L. Rev*. (1999) 1163, 1192.

[18] VoIP services are examined in greater detail in the Global Symposium of Regulators (GSR) paper, Phillipa Biggs, *Voice over Internet Protocol: enemy or ally?*, available at http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR09/papers.html.

[19] For an argument for how computer code effectively establishes the laws inherent in Internet architecture, see Lawrence Lessig, *Code version 2* (Basic Books 2006).

[20] For instance, the capital cost of investing in, and the practicalities of installing, high speed access infrastructure are very different from those involved in developing retail software applications or the operation of web and mail servers. This may inform regulatory policy both in dealing with an infrastructure provider's ability to leverage significant market power over infrastructure into an adjacent market in the provision of services, as well as in ensuring that applications providers will be able to innovate across the network.

[21] For example, UK's Ofcom reported over 2 million new mobile broadband connections between 2008-2009. "Ofcom pledges further consumer protection for mobile users and publishes 3G mobile coverage maps for the first time," Ofcom press release, 8 July 2009. See http://www.ofcom.org.uk/media/news/2009/07/nr_20090708. Similarly, Infonetics Research predict that between 2009 and 2013, worldwide mobile broadband service revenue will more than double. See http://www.infonetics.com/.

[22] Acer and Dell for example are entering the smartphone market. See Robin Kwong, "Smartphones set to become mainstream," *Financial Times* (September 28 2009)

[23] For example, 3 in the UK permits WiFi access and use of Skype on mobile handsets connected to its network.

[24] Alan Harten, "AT&T admits blocking 3G VoIP", *VoIP News*, 14 September 2009. See http://www.voip-news.co.uk/2009/09/14/att-admit-blocking-3g-voip/

[25] O2, Vodafone, T-Mobile and 3 in the UK have outsourced their backhaul to BT Outreach. Rob Minto, "T-Mobile and 3 deal provides boost for BT arm", *Financial Times*, 5 October 2008

[26] "We expect to see up to 300 billion euros of investment in both high and very high speed European broadband networks in the coming decade." Neelie Kroes European Commissioner for Competition Policy Commission Guidelines for broadband networks Introductory remarks at press conference Brussels, 17th September 2009. See http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/09/394&format=HTML&aged=0&language=EN&guiLanguage=en

[27] See for example: Mark Williams, *Broadband for Africa: Policy for Promoting the Development of Backbone Networks*, InfoDev - World Bank 2009; Telecommunications Regulatory Authority of Lebanon, *Broadband Licensing Plan* (issued for consultation), 4 May 2009.

[28] Ordinary digital voice requires 32-64 kb/s; voice carried in packets requires less, possibly even as low as 8-16 kb/s; high definition voice can require from 32 kb/s to 256 kb/s depending upon whether it is packetized or uncompressed.

[29] One vision sees the development of personal networks managed by mobility providers which use a service platform to communicate with the device, ensure access to services roaming among different access networks, act as a one-stop shop for providing their services to the personal network, and avoids the user having to deal repeatedly with the choice of network, authentication, handover and charging. See Nico Baken, Edgar van Boven, Frank den Hartog, and Ramin Hekmat, *A Four-Tiered Hierarchy in a Converged Fixed-Mobile Architecture, Enabling Personal Networks* (2004).

[30] For example, in Geneva's Cointrin Airport, the WiFi provider offers various ways of paying for access, including credit cards, Swisscom's mobile number and other methods. A Swisscom mobile customer may enter his or her mobile number and receive a code by short messaging service (SMS) which is then used to log on to the WiFi network. The customer is then charged under his or her mobile contract with Swisscom. While typically two devices are used (the mobile phone and the laptop), a single device – a smartphone with WiFi capability – could be used instead.

[31] Mobile operators in India are reckoned to share 30 to 40 percent of all cell towers through passive infrastructure companies jointly owned by the mobile operators, supported by subsidy conditions that favor such sharing. See "Mobile broadband for the masses," *supra* footnote 102. There are less market-led initiatives in the wireline sector, in large part because a substantial portion of the assets that could be shared to reduce costs are in the possession of incumbent wireline providers which naturally seek to avoid losing market position through allowing competing providers share their infrastructure. See generally ITU, "Six Degrees of Sharing," *Trends 2008*.

[32] Vodafone and Orange share their 3G radio access network in the UK but keep separate quality of service, customer issues, and application portfolios, thereby providing assurance that while the benefits of infrastructure consolidation enable faster rollout and better quality of service, competition at the retail customer face will remain vibrant.

