

The Future of Voice

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New Initiatives Programme

REGULATORY TRENDS: NEW ENABLING ENVIRONMENT

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1 INTRODUCTION

In a few short decades, radical changes in technology, market institutions, and regulatory and competition policy have transformed telecommunications markets. Telecommunications service traditionally meant "voice communication", however, the term now encompasses audio (voice), data (fax and email), and video (graphics and multimedia). It is common to refer to these forms of electronic communication as the "triple play" when made available from a single provider. With these changes, the phenomenon of "convergence" has emerged as both the principal offspring and driver of the technology-market-policy triad. Convergence is bringing together previously disparate communication services, content, and consumer market segments. This phenomenon raises questions about the future of communications and, in particular, about that of voice communication.

Two questions explored in this paper are: (1) what place will voice communication have in the converged world of electronic communication? and (2) how will regulation and competition policy shape the environment in which voice communication services will be provided and consumed? Given overhanging influences of evolving technology and market institutions on electronic communication, any forecasts about regulatory policy in isolation is speculative. However, even in the dynamic electronic communication industry, trends in regulatory policy are foreseeable and likely shaped by a loosely-knit consensus that is emerging globally. Certain developments are now almost universal, e.g., privatisation, liberalisation and promotion of competition, movement to independent and separate regulators, transition from *ex ante* to *ex post* regulation, and promotion of broadband to aid universal access and socio-economic development. In this paper, we review some of these developments and speculate about the future course of regulatory policy in shaping and enabling the electronic communication environment.

2 VOICE IN THE FUTURE

2.1 Service Characteristics

Voice communication once meant the capability for two or more spatially separated parties to communicate verbally via wireline and wireless systems. Sustaining this capability required the construction of extensive networks to which both calling and called parties "subscribed", Because the value of such networks grew rapidly with subscription, regulatory policy in most, though not all, countries was designed to maximise that value by mandating or setting targets for universal service or access. Most importantly, those networks remained closed, i.e., they were protected as either exclusive franchises if privately owned or government-mandated monopolies if publicly owned.

In recent decades, technological and regulatory change brought significant reform to these voice-only networks. With the introduction of competition, artificial distinctions between purely "local" networks (that provide network access and voice calling services within "local calling areas") and "long distance" networks (that provide primarily domestic short- and long-haul transport and international transport) became unsustainable and dissolved, raising new questions as to the future shape of universal service or access. But, the fundamental question to emerge was: with competing ubiquitous networks based on distinct technologies or platforms, what is to become of voice communication?

Besides voice calling to communicate across space verbally, "voice" communication now takes the form of email, instant messaging, message texting, fax, and even some forms of video transmission. That is, numerous close, if not perfect, substitutes for pure audio transmissions have emerged, and promise to grow in their variety and reach. The rise of social networks such as Facebook and MySpace and portals like YouTube provide examples of this innovation. Although these are not strictly forms of voice communication, there is no doubt about their importance for facilitating and expanding social contact, sharing information, and propagating ideas and content. Hence, it appears that the future of voice communication will inevitably feature complex mixes of audio, data, and video transmission.

In the convergence era, voice communication is not distinct from other elements of electronic communication. That is, from a service perspective, voice communication is indistinguishable from electronic communication generally. Because of this, market and regulatory policy implications for voice communication cannot be regarded as separate from those for other forms of electronic communication. Indeed, under convergence, the narrowly defined market for voice communication must yield to a more expansive view of the market. Following in concert, regulatory policy must be designed and implemented with that broader market definition in mind.

2.2 Supply Characteristics

Voice communication, narrowly defined as audio transmission, was once the exclusive province of the narrowband, circuit-switched, wireline network (public switched telephone network or "PSTN"). PSTNs transport voice calls between calling and called parties ("end users") by employing a combination of copper local loop, electronic switches, and high-capacity link facilities among switching centres. Calls between parties set up a dedicated communication path through the switch (or switches) that is removed when the call is completed. This environment makes the electronic switch at the centre of the PSTN a congestible resource, since a communication path established through that switch makes a portion of the switch unavailable for other transmissions. This constraint on the use of switching facilities in PSTNs also limit the capacity to carry audio transmissions.

Currently, voice transmission is increasingly facilitated by broadband, packet-switched networks that are either conventionally wireline or wireless. Broadband networks bypass congestible resources like PSTN switches and greatly expand the technological options for providing low-cost voice communication, as both pure audio and mixed transmissions. A significant development is the emergence of services that employ the Internet Protocol ("IP") to carry audio transmissions digitally. Thus, voice over Internet Protocol ("VoIP") and its successor, voice over broadband ("VoB"), have emerged as distinct alternatives to circuit-switched telephony in many countries, especially for business customers and in countries where broadband technology is deployed on a stand-alone basis or as an overlay to existing PSTNs.

Similarly, the introduction of mobile (wireless or cellular) networks that rely on radio-based, rather than wireline loop-based, transmissions has expanded technological options for voice communication in several ways. First, mobile service end users are not tied to wireline networks and connections and can call from almost anywhere to almost anywhere. Second, wireless networks and cellular technology provide many developing countries an ability to rapidly expand communications capacity without incurring high sunk costs associated with building wireline networks. Finally, when broadband capabilities are combined with the convenience of mobile telephony, end users experience a range of services not available under PSTN-based telephony. Currently, there are substantially more mobile than fixed (wireline) connections worldwide, and evidence of the substitution of mobile for fixed voice communication has emerged in both developing and developed countries.¹

Successive generations of mobile technology have substantially expanded end user options for voice communication. For example, the move of mobile telephony from analog to digital signalling using second generation or "2G" technology (principally under the GSM and CDMA standards) enabled both a more efficient use of radio bandwidth through compression and multiplexing and the carriage of substantially more voice calls. An intermediate-stage mobile technology ("2.5G") introduced packet-switching but not full broadband capability. The arrival of third generation ("3G") technology led to the realisation of true IP-based mobile services and completed the transition from pure audio to mixed transmission by wireless means. Mobile broadband networks currently represent the best scenario for voice communication. This confluence of broadband and mobile technology is made possible, in part, by the opening up of a substantial range of licensed frequencies in the electromagnetic spectrum. However, at the same time, even unlicensed frequency bands are put to use through IEEE 802.11 technology (Wi-Fi) that currently supports limited-radius wireless or radio local area networks that connect — and provide communication through — computers (typically, laptops).²

¹ According to ITU (2006b), in 2004, there were 1.76 billion mobile subscribers and 1.21 billion fixed lines in service worldwide.

² IEEE 802.16 (WiMax), a successor to Wi-Fi, is considerably more powerful (with an operating radius of at least 30 miles) and better suited for non-line-of-sight propagation and connectivity. Unlike Wi-Fi, however, WiMax operates across frequency bands

New developments in broadband and mobile technology offer a lasting solution to an old telecommunication policy question: what to do about the natural monopoly characteristics of traditional PSTNs? Because of pervasive economies of scale and scope and high minimum efficient scales of operation, PSTNs were regarded as natural monopolies to be protected via government-sanctioned exclusive franchise or government-run corporations. However, despite their economic efficiency advantage over markets with competing suppliers, natural monopolies were considered susceptible to the possession and exercise of market power. This argument made regulation of PSTNs (through common carrier obligations and explicit regulatory control over profits or prices) imperative until economically viable alternatives were developed for the PSTN's "last mile" network access bottleneck.³ Those alternatives now appear in the form of mobile networks and newer end-to-end fibre-based networks.

3 TECHNOLOGY ISSUES TO GUIDE REGULATORY POLICY

3.1 Trends in Broadband

As noted, the future environment for voice communication depends on the diffusion path of alternative communication technologies. One such technology, namely, broadband, is "an array of digital, packet-switched network technologies that allow the transport of digital bits at high speeds". Some regulators ascribe specific properties to broadband, principally with respect to access speed and availability. For example, the Federal Communications Commission ("FCC") in the United States defines broadband as high-speed Internet access with data transmission speeds exceeding 200 kilobits per second ("kbps"). The Organisation for Economic Co-operation and Development ("OECD") requires that the downstream access speed is at least 256 kbps although upstream access can be slower. These access speed definitions contrast sharply with that specified by the ITU, namely, at least 1.5 to 2 megabits per second ("Mbps"), and reflect access speeds that early and widely available broadband access technologies such as digital subscriber line ("DSL") can realistically provide. In Japan and South Korea, broadband service is frequently available at higher speeds, such as 8-20 Mbps.

The global diffusion of broadband technology and services has been uneven, prompting policymakers in many countries or blocs like the European Union to address the "digital divide" problem. Generally, the highest penetration rates for broadband services are found in developed (mainly OECD) countries.

within the licensed spectrum and these bands may vary by country and depend on spectrum allocations made by national regulatory authorities.

³ The "last mile" network access bottleneck refers to the final stage of the connection between an end user of voice and other forms of electronic communication and a service provider, which is typically a physical access network that can control how, and on what terms, service is provided to that end user.

⁴ See ITU (2006a), Chapter 8: "Making Broadband Work for All", p. 127.

⁵ See FCC (2006).

⁶ See OECD (2001), p. 6.

⁷ See ITU (2001).

⁸ See Crandall (2005), p. 156. In Japan, all-fibre based broadband systems now offer speeds up to 100 Mbps.

⁹ See Commission of the European Communities (2006).

¹⁰ In 2006, OECD countries with broadband penetration rates — defined as subscribers per 100 inhabitants — in excess of 19 percent were (in order) Denmark, Netherlands, Iceland, South Korea, Switzerland, Finland, Norway, Sweden, Canada, United Kingdom, Belgium, United States, and Japan. In contrast, Greece, Turkey, Mexico, and the Slovak Republic (all countries with comparatively lower per capita incomes) had penetration rates of only 3 percent or below (compared to the OECD average of 15.5 percent). See www.oecd.org/document/9/0,2340,en_2649_34223_37529673_1_1_1_1,00.html. Among non-OECD countries, Hong Kong, Taiwan, and Israel had broadband penetration rates (per 100 inhabitants) of 23.56, 20.21, and 17.82 percent, respectively, in 2005 (comparable figures for 2006 are not yet available). Source: ITU (2006a).

