2 CONNECTIVITY, OPENNESS AND VULNERABILITY: CHALLENGES FACING REGULATORS

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2.1 Introduction: What Has – and Hasn't – Changed in ICT Markets

Huge strides in ICT service penetration have been made over the last decade, with particularly strong gains in mobile voice services. The leading causes are the lower cost of deploying mobile networks and competition in prices and services in the vast majority of countries.[1] But growth has not been confined to mobile services. According to 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]

Policy-makers and regulators are focusing increasingly on achieving extensive, and even ubiquitous, availability of advanced ICT services, in order to address the "digital divide" and to reap the trans-sector benefits of network effects available from ICTs. While the digital divide has narrowed significantly for voice services, it is widening between and within societies in the technology sectors that have a major impact on innovation and economic development. These include high-speed telecommunication 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 or the ability to use such services. As much as 76 per cent of the world's population did *not* use the Internet in 2008.[4]

This problem confronts both developing and developed economies. In any country, the more relationships among individuals, governments and businesses are handled online, the greater the risk of social and economic exclusion for those who do not have access to ICTs. And as ICT services advance, the divide deepens, becoming more difficult for those on the wrong side of it to cross. For example, when job advertisements move online – as they increasingly are in developed economies – it will be harder for those who do not have access to (or are not comfortable with) ICT services to find jobs. The cycle is perpetuated as such population groups become further economically disadvantaged, lacking the financial means to afford ICT access.

The positive impacts (or "externalities") of widespread ICT connectivity on education, health, finance and other sectors – particularly from broadband, high-speed Internet access – are as abundant as they are varied. These positive effects fuel demand for ICT products and services and contribute to economic growth.[5] ICTs drive productivity improvements,[6] enable an economy to run closer to full capacity, improve efficiency in the allocation of goods and services, and support higher-quality products and services.[7]

ICTs offer a platform for a new phenomenon of connectedness – changes in the ways information is created and shared that 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 innovate in technology, design, marketing, sales and numerous other areas.[8] User participation in innovation is contributing significantly, increasingly enabled 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. ICTs and broadband telecommunications have a multiplier effect, taking society to a new level of connectedness.[10]

The more ubiquitous and open networks are, however, the more vulnerabilities they face. Some vulnerabilities are economic, arising from market structures and threats from service providers that have significant market power (SMP). At the customer end of the value chain, there are threats to privacy, the loss of control over data, and child protection concerns. ICT systems are vulnerable to cyber-security and cyber-crime threats even at a national level, as seen in Estonia and Georgia, for example.

This chapter discusses the challenges regulators face in coping with these developments. Regulators are typically tasked with implementing and administering a large number of policies and processes, including licensing of key resources such as radio spectrum, numbering and access to physical property, as well as interconnection, network access, competition, price regulation, dispute resolution, consumer protection and universal service/access. Regulators need to anticipate and address problems of market failure, and they accomplish this through their ability to frame positive and negative incentives for behaviour by service providers. Regulators need effective legal power and reliable information if they are to carry out their roles. A discussion of the challenges facing regulators could range across:

- **Financial challenges,** concerning the adequacy of their funding to carry out their mandates;
- **Information challenges,** arising from asymmetry of information needed to understand market and technological changes;
- **Technical challenges**, such as in monitoring and testing spectrum and equipment use, as well as measuring quality of service;
- **Economic challenges**, particularly understanding and defining markets for the purposes of determining the level of competition and what regulation may be required;
- **Legal challenges,** arising from inadequate powers to introduce regulations and decisions and respond to some sector participants' resistance to change; and
- **Political challenges,** to regulators' ability to implement their statutory mandates in a transparent, professional and impartial manner.

As is the case with many issues in telecommunication 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 2.2 describes three dimensions of network architecture and ICT usage that 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 of where computer processing and content production occurs on networks.

In light of these developments, Section 2.3 discusses the challenges facing regulators in:

- Attracting substantial investment to **significantly increase connectivity to high speed networks**;
- Setting the appropriate level of **openness of networks and ICT systems**; and
- Ensuring protective **safeguards against the vulnerabilities** of networks that arise from the open nature of networks and devices and the distribution of computing functions across the network.

It is evident throughout these sections that, in the context of a rapidly changing sector requiring substantial investment, regulators must allow for adaptable regulation while providing sufficient predictability to maintain investor confidence. Section 2.4 concludes by offering observations on the need for regulators to take a wide view of the ICT sector and to commit to an inclusive and open manner of regulation.

2.2 Network Revolutions

The architecture of telecommunication networks and services is undergoing a revolution, and the initial challenge facing regulators is to understand what is happening. The revolution can be seen in three dimensions, each of which has major implications for telecommunication regulation:

1. The emergence of a network architecture understandable in terms of a stack of horizontal layers;
2. A shake-up of network technologies and network management; and
3. A major redistribution of computing functions and content production across networks.

Understanding these dimensions and trends allows regulators to identify and analyze problems. For example, understanding network architecture changes enables one to know 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 regulatory solutions, as discussed in Section 2.3.

2.2.1 Platform-Based Architectures

IP-based networks have been introduced pervasively in many developed countries. Developing countries are also showing strong signs of the shift to IP-based networks. Kanartel, Sudan's fixed-line competitor to incumbent Sudatel, for example, operates an all-IP network. These trends are likely to continue, as regulators in many developing countries now focus not only on increasing geographical network coverage (often through mobile service) 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 altered the way networks are viewed in terms of design, service provision and regulation.[12] Circuit-switched networks integrate the information technology required for services into the physical network design. Calls are routed through a tree of central and local exchanges to establish dedicated connections. Terminal devices, such as telephones and fax machines, are a function of that design. They are essentially "dumb terminals" that offer limited creative processing power. The network transport system effectively determines what can be done by the network's users. The owner and operator of the network controls what services can be offered.

The pioneering impact of IP-based networks lies in their "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 parts of 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, despite 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 calls for the best allocation of functions in a distributed system. In effect, it results in key information technology functions being implemented as close as possible to the computers and other devices that are sending and receiving the packets across the network.[15] This has been described as the basis of the "dumb network," with the intelligence held in devices (computers and handsets) attached at each end.[16] 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 support, protocol layering or modularity makes possible a huge, perhaps infinite variety of applications that can be carried across the common platform of the IP/TCP (IP-based) suite. Moreover, the end-to-end argument places the power to write the software code that drives applications in the hands of applications designers.[17] The network has become multi-purpose, with a potential for creativity beyond imagining.

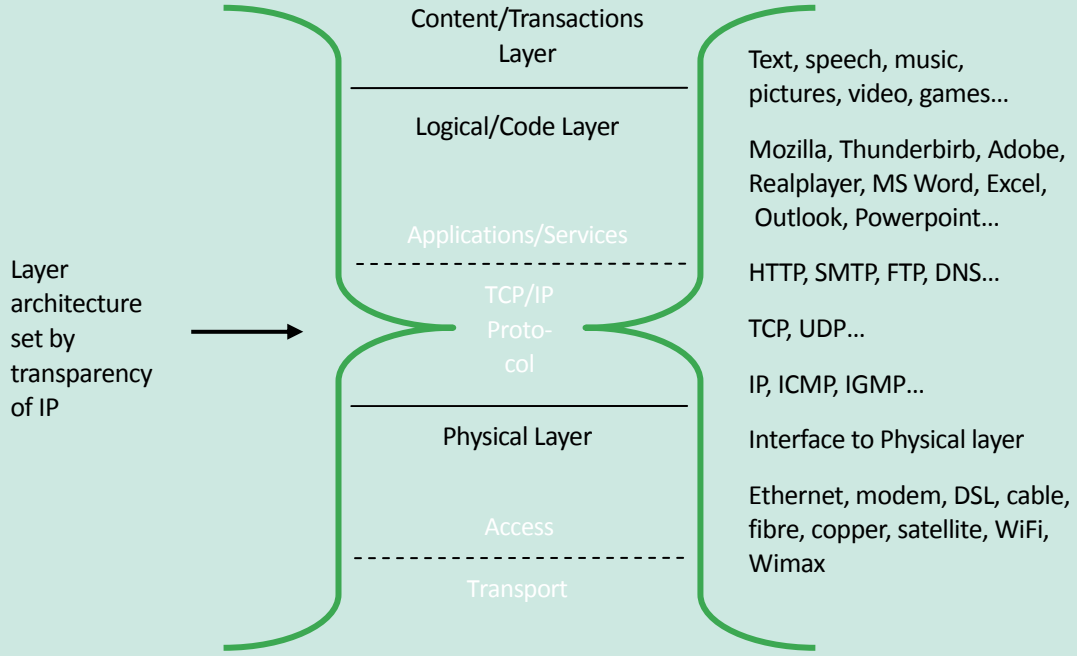
Beneath this logical layer of the network is the physical network infrastructure across which it rides. This can be simply described as "active infrastructure" and "passive infrastructure":

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

Above and 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 communication products such as voice calls, voicemail, email, messaging and numerous others, some of which are effectively becoming substitutes for circuit-switched telecommunications.[18]

The innovation unleashed by placing significant power over "coding" the network in the hands of the applications developers has been extraordinary.[19] It gives the network a quality of "openness." That is, the network is available to be used for applications created by third-party providers. This embeds an operating principle often referred to as "innovation without permission." Fundamentally, when a network operator shares control over usage of the network, it constitutes a revolution in the way services can be provided. All services can effectively become applications that run on the computers and other devices attached to the network. So the widespread deployment of IP-based networks is changing the way networks function. Figure 2.1, below, illustrates the layers of the network described above.