[33] Richard Martin, "Outsourcing Operations, Telcos Remake Business Models: Sprint-Ericsson Managed Services Deal a Watershed for U.S. Carriers," *Von Magazine*, 13 July 2009. See http://www.von.com/articles/outsourcing-telcos-remake-business-models.html

[34] Managed services are apparently creeping up the value chain ever closer towards the customer relationship. Outsourcing proposal, Ericsson has offered to manage the entire marketing operations of Indian operator BSNL's 3G services, including fixing tariffs, promotional campaigns and consumer feedback. See "BSNL mulls Ericsson's consulting offer," *Telegeography*, 21 September 2009. See http://www.telegeography.com/cu/article.php?article_id=30174&email=html

[35] Moore's Law refers to the Gordon Moore's observation (as adjusted) that the number of transistors that can fit on an integrated computer circuit doubles every two years (variants provide that processing performance doubles every 18-24 months). See Gordon Moore, "Cramming more components onto integrated circuits", *Electronics Magazine* 19 April 1965.

[36] The relatively low capital costs of computers means now that "the physical machinery necessary to participate in information and cultural production is almost universally distributed in the population of the advanced economies." Yochai Benkler, *The Wealth of Networks* (Yale University Press 2006), 105.

[37] "Generativity is a system's capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences." Jonathan Zittrain, *The Future of the Internet and How to Stop It* (Yale University Press 2008), 70; and Zittrain, "The Generative Internet," *Harvard Law Review 119* (2006), 1974.

[38] Thus, "…the technical architectures, organizational models, and social dynamics of information production and exchange on the Internet have developed so that they allow us to structure the solution to problems—in particular to information production problems—in ways that are highly modular. This allows many diversely motivated people to act for a wide range of reasons that, in combination, cohere into new useful information, knowledge, and cultural goods. These architectures and organizational models allow both independent creation that coexists and coheres into usable patterns, and interdependent cooperative enterprises in the form of peer-production processes." *The Wealth of Networks*, 105-106

[39] See http://setiathome.berkeley.edu/sah_about.php.

[40] See *The Wealth of Networks*, 82-83.

[41] See: D.Neumann, D.Veit and C.Weinhart, "Grid Economics: Market Mechanisms for Grid Markets," in Von Thomas Barth, Anke Schüll, *Grid Computing* (Vieweg 2006), 65; *Distributed Computing: Utilities, Grids & Clouds*, ITU-T Technology Watch Report 9 (2009); and for a survey of case studies, http://www.gridipedia.eu/grid-computing-case-studies.html.

[42] "When the network becomes as fast as the processor, the computer hollows out and spreads across the network." *Email from Eric Schmidt, then CTO of Sun Microsystems, to George Gilder* (1993)

[43] See Jack L. Goldsmith and Tim Wu, *Who Controls the Internet*? (Oxford University Press 2006).

[44] To some degree, the underlying idea of splitting functions is not entirely new. For example, the cable TV industry has long provided content from a central location but cached locally for quick access by subscribers on dumb terminals (i.e., their TVs). But what is new is the variety, scale and comprehensiveness of the services becoming available and the scope for a significant redistribution of computer processing across the network.

[45] Benefits include elasticity and potential for pay-as-you-go and other modular billing arrangements, with charges based on consumption. These are typically a factor of time and computer processing unit requirements plus storage (e.g., US$0.10/CPU hour charged by Google Apps and Amazon's EC2). These features allow customers to convert upfront capital costs to operating costs by renting capacity or using online applications rather than purchasing their own hardware. Onsite data processing of companies is reckoned to operate far below capacity, leading to large inefficiencies despite the benefits of local control over a company's data and information technology. Cloud computing offers (although it does not necessary deliver yet) to reduce such inefficiencies through consolidation – offering resources that can be shared by many at the same time. This allows scalability of processing capacity with a rapidity that in many cases will exceed the time that would be required to acquire hardware.

[46] Elinor Mills, "Los Angeles gets its Google Apps groove," *Cnet News*, August 20, 2009 available at http://news.cnet.com/8301-27080_3-10313846-245.html.

[47] See http://nebula.nasa.gov/.

[48] See generally, Kenneth I. Juster, "Cloud Computing Can Close the Development Gap."

[49] "Electricity and computing share a special trait that makes them unique even among the relatively small set of general purpose technologies: they can both be delivered efficiently from a great distance over a network. "Nicholas Carr, *The Big Switch* (Norton 2008).

[50] Employing content delivery or distribution networks (CDN), providers store data on servers located strategically on the network according to the need for proximity to the customer (for usage) or the cloud provider (for data processing). Traffic can be offloaded from backbones to servers at the network's edge, reducing congestion on the backbone. Placing servers nearer users enables improved quality of service, who is less affected by peaks and surges, and experiences less jitter. Popular web content can be stored nearer the users for quicker download.

[51] See McKinsey report, *Clearing the Air on Cloud Computing*, April 2009, which concluded that cloud computing will be cost efficient for small and medium sized businesses but less so for large businesses which will likely require to retain substantial onsite computing processors.