However, the fastest broadband adoption growth rates are found in emerging "Internet countries" including China, Thailand, Mexico, Pakistan, India, South Africa, Turkey, and Poland. 11

Many broadband technologies that employ wireline or wireless systems are currently in use. Wireline systems include DSL, cable modem, power line, and fibre to the home or premises ("FTTH/FTTP"). Broadband over wireless systems include Local Multipoint Distribution System (or fixed wireless), WiMax, High-Speed Downlink Packet Access ("HSDPA"), and Evolution-Data Optimised ("EV-DO") in conjunction with the CDMA wireless standard. Finally, broadband access is available over satellite systems. While the vast majority of broadband connections are DSL or cable modem service, a bright future for broadband over all-fibre networks such as FTTH and other wireless options is forecast. That transition will mean a substantial increase in the available bandwidth to the average broadband subscriber. In fact, some countries have already surged ahead in bringing about this transition. We explore some of the policy implications of this transition in Section 4.

The dominance of DSL and cable modem is evident in the data from 2005. DSL accounts for more than half of broadband connections in at least 84 countries, and more than 80 percent of those connections in at least 46 countries. Cable modem accounts for more than half of broadband connections in seven countries (including Canada, the United States, and Russia). In only two countries (Japan and Sweden) does the combined proportion of DSL and cable modem connections fall below 80 percent. This finding is no coincidence as Japan and Sweden lead the world in FTTH and broadband wireless (3G) deployment. As we explain in Section 4, these trends are a harbinger of the future of voice within broadband globally and have major implications for the role of regulation as an enabling force.

The transition from narrowband, circuit-switched PSTNs to an array of broadband networks is important. First, unlike traditional PSTNs, broadband networks do not need to be "greenfield" constructions. In most countries, broadband capability began with the application of compression technologies to copper networks (resulting in the widely-deployed DSL technology) and the meshing of packet switching with regular and high-capacity telephone lines (resulting in VoIP service). As demand for higher-bandwidth services matures, broadband technologies that offer higher access speeds (such as cable modem or FTTH) become economically viable. Second, barriers to entry can be lowered by pursuing a strategy of deploying broadband facilities in phases. The "all-at-once" strategy — typically associated with narrowband PSTNs — requires reaching a minimum efficient scale of operation that is a "high" proportion of existing market demand. Such entry entails high fixed (and frequently sunk) costs, a factor that deters entry by operators and results in a natural monopoly or oligopoly market structure. Phased deployment made possible by the more flexible broadband architecture, can attenuate barriers to entry imposed by high sunk entry costs and allow broadband networks (whether overlays to existing networks or new construction) to "start small" and grow incrementally. Finally, broadband networks remove the problem of switch congestion and allow fundamental change in service pricing models, i.e. from metered (e.g., per-minute or per-call) pricing to flat-rated pricing. 14 In addition to being an efficient form of pricing under broadband network conditions, flat-rated pricing (typically comprising a one-time connection charge and fixed monthly recurring charge) removes uncertainty related to consumer expenditure and so encourages greater use. In particular, flat-rate pricing stimulates demand for "always on" broadband services.

3.2 Market and Regulatory Implications for Voice Provision over Broadband

It is important to rate the role of markets and regulatory policy in shaping the environment for broadband deployment. Several important aspects of that role are:

¹¹ See Economist (2005).

¹² In 2006, although Japan ranked only 13th globally in broadband penetration, for FTTH service alone, it led the OECD (and the world) with 6.3 million subscribers. That exceeded the combined number of broadband subscribers in 22 of 30 OECD countries.

¹³ See ITU (2006a).

¹⁴ Sustaining flat-rated pricing requires that service providers maintain sufficient peak-load carrying capacity in their transport networks.

3.2.1 Competing broadband platforms

Broadband capability comes in several dimensions, namely, architecture, bandwidth/speed, and scale. Although DSL and cable modem (both wireline technologies) are dominant currently, future broadband services (of which various forms of voice communication will be an integral part) will likely be migrated to all-fibre or wireless systems. ¹⁵ As Japan pushes fibre deeper into existing networks (aiming for all-fibre networks operating nationally by 2015) to capitalise on 3G and higher level wireless technologies (involving some blend of CDMA2000 1x and W-CDMA standards), other countries will have several competing (and sometimes complementary) standards and systems on which to model their broadband deployments. To some extent, cultural and historical (i.e., market-related) factors will determine outcomes in this regard. For example, countries with strong traditions of using mobile phones as the essential information and communication apparatus (e.g., the Asia-Pacific region) may see increasing reliance on broadband wireless access, while other regions with a tradition of using computers and fixed devices may prefer FTTH/FTTP access. However, the two systems are likely to co-exist, and which system has the edge will depend on market factors and the regulatory climate.

3.2.2 Inter-operability and standards

Even as parallel standards are likely in the future evolution of broadband (and, within it, voice communication), markets and, more specifically, consumers and policymakers will demand greater inter-operability among systems. It is unlikely that convergence and integration will drive the world to a single standard or system. However, it is also unlikely that consumers will be unable to communicate with one another or fail to reach the content they desire solely because of divergent systems or standards. Standards-setting institutions at the ITU and national governments or regional blocs will likely ensure that, at a minimum, inter-operability is feasible. ¹⁶

3.2.3 Future broadband access networks

Markets and regulators will also have to grapple with the consequences of a complete transition to IP-based service provision. As triple-play services are increasingly transmitted over the public Internet (IP network) and then into last-mile access networks on their way to end users, the need for higher-bandwidth access networks will become crucial. Importantly, whatever the bandwidth requirement of voice (plain or enhanced) communication, the ultimate choice of access network will depend on the extent to which the market and operators believe that the demand for bandwidth-intensive video and multimedia services (e.g., IPTV) will drive demand. One possible outcome is that existing copper networks may be upgraded to VDSL or near-VDSL speeds to serve as the access network. Alternatively, passive, end-to-end, fibre-based networks (such as the Gigabit passive optical network or "GPON") may prove to be a more powerful and efficient choice of

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¹⁵ In 2001, an OECD Working Group noted that the anticipated hand-off from DSL to all-fibre technology may be slowed by the development of "very high bit rate" DSL ("VDSL") systems that could reach access speeds of up to 60 Mbps. Also, DSL variants will continue to interest most end users (despite downstream access speeds) as long as FTTH and similar services remain relatively expensive. See OECD (2001), p. 20. In Japan, the solution has been to allow shared (community) use of all-fibre connections through splitters located close to end users. While this solution sacrifices access speed, the connections themselves are more affordable.

¹⁶ In Section 4.3, we discuss the role of standards-setting in creating an enabling environment, and whether standards should be mandated by policy or determined by market forces. For now, we note that, in telecommunications, inter-operability within a particular platform (such as wireless) is logically similar to interconnection; even if a GSM phone cannot access the CDMA network or vice versa, interconnection between the networks makes calling between them possible and has the same effect, from the end user's perspective, as inter-operability.

¹⁷ For an illuminating discussion, see Hatfield et al. (2005), pp. 53-54. The authors also characterise the network of the future in the following terms:

[[]T]he trend is towards an architecture where all applications — audio/voice, data, image, and multimedia — are conveyed to an all-digital, packet-switched, broadband, low-latency network of networks that uses common open standards and protocols (i.e., the IP suite). Using the modularity and layering associated with modern communications protocols, this network, in turn, will increasingly rely on fiber-optic transmission facilities for the needed bandwidth and on wireless technologies to extend the network to allow users to communicate anyplace, anytime, in any mode or combination of modes. In this architecture, traditional voice conversations will become just another digitized, compressed, and packeted bit stream along with data, image and video traffic and with the intelligence or service logic defining the equivalent of traditional voice services being distributed throughout the network and not necessarily controlled by traditional telephone carriers. Id., p. 56.

network.¹⁸ Apart from the technological differences, policy implications of alternative networks are likely to be substantial. With a GPON, intelligence and control shifts almost completely to the edges of the network, i.e., to end users and content/service providers. This contrasts with older access networks (even after upgrades) where some intelligence and control always remain within the network, implying a continuing need for regulation to maintain open access to the desired degree.

3.2.4 Scalability of broadband

For broadband to realise its market potential, deployments must be possible at different scales. Unlike narrowband PSTN, the easy scalability of broadband (IP-based) technology make it well suited for deployment in areas with fragmented or low demand. Such scaled deployment implies that almost any entity can establish a broadband network by constructing an access network (whether wireline or wireless) and then connecting it to the backbone IP network. Thus, municipal or town authorities, companies, universities, and research laboratories can build broadband networks and interconnect either directly or through the IP network. To ensure that sufficient demand develops for broadband services, regulators must facilitate aggregation of demand to levels that can be served efficiently.

3.2.5 Regulatory principles under convergence

As convergence progresses and new broadband technological options become available, regulators and policymakers need to re-examine their role in shaping the future of electronic communication. It is likely that most forms of communication will occur in two- or multi-sided markets.²¹ That prospect presents several options for the efficient recovery of the costs associated with building converged or next-generation networks. Regulators must avoid enacting policy — intentionally or otherwise — that create disincentives to invest for both incumbent operators and entrants, or favour the adoption of particular technologies or provision of particular services. Thus, technology and service-neutrality must be the hallmark of enlightened regulation.²² Indeed, we propose that the very cornerstone of any enabling future regulatory environment for electronic communication should be dynamic efficiency. This principle marks a significant departure from generations of regulatory policies (particularly for *ex ante* regulation) that are based instead on the principle of static allocative efficiency.

3.3 Trends in Mobile

One aspect of future broadband development is the growing intersection between broadband technology and wireless platforms. Given the success of mobile communications globally, it is difficult to overstate the potential gains in economic welfare and productivity from bringing broadband capability to mobile telephony. Already, with the emergence of 3G technology and possible successors, markets and mobile operators are searching for innovative applications and content that fully exploit their flexibility and power.