Figure 2.1: The Network Layer Model



Source: Adapted from Yochai Benkler, Richard Whitt and others.

The IP-based network model now defies the historical silos of voice telecommunications, data telecommunications, Internet access, and "enhanced" or "value-added" services. Similarly, it no longer matters whether the network is fixed or wireless. For instance, in many countries now, Skype calls are available on mobile handsets.

The benefit for regulators in understanding network architecture, particularly the Internet's modular structure, is chiefly in understanding different economic and market realities at the various levels of the network. With this understanding, regulators can set rules that will encourage investment, apply an informed competition policy and maintain a platform for innovation. Understanding changing network architectures informs regulators' analysis of different economic barriers to entry, the activities of providers at each level, potential "control points" for effective regulatory intervention and enforcement, and consequent implications for applying competition policy and economic regulation.[20] But it presents challenges, because the distinction between *services* (which historically have been regulated) and *applications* (which have not been) erodes and in some cases is lost entirely.

2.2.2 The Shake-Up of Network Technologies and Management

The ongoing evolution and rapid uptake of various wireless access technologies is accompanied by increasing investment in high-speed broadband networks. Some network elements and processes are undergoing a process of unbundling and consolidation, driven by technological innovation and market pressure. These developments present challenges for traditional regulatory models.

2.2.2.1 Diversifying Access Network Technologies

The use of wireless access – whether "fixed wireless" or mobile – for telephone calls was only the beginning of major growth in wireless technology. Wireless access networks are fast becoming available for access to the Internet. WiFi connections are already widely available and continue to increase, either as a paid service or as a free feature bundled with another service. Wireless networks have become an important means of providing broadband access in many countries, as either fixed, nomadic or mobile services.

While facing challenges, technologies such as WiMax are anticipated to increase bandwidth. IMT-2000 (3G) networks offer Internet access with seamless handover among cells, allowing a fuller "mobile" experience. And recent tests have demonstrated the technical viability of Long Term Evolution (LTE) technology, with rollout anticipated in the coming years. In countries without extensive wireline access networks, wireless technology has become the dominant form of retail telecommunication service, particularly in Africa. And where it is available, 3G mobile broadband is showing signs of rapid consumer uptake.[21]

Different technologies offer different advantages and disadvantages, with trade-offs involving mobility, quality of service, bandwidth and cost. Wireless local area networks (WLANs) and personal area networks (PANs) using the IEEE 802.16e (commonly marketed as WiMAX) 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 capability provides mobility. LTE is anticipated to offer more efficient use of radio networks, reduced latency, better mobility and higher bandwidth. And it 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 have allowed greater use of wireless networks. With laptops, smart phones, 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 that connect to 3G networks. Major traditional computer manufacturers are entering the smart phone market.[22] Handsets are capable of running a respectable and increasingly wide range of applications – many designed and offered by third-parties – on operating system platforms. Cloud computing, which allows operation and data storage on remote servers, reduces the burden on customer devices, offering 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 currently block this functionality.[24]

Meanwhile, on the wireline side, fibre optics offer major capacity advantages and so are essential for aggregating the increasing volumes of backhaul transport. In their core and metropolitan networks, operators are seeing both cost reductions and rising volume and bandwidth demands from mobile Internet traffic. This is leading them to rely upon wireline fibre backhaul providers to carry their aggregated traffic instead of managing their own microwave backhaul transmissions. In some cases, backhaul capacity is secured by contract through an interconnection agreement (for example, in Sudan). In others, the mobile operators outsource the backhaul between base stations to a fixed-line operator.[25]

Of course, fibre optic cable is not just for backhaul transport. Indeed, fibre is beginning to spread throughout access networks.[26] One of the main debates among telecommunication policy-makers and businesses in OECD countries today concerns ensuring investment in *fibre-to-the-node* – which takes in the home, the office building, the cabinet or the curb (known collectively as FTTx) – as well as the creation of next-generation access networks (NGNs). Some countries, such as France, Japan, the Republic of Korea and The Netherlands, have advanced further than others, but the overall trend is towards increasing fibre deployment. The same debate is occurring in countries with less-developed infrastructure and economies, except that it focuses more on developing fibre in the core networks – 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. 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 power lines, respectively. None of these matches fibre optic cable for bandwidth and reliability, but where networks already exist, some of these tech-

nologies have cost and coverage advantages, at least in the short and medium term.

2.2.2.2 Different Technologies for Different Needs

So, driven by a combination of customer demand, network capacity and economic efficiencies, telecommunication traffic is increasingly finding its way onto the technologies that meet different needs at the core, metropolitan and access parts of the network. Different uses require different bandwidths, and thus different types of networks. Some video requirements, such as high-definition video conferencing and video streaming, generally require fibre 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 their needs and environments. They might use a Blackberry to send an email rather than logging on to a high-priced hotel WiFi network. But they might use an airport's WiFi network for transmitting large files or surfing the Internet in another city, rather than using a 3G wireless network with high roaming charges. And then again, they might rely on that same 3G service while travelling by car or train in their own coverage areas. 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 these selection processes. Google Voice, for example, represents the 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 chosen and preset by the customer. The application also permits management of calls from the various devices under a single 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, allowing users to access their personalized applications and content seamlessly using different access networks and end user equipment.[29] Early signs of the development of such "personal networks" are visible in cases where a mobile phone contract is used as the billing mechanism for logging on to another operator's WiFi connection.[30]

The emerging network architecture gives users greater choice to select the network they require according to their needs for a given situation:

- Mobile or fixed;
- High or low bandwidth;
- Delay-sensitive (e.g, real-time voice or video) or not; and
- High or low cost.

Realizing potential efficiency gains will depend upon the sufficiency of bandwidth in access and backhaul networks, as well as interconnection and openness of networks, as discussed in Section 2.3.

2.2.2.3 Unbundling and Consolidation in Network Management

Where service providers are subject to competition, they can be expected to seek out efficiency gains. In the active network infrastructure and wholesale services layers, for example, significant consolidation is occurring through outsourcing of backhaul traffic. There is increasing consolidation of assets under common 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] Most regulators take the position that such sharing, even among a limited number of providers in a sector with high barriers to entry, does not undermine competition; nevertheless, they often set limits on such consolidation.[32] Regulators can encourage cost reductions through such market-led initiatives by taking a clear position, on which investors may rely, of a presumption against regulatory control in the absence of evidence of actual harm to competition.

Box 2.1: Unbundling and Outsourcing of Network Operations

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

Source: Author.

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

Cumulatively, the sheer variety of types of networks today, along with the trends towards unbundling and consolidation discussed in this section, present numerous quandaries for regulators in assessing competition and regulating operators. Seeking to provide a level playing field for inter-modal competition between different types of wireless and wireline networks often involves rethinking regulatory arrangements. Regulators must ensure that the extensive benefits of technology and market pressure described above are not lost through legacy regulations and slowness to adapt to new conditions.

2.2.3 The Redistribution of Computer Processing and Content Production

Together with the availability of greater network capacity, the employment of IP technology in networks' logical layers has opened up the possibility for a substantial redistribution of computing functions across networks. 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.

2.2.3.1 Decentralization

Historically, communication devices have been two-way, closed, and configured for a given network, such as the public switched telephone network (PSTN) or a GSM mobile system. Entertainment devices have been closed and predominantly one-way, receiving broadcast, cable or satellite video and radio content. Computing devices have offered open platforms but with minimal communications functionality.

Year by year, as predicted by "Moore's Law," microchips have become faster and smaller, even as 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 computing has, in turn, rapidly declined. As a result, significant computer processing capacity is widely available on a proliferation of devices, and can be integrated with communication devices, resulting in a convergence between computers and communications. The result is a flourishing market of multi-use PC desktops, laptops, smart phones and "netbooks."

This has also made it financially possible for individuals, families and small enterprises to create and manage information for an unlimited range of business and personal uses.[36] The world has seen a gusher of latent ICT demand across human society, as illustrated by the trend in maturing markets away from the passive experience of broadcast television and radio toward the interactive use of ICTs for such purposes as production and distribution of user-generated video content, as well as social networking.

The predominant pattern has been for traditional computing and the newer mobile devices to offer open access similar to the layer structure of the Internet. The passive casing of a laptop, for example, 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 something else. 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," unleashing human society's apparently tremendous potential for creativity and innovation.[37]

The combination of these developments with the architecture of the Internet described above allows this human potential to be networked, producing new forms of interaction and information production, whether for commercial, financial, logistical, inter-personal or entertainment purposes.[38] Various types of networks result, from social networks to *distributed computing*, also known as grid computing.

One experiment involving grid computing combined the unused capacity of computer processors in widely distributed PCs belonging to millions of individual volunteers, resulting in the temporary establishment of the most powerful supercomputer in the world. It was all part of a University of California at Berkely project designed to analyse huge amounts of radio signals from space in the search for extra-terrestrial intelligence.[39] In 2004, the seti@home project's cumulative processing capacity 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 processing power harnessed by the CERN nuclear research facility's Large Hadron Collidor in Geneva, Switzerland.