[52] Factors determining what will be efficient in a given situation include for example: the scale and complexity of computer processing needs; the availability of local storage, e.g., through caching, for weighty types of data subject to popular demand, such as video; the user's timeliness requirements (e.g., real time voice call or video conference as opposed to overnight information processing); and the availability of bandwidth in the core and access networks.

[53] See for example Article 21 of the Lebanese Telecommunications Act prohibits the Telecommunications Regulatory Authority from imposing any restriction on value added services. The United States operates under a distinction between "telecommunications" and "enhanced" services.

[54] See, Corning, "Broadband Technology Overview," White Paper, (June 2005), WP6321.

[55] See, e.g., *Broadband for Africa*, *supra* footnote 27.

[56] The UK Broadband Stakeholders Group found that fixed costs are around 70-80% of total costs depending on whether it was FTTC or FTTH. See Broadband Stakeholders Group, supra note 89.

[57] These challenges are further discussed in the ITU GSR discussion papers, "Impact of effective regulation on investment: an investor's perspective" and "Effective regulation: the 'stimulus plan' for the ICT sector."

[58] For example, the mobile operator Digicel, which provides services in several Caribbean and South Pacific countries, has employed this tactic in some of its markets.

[59] See "Broadband Quality Score: A global study of broadband quality 2009," Saïd Business School at the University of Oxford and the University of Oviedo's Department of Applied Economics, and sponsored by Cisco (30 September 2009).

[60] According to the Allot Communications Global Mobile Broadband Traffic Report for the second quarter of 2009, "Global mobile data bandwidth usage increased significantly over the second quarter of 2009, with a jump of approximately 30%. The APAC region had the highest individual growth rate with 36%; EMEA followed with 28%, the Americas with 25%. HTTP browsing is the #1 application both globally and in each of the individual regions, although its growth rate is slower than that of streaming and HTTP downloads. HTTP streaming (including sites such as YouTube, Hulu, MySpace, MSN Spaces etc.) is the fastest growing application with a rise of 58%. HTTP downloads (including one-click hosting sites such as RapidShare and Megaupload) are fast gaining popularity with a growth rate more than double that of P2P file sharing. HTTP downloads currently generate 19% of mobile broadband traffic worldwide and in EMEA, HTTP downloads are already more popular than P2P file-sharing. The single largest factor leading to cell congestion is P2P which accounts for 42% of bandwidth utilization in the top 5% of cells. This is double P2P's bandwidth utilization in the average cell which is 21%. What is most noticeable from the data gathered in this report is that subscribers are treating their mobile networks much the same as they treat their fixed networks. This is particularly true for heavy data users who seem to expect the same service from the Internet, irrespective of their access method." Available at http://www.allot.com/index.php?option=com_content&task=view&id=810&Itemid=3

[61] The importance of devices in leading this usage growth is illustrated by the large amount of mobile traffic accounted for by the iPhone, although studies also find that the usability of websites by mobile devices remains severely limited. See Nielsen Norman Group Report "Usability of Mobile Websites" (2009). Available at http://www.nngroup.com/reports/mobile/

[62] Telefonica announced on 1 October 2009 that it would be rolling out LTE equipment in Spain, the United Kingdom, Germany and the Czech Republic in Europe, and Brazil and Argentina in Latin America. "Telefonica Announces Wide-Spread Trials of LTE Networks," Cellular News (30 September 2009).

[63] See Robert Coase, "The Federal Communications Commission," *Journal of Law and Economics*, vol. 2 (October 1959), 1-40.

[64] See Eli Noam, "Beyond Auctions: Open Spectrum Access" available at http://www.citi.columbia.edu/elinoam/articles/beyond_auctions.htm

[65] See Gerald R. Faulhaber and David Farber, "Spectrum Management: Property Rights, Markets, and the Commons."

[66] Spectrum sharing issues including spectrum trading were examined in the 2008 edition of the ITU *Trends in Telecommunication Reform* report on "Six Degrees of Sharing" and in the radio spectrum management module of the ITU-infoDev ICT Regulation Toolkit, available at http://www.ictregulationtoolkit.org/en/Section.1247.html

[67] New Zealand and the UK have taken the most significant steps towards spectrum trading.

[68] See Richard Thanki, Perspective, "The economic value generated by current and future allocations of unlicensed spectrum," (8 September 2009), a study supported by funding from Microsoft .

[69] In part this means ensuring the spectrum is offered in sufficiently large contiguous blocks (e.g., 10-12 MHz) to reduce costs and improve efficiency.