Mobile telephony began to realise its market potential after becoming widely available in developing countries where it is the preferred means for voice communication. Table 3.1 shows median values for (1) mobile subscribers per 100 inhabitants (penetration rate), (2) compound annual growth rate ("CAGR") of mobile subscribers, and (3) mobile subscribers as a percentage of total telephone subscribers. The values are reported by "Low Income", "Lower Middle Income", "Upper Middle Income", and "High Income" countries.

¹⁹ See ITU (2006a), Chapter 3: "Understanding Broadband Technologies", p. 27.

¹⁸ See Griffin (2005).

²⁰ The European Union clearly sees this as a priority for overcoming the digital rural-urban divide and facilitating universal access. See Commission of the European Communities (2006).

²¹ See Borreau and Sonnac (2006).

²² This may be easier said than done. As explained in Section 4.3, policies — particularly those that mandate specific technological or service standards — can often conflict with the general principle that policymakers should not attempt to pick winners.

Table 3.1: Median Values of Selected Indicators of Mobile Subscribers, 2004

National Per Capita Income	Mobile Subscribers per 100 Inhabitants	CAGR of Mobile Subscription (%)	Mobile to Total Telephone Subscribers (%)
Low Income	3.6	84.2	75.6
Lower Middle Income	17.9	63.4	63.6
Upper Middle Income	48.0	43.7	67.0
High Income	84.8	21.1	63.3

Source: Adapted from ITU (2006b), World Telecommunication/ICT Development Report 2006, Table 7

As expected, the median penetration rate for mobile communications rises strongly with per capita income. However, the median annual growth rate of mobile subscription is inversely related to the penetration rate. That is, countries with high or near-saturation penetration rates have the slowest annual growth rates. Table 3.1 also indicates that mobile subscription is high in Low Income countries. Further, it is evident that Low Income or developing countries have chosen mobile telephony to "leapfrog" technology stages, i.e., to develop their mobile telephony capability without first developing their fixed-line telephone networks. In High Income countries (especially European) mobile telephony developed apace with fixed-line telephony.

Fixed-line PSTN networks are relatively expensive to build and maintain, especially when built to achieve minimum efficient scale. The investment required for mobile network construction — especially the portion of cost that is sunk — is not as prohibitive. Accordingly, many developing countries have chosen wireless technology — both licensed cellular mobile networks and Wi-Fi (which uses unlicensed frequencies) — to meet universal access goals.

The global diffusion of mobile telephony epitomises the co-existence — sometimes aided by regulatory policy — of competing standards. The most popular standard, the Global System for Mobile Communications ("GSM"), offers digital voice calling quality, inexpensive text messaging, and common encryption over different frequency bands.²³ GSM is an open standard that allows considerable interoperability. ²⁴ GSM is best positioned for international roaming and, according to the GSM Association, has over two billion subscribers (or 80 percent of mobile phone users) globally.²⁵ Additionally, GSM — a 2G standard — has introduced packet data capabilities, including General Packet Radio Service ("GPRS") and Enhanced Data Rates for GSM Evolution ("EDGE"). The successor to GSM or, more precisely, the air interface to the 3G mobile technology Universal Mobile Telecommunications System ("UMTS"), is Wideband Code Division Multiple Access ("W-CDMA"), pioneered by the Japanese mobile operator NTT DoCoMo.

The alternative standard is the 2G air interface and multiplexing technique Code Division Multiple Access ("CDMA"), which was pioneered by QUALCOMM under the label IS-95. Successors to this standard that introduced 3G features include IS-2000 (also known as "CDMA2000 1xRTT") and IS-856 (also known as 1x Evolution-Data Optimised or "1xEV-DO"). Although not deployed as widely as the GSM standard (and its successors), the CDMA-based standard and its successors are used primarily in North America, Russia, some European "transition economies", Australia, New Zealand, South Korea and Japan. ^{27,28} This

²³ "GSM" meant Groupe Speciale Mobile in the 1980s.

²⁴ In 2004-05, 42 percent of the global GSM subscriber base was from Europe, 38 percent from Asia-Pacific, and only 11 percent from the Americas. See ITU (2006a), Chapter 1: "Market and Regulatory Trends in the ICT Sector", Figure 1.9, p. 8.

²⁵ See GSM World (2006a).

²⁶ QUALCOMM claims that the seemingly divergent standards CDMA2000 and W-CDMA have much in common. According to QUALCOMM, "the essential fundamental technologies needed to deploy high-capacity voice and high-speed data services on a cellular CDMA network are common to both CDMA standards although they were standardised by different partnership projects". See QUALCOMM Inc. (2006).

²⁷ In 2004-05, 55 percent of global CDMA subscribers were in the Americas, 43 percent in Asia-Pacific, and less than 2 percent in Europe. However, GSM remained the dominant 2G standard with a worldwide subscription share of 78 percent as compared to CDMA's 14 percent. ITU (2006a), Chapter 1: "Market and Regulatory Trends in the ICT Sector", Figure 1.9, p. 8.

standard is not as conducive as GSM to international roaming, but it is well suited for bursty data communications and provides better performance with data than either GPRS or EDGE.²⁹

In recent years, competition between these standards has seen the introduction of HSDPA, a new 3G protocol that substantially boosts data transfer speeds and eliminates the inherent advantage of EV-DO for data transmission. According to the GSM Association, HSDPA has been adopted by Telstra for ubiquitous service within Australia, and 121 networks in 55 countries have committed to upgrading to HSDPA.³⁰

To summarise, competition among mobile telephony standards, which initially concerned how universally voice communication capability was being provided, has now shifted to data and multimedia communications. That networks based on new standards may not be fully backward compatible with legacy voice networks has not hindered deployment of more data-oriented (and IP-based) networks. The ability to make voice calls from anywhere to anywhere will remain important to mobile communications. However, interconnection, rather than true inter-operability or emergence of a single universal standard, is likely to remain the basis for serving voice calling needs. Significantly, the intersection of mobile and broadband technology has brought to the fore WiMax and HSDPA as potential alternatives to traditional last-mile access networks, such as the PSTN, DSL, or cable.³¹ We explore some of the policy implications of this trend and the persisting difference of standards for mobile communications in Section 4.

3.4 Market and Regulatory Issues in Voice Provision over Mobile Networks

Apart from the competition among alternative mobile telephony technological standards, several regulatory policy issues are likely to require attention around the world. Below, we identify and discuss several such issues.

3.4.1 Spectrum allocation and management

Recent technological advances in wireless communications have important implications for markets and regulatory policy. These advances have made the movement of voice, data, and video transmissions at high speeds more reliable and secure. Also, the range of devices (including the mobile telephone handset) that can use wireless means for all forms of electronic communication is becoming more diverse. Since wireless communications require the use of the electromagnetic spectrum, markets and regulatory policy must develop techniques to better allocate the spectrum to alternative uses and spectrum management practices to utilise scarce spectrum resources efficiently. Spectrum allocations have historically been conducted through a hierarchical scheme of international and national allocations of frequency bands.³² At present, most national regulatory authorities use either the "beauty contest" or formal auctions to allocate the spectrum within limits set by the ITU. Auctions are a source of substantial revenue for governments capitalising on a non-homogeneous and non-exhaustible (although non-storable) resource. However, auctions are not always efficient in the distribution of spectrum resources. Recently, better spectrum management practices relying

²⁸ In Japan, NTT DoCoMo's 3G service Freedom of Mobile Multimedia Access ("FOMA") is competing with the KDDI Corporation's CDMA2000 and EV-DO based services launched under the "au" brand name. In the U.S., Verizon Wireless and Sprint Nextel have aggressively deployed CDMA2000 and EV-DO based services, while competitors Cingular Wireless and T-Mobile offer GSM (and successor) services.

²⁹ EV-DO networks are not backward compatible and have to be deployed as overlays on existing voice networks. An alternate standard EV-DV ("V" stands for voice) is backward compatible with existing voice networks. It has not, however, succeeded in displacing the momentum for EV-DO because EV-DO uses the IP network and is able to avoid expensive switching and other facilities associated with EV-DV.

³⁰ See GSM World (2006b).

³¹ Mauritius and Macedonia, with populations of 1.2 million and 2 million, respectively, both launched plans to use technologies that conform to the WiMax standard to provide universal broadband wireless access. See ITU (2006a), Chapter 1: "Market and Regulatory Trends in the ICT Sector", Box 1.1, p. 7.

³² The ITU is responsible for radio regulations that govern spectrum allocation. It allocates certain frequencies for specific uses globally or regionally, and national regulatory authorities then make further allocations (through formal auction and licensing procedures) from those allotted frequencies to operators within their jurisdiction. In some instances, certain frequencies are reserved for specific uses or users and notification and registration procedures are used to minimise interference or conflict. Certain frequency bands that are left unlicensed — based on a "commons" justification —can sometimes be used for wireless communication as well, such as those in which the Wi-Fi technology operates. For more information, see Gans et al. (2005).

more on market forces have been proposed — primarily the introduction of spectrum trading in spot and forward markets.³³ Going forward, the purpose of the interaction between markets and regulation will be to develop more efficient spectrum management practices and common and non-conflicting spectrum policies. Also, there will be a continuing need to strike a strategic balance between licensed and unlicensed uses of spectrum for mobile communications.

3.4.2 Mobile termination charge

Another problem in mobile voice communication markets is determining the appropriate mobile termination charge ("MTC"), particularly when assessed on calls from fixed-line networks that terminate on mobile networks.³⁴ A related issue is whether the compensation regime that applies to the MTC should be Calling Party Pays ("CPP") or Receiving Party Pays ("RPP"). CPP, the most common regime, is a cost-causative form of pricing that attempts to recover the cost of terminating a cross-network call from the caller and the network — fixed-line or mobile — to which the caller belongs. CPP is credited with having stimulated mobile voice communication and rapidly increasing national mobile telephony penetration rates. In contrast, the less common RPP regime requires that the termination cost be recovered instead from the called party ("receiver") and the receiver's network. It is widely believed that placing the cost onus of a call from another network on the receiver discourages mobile subscribers from sharing their phone numbers and suppresses calling from fixed-line or even other mobile networks.³⁵

High MTCs are mostly observed in countries with CPP but rarely in countries with RPP. Under CPP, the caller cannot choose the network nor avoid paying whatever MTC is assessed by the receiver's network. This market power of the terminating network — typically the mobile network to which the receiver is subscribed —generates revenue to subsidise existing subscribers and attract infra-marginal subscribers. These subsidies can apply to subscription charges and mobile handset prices. Despite the high MTC and an accompanying problem of double marginalisation, some observers consider it to be a virtue of CPP that it helps to internalise call externalities. Others dispute the argument that RPP suppresses subscribers to mobile networks or mobile subscribers' willingness to receive calls from other networks.³⁶ These observers point to lower MTCs (because receivers' mobile networks no longer have market power over call termination) and lower subsidies in countries with RPP as evidence.³⁷ This controversy over the appropriate compensation regime for cross-network call termination, the role of call externalities, and the appropriate level of the MTC remains unresolved and will likely persist as wireless technologies and standards continue to evolve. Presently, as Table 3.2 shows, countries differ not only by the compensation regime (CPP or RPP) but also by the extent to which regulators intervene in setting MTCs.