So, a huge redistribution of computer processing functions across populations, businesses and institutions is under way, facilitated by the reduced capital cost of computing, the increased speed of computer processors and – crucially – the existence of high speed networks for carrying signals among them.[42] As a result, an extraordinary revolution has occurred in the production and distribution of content. The low cost 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. The classic, centrally distributed media industry structures of TV and radio broadcasting, films, music, newspapers – and, within the last year or two, books – are challenged by the peer-to-peer structure of the Internet and the possibility of distributed innovation. The development of distributed multi-media applications such as YouTube, Facebook, MySpace, Twitter and numerous others, has had a huge social, economic and political impact. Usage of such Internet services is increasing demand for greater investment in connectivity. These developments are also creating new challenges for regulators to protect against the many vulnerabilities that arise from freely distributed and uncontrolled content, including threats to intellectual property rights.[43]

2.2.3.2 Centralization

Paradoxically, while all of this decentralization is happening, there is also a trend toward 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: (1) computer processing, (2) storage, and (3) display/interface. These can now happen in different locations. A user may access a central data centre 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, and Microsoft, and the provision of cloud services by these companies and others such as Salesforce.com, is fundamentally changing the provision of applications and services from a distance. The ability of cloud providers to offer on-demand, scalable computing resources offers IT economies of scale. Cloud computing can be classified as "software-as-a-service" (SaaS), "platform-as-a-service" (PaaS) or infrastructure-as-a-service (IaaS).[45]

Box 2.2: Cloud Computing: On the Rise for Government and Corporate Customers

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

- Corporate versions of simple, long-existing services like hosted email – for example, 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 – for example, Dell's sales, marketing and customer relations management and Citibank's global wealth management system; or
- Complex, tailored computer processing – such as the US Census Bureau's use of Salesforce's SaaS in connection with the 2010 decennial census, or NASA's use of NEBULA cloud computing for collaboration, public input, education and outreach programs.[47]

Source: Author.

Data centres are not just being built in developed economies. IBM has built a data centre in Egypt for Telecom Egypt (dubbed the "Big Green") and also has data centres in India and other developing countries. Developing countries might reap particular benefits from the IT revolution once connection speeds are sufficient to carry data for complex computing tasks. Cloud computing may enable economically viable scaling for 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 telecommunication networks that can carry data at high speeds, a substantial shift of computer processing to centralized locations is under way. Illustrating the large-scale potential impact of these changes, some observers have compared the shift to centralized server farms with the industrial revolution 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 the companies traditionally associated with information technology that are becoming cloud providers. In the United States in 2009, the telecommunication operator Verizon introduced its Computing-as-a-Service (CaaS), while AT&T launched AT&T Synaptic Storage, an on-demand, web-based data storage service. The advent of cloud computing and other developments may signify an underlying trend that is both consistent with – and indeed, inextricably linked to – the wider distribution of computing functions mentioned earlier.[51] What is occurring is essentially a constant redistribution of computer processing and storage across the network to optimize efficient network utilization. Basically, it is a reflection of the by-now symbiotic relationship between computing and telecommunication resources.[52]

These developments blur the boundary between IT and telecommunications, posing questions about the regulation of cloud-based services that are substitutable for traditional regulated telecommunication services. They increase the pressure on regulatory distinctions used in many countries between "telecommunication" services (typically regulated) and "enhanced" or "value added" services (typically lightly regulated or unregulated).[53]

2.3 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 2.1 and 2.2. Those changes can be analysed in terms of three themes:

- The economic and social value of increasingly high-speed network **connectivity** for ever larger segments of the population;
- The appropriate level of **openness** of networks that will achieve innovative and efficient use without undermining operational integrity or investment incentives; and
- The consumer **vulnerability** that stems from increasing dependence of economic and social activities and relations on connectivity to open networks.

2.3.1 Connectivity

The stage of high-speed network development reached by countries varies. Some countries have ex-

tensive 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 network development, generating investment in ubiquitous high-speed. IP-based networks has risen 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 in the 1990s. But even these countries anticipate congestion problems with the expected growth of higher-speed services. These countries are focusing increasingly on spreading fibre optics throughout their networks. Where it is not economically viable to extend fibre all the way to the customer, they rely on other high-speed access technologies.[54] Many developing economies still lack the high-speed IP backbones and international bandwidth capacity required to offer broadband connectivity. So they are focusing on enhancing investment and competition in core networks and international submarine and overland cable connections.[55] For access networks, their primary focus is on wireless broadband technologies.

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 of both 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 levels of customer take-up, greatly increasing the risk to investors.[56]

On the wireline side, deployment is particularly expensive, especially where it is green-field 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 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, in terms of improved speed and coverage.[57] As a threshold matter, investors seek to recover their costs and make a return on investment that is commensurate with the risks and opportunity costs involved. From a regulatory perspective, network development is essentially tied to issues of universal access and the Digital Divide. Addressing this involves setting in motion a virtuous circle of increasing market demand, which then justifies investment in networks and ICT equipment, which in turn fuels demand.

This section discusses key challenges facing regulators that seek to improve connectivity, exploring:

- Increasing competition to drive network build-outs;
- Optimizing use of radio spectrum;
- Exploiting property assets, public and private;
- Addressing infrastructure investment gaps resulting from persistent market failures; and
- Handling the role of Government in the sector.

2.3.1.1 Competition for Connectivity

Attracting investment requires providing attractive conditions, which in turn depends on establishing a regulatory framework allowing investors to enter the market and compete on a fair basis. Competition at the physical infrastructure layer of networks has proven to be a valuable means of driving market 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 some countries where lack of electrical power supply constrains the recharging of mobile phone batteries, some mobile operators offer solar chargers and battery recharge services at retail outlets, generating usage that enables the operators to extend their networks.[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 some of the highest broadband quality scores in the world[59] – have engaged in a race for market share by stringing fibre optic cables across buildings to their customers' homes, contributing to these countries' high broadband access rates. Regulators need to ensure that licensing regimes and network build-out programmes do not overly restrict distributed competition initiatives while respecting environmental and planning laws.

The diversification of access technologies today demonstrates that not only is competition among providers of the same service beneficial, but intermodal competition is also driving improved access to higher-speed networks 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 legacy telephony market and the IP-empowered 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 2.3.2, this involves setting an appropriate degree of openness in terms of market entry and access to open network platforms.

2.3.1.2 Optimizing Use of Radio Spectrum

If the experience of the mobile sector's growth in voice services over the last 10-15 years offers any indication, competition in mobile broadband may be expected to reduce prices and increase market penetration and usage. Mobile broadband is already enjoying very high growth,[60] driven by the development of Internet-capable devices as well as multiplexing and other spectrum efficiency improvements.[61] Radio spectrum offers an extensive raw material for telecommunications, and not only for developing countries. It is a valuable, and in many places crucial, means of extending networks to users. It can make networks feasible where the cost of laying wireline infrastructure is economically unviable. It also enables mobility.

Countries worldwide are making larger amounts of radio spectrum available as they refarm it from inefficient uses towards more productive purposes. Many regulators have taken major steps to make more spectrum available for narrowband and broadband connectivity. With spectrum being distributed for 3G and 4G (e.g., WiMAX and LTE),[62] along with unlicensed WiFi use, the last 10 years have seen a huge shift towards wireless communications. Making available more spectrum, particularly in lower frequency ranges that allow for higher quality of service over longer distances, can facilitate mobile broadband growth.

Significant amounts of spectrum that are expected to be useful for telecommunication purposes are being freed up through digitalization of TV. This represents the latest wave of digitalization of communications carried out over recent decades. First there was the digitalization of wireline networks, then mobile networks and now broadcasting. The spectrum made available from this process – the so-called "digital dividend" – includes bands that are expected to be useful for broadband Internet access. 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 broadcasters (many of them government entities) and telecommunication regulators – with the latter most often holding authority over spectrum management.

Spectrum is, however, not a blank slate on which the regulator can simply design the perfect assignments and allocations. Various government departments (e.g., the military), institutions and companies typically already hold rights to use substantial blocks of useful spectrum. Furthermore, in many countries spectrum is still managed under a "command and control" approach, a legacy of earlier government monopolization of spectrum-dependent uses. Proposals for decentralized methods of management

have ranged from treating spectrum under a tradable property rights regime,[63] allowing "open access" to certain spectrum blocks,[64] and creating spectrum "commons,"[65] – unlicensed frequency ranges available for use by all, like a public park. These new paradigms of spectrum distribution have not been adopted universally, but various initiatives are allowing market forces to influence the allocation and assignment of spectrum.

Spectrum is often shared for point-to-point and point-to-multipoint microwave links needed for trunking and backhaul. Apart from MVNO arrangements, most regulators license access to spectrum on an exclusive basis. Technological neutrality is often encouraged in order to allow operators to select the most cost-effective technologies to meet market demand. Still, since deciding to license a certain spectrum band is closely associated with industry standards, there are few truly technology-neutral regulatory decisions.

The challenge regulators face is to ensure that spectrum is made available in a manner that ensures its optimal exploitation.[66] In addition to allocation and assignment, optimal use is significantly influenced by spectrum pricing. Spectrum pricing may serve various purposes, including:

- Advancing fiscal and political goals;
- Ensuring a fair return on private use of a public asset through charging economic rents; and
- Rationing a scarce resource to ensure its efficient use.[67]

Spectrum pricing mechanisms have not been developed in many countries, partly due to the complex economic and technical analysis involved. Pricing methods often depend on perceived demand for spectrum, potential congestion in a given band, and (of course) political pressures. Payments can be determined by up-front auctions, setting fixed charges (whether one-time or recurring), setting revenue-sharing obligations or "administrative incentive pricing." AIP involves basing the price on a calculation of the opportunity cost value of the spectrum. Tailored pricing mechanisms can reduce economic barriers to efficient spectrum usage.

The 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 a 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 are intensifying the debate today about wireless "network neutrality" in the United States.[68] It will be important for regulators to ensure that their allocation and assignment methods and associated pricing do not hinder the potential of telecommunications but rather facilitate the efficient use of a valuable national resource.