[70] For a helpful discussion of this in the German context, see J. Scott Marcus, Dr. Lorenz Nett, Mark Scanlan, Dr Ulrigh Stumpf, Prof Dr. Martin Cave and Prof Dr. Gerard Pogorel, "Towards More Flexible Spectrum Regulation," WIK Study for the German Federal Network Agency (December 2005)

[71] See a discussion of these matters for example in the Lebanese TRA's "Draft Opinion for Determining Spectrum Right to Use Fees," at http://www.tra.gov.lb/Draft-Opinion-for-Determining-Spectrum-Right-To-Use-Fees.

[72] See Richard Keck, "Instalment payments in spectrum auctions and telecom privatisations," *Butterworth's Journal of International Banking and Finance Law* (September 2009)

[73] The FCC recently announced that it would explore net neutrality measures and the mobile operators have voiced concerns that due to capacity constraints in and competitiveness of the mobile sector any such new rules should not apply to mobile services. See also Tim Wu, "Wireless Net Neutrality: Cellular Carterphone and Consumer Choice in Mobile Broadband," New America Foundation Wireless Future Program, Working Paper #17 (February 2007).

[74] See http://ec.europa.eu/information_society/policy/ecomm/doc/library/public_consult/nga/expl_note_nga.pdf. The UK's Ofcom has estimated that deploying passive infrastructure could represent 50-70 per cent of the costs of deploying next generation access infrastructure (see: http://www.ofcom.org.uk/consult/condocs/newbuild/statement/new_build_statement.pdf).

[75] "Public Rights of Way for Fibre Deployment to the Home," 4 April 2008, OECD, Committee for Information, Computer and Communications Policy, DSTI/ICCP/CISP(2007)5/FINAL.

[76] The UK Broadband Stakeholders Group found that the cost of national FTTH deployment would be 20% (£5 billion) less if investors had access to alternative infrastructure. See Broadband Stakeholders Group, *supra* note 89.

[77] The public sewer systems are being used for conduits by, for example, Free in Paris, France, H2O in Bournemouth, UK and CityNet in New Mexico and Vienna, Austria.

[78] Section 43, Telecommunications Act 1993.

[79] See OECD Study, supra note 75, p13.

[80] See Bahamas Communications Act 2009, available at www.pucbahamas.gov.bs, and the Solomon Islands Telecommunications Act 2009.

[81] See for example the Lebanese Telecommunications Regulatory Authority's study on public properties, available at http://www.tra.gov.lb/Use-of-Public-Properties.

[82] See Portugal's Ministry of Public Works, Transport and Communications, Decree-Law No. 68/2005 of 15 March, and the Conduit Access Offer of incumbent PT Comunicações available at www.anacom.pt.

[83] Analysys Mason, "Telecoms infrastructure access – sample survey of duct access", a report for Ofcom (3 March 2009) Z03A005I

[84] Décision n° 2008-0835 de l'Autorité de régulation des communications électroniques et des postes en date du 24 juillet 2008 portant sur la définition du marché pertinent de gros des offres d'accès aux infrastructures physiques constitutives de la boucle locale filaire, sur la désignation d'un opérateur exerçant une influence significative sur ce marché et sur les obligations imposées à cet opérateur sur ce marché, available at www.arcep.fr.

[85] See for example proposals recently considered by Saudi Arabia's Communications and Information Technology Commission: "Request for Public Comments on proposed documents: Rights-of-Way Guidelines (ROW Guidelines), Co-location for Outside Plant (OSP) Guidelines (Co-location Guidelines)", Public Notice: PN No. (5 /1429), Dated, 14/10/1429H, 14/10/2008G, available at http://www.citc.gov.sa/citcportal/PublicConsultationsDetails/tabid/120/cmspid/%7B0238DEAF-738E-410D-97C5-096CF96CBE3D%7D/Default.aspx.

[86] Australian Competition & Consumer Commission, "A Code of Access to Telecommunications Transmission Towers, Sites of Towers and Underground Facilities" (October 1999). Available at www.accc.gov.au.

[87] See http://www.mobilemastinfo.com/index.html.

[88] See Telecommunications Regulatory Authority of the Kingdom of Bahrain, "Draft Position Paper on the Deployment of Telecommunications Networks in New Property Developments" (27 May 2009), Reference Number: TOD/0509/024. Available at http://www.tra.org.bh/en/consultations.asp#Tele%20Infra%20Deploy.

[89] In the case of fiber networks, the amounts are particularly large. The US Federal Communications Commission's estimate of the cost of extending high-speed access to all Americans is between US$ 20 billion to US$ 350 billion. See David Hatch, "Cost of

Expanded Broadband Service Could Reach $350B Wednesday," *Telecommunications*, 30 September 2009). In its study of the costs of fiber deployment in the UK carried out for the Broadband Stakeholders Group, Analysys Mason found that the costs of deploying FTTC nationally would be about £5.1 billion and almost five times this, at £24 – 28 billion for FTTH depending on whether it was GPON or PTP. See Broadband Stakeholders Group, "The costs of deploying fibre-based next-generation broadband infrastructure" (8 September 2008) Ref: 12726-371.