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³³ See Noam (1997), Valetti (2001), and European Commission (2006).

³⁴ See Gans et al. (2005) for a summary. The higher the MTC, the more expensive is cross-network calling. How that greater burden is, or should be, shared between the caller and called party is unresolved.

³⁵ Not being non-cost-causative, RPP fails a fundamental requirement of efficient pricing. Nevertheless, it is most frequently justified by the argument that the termination cost of a call should, at least in part, be recovered from the receiver as long as, by voluntarily engaging in the call, he or she receives some benefit. Moreover, in practical terms, mobile networks in RPP countries may have successfully offset the disincentive to mobile subscribers to receive calls from other networks by offering "bucket" price plans and "free" night/weekend calling windows. However, those who view voice communication as essentially generating "two-sided benefits", i.e., benefits to both the caller and the receiver, sharing the cost of termination rather than assigning that cost entirely to the caller (as in a CPP regime) generates greater social welfare. See Hermalin and Katz (2002, 2003).

³⁶ Call externalities are naturally internalised by reciprocity of calling patterns among callers belonging to different networks. Some observers question the extent to which such externalities exist or matter in "mature" mobile markets with high penetration rates and, therefore, the very policy basis for permitting high MTCs under CPP. See Albon and York (2007).

³⁷ See Littlechild (2006) and Crandall and Sidak (2004).

Table 3.2: MTC Regulation and Compensation Regime, Selected Countries

Country/Bloc	MTC Regulation	Compensation Regime
Argentina	No	СРР
Australia	Yes	СРР
Brazil	No	СРР
Canada	No, effectively "bill and keep" (zero termination charge)	RPP
China	Yes	RPP
European Union	No, although a Member State must determine if regulation is required. Most Member State regulators require that mobile operators with significant market power designation must charge cost-based MTCs	СРР
Hong Kong	No, except for symmetry of fixed-to-mobile and mobile-to-fixed termination charges	RPP
India	Yes	СРР
Japan	Yes	СРР
Mexico	Yes	СРР
Singapore	Yes	RPP
South Africa	Yes, although regulation is limited and occurs through licensing requirements	СРР
South Korea	Yes	RPP
Switzerland	No	СРР
Turkey	No	СРР
UK	Yes, using price caps	СРР
USA	No, except for symmetry between fixed-to-mobile and mobile- to-fixed termination charges as required by the Telecommunications Act of 1996	RPP

3.4.3 International roaming charges

A convenience of mobile telephony for voice communication is an ability to "roam", i.e., for mobile network subscribers to make and receive calls while travelling in areas served by other mobile networks, whether within the "home" country or abroad. With globalisation and the wider reach of international business interests, roaming is now a global phenomenon. Typically, when mobile callers roam internationally, i.e., on mobile networks abroad, they are assessed international roaming charges ("IRCs") by foreign mobile networks. Some regulatory agencies believe that IRCs are "high" and unjustified by costs, while others contend that high IRCs may reflect Ramsey pricing applied in conditions of price-inelastic demand for roaming. ^{38,39} This situation is formally analogous to the high MTCs that mobile networks in CPP countries assess because of their termination access monopoly power. Although, high IRCs can be efficient when based on Ramsey pricing, there are concerns that collusion (tacit or otherwise) at the wholesale level for the provision of roaming services and lack of customer information at the retail level can keep IRCs at higher than efficient levels. ⁴⁰ For this reason, some regulatory authorities have launched customer information campaigns to accompany direct efforts to "control" wholesale roaming rates. ⁴¹ Table 3.3 shows the extent of

³⁸ See European Commission (2005, 2006) and Sutherland (2001).

³⁹ See Gans et al. (2005), p. 271.

⁴⁰ Id.

⁴¹ The website http://europa.eu.int/information_society/activities/roaming/index_en.htm has been launched by the European Commission to educate mobile subscribers about tariffed IRCs in the 25 Member States of the European Union.

regulatory supervision of IRCs practiced in selected countries. If such supervision reduces IRCs and stimulates demand for mobile services internationally, then that form of regulation is likely to continue.

Table 3.3:	TDC Dag	ulation C	alastad (70
Table 5.5:	INC Neg	เมลเมงม. 5	eiectea (Jountries

Country/Bloc	IRC Monitoring and Regulation
Argentina	No, but mobile operators must file monthly tariffs
Australia	No
Brazil	No
Canada	No
China	Yes
European Union	Yes, IRCs must reflect costs and not exceed domestic roaming charges
Hong Kong	No
India	Yes
Japan	No
Mexico	Yes
Singapore	Yes
South Africa	No
South Korea	Yes
Switzerland	No
Turkey	No
UK	No
USA	No
Source: Global Competition Review (2006)	

3.4.4 Regulatory policy for mobile virtual network operators

A new type of wireless entrant is altering the structure of mobile communication markets. Mobile virtual network operators ("MVNOs") are service resellers that purchase airtime from facilities-based mobile network operators ("MNOs"). Unlike typical telecommunications resellers, however, MVNOs add value in the form of brand appeal from their principal lines of business and distribution channels. However, MVNOs rarely, if at all, build their own network facilities.

In certain circumstances (e.g., product differentiation and significant MVNO brand appeal), MVNOs can widen and deepen mobile service markets, and expand profits for the host MNO. In the U.S. and in several European Union Member States, MNOs and MVNOs have voluntarily entered into strategic partnerships without regulatory intervention. Elsewhere, however, spontaneous alliances have not been formed, and policymakers are considering mandating that MNOs grant network access to MVNOs on cost-based and non-discriminatory terms. Clearly, if MVNOs bring substantive growth and depth to markets for mobile services (including voice communication), then this interplay of market forces and regulatory policy will likely be an important factor in determining mobile telephony market trends.

4 REGULATORY POLICY AGENDA FOR THE FUTURE OF VOICE

In this section, we examine a number of regulatory or policy options for enabling a future environment that is conducive to continued expansion of voice communications, in both its original and enhanced forms. Issues selected for particular emphasis are: (1) the role of dynamic efficiency in guiding regulatory policy, (2) specific directions for designing policy to encourage wireline and wireless broadband growth, and (3) the central role of standards in charting the course of competing but co-existing communication technologies and

platforms. We also outline briefly some additional issues that we expect to feature prominently in that future enabling environment.

4.1 Dynamic Efficiency and Future Regulatory Policy

We begin with the maintained hypotheses that: (1) the future of voice communication will be the future of all forms of electronic communication; and (2) the market will most likely be served by a combination of broadband technologies, prominent among them end-to-end fibre (wireline) and 3G (wireless) technologies (and their successors). In this context, the central question is: how must regulatory policy change to facilitate such a future?

4.1.1 Purpose of regulation

The purpose of economic regulation is to emulate the workings of competition when competition does not occur efficiently or fairly in a market. ⁴² That is, the most important role is to provide remedies for failures or distortions in the market. Thus, regulation is a form of government intervention in markets intended to secure the social good (or "public interest"). This appeal is based on the principle that the public interest is best served when markets work efficiently, generally in a competitive market setting. Any market failure that causes a loss of efficiency, therefore, requires regulation to restore or protect the public interest.

Market failure occurs when a market is unable to, or is prevented from, reaching an equilibrium state in which all resources are allocated and used efficiently, and collective social welfare is maximised. While market failure occurs in many forms, the two most commonly associated with the need for regulatory intervention are monopoly (including natural monopoly) and the presence of externalities.

Regulation cannot be a permanent state, as regulation is more privately and socially costly than competition. Regulation generates direct administrative costs of maintaining and operating the regulatory apparatus and indirect costs that arise from losses of efficiency when regulatory policies, based on imperfect information and formed from an adversarial process, introduce distortions that are avoided in a competitive market.

Given these considerations, the purpose of cogent regulation is to establish or restore conditions that promote market competition, rather than create a permanent non-market mechanism for directing market outcomes. Thus, regulation should ensure that effective competition occurs on a sustained basis. In most markets (including telecommunications), that means: (1) removing any barrier to entry or exit that prevents entry by new and competing firms; and (2) enabling the market — through the entry of competitors and creation of new and substitutable production capacity — to prevent an incumbent firm from exercising market power to set prices above competitive levels. This two-pronged approach, which relies substantially on market forces, can be achieved by adopting the standard of effective competition.⁴³

4.1.2 Forms of regulation and approaches to antitrust regulation

Recently, the general rubric of "regulation" has come to admit several distinct ways in which regulatory intervention may occur. It is now commonplace to draw distinctions between "ex ante regulation" and "ex post regulation". Moreover, several countries have adopted competition policies that rely, to varying degrees, on mixing elements of both ex ante and ex post regulation.

As the term suggests, *ex ante* regulation is anticipatory intervention, i.e., the use of government-specified controls to: (1) prevent socially undesirable actions or outcomes in private markets or (2) direct private market activity toward socially desirable ends. The key to such regulation is that compliance by regulated entities is, more or less, expected. That is, those entities have no choice but to incorporate regulatory directives into their business plans or market activity. Examples of *ex ante* regulation include, among others, preauthorised earnings or price constraints. Although several variants exist of this form of regulation, the aim

⁴² See Carlton and Perloff (2000), Chapter 20. For a more general introduction to regulation and antitrust policies, see Viscusi et al. (1995).