Box 2.3: Liberalizing Spectrum Distribution[69]

Liberalization of spectrum assignment has included:

- Initial public offerings by governments, approving rights to use frequencies for certain periods;
- Relaxation of controls over transfers and consolidations of licensees (and thus indirectly spectrum rights);
- 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 and, inversely, to transfer spectrum rights to other entities when they expect to make more profitable use of it;[70] and
- Using spectrum on a commons (typically unlicensed) basis.

Typically, unlicensed use involves limiting the transmission power of radio devices to protect against risk of interference. Such low-power devices, however, may proliferate if the vision of an "Internet of Things" – such as interconnected kitchen appliances – evolves into reality. That could have the effect of sparking demand for more unlicensed spectrum.[71] It may also elevate the radio-magnetic "noise floor," prompting interference concerns for licensed users.

Source: Author.

2.3.1.3 Exploiting Property Assets

Wireline networks remain crucial to developing high-speed connectivity – both as backhaul for services that rely on spectrum for access and as a means of access itself. The physical nature of wireline networks means that there is increasing focus on the costs of the passive layer of the network (See Section 2.2.1). For example, various studies have found that 65-80 per cent of the cost of rolling out fibre networks consists of network-related construction.[72] So any policy that can reduce those construction costs would provide an important impetus to the roll-out of fibre networks.[73]

Access to Public and Private Property

Given the high cost of construction, access to publicly owned real estate can greatly reduce the cost of network deployment. This is particularly true for rights of way (e.g., roads and rail, power and gas lines), duct systems, and dark or lit fibre.[74] Numerous innovations are being tried, including use of public sewer systems.[75] Much depends on the facilitating legislation. In Canada, service providers may physically enter or set up construction sites along any highway or other public place for the purpose of constructing, maintaining or operating transmission lines.[76] German service providers may use public roads, paths, squares, bridges and waterways to deploy telecommunication lines without charge.[77] In the United States, the National Telecommunications and Information Administration facilitates service providers' access to a wide range of public properties.

A major impediment to accessing public resources appears to be lack of initiative and coordination across government bodies, along with regulatory barriers to approval. Regulators can take the lead in this regard. The Lebanese Telecommunications Regulatory Authority recently published a study identifying legal barriers preventing 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 this decree to be a cornerstone of its broadband policy.[78] Such studies and legislative initiatives can lead to significant improvement in the use of public assets to support ICT services. By thinking holistically of the public assets available to support telecommunication networks, regulators can contribute greatly to reducing costs and accelerating network rollout.

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 centres 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 the deployment of networks.

Many of the assets required for network installation are not owned by public bodies. In the developing country context, the lack of a clear regime for property rights often presents problems, particularly in the absence of land registers. Regulators can nevertheless facilitate negotiations with those who lay claim to land. Laws enacted in 2009 in the Bahamas and Solomon Islands provide innovative approaches for securing access to private and customary land for telecommunication purposes.[79]

Sharing Passive Telecommunication Infrastructure

The benefits of infrastructure sharing among telecommunication providers have been discussed extensively in recent years.[80] Due to the cost of digging up pavement and installing towers, there is increasing focus on access to ducts that are privately owned by service providers. This includes interest in requiring operators to publish a "reference duct offer," such as has been introduced in Portugal.[81] Such a requirement also is currently being considered in the UK, which recently carried out a major study of the country's duct system,[82] and in Lebanon, where the ducts are still in the public domain. France's regulator, ARCEP, reached the conclusion in 2008 that the provision of access to ducts was a "relevant market" for the purpose of analysing market definition and power. ARCEP has determined that France Telecom has significant market power in that relevant market and has applied access obligations as a reasonable and proportionate remedy.[83]

Some countries' regulators and municipalities require coordinated planning for construction to avoid repeated digging, disruption and duplicative

costs for operators. Some have considered ambitious mandatory planning requirements involving industry committees established by the regulator.[84] Such plans face operators' concerns about the managerial nature of such regulation, as well as the loss of stealth as a competitive strategy. Then there is the "lowest common denominator" drag on operators' competitive incentives to be the first to install infrastructure in an area. Australia's access regime steers between these pressures, requiring operators that are planning to install infrastructure to notify other operators and requiring some negotiation among those that are interested in participating in infrastructure sharing.[85] In some countries, the operators themselves have taken the initiative to coordinate planning, such as through the UK's Mobile Operators Association.[86]

The nature of passive infrastructure makes it important that regulators look beyond just obligations applicable to telecommunication network operators to broader questions of how costs of deployment may be reduced.[87] An increasing number of countries (for example, Bahrain) are engaging building development and landlord associations to ensure optimal use of their rights of way, ducts and in-building cabling in order to facilitate investment and competition.[88] In some countries, such as Sweden, building developers and landlords are recognizing the benefits of securing high-speed networks, which include increased property value, higher rent, customer lock-in and building management systems.

In the active network infrastructure and wholesale services layers, meanwhile, 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, they do not guarantee investment in new, high-speed network infrastructure. Regulators have to weigh the anticipated benefits of reducing new market entrants' costs against the incentives for investing in the infrastructure in the first place.

2.3.1.4 Addressing Persisting Market Failure Gaps

Even with competition and good use of public resources like spectrum and rights of way, the costs involved in making substantial advances in connectivity can remain a significant barrier to rapid private sector investment.[89] Countries have varying geographic topologies and distributions of wealth, which affect network deployment costs. Notwithstanding the benefits of competition, its introduction may weaken the traditional means of striving for universal service objectives. In the past, internal cross-subsidies were drawn from higher margins from certain services, such as international services. These lucrative offerings cross-subsidized the below-cost provision of standard telephony in rural and low-income areas. Over time, competition may yet drive coverage beyond the more economically attractive areas towards the poorer ones. Nevertheless, the threat of "cherry picking" gives an advantage to operators who enjoy higher margins from high-revenue areas without taking on 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, then, 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. They have to consider whether (and if so, where) 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-speed networks. A now-common approach to the loss of the internal cross-subsidies is to extend this traditional method by instituting 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 licence and spectrum fees, encouraging partnerships among operators, and coupling profitable areas with under-served rural areas in licences.

Universal service funds raise particular challenges for regulators since collecting funds inevitably attracts attention and changes incentives. The political dimension and scale of such funds in many cases necessitates additional supervision, sometimes through the creation of cross-sector participant committees and sometimes involving politicians.[90] Ensuring that 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 to a fund. The effects of convergence may change the ranks of entities required to contribute.[91]

Dealing with Government as a Player in the Sector

The last two decades of telecommunication reform in most countries have reduced the direct role of government in the sector. The basis of such liberalization and privatization policies has been the observation that government ownership or interests in national telecommunication providers risks a misalignment of investment planning, risk and reward, with resulting inefficiencies. Governments have, therefore, been increasingly separating themselves from service provision and network operation, transitioning those activities to private sector control through privatization. Policy-making and regulation have, in turn, been separated through the establishment of independent regulatory authorities, with government 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 a regulatory environment insulated from the whims of political change.

In some countries, however, limitations in the separation of policy, regulation and operation are arising. Of course, in many countries, governments have remained significantly invested in the sector as a part or even whole owner of the national operator.[92] But as shown in Box 2.4, there are now signs that the importance of high-speed networks to national economic policies in some wealthier countries is leading to increasing government involvement through financial investment and public-private partnership arrangements (PPPs), often organized through economic stimulus funding.[93]

The most ambitious of these is the Australian Government's AUD 43 billion (about USD 37 billion) plan to build out FTTH capability and to subsequently privatize a large portion of the network. Both the Japanese and Republic of Korea governments have provided substantial subsidies, with significant results.[94] Other countries have seen significant initiatives at the municipal level, including Norway and Sweden.[95] In Europe, the majority of FTTH projects are led by municipalities and power utilities.[96]

Decisions by national or municipal governments to invest public money in telecommunication networks may boost connectivity significantly, but they also raise significant regulatory issues. Where government funding is provided in a multi-operator market, there are significant risks of adverse competitive effects on private operators. This may create distortions in competition and dampen incentives to invest in the private providers.

Box 2.4: Recent Public Funding Commitments for Next-Generation Broadband Networks

Country	Announcement	Total investment (USD million)	Investment per capita (USD)
Australia	2009	3,300[97]	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.

For this reason, 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 government aid will generally be permitted;
- "Black areas," where at least two broadband network providers are present and there is facilities-based competition, making government aid for rolling out additional broadband networks unnecessary potentially anti-competitive; and
- "Grey areas," where a broadband operator is present and further analysis is needed to assess market conditions and determine whether government aid would help or hurt.

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

- Where, in the absence of private investment, 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 dynamics in the market and addressing specific market failures. Whether it will suffice to bring about a sea change of major investment in ubiquitous high-speed networks remains 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.

2.3.2 Openness

The sweeping introduction of competition across the world's telecommunication 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 it generally is understood to be 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 permitted and encouraged, regulated to require mandatory access and non-discrimination obligations, or even prevented; and
- The degree to which processes that are critical to the development of the sector are transparent and consensus-oriented, not controlled by a narrow set of interests.

These examples cross multiple domains and disciplines, and many are the subject of extensive controversy. The chief benefit of open systems lies in the permission they allow for innovation and competition among their users, 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 that affect the behaviour of network operators and service and applications providers. [99]

This remainder of this section explores the challenges regulators face when:

- Seeking to establish and maintain an open market by policing fair competition and market dominance;
- Considering whether and how to impose openness in order to increase competition and innovation across shared platforms; and
- Ensuring open processes in the development of industry standards.