[90] For instance, if universal access charges are levied on licensees or telecommunications service providers, questions may arise regarding whether an ISP should require a license or is a telecommunications service provider, which may depend upon whether it has its own equipment and infrastructure connecting to the Internet or is merely a reseller, and even then whether it should be required to contribute to the universal access fund. This becomes more complex and contentious to the extent that services are provided in the form of applications by persons other than the provider of access connection (such as VoIP providers or MVNOs).

[91] E.g., the French Government ownership of shares in France Telecom, or the Sudanese Government ownership of shares in Sudatel.

[92] See ITU, "Confronting the Crisis: ICT Stimulus Plans for Economic Growth," 2nd ed. October 2009, available at http://www.itu.int/osg/csd/emerging_trends/crisis/index.html, and OECD, "The Role of Communication Infrastructure Investment in Economic Recovery", Paris, 11-13 March 2009.

[93] Based on an initial commitment of A$4.7 billion, out of a A$43 billion required investment; considering the plan to keep a 51 percent stake in the announced National Broadband Network Company, the Australian government's investment could go up to A$21.9 billion.

[94] The Japanese Government offers tax benefits for operators introducing broadband access networks, including corporate tax redemptions and depreciation and amortization tax benefits for fixed assets. It also offers broadband access providers guarantees for their debts and low interest financing by the Development Bank of Japan.

[95] The Singapore Government committed S$ 710 million (about US$ 500 million) to support the building of passive infrastructure for an all fiber network to be made available on an open basis to operators of active networks.

[96] The municipal Stokab network in Stockhold in Sweden lays fiber and allows network providers to connect their servers for a fee.

[97] According to the research firm IDATE, 56% of FTTH/B projects in June 2009 were led by municipal authorities or power utilities. IDATE for FTTH Council Europe.

[98] See European Commission, *Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks*.

[99] See http://www.opensource.org/docs/definition.php for a more detailed definition of open source software provided by the Open Source Initiative (OSI).

[100] See http://creativecommons.org/.

[101] These incentives vary, and indeed proponents of open systems emphasize how the "generative" (see *supra*, footnote 37) nature of open systems facilitate activities motivated by a broad range of purposes including curiosity, empathy, play, fame, politics, personal and religious values and others which are non-monetary. See Benkler, "The Economics of Social Production," Paper 4 of *The Wealth of Networks*," *supra* footnote 36.

[102] McKinsey & Co have estimated potential cost reductions of between 20 and 30 per cent if the number of mobile providers in a country is reduced for example from five to three. See Sören Buttkereit, Luis Enreiquez, Ferry Grijpink, Suraj Moraje, Wim Torfs and Tanja Vaheri-Delmulle, "Mobile broadband for the masses: Regulatory levers to make it happen," *McKinsey & Company* (February 2009).

[103] For example, a new entrant may compete in retail services against a dominant provider, but may depend upon using that dominant provider's network in order to provide its services. In such a situation, the dominant provider may abuse this dependence to drive the new entrant out of business. The dominant provider could raise the cost of its wholesale network service and/or reduce the price of its retail service in a way that leaves the new entrant with no margin (known as a "margin squeeze"). Or the dominant provider might use revenues from a service with high margins because it does not face competition in order to subsidize a service in which it competes with other providers (known as "anticompetitive cross-subsidisation"). This would result in an unfair advantage over the competitors. These are conventionally viewed as "abuses of dominance" and a dominant provider typically faces penalties or the introduction of regulatory conditions if found to have engaged in them.

[104] This is not only the case in mobile markets. The Sudanese wireline market, for example, has seen Kanartel greatly strengthen its market position compared with the incumbent wireline provider Sudatel.

[105] Section 30(1) of the recently enacted Solomon Islands Telecommunications Act 2009, for example, requires the Telecommunications Commission to refrain from regulating "where it reasonably anticipates that the presence of effective competition in a telecommunications market are sufficient" and ensure that regulation, "including each obligation therein, is proportionate to its purpose."

[106] The principle that regulatory remedies should be specific, relevant and proportional to the problems they address is prevalent in laws and to a significant degree in regulatory practice in many developed nations. See, e.g., the European Framework Directive, DIRECTIVE 2002/21/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 March 2002 on a common

regulatory framework for electronic communications networks and services (Framework Directive). The principle is increasingly introduced in developing country legislation, e.g., laws recently enacted in Fiji and Solomon Islands, but many developing country regulators continue to apply blanket regulation in areas where it is no longer necessary, such as applying tight retail price control in a competitive mobile sector. In some countries, even where laws have introduced the key principle, only the passage of time and pressure of challenges from other sector participants are likely to result in a genuine change in administrative culture.