⁴³ When considering whether to relax market regulation, it is meaningful to determine whether effective, rather than perfect, competition is achieved. The perfect competition standard used in economics is a way to develop benchmarks in the study of competition, but it has never been expected to occur in real-world markets, particularly markets for telecommunications services that are characterised by economies of scale and scope and high fixed costs of facilities-based operation.

is to prevent regulated firms from earning "excessive" profits or charging "exploitative" prices. 44 In telecommunications, *ex ante* regulation is a common feature in interconnection and mandatory unbundling policies. For example, in many countries, incumbent telecommunications carriers that had monopoly control over their network facilities are now increasingly required to "unbundle" and lease those facilities at regulated and, generally, cost-based rates to new entrants and competitors who may not have facilities of their own or find it technologically or economically infeasible to duplicate infrastructure. Such regulation seeks to promote the public interest by stimulating more efficient competition by enabling new entrants overcome hurdles posed by the high and sunk costs of facilities-based entry. In general, *ex ante* regulation's concern is with market structure, i.e., the number of firms and level of market concentration, entry conditions, and the degree of product differentiation.

In contrast, *ex post* regulation takes the form of administrative actions that address allegations of anticompetitive behaviour or market abuse by firms that may or may not be subject to any form of *ex ante*regulation. Antitrust laws provide regulators or fair trade authorities with the means to investigate such
practices or abuse and to redress proven wrongs through a range of enforcement options, including fines,
injunctions or bans, and other punitive measures. A key difference from *ex ante* regulation is that *ex post*regulation seeks to remediate losses of efficiency or protect the public interest on an as-needed basis and
only for specific harms attributable to the actions of identifiable players in the market. For example, while *ex ante* regulation automatically subjects firms with market power (and an ability to earn returns above the cost
of capital) to pre-set limits, *ex post* regulation moves to curtail that firm's earnings or prices only if it is
established that the firm is using its market power to diminish competition and further improve its dominant
market position. In general, *ex post* regulation's concern is mainly with market conduct, i.e., the behaviour of
firms with respect to both its competitors and customers.

Competition policy, in general, straddles both *ex ante* and *ex post* regulation, although it is most commonly identified with antitrust policy or regulation. ⁴⁵ Competition policy foremost purpose is to promote efficient competition and preserve the market environment in which competition can flourish. Thus, competition policy can range from being anticipatory (through implementation of competition-enhancing interconnection and unbundling policies) to being reactive (through enforcement of competition-preserving practices). ⁴⁶ In most countries, competition policy (backed by competition or antitrust law) aims to ameliorate the consequences of market power, abuses of dominant market positions, unfair restraints on trade, and acts that increase market concentration.

4.1.3 Evolution of telecommunications regulation

The foundations of traditional telecommunications regulation rest on the following premises of public utility regulation:

The underlying physical layer of the industry, namely, the last-mile access network, is a natural
monopoly and an essential facility that poses potential barriers to entry and asymmetric competitive
risks for unaffiliated rival suppliers.

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⁴⁴ Returns above the prevailing cost of capital are typically controlled by this form of regulation. As regulators realise supra-normal returns could arise just as much from efficiency gains and superior performance (which should be rewarded) as from excessive pricing and output restrictions associated with monopoly franchises in these industries and sectors, cost-based regulation was replaced gradually by alternative forms of "incentive" regulation. The incentive regulation protects consumers more directly by controlling only the retail prices and service quality of regulated firms and place no constraints on their profits.

⁴⁵ The World Trade Organization also includes privatisation policies within the ambit of competition policy.

⁴⁶ In telecommunications, an important distinction between ex ante and ex post regulation arises in how incumbent firms relate to competitors. In the U.S., Sections 251 and 252 of the Telecommunications Act of 1996 imposed on regulated incumbent local exchange carriers the affirmative duty to deal with competitors (in terms of resale, unbundling, and interconnection requirements). In contrast, the Sherman Act — the fountainhead of antitrust laws in the U.S. — imposes on incumbent firms more general prohibitions on affirmative acts intended to damage or eliminate competition. Again, the dichotomy is between market structure (and competition-fostering) issues in the first instance and market conduct (and competition-preserving) issues in the second. Appeals courts in the U.S. split, however, on whether antitrust laws could be applied to conduct governed by the Telecommunications Act of 1996. In a recent decision, the U.S. Supreme Court resolved the issue by deciding not to apply Sherman Act provisions over and beyond remedies contained in the Telecommunications Act of 1996. In that case, the plaintiff complained of an incumbent local exchange carrier's alleged failure to provide it reasonable access to essential facilities on reasonable terms. Verizon Communications Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398 (2004).

• Regulation must attempt to emulate the outcomes of competitive processes by requiring adherence to pricing rules based on allocative efficiency even under second-best conditions. 47

These foundations provide the intellectual antecedents for alternative forms of telecommunications regulation, beginning with rate-of-return (or cost-based) regulation and forms of incentive regulation (including price caps, revenue or earnings sharing, banded rate-of-return, and limited pricing flexibility). At their core, these forms of regulation have in common a design to ensure that end users are not exploited by monopolistic retail service prices and, where interconnection or network sharing with rivals is involved, anti-competitive manipulation of prices and quality of essential wholesale services are not possible.

In addition, much national telecommunications regulation is guided by the imperatives that:

- Regulation should be applied separately to individual services of categories or service, where
 distinctions among them arise not from technical, but rather geography-based or location distinctions
 (such as local, national long distance, and international long distance voice calls).
- Telecommunications generates substantial network effects or externalities. Hence, an effort should be made including the use of regulation-mandated cross-subsidies to ensure universal service and access. Usually, this means that PSTNs be prepared to offer, on request, service to any customer at any location. Common carrier principles (including "just and reasonable" pricing and non-discrimination) typically apply in these circumstances.

4.1.4 Natural monopoly

The central tenet of traditional telecommunications regulation is that the typical PSTN designed for voice telephony is a natural monopoly. Therefore, the most efficient industry structure is a single monopoly PSTN that can capitalise on potential economies of scale and scope. This structure is allocatively efficient (or nearly so) because it permits prices to be set at, or as close as possible to, marginal or incremental costs. In reality, the allocative efficiency principle applies to a PSTN only in a second-best sense. Since constraining the PSTN's service prices to not exceed incremental cost would not enable recovery of its substantial fixed costs, the PSTN should be permitted to set Ramsey prices (or mark up prices above underlying incremental costs in some optimal way) to enable full cost recovery. In practice, regulatory authorities, concerned about the exercise of market power by PSTNs, typically retain some control over how (or how much) prices may be marked up. ⁵⁰

4.1.5 Liberalisation and competition

Despite natural monopoly conditions, many countries have successfully liberalised their telecommunications markets and introduced competition to varying degrees for their PSTNs. Primary instruments are policies that mandate interconnection among rival networks and cost-based sharing by non-facilities-based rivals of the PSTN's essential network (mainly last-mile and sunk) facilities. Mandatory unbundling policies have encouraged entry and competition for the PSTN.

Although guided by allocative efficiency (e.g., making the PSTN's essential wholesale facilities available to rivals at prices based on incremental costs), actual unbundling and interconnection practices are sometimes

⁴⁹ In some countries, these distinctions correspond to parallel divisions of regulatory authority. For example, in the U.S., local and short-haul long distance voice services are both subject to the authority of state regulatory agencies, while long-haul long distance voice services (both domestic and international) are subject to federal regulatory oversight. These jurisdictional separations have little to do with underlying technological properties of telephony and frequently encounter seemingly intractable problems, such as with deciding whether data calls that are made to Internet sites are "local" or "long distance" in nature and, therefore, which regulatory authority should assert jurisdiction over them. In the European Union, regulatory authority is shared between the European Commission that determines the guidelines for regulation in wholesale and retail markets and the national regulatory authorities of Member States that interpret and implement those guidelines.

⁴⁷ Second-best optimality is the best to which a regulated entity can aspire when it can only maximise its profits or surplus subject to regulatory constraints. See Berg and Tschirhart (1988).

⁴⁸ See Sappington (2002).

⁵⁰ In fact, not all regulatory authorities accept Ramsey prices in these circumstances because they are viewed as being "unfair" to end users with the least elastic demand that have to pay the most marked-up prices. See FCC (1996), paragraph 696, on Ramsey prices.

controversial. A frequent complaint is that regulators are handicapped by imperfect cost and supply-side information and so fail to set wholesale prices for unbundled facilities that encourage competition without dampening investment incentives of incumbent operators and entrants.⁵¹ That is, misapplication of *ex ante* regulation, intended to vitiate the market power of natural monopolies and develop competition in accordance with allocative efficiency, has only succeeded in obstructing dynamic efficiency.

Whatever the virtues of *ex ante* regulation based on a natural monopoly model, the advent of technological alternatives to the fixed PSTN (whether for voice or all forms of electronic communication) and convergence have rendered concerns about the vitality of fixed-line competition less important. In particular, the emergence of intermodal competition (cable modem and all-fibre alternatives to the copper-based PSTN, and wireless alternatives to wireline) and increasing end user demand for single-source provision of the triple play are prompting intermodal networks to deploy end-to-end delivery platforms that contain sufficient and reliable bandwidth and can deliver services at affordable prices.

To summarise, in telecommunications, static allocative efficiency has traditionally been the centrepiece of *ex ante* regulation. Such regulation has been intended to prevent market power anticipated from, while preserving the efficiency incentives of, natural monopoly. Regulatory policy and policy instruments (e.g., interconnection and mandatory unbundling of essential network facilities) have increasingly shaped fixed-line competition in many countries. In the meantime, technological and market change have altered the competitive landscape, by enabling vigorous intermodal competition. With the original goals of enabling competition among fixed-line operators, or for narrowband services such as voice, now less of a priority, traditional telecommunications regulation has become obsolete and a fundamentally different approach to regulation is required.⁵²

4.1.6 Regulatory policy for the new telecommunications environment

Global telecommunications are being shaped by the rapid spread of broadband and wireless options. While market diffusion of platforms and technology differ geographically, the retooling of regulatory policies to fit this new reality is just beginning. Most policy still reflects the pre-convergence era, PSTN-centred, natural monopoly-based industry model. As fundamental technological change permeates this industry, long-held views of how networks function and for what purpose are being challenged. PSTN architecture, in which all the intelligence resides inside the network, is yielding to the Internet-centred architecture in which intelligence resides increasingly at the edges of the network. The "smart network, dumb user device" network is being transformed into the "dumb network, smart user device" network. At the same time, the last mile access bottleneck is being relieved and, in particular, GPON versions of FTTH networks are pushing intelligence and control to the edges. These changes have implications for policy.