Box 2.5: Open Systems 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);
- Non-discriminatory access to infrastructure and wholesale services, providing a platform for many service and applications providers to compete and offer services;
- Devices that can host any application, can connect to different network providers using different modalities (e.g., GSM, UMTS, WiFi), and can be used for multiple purposes;
- Inclusive standard-setting bodies such as 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 that ensures there are no limits on the royalty-free, non-discriminatory redistribution of the licensed software, and provides source code to facilitate incremental development derived from it;[100]
- "Creative commons" content copyright licensing, which "provides free licences 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";[101] 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.

2.3.2.1 Open Markets

A regulator's stance on what kind of market structure is to be allowed to develop, and how open it will be, has a major impact on the functioning of that market. Regulators have to consider the optimal approach to facilitating market entry through the authorization 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 incentives for service providers, in order to derive the greatest benefits from investment and competition.

2.3.2.2 Optimizing Open Market Entry

A significant number of regulators have adopted open authorization regimes, which either make an unlimited number of licences very easily available or require only a notification to the regulator and no approval to commence business. In the majority of countries worldwide, however, telecommunication services are provided, and networks are operated, under licences 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 licence. 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 licences.
- Licences 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 dynamics of the market.

Regulators, then, face the challenge of ensuring sufficiently open and flexible licensing regimes to encourage investment and competition. Thus, more and more countries are adopting universal licences (which permit the holder to offer any service and deploy any network) and open authorization regimes. The transition of key rights and obligations from provider-specific licences to generally applicable regulations (which can be modified more easily than licences) is usually bumpy, and regulators face challenges in minimizing disputes in the process.

Despite a 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' needs 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 guaranteed period of time. This often means providing long-lasting licences on which investors may rely in case of disputes with the government or the regulator. The challenge for regulators in such countries is to provide the required certainty without creating greater problems for the regulatory regime in the future.

Secondly, every country needs a mechanism for regulating the use of publicly owned physical resources (spectrum, numbering and access to public property). A simple means of controlling and rationing the use of such resources is through licensing. Permission to use resources can, of course, be separated from service provider licences. In practice, however, the benefits of a one-stop-shop have meant that in many countries, at least with spectrum, the right to provide a service has been combined with the right to use the resource.

Thirdly, almost all regulators take the view that at least certain dimensions of the market require a limited number of sector participants. And the best way to control that is through licensing. It is generally recognized that the potential for competition to produce ubiquitous coverage is limited by the large cost of rolling out networks. So, in the mobile sector, there are arguments for restricting entry to the market because (aside from technical arguments based on spectrum requirements and interference risks) an industry structure with a smaller number of players is seen as providing substantial reductions to the cost of serving subscribers.[102]

Similar arguments may apply in the wireline sector, particularly when it comes to installing FTTx. With large-capacity facilities such as fibre cables, it makes less sense to roll out redundant network infrastructure, 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" thinking among regulators for passive (and sometimes active) network infrastructure in given geographic area – and, in some countries, even nationally. Fibre networks are increasingly regarded as crucial national infrastructure, a genuine information transport "highway" with economies of scale that may require a single supplier to aggregate traffic and ensure efficiency. This thinking emphasizes the substantial trans-sector externalities that a society can expect to gain from having ubiquitous high-speed connectivity. And these externalities usually are not priced into individual telecommunication 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, on the one hand, high-speed networks will be profitable as the entire economy shifts gear and usage rises exponentially, and on the other hand, that demand remains uncertain and the transformative effects on economic productivity unproven. The contrasts between the visions of a leap forward and incremental change are starker than ever.

2.3.2.3 Policing the Open Functioning of the Market

As market competition has developed, so has the sophistication of understanding competition problems and the regulation tailored to address those problems. Still, regulators face major challenges in keeping multi-operator markets open. The challenges of policing open markets include defining and analysing the relevant markets in which the level of competition is to be assessed. Of particular importance is identifying dominance or significant market power, with the attendant anti-competitive abuses that can close the market. As experience with anti-competitive behaviour has grown, countries have legislated against specific activities carried out by providers that have been identified as dominant. This often takes the form of *ex post* remedies.[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 so difficult and slow to prove, that the remedy often comes too late and the harm to competition is already done. For this reason, legislation typically also provides for regulations that will prevent such abuses from 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 other conditions offered to competing 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, which in turn may argue that matters should be dealt with more by *ex post* regulation. The risk with *ex ante* regulation is similar to that with licences, which in effect are another form of *ex ante* regulation. The boat risks being beached as the tide turns. In some markets – some African and Caribbean mobile markets, for example – very rapid changes in market structures challenge regulators' abilities to keep up as new entrants quickly overtake incumbents.[104]

The trick for regulators is to be agile enough to ensure that *ex ante* regulation does not overly burden the operators. Many countries still apply unexplained controls on retail prices in competitive mobile sectors. The flexibility to change regulations where they no longer match the facts on the ground is, then, just as important as getting it right the first time.[105] In the European Union, and increasingly elsewhere, regulators are duty-bound to ensure that the obligations and remedies they impose are specific, relevant and proportionate to the problems they are designed to address.[106]

2.3.2.4 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, also often referred to as significant market power (SMP), is often defined as a level of market power enabling a provider to behave to an appreciable extent independently of competitors and customers. Such power can include the ability to close down markets and undermine the benefits of open competition. Identifying dominance, then, enables regulators and service providers to know which operators are likely to engage in abuses of their dominant positions; the regulators can then apply specifically targeted regulatory obligations. The use of dominance as a threshold trigger for various regulatory obligations is useful for various reasons:

- It applies lighter regulatory treatment where dominance does not exist, thus placing the emphasis on market forces rather than regulation to drive service improvements and lower prices;
- It focuses on the underlying sources of competition problems, which often arise from dominance; and
- 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 focuses competitive analysis on the precise market failure potential that regulation has to address. It requires detailed fact gathering and complex economic analysis. The regulator has to look at 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 methodologies for identifying what markets authorities ought to look at when considering whether a producer or service provider has reached a position of dominance. Experience in developed markets has yielded 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 originated from broad competition law and policy, where it was necessary to identify what segment of the country's entire economy was being considered.[108]

Box 2.6: Competition Analysis in a Converging Market

The revenue base of network-delivered services is changing significantly. For example, 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] Telecommunication 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 2.2.1. For example, in the UK, broadband providers BT and Virgin Media joined in a complaint against BSkyB. BT and Virgin Media alleged that BSkyB would not permit them to use its "premium content" – in this case, sports and blockbuster movies – for distribution on their networks. UK regulator Ofcom found that such content constituted a wholesale market, and that Sky was indeed dominant in that market in the UK.

Ofcom also found that Sky was using this dominance in an "upstream market" to favour its own distribution platforms over competing cable, digital terrestrial television (DTT) and IPTV platforms.[111] The finding was that dominance in one network layer (content) was being used for anti-competitive purposes in another layer (transport). The case, which already had taken three years and thousands of pages of consultation documents, was not resolved by late 2009.

Source: Author.

The increasing availability of high-speed connectivity, combined with the horizontal layering structure of the network created by the IP platform, greatly accelerates the impact of convergence, which in turn increases the complexity of competition analysis. The market developments described in Section 2.2 of this chapter are complicating the role of regulators, particularly given the convergence of wireline and wireless services and applications.

In many countries, the inadequacy of economic and legal resources and the information available to analyse such factors presents a huge challenge for regulators. If service providers pursue aggressive competition into the regulatory process and the courts, they may turn the dispute into a forum for arguing a wide range of issues – in effect, a referendum on the regulator. Operators are also likely to challenge whether the regulator has taken into account all relevant information in its economic analysis. This presents a significant risk that regulators' designations of dominance (and regulatory remedies applied as a result) may become lightning rods for disputes, tying up regulatory initiatives in the courts without addressing the actual problems that need resolution.

In countries where economic, technical and legal resources are extremely limited, there may be little choice but to use somewhat blunt regulatory instruments. The regulatory agency might apply more symmetric regulation on operators, involving less distinction between dominant and non-dominant providers. For example, it might focus on non-discriminatory interconnection negotiations rather than requiring the incumbent to publish a reference interconnection offer. The agency might apply infrastructure access obligations on the basis of a simplified "essential facilities" test. Where there is a severe lack of cost information, it might regulate prices solely or principally according to international benchmarks.[112]

However, these alternatives to applying competition policy as a basis for regulatory remedies are not particularly satisfying. And they may simply replace arguments over market definition and market power with disputes that 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.

2.3.2.5 Mandating Openness

In some cases, such as for network interconnection, or access to infrastructure and wholesale services, regulation has been applied to bring about the desired result. In others, such as open source software, "creative commons" licensing and social networking websites, the open systems have emerged without prescriptive or coercive regulation. For business reasons, many companies have endorsed openness to some degree or another in their business models, without any strong regulatory coercion, often in order to generate further or linked sales or services and sometimes to disrupt prevailing monopolies.

Box 2.7: The Business Case for Openness

Businesses have chosen open systems at many of the layers described in Section 2.2.1:

- At the **content layer**, huge amounts of content are made freely available online by institutions and individuals. Many content providers – newspapers, for example – have embraced open provision of their proprietary information on the Internet. Now there are signs, however, that their dissatisfaction with the current Internet advertising business model (including Google's strong position) is leading to increased charging for content.[113]
- At the **computer operating system and applications layers**, 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.
- Both the manner of Internet traffic exchange (typically bill & keep and transit agreements) and the **logical layer** of the Internet itself, may be described as relatively open, even if there are limits to such openness due to firewalls, network address translation, proprietary protocols in the middle of the network, ISP liability, government controls, traffic prioritization, and virtual private networks.[114]
- At the layer of **network wholesale services**, KPN's CEO Ad Scheepbouwer is credited with perceiving the benefits of a national network operator opening its network for use by other providers – even competitors – because such open use would increase usage and therefore maximize network capacity.[115]
- At the layer of **physical network infrastructure**, tower companies and other voluntary infrastructure management arrangements are often open to adding the equipment of new network operators or using new technologies.