[107] An example of a regulator carrying out a dominance analysis can be found at: http://www.ofcom.org.uk/consult/condocs/wbamp/wholesalebroadbandreview/paper3/.

[108] The test seeks to define a relevant market in a defined geographical area such that a hypothetical profit-maximizing service provider, not subject to price regulation, that is the only present and future producer or provider of products or services for the relevant market in that area could impose a small but significant and non-transitory increase in price (hence SSNIP), assuming the terms of provision of all other products are held constant. The test is repeated until the market boundary is set. It requires an analysis of whether consumers of a particular product or service would be likely to switch to readily available substitutes in the short term and at a negligible cost in response to a hypothetical SSNIP in the range of 5 to 10% that is applied to the products or services under consideration. An example of a regulator carrying out this test can be found at http://www.ofcom.org.uk/consult/condocs/wbamp/wholesalebroadbandreview/paper2/.

[109] "According to the bi-annual online advertising expenditure study from the Internet Advertising Bureau (IAB) - the trade body for digital marketing - in partnership with PricewaterhouseCoopers (PwC) and the World Advertising Research Centre (WARC) - the internet has now overtaken TV advertising to become the UK's single biggest advertising mediumAdvertising online reached 23.5 per cent of the total market in the first half of the year, compared with TV's 21.9 per cent." See UK Online Adspend Study Results for the First Half of 2009, available at http://www.iabuk.net/en/1/adspendgrows300909.mxs. See "Net Advantage", *Financial Times*, 30 September 2009.

[110] See *Verizon Boss Hangs Up on Landline Phone Business*, New York Times, 17 September 17 2009, at http://bits.blogs.nytimes.com/2009/09/17/verizon-boss-hangs-up-on-landline-phone-business/ (last visited on 21 September 2009).

[111] The Pay TV consultation documents are available at http://www.ofcom.org.uk/tv/paytv/.

[112] "In an annual poll of its members, the UK's Association of Online Publishers found that 50 per cent were already charging for some or all of their websites, while a further 20 per cent intend to do so in the next 12 months." See Tim Bradshaw, "Publishers rush into online payments," *Financial Times* (1 October 2009).

[113] Network address translation, also referred to as IP masquerading, whereby a number of private IP addresses are hidden behind a public IP address, is a method used to deal with the exhaustion of IPv4 address space. It prevents end-to-end connectivity and thus reduces the openness of the Internet architecture. Address constraints are expected to be addressed with the introduction of IPv6.

[114] Some, such as Benoit Felten of the Yankee Group, have argued that return on investment in new fiber access networks is significantly more affected by take up rates than by revenue per subscriber, that opening the network to use by many competing service providers is likely to produce a greater variety of attractive services with better pricing that drive take up, and that therefore higher returns on investment are likely from embracing network openness. See http://www.fiberevolution.com/.

[115] 238 F.2d 266, HUSH-A-PHONE CORPORATION and Harry C. Tuttle, Petitioners, v. UNITED STATES of America and Federal Communications Commission, Respondents, American Telephone and Telegraph Company et al., and United States Independent Telephone Association, Intervenors, No. 13175, UNITED STATES COURT OF APPEALS DISTRICT OF COLUMBIA CIRCUIT, 99 U.S. App. D.C. 190; 238 F.2d 266; 1956 U.S. App. LEXIS 4023. Available at http://www.cavebear.com/archive/ialc/hush-a-phone.htm.

[116] In the Matter of USE OF THE CARTERFONE DEVICE IN MESSAGE TOLL TELEPHONE SERVICE; In the Matter of THOMAS F. CARTER AND CARTER ELECTRONICS CORP., DALLAS, TEX. (COMPLAINANTS), v. AMERICAN TELEPHONE AND TELEGRAPH CO., ASSOCIATED BELL SYSTEM COMPANIES, SOUTHWESTERN BELL TELEPHONE CO., AND GENERAL TELEPHONE CO. OF THE SOUTHWEST (DEFENDANTS) Docket No. 16942; Docket No. 17073 FEDERAL COMMUNICATIONS COMMISSION 13 F.C.C.2d 420 (1968); 13 Rad. Reg. 2d (P & F) 597 RELEASE-NUMBER: FCC 68-661 June 26, 1968 Adopted. Available at http://www.uiowa.edu/~cyberlaw/FCCOps/1968/13F2-420.html.

[117] FEDERAL COMMUNICATIONS COMMISSION WASHINGTON, D.C. 20554 In the Matter of Skype Communications S.A.R.L. Petition to Confirm A Consumer's Right to Use Internet Communications Software and Attach Devices to Wireless Networks RM - ___ PETITION TO CONFIRM A CONSUMER'S RIGHT TO USE INTERNET COMMUNICATIONS SOFTWARE AND ATTACH DEVICES TO WIRELESS NETWORKS. Available at http://files.ctia.org/pdf/Skype_Wireless_Device_Petition_2-20-07.pdf.