First, unlike the PSTN, the Internet-centred network cannot affect transmissions (whether of voice, data, or video images) among end users and content providers. Those transmissions, made in the form of IP packets, are routed not over pre-selected or dedicated paths within the network but rather over paths available at any instance that can convey those packets most efficiently.

Second, as content and applications are demanded and supplied at the edges of the Internet-centred network, the network cannot be used to discriminate unduly, manipulate content, or limit access to end users. This technological characteristic reduces the end-to-end network's role to that of a neutral delivery system and, therefore, a suitable means to launch innovation by content providers and end users. For example, communications (whether voice, data, or video) occur among devices attached by a variety of hosts or nodes

⁵¹ See Hazlett et al. (2004), Haring and Rohlfs (2002), Eisner and Lehman (2001), Crandall et al. (2004), Jorde et al. (2000), and Pindyck (2004). For the perspective that mandatory unbundling policies should only be adopted with the welfare of consumers in view, not that of the PSTN's rivals, see Hausman and Sidak (1999).

⁵² U.S. federal legislators are currently drafting new telecommunications legislation that recognises and reflects the changing circumstances. Only a decade after it was enacted, the limitations of scope and vision of the Telecommunications Act of 1996 are being increasingly acknowledged. The European Commission is also in the middle of a significant overhaul of its "new regulatory framework", adopted as recently as 2003 and codified in its Framework Directives. Of particular concern to the Commission are implications of recent technological developments and convergence.

⁵³ See fn. 17, supra. More generally, see Hatfield et al. (2005).

⁵⁴ Id., p. 54.

along the edges of the network without a requirement that those devices conform to pre-set standards of compatibility. It is only necessary that the devices be compatible with the underlying software that drives IP transmission. Thus, end users and content providers are empowered to use a variety of devices to attempt communication. The PSTN is incapable of fostering innovation in this manner.

Next, the PSTN's last mile problem is possible to solve in an Internet-centred network. That is because an Internet-centred network has no means available to direct or deny service or access to service providers and end users. In fact, it is now common in some countries for end users to be able to choose among last mile technologies (whether wireline or wireless), and the dropping cost of bandwidth media is enabling that choice even in real time. What was once a vexing limitation of the PSTN (or fixed-line networks generally) is now an opportunity for unprecedented network diversity.

Under these circumstances, the Internet-centred network solves many policy conundrums associated with essential facilities, the last mile, and market power concerns. The end-to-end and neutral nature of an Internet-centred network helps end users and content or applications providers to bypass the bottleneck potentially posed by the network operator. While telecommunications regulation may almost be unnecessary in these circumstances, sceptics may argue that regulatory checks will still be required to ensure that private access networks connecting to and interacting with the Internet remain open and accessible by both end users and service providers. However, without the access monopoly that was the preserve of the PSTN, it is unlikely that private access networks can successfully exercise control over end users and service providers. Therefore, a more fruitful inquiry about telecommunications policy options for the convergence era may be one that steps out of the historical "prevent mode" into encouraging the emergence of viable intermodal alternatives to private PSTNs (even those reincarnated as broadband services).

4.1.7 Policies based on dynamic efficiency

The cornerstone of communications policy in an Internet-centred world of convergence should be dynamic efficiency. The efficiency implications of policy measures have been studied widely but, in general, only measures of static efficiency are considered. The most common measures applied are: (1) allocative efficiency, which measures whether a firm has chosen the optimal allocation of input resources given their prices; and (2) technical efficiency, which measures whether a firm has maximised output given a set of input resources. Unfortunately, these efficiency measures do not fully account for the dynamic and evolving nature of the telecommunications industry.

Application of the allocative efficiency principle restricts firms to charging service prices that exactly recover marginal (or incremental) costs. Because this pricing rule is insufficient for a natural monopoly to recover fixed costs it cannot always be applied exactly. Optimal regulation must then ensure that the natural monopoly recovers total costs by a marking up its service prices in a manner that minimises the loss of allocative efficiency.⁵⁵ In reality, telecommunications regulation is rarely optimal in this sense.⁵⁶

A limitation of the static allocative efficiency rule is that it does not perform well as a guiding principle outside the natural monopoly setting. Competition is a dynamic and disruptive process, with firms employing alternative technology, production methods, and marketing techniques to attract customers. Over time, consumer preferences help to establish standards and protocols and to determine which services survive. Innovation occurs in response to possibilities that arise from inventions or new ideas that often generate short-term rents or first-mover advantages. In the course of this birth-and-death process, investments are made or abandoned, and firms incur upfront (and often sunk) costs in the expectation of later recovery.

In this environment, how efficiently resources are used over time is more important for social welfare than whether the allocative efficiency rule is satisfied exactly at any given point of time. Viewing efficiency in dynamic terms, temporary deviations from regulatory rules based on allocative efficiency should not matter. Therefore,, regulation that attempts to shepherd the competitive process should be based on dynamic, rather than static allocative, efficiency. This will recognise that actions that are dynamically efficient over time

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⁵⁵ See Train (1991).

⁵⁶ The role of allocative efficiency is also evident in antitrust or competition policies adopted in the U.S. and the European Union. For example, the prime concern with market power is that it enables a firm to violate the allocative efficiency rule with impunity and, therefore, its mitigation is desirable on grounds of efficiency alone.

need not also be allocatively efficient at any instant of time. That is, dynamic (Schumpeterian) competition based on significant capital and long-term commitments cannot fulfil the requirements of static allocative efficiency, and it is misguided to attempt to build meaningful telecommunications policy around static efficiency principles.

Replacing the static allocative efficiency with a dynamic efficiency principle as the basis for regulation will accelerate the process by which a PSTN-centred natural monopoly is transformed into an Internet-centred and competitive model of telecommunications. The fact that broadband technology is inherently flexible and scalable is helpful in this regard. Moreover, with dynamic efficiency guiding telecommunications policy in a future marked by intermodal competition and convergence, several policy problems are likely to be resolved.⁵⁷ First, last-mile access bottlenecks will be dissipated. Second, guided by dynamic efficiency over the longer term, regulators can avoid formulating shorter-term ad hoc policies that inadvertently create opportunities for regulatory arbitrage and inefficient entry or investment. Third, policy based on dynamic efficiency can hasten the transition from supporting universal service or access using inefficient crosssubsidies to encouraging the emergence of low-cost alternative technologies that bypass the PSTN. Finally, dynamic efficiency can help to change the nature of regulation from ex ante to ex post and thus ease problems inherent in investigations of market power and follow-on enforcement.⁵⁸ For example, second-best prices that diverge from incremental costs will not necessarily be seen (and prosecuted) as a manifestation of market power. Rather, policymakers will have an option to examine whether technological advantage and product differentiation — and the short-term rents and first-mover advantages they generate — contribute to the dynamically efficient development of the industry.

In sum, adoption of the dynamic efficiency principle will require regulators to re-examine fundamental premises of traditional telecommunications policy that governed PSTN-provided voice communication services. For example, is the natural monopoly regulation model still tenable? With increasing intermodal competition and convergence, do essential facilities and access bottlenecks still remain to justify mandatory cost-based unbundling policies? Are traditional common carrier obligations (carrier of last resort, just and reasonable pricing, and non-discrimination) still warranted when end users and service providers have increasing control over IP-based transmissions? Must subsidised network access remain the only way to achieve universal service or access objectives? We believe that some of these pillars of traditional telecommunications regulation must yield to a more "light-handed" policy paradigm to create a more enabling environment for communication.

4.2 Future Directions for Broadband

Narrowband PSTN services (including voice) are being increasingly displaced by IP-based services offered over DSL and cable modem lines which, in turn, may yield to higher-bandwidth end-to-end fibre networks in the future. Alternatively, 3G and successor wireless technologies will carry triple-play services, and may become the medium by which universal service or access goals are met. The challenge for regulatory policy is to enable these developments in a seamless and concerted manner.

In order for the technological possibilities to reach fruition, the other two pieces of the broadband puzzle, namely, the market and regulatory policy, must also play a facilitating role. We first consider the ways regulatory policy can play that role. In Section 4.3, we consider one aspect of the market's role, namely, standards and the role of content in creating demand for broadband communication.

4.2.1 Redesign of regulatory policy

Policymakers globally realise the potentially lasting significance of broadband and have given it considerable attention. Most prominently, a Global Symposium for Regulators (held in Geneva, December 8-10, 2004) endorsed "best practices" guidelines for national regulatory authorities to promote broadband growth in their respective countries.⁵⁹ We focus on some of the forward-looking guidelines. In order to

⁵⁷ For a more detailed explanation, see Banerjee and Dippon (2006).

⁵⁸ The European Commission's competition policies and, in particular, its regulatory focus on conduct issues like SMP are a good instance of this trend. For a comprehensive examination of trends in telecommunications regulation, see Geradin and Sidak (2005).