Source: Author.

The challenge regulators face is to identify where openness is particularly valuable and, if it does not arise voluntarily, whether and how intervention might be needed to mandate it. When considering taking such steps, it is critical for regulators to weigh carefully:

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

2.3.2.6 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, BT Openreach in the UK has 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 Australia, Italy, New Zealand and Singapore, among other countries – exemplifies 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. For example, requiring openness for customer premises equipment has had benefits universally, prying apart equipment from services offerings, unbundling components that could be subject to market competition. In the United States, for example, the decision of the US Court of Appeals of the D.C. Circuit in the 1956 *Hush-a-Phone* case[116] – and the subsequent 1968 *Carterphone*[117] decision of the US Federal Communication Commission (FCC) – presaged separate regulation of networks and services from terminal devices. The FCC 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 devices.

Since most countries adopted arrangements similar to the FCC's post-*Carterphone* construct, devices have been treated as consumer products and, other than some type-approval concerns and consumer protection activities, have not been at the

forefront of regulatory policy. Today, devices are clearly an important driver of telecommunication traffic, a generator of revenues and a 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, they spark a positive feedback loop that drives network development and generation of third-party applications.

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 from handcuffing exclusive mobile devices to the networks.[118] France, for example, has laws restricting such tying.[119] These and other "net neutrality" measures are the subject of increasing focus.

2.3.2.7 Operational and Technical Realities

Openness often involves a reduction in proprietary control over content, applications, networks and infrastructure. In networks, it typically has significant operational implications. 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 difficulties in managing hand-offs among different cells, require more careful traffic management. Likewise, functional separation involves major changes in the manner in which the network is managed. The technique has been criticized for undermining the operational link between retail services and the networks that support them, watering down the effect of market forces on network management decisions.[120]

Determining whether and how to mandate openness involves parsing a complex blend of policy goals and operational and technical issues. 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 – whether technical, economic, political or social – solved at such layer's level. An example of this would be that an ISP should not be held responsible for unlawful online content provided by a third party, since the ISP merely provides access to the Internet.[122] This has been criticized by others as misconstruing the historical development of the Internet, of freezing the evolution of network design, of undermining technology neutrality,[123] 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.[124]

The debate over network neutrality ranges across the operational necessities of network management, including management of congestion, dealing with harmful traffic (such as viruses and spam), blocking unlawful content (child pornography, for example) and intellectual property management. Rapidly rising volumes of broadband traffic on mobile networks strains these management systems.[125] Similarly, video content now represents about a third of all consumer Internet traffic – not counting peer-to-peer video sharing.[126] All forms of video transmission combined are expected to increase to over 90 per cent of traffic by 2013.[127] This acceleration of bandwidth-hungry transmission intensifies arguments over the way network operators manage traffic flows. There are increasing concerns that "throttling" traffic with low tolerance for latency – such as real time audio or video – may render transmissions worthless to the recipient.

This policy discussion has been most intense in Canada (the CRTC recently issued a decision on the matter)[128] and the United States (the FCC recently initiated a consultation process). Each government is focusing on whether ISPs can reasonably discriminate against certain traffic, particularly where such discrimination degrades the quality of that traffic in comparison with other traffic favoured by the ISP. Requirements that service providers disclose their traffic management practices aim at providing greater transparency for end users. The debate over what (if any) additional regulation to introduce in this area is highly contentious. Some observers view it as a referendum on the open nature of the Internet itself.

2.3.2.8 Impact on Investment

Mandating openness often affects perceptions of basic property rights. In most countries, property rights imply a significant measure of exclusive control

over usage of an asset. This exclusivity is often constrained by the government's right to encroach upon property rights for the public welfare, which can include protection or development of national infrastructure (e.g., building roads and railways), environmental protection, divestiture to break up monopolies and other reasons. Nevertheless, a key economic rationale for property rights is the ability to develop and exploit the asset – a primary motive for investment.

A key question regulators need to consider, then, is how to balance actions that attract investment against rules that promote openness. Of course, openness that makes competition possible may allow new entrants and new investment into a market. But the impact on investment may vary, and views differ on where openness will increase or harm investment prospects.

Investors and telecommunication providers often seek to persuade regulators not to impose infrastructure access obligations or to allow their customers to have access to the services of others, for example Internet-based services. The arguments are particularly familiar now in the mobile sector, which in many countries is characterized by "walled gardens" – a term that refers to completely exclusive, closed networks whose operators allow no services or applications to be delivered other than their own. These closed networks often limit or prescribe which handsets can be used and apply 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 inability to analyse such information effectively. 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 2.8: The Debate over Open Access to Fibre Networks

The debate over mandating openness, and its impact on investment, may be illustrated in the policy disagreement between the European Commission and the German government over development of Deutsche Telekom's high-speed networks. The question revolved around whether the company should be allowed a "regulatory holiday" from access obligations, or whether it should be required to grant bit-stream access to new fibre networks.

In 2006, the German legislature had amended the Telecommunications Law, establishing a presumption against regulation of "new markets."[129] The law permitted the Federal Network Agency to introduce regulation if it perceived that a lack of regulation would impede development of a competitive market. But the legislation also directed the Agency to "give particular consideration to the aim of fostering efficient investment in infrastructure and the promotion of innovation."[130] Like the FCC in the United States, the German national regulatory authority decided not to impose access obligations on Deutsche Telekom's new FTTx and xDSL deployments. Not impressed, the European Commission brought enforcement proceedings against Germany for not applying the EU's access obligations.

Given the sums of money involved, these issues are highly contentious. For example, the French regulator ARCEP announced in early 2009 that it would require sharing of in-building cabling. In response, France Telecom froze investment and threatened not to proceed with fiber deployment. FT's position softened later in the year when it reached a compromise to treat dense urban areas differently from other areas. Only in those urban areas would FT be required to install multiple fibre optic lines for in-building cabling.[131]

Targeting the precise point at which openness should be required can reduce some of the contentiousness and risk for investment. For example, the Dutch regulator OPTA has explored compromises between the German and EU approaches. Its staff has observed that emerging service markets are often intertwined with existing ones. Rather than applying existing regulatory mandates, on the one hand, or completely forbearing from all regulation, on the other, regulators can focus on essential facilities or other non-replicable assets used by new technology platforms. This means applying ex ante regulations to open up access to nonreplicable assets, and then focusing competition law on operators' behaviour in the provision of services over these assets. This may allow longer-term certainty for investing in new infrastructure, preserving investment incentives and addressing the risks associated with monopoly fibre investments.[132]

Source: Author.

2.3.2.9 Open processes, Standardization and Intellectual Property

Networks and Services are not the only subjects of debates over openness. Some industry processes have a major impact on the shape of markets as they develop. For example, as is evident in the development of GSM, UMTS, WiMAX, WiFi and LTE, the development of standards determines the technologies that may be used, the radio spectrum that will be required, and services that can be provided.[133] These standards may not be laws handed down by authorities, but they have so much importance in setting market conditions over long periods that they have an implicit quasi-regulatory nature, analogous to the way software "code" has been described as "law."[134] Standards development, then, is a matter of public interest. It is important for regulators to understand these processes. They must recognize when standard-setting is sufficiently inclusive and transparent to avoid the risk of subversion by narrow interest groups, and when it is open enough to encourage innovation.

Many standardization bodies are relatively open. But that is not always enough, since individual companies may still control assets that are essential to 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) and the European Telecommunications Standards Institute (ETSI), for example, seek to resolve these issues by focusing on "essential patents." These are patents that would be infringed by the implementation of a particular standard or specification. The standards bodies will require members to disclose such essential patents and license them on fair, reasonable and non-discriminatory terms, on a reciprocal basis with other members. Despite this, the complexity of new ICT technologies, and patent fragmentation, mean that thousands of disclosures of essential patents might be made (together with royalty claims), risking the rapid and efficient development of standards.[135]

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.[136] 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 anti-competitive actual or attempted monopolization.[137] Many countries have not developed clear legal positions on such matters, and regulators face the challenge of broadening their vision to understand the dimension played by intellectual property rights and standard setting processes.

2.3.3 Vulnerability

Just as the combination of connectivity and openness produces the extensive benefits, it also creates various vulnerabilities, particularly relating to security and consumer protection. This section discusses several types of vulnerability, including threats relating to:

- Privacy and data protection;
- Cybersecurity;
- Social goods;
- Lawful intercepts; and
- Availability of unlawful content.

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

2.3.3.1 Privacy and Data Protection

Threats to privacy and data protection have increased hugely as a result of the network openness, the distributed nature of computer processing and storage, and the commercial value of information. Users share extensive information about themselves through electronic communications. An individual's activities – sending emails or chatting, making purchases, sharing photographs of themselves, and Internet searching – constitute a mosaic of that person's identity. The large amount of shared data about individuals is interesting to businesses seeking to sell

products and services. It is also attractive to tax officials and other authorities (including those monitoring political views or potential criminal activity).

Privacy is complex and multifaceted, mixing notions of dignity, liberty, democracy and human rights. The many types of privacy-related problems have been organized as follows (this is known as "Solove's taxonomy"):[138]

- 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).

Many countries have established privacy and data protection laws to protect citizens from many of the problems listed above.[139] However, the evolving nature of the ICT sector means that fresh privacy issues are being considered routinely (See Box 2.9, below).