[118] In 2007, Orange was prevented in France from selling only iPhones that were tied to its network

[119] CRTC, Telecom Regulatory Policy CRTC 2009-657, *Review of the Internet traffic management practices of Internet service providers*, File number: 8646-C12-200815400, available at http://www.crtc.gc.ca/eng/archive/2009/2009-657.htm.

[120] For an introduction to functional separation, see Malcolm Webb, "The Emergence of Functional Separation," *Trends in Telecommunications Reform: Six Degrees of Sharing* (2008), 139.

[121] Professor Lawrence B. Solum and Minn Chung, for example, take the view that "Public Internet regulators should not adopt legal regulations of the Internet…that violate the integrity of the layered nature of the Internet architecture without a compelling regulatory interest and consideration of layer-respecting alternatives." See, Lawrence B. Solum and Minn Chung, "The Layers Principle: Internet Archicture and the Law," Research Paper 55, June 2003, University of San Diego Law School, at page 42; available at http://ssrn.com/abstract=416263; Richard S. Whitt, "A Horizontal Leap Forward: Formulating a New Communications Public Policy Framework Based on the Network Layers Model", *Federal Communications Law Journal* 2004, 587 [Vol. 56]; and Rob Frieden, "Adjusting the Horizontal and Vertical in Telecommunications Regulation: A Comparison of the Traditional and a New Layered Approach", *Federal Communications Law Journal* 2003, 207 [Vol. 56].

[122] While there is significant consensus that communications should not be regulated according to "vertical silos" (comprised of traditional integrated networks and services such as fixed, mobile, date, TV), it has been argued that establishing a regulatory regime based on horizontal layering simply "rotates the silos 90 degrees to the right, replacing vertical stovepipes with horizontal ones." See Bennet, *Designed for Change*, supra note 14.

[123] Richard Bennet warns against trying to set regulatory policy to reflect ideas of horizontal layering, which he disputes as even existing in the form often used as a basis for network neutrality arguments. "At a time when network engineering is re-thinking the 30-year-old functional layering model that was never more than a conjecture in favour of simplified, recursive models, Cyberlaw scholars and activists are trying to freeze it in law as a *fundamental principle*. This disconnect should be cautionary to network architects: every time an architect sneezes, apparently, a 20-year chain of events is triggered that will ultimately result in a policy advocate insisting on a new regulation." Bennet, *Designed for Change*, supra note 14.

[124] CISCO's *Visual Networking Index* (June 2009) forecasts at page 2, "Mobile data traffic will grow at a CAGR of 131 percent between 2008 and 2013, reaching over 2 exabytes per month by 2013…Almost 64 percent of the world's mobile data traffic will be video by 2013. Mobile video will grow at a CAGR of 150 percent between 2008 and 2013."

[125] See CISCO's *Visual Networking Index, supra* note 124 at page 2.

[126] "The sum of all forms of video (TV, video on demand, Internet, and P2P) will account for over 91 percent of global consumer traffic by 2013. Internet video alone will account for over 60 percent of all consumer Internet traffic in 2013." See CISCO's *Visual Networking Index, supra* note 124 at page 2.

[127] A "new market" was defined as "… a market for services and products which are more than insignificantly different from existing services and products in terms of performance, range, availability to larger groups of users (mass-market capability), price or quality from the point of view of an informed user and which do not merely replace existing services and products." Section 3, Law of 18 February 2007.

[128] Section 9a, Law of 18 February 2007.

[129] See http://www.reseaux-telecoms.net/actualites/lire-tres-haut-debit-retropedalage-de-france-telecom-20935.html.

[130] See Daan Vrijmoet and Jonas Rosenstok, "How to regulate new markets? Innovation and competition in the EU electronic communications framework," *Oxera Agenda* (November 2005).

[131] The International Organization for Standardization (ISO) defines a formal standard as "a document, established by consensus that provides rules, guidelines or characteristics for activities or their results."

[132] For a discussion of this problem in the development of mobile WiMax, see Tobias Kaufmann, "Intellectual Property in Broadband Mobile Telecommunications: Predictions on 4G WiMAX", available at http://www.frlicense.com/IntellectualPropertyinBroadbandMT.pdf.

[133] See FTC Challenges Patent Holder's Refusal to Meet Commitment to License Patents Covering 'Ethernet' Standard Used in Virtually All Personal Computers in U.S. Available at http://www.ftc.gov/opa/2008/01/ethernet.shtm.

[134] See *Broadcom Corp. v. Qualcomm Inc.*, 501 F.3d 297 (3d Cir. 2007).