⁵⁹ See ITU (2006a), Chapter 4: "The Role of the Regulator in Broadband Development", Box 4.1, p. 52.

create an "enabling regulatory regime that encourages broadband deployment and internet connectivity", the Symposium recommended:

- designing policies to stimulate competition among broadband technologies and industry segments and to ensure non-discriminatory access to essential facilities
- retooling regulation as the convergence of platforms and services proceeds to ensure consistency and eliminate unfair market advantages or unnecessary regulatory burdens
- designing policies that enable Internet service providers and broadband operators to set up alternative last mile access to end users
- allocating spectrum to encourage greater deployment of broadband mobile technologies and adopting innovative spectrum management practices including spectrum sharing and allocations on a license-exempt non-interference basis
- ensuring that policies are technology-neutral and do not favour any one technology
- minimising licensing hurdles

Similarly, to develop innovative regulatory policies to promote universal access, the Symposium also recommended:

- promoting low-cost broadband access at all levels of society by aggregating demand from the local level up and involving government, businesses, and non-governmental organisations
- facilitating the use of all transport mechanisms, including wireline, wireless (licensed or unlicensed), and satellite systems

We cite these recommendations selectively because they are thematically consistent with the main arguments of this paper. Of significance is the importance given to the need for retooling regulation as the transition proceeds (or is completed) between voice communication over narrowband natural monopoly PSTNs and triple-play electronic communication over broadband and converged systems in the presence of intermodal competition. The following passage expresses succinctly our beliefs about how the redesign of regulatory policies should proceed.

The new broadband regulatory paradigm will paradoxically require regulators to do both more and less than "regulation as usual". Regulators will do more in making potential broadband providers — such as local communities and non-governmental organisations — aware of the technologies and applications they could provide. Regulators will also coordinate more actively with other government agencies and public institutions (such as universities) to drive the demand for health, education and government services that employ broadband technologies and applications. Meanwhile, regulators will do less by dismantling outdated regulatory frameworks that restrict market participation. 60

4.2.2 Policies for Voice over Internet Protocol⁶¹

Nothing epitomises the schizophrenic nature of telecommunications policy globally as the regulation of VoIP. Commonly described as a "disruptive technology", the IP-based VoIP service offers almost complete bypass of the PSTN for any form of voice communication (wireline or wireless) and functionality (vertical features, automatic call routing, and free phone numbers), mobility, and conferencing abilities not available from the PSTN. Moreover, due to quality improvements, VoIP is now a reliable and less expensive mode of voice communication than circuit-switched voice services. Initially adopted by business, VoIP is increasingly offered to residential end users by competing DSL and cable modem providers, and will likely become standard as mobile broadband and FTTH systems proliferate. It is this capacity to displace traditional PSTN-based voice and other forms of communication that has led some regulators (mainly in developed countries) to embrace the technology (and exempt it from certain standard common carrier regulations) and other regulators (mainly in developing countries) to either prohibit the technology or permit

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⁶⁰ Id., p. 51. Emphasis in original.

⁶¹ For a comprehensive discussion of this issue, see ITU (2006a), Chapter 4: "VoIP and Regulation", pp. 91-109.

it under restrictive conditions. It is no coincidence that VoIP is lightly regulated, if at all, in countries where PSTNs are either privately owned (although subject to public regulation) or are privatised and subject to market competition, but remains subject to restrictions in countries where it poses revenue threats to government-owned or supported PSTNs.⁶²

Attempts to block or suppress a truly disruptive technology like VoIP are both myopic and futile. Productivity gains and socio-economic progress from adopting technologies like VoIP can be large and countries that attempt to suppress VoIP risk losing their economic competitiveness. In addition, the possibility of bypass (such as via international callback) makes domestic bans or restrictions on VoIP ineffective for end users aware of bypass options. The loss of dynamic efficiency entailed by protecting incumbent PSTNs from the VoIP threat can place a burden on a country's socio-economic development. In particular, given a propensity to adopt mobile telephony as a leapfrogging communication technology, developing countries stand to gain significantly more by promoting converged mobile VoIP (and other broadband) services. 4

Table 4.4 shows the current diversity of policy choices regarding VoIP in selected countries.

Country/Bloc	VoIP Regulation		
Argentina	No		
Australia	No		
Brazil	Yes, certain VoIP services have to be licensed.		
Canada	Yes, VoIP is regulated the same as local exchange services except for P2P services.		
China	Yes, VoIP is regulated as a value-added service.		
European Union	Yes, the European Commission's New Regulatory Framework treats VoIP the same as all electronic communication services.		
Hong Kong	Yes, VoIP operators must have a 2 Class license and connect to emergency services.		
India	Yes, VoIP is licensed as an Internet service.		
Japan	Yes, VoIP is subject to the same regulations as all voice telephony services.		
Mexico	Yes, VoIP is regulated as a value added-service on par with other voice telephony services.		
Singapore	Yes, VoIP operators must be licensed and observe the Internet code of practice.		
South Africa	Yes, VoIP is regulated as a value-added network service.		
South Korea	Yes, VoIP operators must be certified as telecommunications resellers or service providers and provide 070 numbers for end users.		
Switzerland	No		
Turkey	Yes, VoIP operators are required to be licensed as for long-distance telephone services.		
UK	No, but VoIP-specific regulations with respect to network reliability, provision of emergency calls, number portability, and consumer protection are being considered.		
USA	Yes, but VoIP is regulated lightly as an information service, primarily with the obligation to provide emergency (911) service. Owners of transmission networks remain regulated as common carriers.		

⁶² For example, in the U.S., the FCC has declared VoIP to be an information", rather than a "telecommunication", service and exempted providers from many routine common carrier obligations.

⁶³ It is perhaps no coincidence that the countries that rank higher on the Global Competitiveness Index ("CGI") are developed economies that have embraced enabling Internet-based technologies like VoIP. The GCI is composed of nine "pillars", at least one of which — technological readiness — is likely to be a direct correlate of VoIP use and others — infrastructure, business sophistication, and innovation — are likely to be at least indirect influences. See World Economic Forum (2006).

⁶⁴ See ITU (2006a), p. 20.

4.2.3 Policies under convergence and intermodal competition

Guided by dynamic efficiency considerations, regulatory policy for an era of convergence and intermodal competition must be reformulated. First, when the last mile access bottleneck disappears, regulatory focus should shift from the terms on which service and content providers can gain access to end users to ensuring interconnection (1) among IP networks and (2) between IP networks and access networks like the PSTN. Peering or bill and keep arrangements may suffice, in the absence of significant asymmetry in cross-network traffic patterns, for most forms of interconnection. However, as the deployment of newer access networks pushes intelligence and control to their edges, i.e., to end users and service/content providers, operators that own those networks will require less regulatory attention.

Second, thought should be given to the desirability of applying any blanket "network neutrality" rule. Under the premise that a "bit is a bit is a bit" (regardless of whether it is used to carry voice, data, or video signals), network neutrality is often argued as sensible policy for fostering continued growth and innovation in an IPcentred communications world. In this view, maintaining an "open" Internet means that carriers have no control over (1) which services end users choose, (2) from whom those services are obtained, (3) what service/content providers choose to provide, and (4) to whom they choose to provide service. Thus, network neutrality preserves all intelligence at the edges of the Internet-centred network and access network operators are unable to interfere. 65 By this logic, network neutrality supposedly promotes Darwinian competition among applications, with survivors owing their success to end user choice rather than interference or bias by access network operators. 66 Opponents of blanket network neutrality rules point to the efficiency disincentives and potentially chilling effects of such a rule on broadband network investment.⁶⁷ They argue that any such rule necessarily results in uniform pricing and service quality standards, regardless of differences in the economic value of transmissions (such as voice and video) or a need to prioritise certain transmissions. Without tiered pricing and prioritisation to allow most efficient use of their networks, broadband network operators could elect to defer or cancel planned (often sunk) investments.⁶⁸ A blanket network neutrality rule in an era of convergence and intermodal competition may also discourage product differentiation and network diversity and, in the process, deny substantial benefits to end users.⁶⁹

Third, under convergence and intermodal competition, dynamic efficiency warrants that the policy focus shifts to *ex post* regulation. However, market power investigations — an important component of *ex post* regulation — can become extremely complex in those circumstances. For example, consider what could happen at the market definition step (in both product and geographic dimensions). The scope of the product market is typically determined by the extent of product demand and supply substitutability. With true convergence and inter-platform competition, market definition for voice communication service can prove to be considerably more difficult, particularly for "voice" in the enhanced sense. The European Commission's current practice of directing Member State national regulatory authorities to conduct Significant Market Power investigations in 18 arbitrarily defined retail and wholesale markets is based on weak conceptual foundations already, and the difficulties with market definition will only increase under convergence and intermodal competition.

Finally, regulatory authorities have to redesign their licensing regimes to adapt to the new market realities created by convergence and intermodal competition. While the extent of convergence varies widely worldwide, some commonly accepted principles have emerged. Several countries have abandoned service-specific licensing to move to a unified or "umbrella" licensing of operators that provide converged or intermodal services. The guiding principle, arguably based on dynamic efficiency, is that the licensing

⁶⁵ See Cerf (2006).

⁶⁶ See Wu (2003) and Wu and Lessig (2003).

⁶⁷ See Sidak (2006) and Yoo (2004).

⁶⁸ Even if they do not discriminate in the terms on which they provide access to end users for content or services that arrive over the public Internet, broadband network operators (e.g., those with FTTH networks) must be allowed to offer prioritised, premium-quality services over their private networks so as to make the most efficient use of their installed capacity.

⁶⁹ See Yoo (2004).

⁷⁰ See ITU (2004), Chapter 5: "Licensing Approaches in an Era of Convergence", pp. 81-94.

regime should not favour the emergence of particular technology or service but rather allow the market to decide. Unified licenses also have to be service and technology-neutral. Nowhere is this likely to be more true than in the licensing and management of spectrum.⁷¹

Although Australia, New Zealand, and Guatemala have already adopted this principle by instituting auctions and spectrum trading and some other countries are planning to follow suit, the greater flexibility and neutrality in spectrum licensing practices are not without cost. For example, when licensees are free to use the spectrum as they deem fit, there may be problems with radio interference, loss in economies of scale and coordination, and a conflict with the hierarchical spectrum allocation process instituted by the ITU. Applying the dynamic efficiency principle, however, if these costs of unified and neutral spectrum licensing are outweighed by benefits arising from innovation, more efficient use of spectrum, and the introduction of new wireless technologies (including those in the unlicensed domain), then the reforms in spectrum licensing and management practices will be vindicated as sound policy.