In many countries, various privacy matters are assigned to administrative bodies other than the ICT regulatory authority. Yet the regulator invariably has some responsibilities relating to privacy, particularly where it is a converged entity dealing with all electronic services, including broadcasting and information technology.[140] In many countries, if specific privacy-related legislation is inadequate or lacking altogether, the ICT regulator may have to lead the way in dealing with ICT privacy, including through licences and regulations. In discharging whatever legislative mandate is assigned to them, regulators often face the challenge of finding the appropriate balance between promoting access to advertising-funded services and protecting users' privacy and data.

Box 2.9: Privacy Protection In An Era of New Services

The Article 29 EU Data Protection Working Party recently published an opinion on privacy and social networking communities and services.[141] It concluded that providers of such services (whether fee-based or advertising funded) are "data controllers" that bear responsibilities under the EU Data Protection Directive to:

- Inform users about the purposes and ways they process and share personal data with third parties;
- Offer privacy-friendly default settings;
- Provide information and adequate warnings to users about privacy risks when they upload data;
- Advise users that pictures or information about another individual should only be uploaded with the individual's consent.[142]

After an extensive study, Canada's Privacy Commissioner found various complaints against Facebook to be wellfounded, citing:

- Default privacy settings and advertising;
- Treatment of third-party applications;
- Account deactivation and deletion;
- Accounts of deceased users; and
- Non-users' personal information.

Some countries have taken strong privacy measures. Executives from Google, for example, 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.[143]

Another example concerns behavioural advertising. A significant part of the Internet's value for advertisers – who fund a large part of online content – is 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 a 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 by the Federal Trade Commission.[144] Phorm, a behavioural advertising technology firm, recently announced that it was leaving the UK market after it had failed to reach agreements with telecommunication operators on privacy concerns, among others.[145]

Source: Author.

2.3.3.2 Cyber-Security

With the open, peer-to-peer design of the Internet, governments, companies and individual users face risks from malicious and criminal actors. This results in widespread vulnerability to phishing, spam, viruses, computer-related fraud, denial-of-service attacks, "botnet" abuses and other offences. Even as the benefits of the Information Society multiply, so do the risks and dangers.

Countries worldwide are increasing cyber-security efforts. As an integral part of government, regulators may play a key role, given their broad competencies in the ICT sector. In numerous countries, regulators have progressively added to their mandates in this field. 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 viruses that can lead to denial-of-service attacks against critical information infrastructures – an increasingly recognized cyber-security risk.[146]

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

Another cyber-security challenge facing regulators is the association of cyber-security with national security policy, traditionally the exclusive domain of the military, law enforcement and the intelligence community.[147] In this sensitive area, regulators have to find ways to add value and expertise without necessarily being the lead institution.

Box 2.10: How Regulators Can Help Bolster Cyber-security

In addition to confronting cyber-security threats as a consumer-protection matter, regulators face challenges in various other aspects of cyber-security policy development:

- Building government, commercial and consumer understanding of the nature of cyber-security threats;
- Building broad cross-sector expertise by forging links with other sectors; and
- Assisting in development and implementation of national cyber-security policy frameworks.

Regulators may also assist with the implementation of cyber-security 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 them in a strong position to contribute through:

- Leading or coordinating public-private sector efforts to develop cyber-security standards, procedures, codes of conduct, etc.;
- Mandating or encouraging the adoption of cyber-security standards, recommended best practices, certification and evaluation schemes; and
- Supporting research and development (R&D).

In the area of incident management, regulators may be able to assume the following roles:

- Establishing national cyber-security incident monitoring facilities; and
- Participating in international and regional cyber-security incident monitoring initiatives.

In the area of readiness assessment, regulators may be able to assume the following roles:

- Preparing and implementing periodic cyber-security risk assessments, audits and reviews on a national or sector-by-sector level; and
- Conducting cyber-security exercises to test readiness and responsiveness.

Source: Author.

2.3.3.3 Emergency and Directory Services

Developments in network architecture discussed in Section 2.2 have implications for how the ICT sector provides emergency services, as well as directory and enquiry services. High-speed network access supports multiple services, some of them provided by third parties. The less control the network operator has, the less accountable it is for providing these key public welfare services, some of which have always been tasked to network operators. Furthermore, the more that networks are separated into core and access segments, the more users will rely on a plethora of different access technologies in different locations. This will make it awkward to assign costly responsibilities to any single operator whose margins are under competitive pressure.

Some of these problems may be mitigated or even entirely resolved by developments in the market. For instance, market demand for effective online search facilities may become a substitute for directory and directory enquiry services. Where market developments remain inadequate, the challenge regulators face in all of these areas is how to regulate market failure – possibly even including in the market for search applications.[148] Who to blame for such failures will typically depend on which parties have the greatest ability to control the outcomes[149] and how the costs of securing such social goods should be fairly apportioned.[150]

2.3.3.4 Lawful Intercepts

Lawful intercepts (wire tapping) on an IP-based network are vastly more complex than on the 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 also raises the barriers to effective monitoring. Intelligence or law enforcement operations must apply code-cracking capabilities to penetrate such encryption. *Deep packet inspection* (DPI) has been developed to enable monitoring of multiple internal layers of the Internet. It can be used increasingly for various purposes, including lawful intercepts.

Security ministries, police and defence forces do not typically invite regulators to play a significant role in the practical side of lawful intercepts. Nevertheless, the means by which lawful intercepts are implemented may often involve regulatory instruments, such as obligations built into licences and regulations to allow and facilitate network taps. With this, regulators may also effectively be responsible for deciding whether service providers will bear the attendant 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 on the one hand and the operational and financial realities of service providers on the other.

2.3.3.5 Availability of Unlawful Content

Mass distribution of media content was traditionally the province of broadcasters and printers, because of high production costs and the relative scarcity of the means of communication (such as radio spectrum). But the peer-to-peer nature of the Internet, with its separation of the message from carrier, makes it difficult to control the mass production and viewing of media content. Moreover, content can be produced and disseminated anywhere in the world, making national borders meaningless. This creates jurisdictional questions about legal compliance at the content layer of the network, including with respect to:

- Censorship (of obscenity, child pornography, incitement to violence and other content restrictions); and
- Copyright protection.

Converged regulators – those with responsibilities for media distribution as well as ICT services – have an extensive task to cope with the many aspects of content. Where regulators are not converged – which is more often the case – challenges arise from the lack of an integrated approach to these problems. Even regulators with a more technical and economic mandate face the challenge of assisting policy-makers in identifying who should be responsible for content.

DPI can be used for filtering content and copyright protection purposes, but this puts the spotlight on ISPs 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. This has 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" stemming from a copyright violation.

Many argue that ISPs should be immune from intermediary liability because of the societal benefits inherent in an open Internet. They argue that online communities will themselves produce norms and enforcement mechanisms, as illustrated in Wikipedia's editorial processes.[151]

2.3.3.6 Facilitating Distributed Self-Help Solutions

Given regulators' limited legal mandates in some of these areas, it is fortunate that there are various ways they can help to protect against vulnerabilities without imposing regulatory obligations. Installing anti-virus and anti-spyware software and firewalls can mitigate a significant number of cyber-security problems. A large market has grown in this area. As in any young market, regulators must ensure that consumers receive adequate disclosure about products they are purchasing, but competition for various products will help ensure their effectiveness.

Another example concerns the complex problems parents face regarding children's access to media content and other online communications. Given the demand for filtering solutions, a market is developing in this area, as well. Various ratings, labeling systems, and technologies are available to empower parents to manage the content that comes into their homes.[152] Regulators can facilitate consumer access to, and understanding of, the large amount of information that is available for self-help resources.[153]

Regulators need to keep a constant eye on how the market develops to address the vulnerabilities that arise from ubiquitous and open connectivity. They must ensure they are protecting the public without stifling innovation and creativity – a balancing act that calls for prioritizing intervention to maximize effectiveness.

2.4 Conclusion

The developments described in Section 2.2 of this paper demonstrate the potential of the ICT sector to innovate and restructure itself beyond the conception of policy-makers and regulators. The problem underlying many of the challenges discussed in Section 2.3 is that various assumptions about regulatory frameworks are coming into question. Regulators need to:

- Broaden their perspectives to take in the wider ICT ecosystem;
- Identify and apply durable regulatory principles;
- Cope with contentious markets that are in rapid transition; and
- Bring an open mind to all regulatory processes.

2.4.1 Looking to the Wider ICT Ecosystem

For many years now, the focus of regulation has been on telecommunications, typically defined as the transport of electromagnetic signals through one means or another. But computer processing and storage are integral to many services. Information technology applications are increasingly offered to augment and compete with telecommunication services. Computers and other terminal devices had relatively little impact in the past. They were just minor technologies at the edge of the network. Today, whether computers exist on a server farm on Malta,[154] on corporate mainframes, on desktops or in an individual user's smart phone, they are driving networks and determining what they can do.

Regulators can no longer focus narrowly on classically defined telecommunication services. They must understand the wider ICT ecosystem and the evolving symbiotic relationship between computer processing and the transport of electromagnetic signals. This relationship is affected by technological and capacity differences among the diversifying means of transport. The FCC's historic trilogy of *Computer Inquiries* wrestled with many of these questions as far back as the 1960s.[155] Today, the questions have only multiplied, becoming more complex and widespread. 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 importance of standardization and 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. Yet many countries' regulators do not have effective powers to look beyond telecommunication and deal with the wider ICT sector. The changes occurring through convergence of technologies and networks expose regulators to new areas that were traditionally the domain of other government departments and agencies – or nobody's domain at all. Regulators' mandates to tackle some issues are not clear. For example, the role of regulators in dealing with cyber-security has not been clearly defined in most countries. Similarly, most countries have not converged responsibility for media content with jurisdiction over networks and services. So, traditional telecommunication regulators may find themselves struggling to address market power problems involving media content. Meanwhile, some regulators do not have power to enforce competition policies, which are overseen by a different agency.