[135] This is Daniel Solove's "taxonomy of privacy problems." See Daniel Solove, *Understanding Privacy*, Harvard University Press (2008)

[136] The UK Data Protection Act 1998 for example provides consumers with rights: of access to personal data; to prevent data processing; to prevent processing for purposes of direct marketing; in relation to automated decision-taking; and to remedies including compensation for failure to comply with the Act and rectification, blocking, erasure and destruction of data.

[137] Aarticle 29 Data Protection Working Party, 01189/09/EN, WP 163, Opinion 5/2009 on online social networking (12 June 2009). Available at http://ec.europa.eu/justice_home/fsj/privacy/index_en.htm.

[138] Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data. Available at http://ec.europa.eu/justice_home/fsj/privacy/law/index_en.htm.

[139] Vincent Boland and Richard Waters, "Google executives face Milan trial," *Financial Times* (21 June 2009)

[140] See *Self-Regulatory Principles for Online Behavioral Advertising* (July 2009) available at http://www.iab.net/insights_research/public_policy/behavioral-advertisingprinciples.

[141] See Philip Stafford, "Phorm leaves UK market," *Financial Times* (21 September 2009).

[142] Ofcom, the UK communications regulator, is required under the UK Broadcasting Act 1996 (as amended) to consider complaints about privacy infringements in broadcast programmes or in the obtaining of material included in a programme.

[143] These differ depending on the matter at hand. For example, emergency services are generally relatively local in nature. They require assistance from local police, ambulances, fire brigades, coast guards and others for emergencies in a user's location. This argues, then, for the provision of emergency call services by local and mobile operators that provide physical (i.e., wireline or wireless) connection to the user, regardless of whether or not they typically provide voice services. So long as user behaviour relies upon a small number of ubiquitous service types (wireline connection and mobile phone), these may cover enough of the population to ensure sufficient access to emergency services. If in time a critical mass of the population stops using such service types, it may be necessary to find alternative ways to distribute responsibility.

[144] Whether funding mechanisms such as universal service subsidies are required for such services, or whether they may simply be bundled with or added to the price of access at the cost of the provider (and indirectly the customer) will depend largely upon whether such access providers face significant competition from others which do not bear such obligations and costs.

[145] See ITU GSR paper, Rosalind Stevens, *Consumer protection: meeting the expectations of the connected*, available at http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR09/papers.html

[146] Such tensions were apparent in the resignation of the recently appointed US Cybersecurity chief in March 2009. See for example James Risen and Eric Lichtblau, "Control of Cybersecurity Becomes Divisive Issue," *New York Times* (16 April 2009).

[147] For a discussion of alternatives to regulatory protection, see Adam Thierer, *Parental Guidelines and Online Protection*, Progress and Freedom Foundation (2009). Available at http://www.pff.org/parentalcontrols/.

[148] Such resources include: increasing numbers of devices which limit their usage to specified communications (e.g., mobile phone calls to parents); computer and device administration passwords; email programs that filter spam and obscenity; safe Internet search engines; Internet content filtering and monitoring software; email and instant messaging monitoring software; and various websites that offer advice. Self-help solutions offer the dual benefit of both being under the control of the persons with the greatest motivation to employ them and being closest to the relevant computer or device. As such, rather than relying upon centralized regulation, they leverage the distributed nature of users in a manner analogous to the end-to-end principle of the Internet itself described in section 2.1. Under pressure, regulators face the challenge of identifying how best to leverage their resources, which in some cases may be to encourage such initiatives. See ITU *Guidelines for Policy Makers on Child Online Protection*, available at http://www.itu.int/osg/csd/cybersecurity/gca/cop/guidelines/policy_makers.pdf; and Gregory S. Smith, *How to Protect Your Children on the Internet: A Road Map for Parents and Teachers*.

[149] For a map of data centers worldwide, see http://www.datacentermap.com/.

[150] The FCC Computer Inquiries sought to understand the relationship between telecommunications and information technology, and to treat aspects differently with a view to maximizing the opportunities of innovation and competition. Thus, for example, the Second Computer Inquiry in 1980 separated "basic" telecommunications services, such as calls and transmission capacity, from "enhanced" services, such as computer processing applications. The lighter regulation of the latter allowed greater innovation and growth of the IT sector. For a history of the Computer Inquiries and their contribution, see Robert Cannon, "The Legacy of the Federal Communication's Computer Inquiries," *Federal Communications Law Journal*, 55 (2003) 167.

[151] For example: some are licensed and some are not; many have different scopes of services permitted where they are licensed; some require substantial license fees and some require none; some are subject to significant and costly rollout and coverage obligations and some are not; and some face quality of service obligations while others do not.

[152] See Rudolf Van Der Berg, ITU GSR paper, *The Future of IP Interconnection*; available at: http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR09/papers.html

[153] This year's title to ITU World Telecom Forum is "Open Networks, Connected Minds." See http://www.itu.int/WORLD2009/.