4.2.4. Miscellaneous Policies for Creating an Enabling Future Environment for Voice

If instituted, several other policies hold the promise of creating a more dynamically efficient future environment for voice communication. These include:

- Providing incentives to develop and deploy smaller-scale, modular, and scalable broadband technologies
- Providing opportunities and systems for aggregating demand for broadband (including enhanced voice) services
- Constraining international mobile roaming charges to encourage roaming and international voice communication demand
- Rejecting mandatory MVNO access to the networks of incumbent mobile operators (because, in general, alliances between actors occur spontaneously when mutually beneficial economic conditions exist) unless specific market failure warrants such access
- Encouraging new pricing models that recognise the multi-sided nature of emerging broadband markets
- Renewing global efforts to control spam (often associated with enhanced voice services such as email)

4.3 Standards

High-tech industries often experience the emergence of competing standards and platforms, and that is certainly true of telecommunications. Apart from the parallel evolution of wireline and wireless options, different generations of technologies within platforms (DSL vs. cable modem, W-CDMA vs. CDMA2000) and across platforms (FTTH vs. 3G and successors like HSDPA) have also co-evolved. This trend will allow end users, and markets, and regulatory authorities to determine whether any "tipping point" is reached in favour of a particular platform or technology. However, because of substantial network effects, factors such as compatibility, coordination, and switching costs, are likely to determine which standards survive and for how long.⁷²

Pervasive network effects and externalities in telecommunications and, in particular, voice communication are well documented. Universal service or access policies are motivated by the existence of these effects. However, indirect network effects also occur when content or programming is combined with the physical network. End users do not view the network and content/applications separately; rather, it is the ability of the two to work together as complements that creates value for end users. Thus, just as the expansion of the subscriber base increases the value of the physical network, the expansion of content and applications (in quantity and variety) also imparts greater value to that network. Expansion of the subscriber base increases the value of the network to content/service providers and application developers as well, reflecting the true multi-sided nature of the market that develops via this process.

⁷¹ See ITU (2004), Chapter 6: "Convergence and Spectrum Licensing", pp. 95-104.

⁷² For a comprehensive discussion of these issues, see Church and Gandal (2005).

Whether an end user should subscribe to a particular network or platform depends on the size of the installed base (i.e., the number of existing subscribers) because that acts as a signal to end users to join and to service providers to plan their investments. However, coordination problems among actual and potential end users can hinder the evolution of platforms or technologies that do not already have a substantial installed base. Those problems can be severe when end users must incur significant sunk costs to subscribe to a particular platform or technology an they face a high probability of those costs getting stranded (such as when the platform or technology does not survive because insufficient content/applications are developed for it).⁷³

When a limited number — perhaps as few as two — competing standards emerge, each with a substantial installed base, they are almost always technologically incompatible and not inter-operable. The exception to this rule in telecommunications comes from interconnection (mandated by policy or otherwise) among networks that are apparently technologically incompatible. Therefore, competing standards for platforms and technologies in telecommunications may well persist in the future. Moreover, when end users' switching costs are high (due to high sunk costs), competing standards may co-exist without one inevitably tipping over towards another.⁷⁴

Although international bodies like the ITU help to achieve greater standardisation in communication technology, it is doubtful whether a single, common standard within or across platforms is likely to become a reality. For example, ITU's global standard for mobile communications the International Mobile Telecommunications-2000 ("IMT-2000") permits five different radio interfaces (including W-CDMA and CDMA2000). It is difficult to imagine that agencies such as the ITU or national regulators will ever mandate a single standard across platforms (such as by choosing between wireline or wireless or, more specifically, between FTTH and HSDPA). With many countries favouring unified and technology and service-neutral licensing, and given the dynamic efficiency principle, the interaction of end users, content/service providers, and network operators in the market is most likely to remain the driver of standards for future electronic communications.

While mandated standards appear appealing in certain circumstances, regulators often do not possess the information on costs, quality, or technology needed to make the "best" choices. For that reason, beyond instituting interconnection and unbundling policies to ensure viable competition develops among different networks — even those employing different platforms or technologies — mandating specific standards may not be cogent policy. When network effects are strong, operators with private property rights in their networks have an incentive to internalise externalities by investing to expand their installed subscriber bases. Operators may also provide incentives to content providers and application developers to help sustain and expand their installed bases. Ultimately, much depends on the expectations and preferences of end users. Therefore, in the long run, it may be economically efficient to allow strong network effects in multi-sided markets to drive the evolution of competing standards. Sensible interconnection policy should be used to overcome any problems of incompatibility that afflict competing platforms and standards.

5 CONCLUSION

Recent radical changes in technology, market institutions, and regulatory and competition policy are transforming telecommunications and driving the convergence of markets for audio, data, and video services.

⁷³ Church and Gandal (2005) characterise this as the "chicken and egg" problem.

⁷⁴ This phenomenon, called "lock-in", is well known in technology-based industries. In some countries, lock-in is achieved by mobile operators that do not provide unlocked subscriber identity module ("SIM") cards or only offer handset subsidies in return for long-term service contracts.

⁷⁵ In some countries, national policy-makers are actively engaged in determining the preferred platform for achieving universal access or service. No a priori justification exists for mandating any such platform. Nor is it self-evident that only one platform is uniquely suited for that purpose and, therefore, should be mandated.

⁷⁶ See Church and Gandal (2005), p. 142.

⁷⁷ The uniformly high penetration rates for both fixed-line and mobile services in several OECD (and non-OECD western European) countries suggest that those competing platforms can co-exist, at least for now.

Voice communication — which traditionally meant verbal communication among spatially separated parties — is now taking on an enhanced form that includes email, instant messaging, message texting, fax, and some forms of video transmission. Developments in broadband and mobile technologies are resolving several issues related to the natural monopoly characteristics of traditional PSTNs. Economically viable alternatives in the form of mobile networks and end-to-end fibre-based networks are dissipating the PSTN's last mile network access bottleneck. Faced with low entry barriers, broadband networks based on various wireline and wireless systems are being deployed around the world. The phased or incremental deployment of broadband is being made possible by its flexible and scalable architecture and concurrent efforts to aggregate demand for broadband services. These packet-switched broadband networks are eliminating the characteristic problem of switch congestion in circuit-switched PSTNs and, in the process, enabling more efficient traffic routing and delivery and, in particular, transmission of bandwidth-intensive services (including some related to voice communication). Innovative service pricing models and opportunities for efficient cost recovery in multi-sided markets are following in the wake of these developments. Finally, as the paradigm shifts from PSTN-centred to Internet-centred communication, last mile access bottlenecks are being relieved as intelligence and control are being pushed from inside access networks to their edges and from network operators to end users and service/content providers. As a result, with ongoing convergence and growth of intermodal competition, access networks are becoming increasingly powerless to discriminate unduly, manipulate content, or limit access to end users.

However, most current telecommunications policy still reflects the PSTN-centred, natural monopoly-based industry model and specific regulations (whether ex ante or ex post) are still based on the static allocative efficiency principle. Creating an enabling environment for voice communication in the future will require significant rethinking about regulation and policy. The foremost need in this respect will be the adoption of the dynamic efficiency principle as a basis for all future regulation. Doing so will not only better suit the transformation of the PSTN-centred natural monopoly model to the Internet-centred competitive model, it will also accelerate it. Moreover, with dynamic efficiency guiding telecommunications policy in a future marked by intermodal competition and convergence, several policy problems are likely to be resolved. First, guided by dynamic efficiency over the longer term, regulators can avoid formulating shorter-term ad hoc policies that inadvertently create opportunities for regulatory arbitrage and inefficient entry or investment. Second, policy based on dynamic efficiency principles can transform how universal service or access is supported and achieved. Finally, by recognising that short-term rents, first-mover advantages, and other departures from static efficiency can (and must be allowed to) occur under dynamic and disruptive technology-driven competition, the dynamic efficiency principle can help to ease the rigidities and complexities of defining markets inherent in traditional investigations of market power and sort out truly abusive market conduct from price-cost disequilibria that commonly arise under such competition.

Specific regulatory or policy reforms in future communications markets marked by convergence and intermodal competition must also be guided by the dynamic efficiency principle. First, when the last mile access bottleneck disappears, regulatory focus should shift from the terms on which service and content providers can gain access to end users to ensuring interconnection among IP networks, and between IP networks and access networks. Peering or bill and keep arrangements may suffice, in the absence of significant asymmetry in cross-network traffic patterns, for most forms of interconnection. Second, any blanket network neutrality rule should be resisted. While undue discrimination may still need to be monitored and rooted out, traditional common carrier regulations accompanied by a blanket network neutrality rule can actually prove to be counter-productive. On the contrary, enlightened regulation should recognise that, in some circumstances (such as when convergence and strong intermodal competition have taken hold), tiered pricing and prioritisation will enable efficient use of broadband networks, stimulate investment, encourage product differentiation, and promote network diversity — all features that are likely to produce substantial benefits to end users and service/content providers. Third, regulatory authorities must redesign licensing regimes to adapt to new market realities created by convergence and intermodal competition. Such licensing regimes should not favour the emergence of a particular technology or service but rather allow the market to make those decisions. Unified licensing will be worthwhile only as long as it is service and technology-neutral. Finally, regulation for the future voice environment must mean prudent applications of discretionary policies. Those policies may include: providing incentives to develop and deploy small-scale, modular, and scalable broadband technologies; providing opportunities and systems for aggregating demand for broadband services; constraining international mobile roaming charges to encourage roaming and international voice communication demand; rejecting mandatory MVNO access to the networks of incumbent mobile operators unless specific market failure warrants such access; encouraging pricing models that recognise the multi-sided nature of emerging broadband markets; and renewing global efforts to control spam.

Although international bodies like the ITU help to achieve greater standardisation in communication technology, it is doubtful whether a single, common standard within or across platforms is likely to become a reality. While mandated standards are appealing in certain circumstances, regulators often do not possess the information on costs, quality, or technology needed to make the best choices. For that reason, beyond instituting interconnection and unbundling policies to ensure that viable competition develops among different networks, mandating specific standards may not be cogent policy. Ultimately, much depends on the expectations and preferences of end users. Therefore, in the long run, it may be economically efficient to allow strong network effects in multi-sided markets to drive the evolution of competing standards. Sensible interconnection policy should then be used to overcome any problems of incompatibility that arise from competing platforms and standards.

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