In all of these situations, regulators need to advise policy-makers on the problems posed by their too-narrow jurisdictional powers. Regulators may suggest legislation to broaden their mandates. In the meantime, they may use all means at their disposal to coordinate activities and share information with other government departments and agencies.

2.4.2 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: functional separation, network neutrality, horizontal layering and other models. The choices regulators face are not politically neutral, nor can they be resolved by identifying "right" answers based solely on economic theory. Rather, they are about the kind of ICT environment a country wants. The iPhone is one of the most innovatively open devices, on a technical level, yet it is being marketed in many countries through exclusive locking arrangements with operators. Still, it is driving traffic growth and new mobile Internet services.

In the cacophony of debate, regulators need to seek and apply durable policies and principles that can be continually brought to bear in a changing market. Primary among these is competition policy, which should be applied in a holistic manner to ensure that regulators regard the ICT ecosystem as a whole. A broad perspective is needed to define markets and to identify dominance and abuses of market power. In areas still subject to significant government or regulatory control, such as radio spectrum, regulators must do everything in their power to maximize efficient use of such resources. Regulators need to adopt a trans-sector focus, tailoring regulation to help multiply the effects of ICTs across all sectors of the economy – and without excluding large segments of society.

2.4.3 Managing Transition in a Contentious Environment

Different services (wireline, wireless mobile, fixed wireless, etc.) have in most countries evolved under different regulatory frameworks, including different licensing, interconnection and retail price regulation.[156] Regulators today must minimized distortions arising from varied regulatory treatment of different technologies. This may require reconsideration of licensing regimes to ensure a level playing field. Unified licensing, notification and general authorization regimes may become common.

NGNs introduce a range of issues for the transition of interconnection regulation. These stem from reduced numbers of interconnection points, increased numbers of potential layers at which interconnection may occur, regulation of interconnection pricing, and others.[157] Legacy rights and obligations may distort competition, and operators will use regulatory processes to compete for opportunities and foreclose the market to their competitors.

In many markets, there is a great deal at stake in choosing to either perpetuate or change the prevailing regulatory arrangements. Investments have been made, and sometimes expensive licences have been purchased – all relying on the continuity of the regulatory regime. With rapid market changes coexisting with legacy rights, it is inevitable that many regulatory initiatives will be contentious. Regulators will find themselves in the "hot seat," facing pressures from a variety of interested parties, including politicians, large influential network operators, new entrants and other service providers and users.

Box 2.11: Dispute Resolution as a Regulatory Philosophy

Dispute resolution – and regulation generally – benefit significantly where:

- Parties have an opportunity to present their interests and arguments;
- Parties also have an opportunity to respond to their opponents' arguments;
- The regulator considers all perspectives carefully and has an opportunity to verify and question;
- The regulator reaches a firm and timely decision on the dispute or issue;
- The regulator provides reasons to support that decision, based on the law applicable to the sector and under the authority conferred on it; and
- Parties have an opportunity to appeal for review of the decision, if they file the regulator has erred in judgement or exceeded its authority.

Source: Author.

Processes for dealing with disputes among participants in the ICT sector, as well as between such participants and the regulator itself, are therefore particularly important. Effective and efficient resolution of disputes between operators is required as an important part of any regulatory regime.

In a sense, much of any regulator's work – including issuing *ex ante* regulations – is a sort of dispute resolution, resolving arguments and claims between interested parties. Dealing transparently and objectively with the contentious subjects and disputes that arise, is critical. The lessons from dispute resolution can, then, be brought to bear on regulatory process more generally. In many ways, the features of successful dispute resolution outlined in Box 2.11 above are essentially the same as successful consultation processes in the development of new regulations. Regulators have to bring to the entire regulatory process the same sort of methodical and listening ear as they would when arbitrating disputes between service providers.

2.4.4 Connected Networks, Open Minds

The title of ITU's 2009 World Telecom Forum, "Open networks, Connected Minds," encapsulated the major social and economic benefits emanating from connectivity and open networks.[158] As a result of the trends in network architecture and services discussed in this chapter, 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 also 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.

[1] The World Bank reports that 90 per cent 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.

[3] For example, TeleGeography research predicts by 2013 an increase in the number of broadband subscribers of 72 per cent, reaching over 700 million, and an increase in wireless subscriptions increasing by 60 per cent, to well over 2 billion. See http://www.telegeography.com/.

[4] ITU World Telecommunication ICT 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 extensive 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 analyse the market and produce a determination that will stand up to judicial scrutiny.

[12] The TCP/IP suite was one of several protocol 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, 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 pro-

vider'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 and 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, the UK operator 3 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 kbits/s; voice carried in packets requires less, possibly even as low as 8-16 kbits/s; high definition voice can require from 32 kbits/s to 256 kbits/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. This 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 smart phone with WiFi capability – could be used instead.

31 Mobile operators in India are reckoned to share 30 to 40 per cent 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 interface 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. 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., USD 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 necessarily 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, which 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 have 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, which 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 per cent 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 per cent. The APAC region had the highest individual growth rate with 36 per cent; EMEA followed with 28 per cent, the Americas with 25 per cent. HTTP browsing is the number one 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, Hu-

lu, MySpace, MSN Spaces etc.) is the fastest growing application with a rise of 58 per cent. 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 per cent 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 per cent of bandwidth utilization in the top 5 per cent of cells. This is double P2P's bandwidth utilization in the average cell, which is 21 per cent. 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 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.

67 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.

68 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).

69 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

70 New Zealand and the UK have taken the most significant steps towards spectrum trading.

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

72 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).

73 "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.

74 The UK Broadband Stakeholders Group found that the cost of national FTTH deployment would be 20 per cent (GBP 5 billion) less if investors had access to alternative infrastructure. See Broadband Stakeholders Group, *supra* note 89.

75 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.

76 Section 43, Telecommunications Act 1993.

77 See OECD Study, supra note 73, p. 13.

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

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

80 See generally ITU, "Six Degrees of Sharing," Trends 2008, referred to in footnote 31.

81 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.

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

83 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.

[84] 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.

[85] 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.

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

[87] Innovative approaches may even extend into the way in which properties are marketed. The examples discussed are on the supply side of the market, but governments have taken initiatives on the demand side too. The Republic of Korea, for example, has stimulated demand through a classification system for buildings according to their broadband speeds.

[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 fibre 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 USD 20 billion to USD 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 fibrer deployment in the UK carried out for the Broadband Stakeholders Group, Analysys Mason found that the costs of deploying FTTC nationally would be about GBP 5.1 billion and almost five times this, at GBP 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] 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 centre.

[91] For instance, if universal access charges are levied on licensees or telecommunication service providers, questions may arise regarding whether an ISP should require a licence or is a telecommunication 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).

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

[93] 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.

[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 municipal Stokab network in Stockhold in Sweden lays fibre and allows network providers to connect their servers for a fee.

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

[97] Based on an initial commitment of AUD 4.7 billion, out of a AUD 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 AUD 21.9 billion.

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

[99] 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.

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

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

[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 that market segment) in order to cross-subsidize a service in which it competes with other providers (known as "anticompetitive cross-subsidization"). 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 it is 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 controls 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 per cent 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 medium. Advertising 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 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 The new Solomon Islands Telecommunications Act effectively creates a presumption that benchmarks will be used instead of damming up the regulatory process with attempts to produce, examine and argue over cost information. See Solomon Islands Telecommunications Act 2009.

113 "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).

114 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.

115 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/.

116 238 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.

117 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.

[118] 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. Available at http://files.ctia.org/pdf/Skype_Wireless_Device_Petition_2-20-07.pdf.

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

[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] A commonly cited case occurred in 2002 when the French courts held Yahoo responsible for allowing customers to access auction sites selling online Nazi memorabilia. More recent examples concern responsibility of ISPs for peer-to-peer file sharing of content in violation of copyright laws, or the permissibility of discrimination by ISPs against high bandwidth consuming traffic.

[123] 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.

[124] 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.

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

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

[127] "The sum of all forms of video (TV, video on demand, Internet, and P2P) will account for over 91 per cent of global consumer traffic by 2013. Internet video alone will account for over 60 per cent of all consumer Internet traffic in 2013." See CISCO's *Visual Networking Index, supra* note 125 at page 2.

[128] 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.

[129] 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.

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

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

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

[133] 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."

[134] See "Code", footnote 19.

[135] 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.

[136] 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.

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

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

[139] 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.

[140] 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.

[141] 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.

[142] 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.

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

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

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

[146] See Chapter 9, Rosalind Stevens, *Consumer protection: meeting the expectations of the connected*.

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

[148] See for example papers from the colloquium, "Regulating Search?: A Symposium on Search Engines, Law, and Public Policy," Yale Law School, December 2-3, 2005.

[149] 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.

[150] 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.

[151] See H. Brian Holland, "In Defense of Online Intermediary Immunity: Facilitating Communities of Modified Exceptionalism," *Kansas Law Review*, Vol. 56 (2008) at 101.

[152] 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/.

[153] Such resources include: increasing numbers of devices that 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*.

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

[155] 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.

[156] For example: some are licensed and some are not; many have different scopes of services permitted where they are licensed; some require substantial licence 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.

[157] See Chapter 7, Rudolf Van Der Berg, *The Future of IP Interconnection*.

[158] The theme of the 2009 ITU World Telecom Forum was "Open Networks, Connected Minds." See http://www.itu.int/WORLD2009/.