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**DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY
COMMITTEE FOR INFORMATION, COMPUTER AND COMMUNICATIONS POLICY**

Working Party on Telecommunication and Information Services Policies

VoIP: DEVELOPMENTS IN THE MARKET

**DSTI/ICCP/TISP(2004)3/FINAL
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FOREWORD

This report, prepared by Mr. Atsushi Umino, was presented to the Working Party on Telecommunication and Information Services Policy in June 2004. The Working Party agreed to recommend its declassification to the ICCP Committee. The Committee declassified the report in October 2004 subject to a written procedure.

The report is published under the responsibility of the Secretary-General.

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MAIN POINTS

1. The development of broadband Internet access, as well as the usage of innovative technologies such as advanced wireless systems, including third-generation mobile (3G) and wireless LANs, have triggered a shift in voice traffic from traditional public switched telephone networks (PSTN) to alternative Internet Protocol (IP) networks. While there are a variety of IP-enabled services, one of the most prominent is likely to be voice over IP networks (VoIP). For the moment, the proliferation of IP applications/services is not likely to completely displace traditional telecommunications services as IP services today still generally run across an underlying telecommunications infrastructure. Although, at present, the VoIP market is not large, it is expected to grow dramatically driven by a number of factors such as:

- VoIP can significantly cut costs because all of an organisation's electronic traffic, phone and data, is condensed onto one network, which reduces costs for service providers and potentially may lower prices to customers.
- VoIP could lower capital and operating costs by allowing existing service providers to evolve to a single platform for voice, data and multimedia services. New entrants can launch services with a single platform.
- The use of packet switched infrastructure can provide new revenue opportunities for access providers through opportunities for "triple play", that is, offering voice, data and multimedia via broadband Internet access services, although each provider's ability to do this will depend, in part, on the policy framework applied to that operator.
- VoIP can significantly enhance voice capabilities by enabling new features via web-based technologies;

2. VoIP technology can be combined with other applications, adapted to a wider range of circumstances, transformed from one form to another, and generally utilized in more flexible ways (e.g. mobility) than circuit-switched technology. In some aspects, however, technological progress is still required before VoIP will support functionality equivalent to all aspects of the current functionality of PSTN services. For example, further work is needed to ensure that VoIP can provide calling party location information in an emergency call services or communications during power outages in the same manner as traditional circuit-switched telephone services.¹

3. Service providers using VoIP include local telephone operators, long-distance telephone operators, CATV companies, Internet service providers, non-facilities-based independent providers, and will possibly include mobile operators. The incentives for local telephone operators to use VoIP technology is in part to 'pre-empt' other operators, in particular new entrants and Internet Service Providers (ISPs) from taking their customers by using DSL services to provide voice applications. In the case of cable operators, VoIP provides an efficient and relatively low incremental cost opportunity to offer voices using their broadband cable modem technology, and thus an opportunity to expand their potential revenue base. VoIP is thus expected to become a driver of competition and may impact the market share of incumbent operators. As noted, VoIP is also used by operators as a means to provide a comprehensive package of capabilities including telephony (voice), broadband Internet access (data), and broadband audio-visual services (video).

4. The growing importance of VoIP services is reflected in the regulatory debate at both the national and international level among OECD countries. There are a range of issues that need to be addressed surrounding the issue of whether traditional regulations should or should not apply to VoIP services. They include classification of the application/service, interconnection, possible market entry barriers, numbering, universal service issues, customer protection, privacy protection, emergency call capabilities, law enforcement issues, and technical safeguards (*e.g.* solutions for possible low quality of sound). These issues are complicated by the fact that IP can be utilised in all or some parts of traditional and non-traditional communication networks. Delivering a voice service or application can be provided entirely over IP or partly over IP and partly over non-IP. Depending on how it is defined, the term “VoIP” can seep into the term any voice service which runs over IP at any point of their transmission. This might include services that differ in no respect from traditional circuit-switched analogue voice services provided to customers today other than at some point in the middle of the transmission of the service it traverses an IP-based part of the network. Currently, VoIP is, to a large extent, unregulated in a number of OECD countries, but there are several countries which impose regulations similar to PSTN regulations on VoIP. Some countries distinguish between the types of VoIP services in regulations; for example, VoIP services based on PC-to-PC calls are unregulated, whereas calls from a VoIP phone to the PSTN will be regulated. In the last year, a number of governments have started consultation processes on VoIP regulation.

INTRODUCTION

5. The use of Internet Protocol (IP) technology has been widening in the last few years. Originally, IP and IP networks have mainly been used for data communications including e-mail and file-transfer, and more recently for access to the World Wide Web. Recent years has seen a shift in new IP-based services, such as instant messaging, file sharing, online gaming and audio-visual services. The use of IP technology to deliver voice, commonly referred to as 'Voice over IP' (VoIP)² and voice over broadband (VoB)³ is rapidly being commercialised in some OECD countries.

6. In the early stages, as dial-up Internet access was developing, there was speculation of the potential to use the Internet to offer voice services to the public. The initial attempts at providing VoIP were software based and were limited to PC to PC communications. As technology improved it became possible to have voice communications from a PC directly to a telephone connected to the public switched telecommunication network and in more recent years voice communications using the Internet could be made from a telephone to another telephone. In addition to the inconvenience of using a PC to make calls, quality was a problem in the early development of VoIP and in particular signal latency. However, extremely low prices for voice communications, in particular for international calls, far outweighed concerns with quality for a small number of users. The recent rapid increase in the number of broadband connections and lower prices for end-user equipment is stimulating the market.

7. Improvements in technology have meant that there is no longer a limitation which had resulted in IP being used in backbone networks, while maintaining the use of circuit-switched networks between subscribers and local exchanges. Now an increasing numbers of VoIP operators have started to use broadband networks to transmit IP-based voice messages using local access lines. As a result, VoIP is becoming popular among consumers because it is providing cheaper telephone calls and is consequently resulting increasingly in the bypass of traditional circuit-switched telephone networks.

8. This paper is aimed at providing an overview of the initiatives taken and market developments in VoIP services across OECD countries focusing on an examination of who the providers are and what kind of features VoIP services are currently providing.

9. The current usage of VoIP is still limited despite high growth in the number of VoIP subscribers. Estimates indicate that, as of May 2004, there were less than 200 000 voice over broadband users, which include fewer than 20 000 in Europe.⁴ However, other estimates suggest that in the US alone there are an estimated 4 million VoIP subscribers.⁵ However, it is expected by some industry analysts that VoIP will develop rapidly over the next few years and may replace traditional public switched telephone network (PSTN) in the long term. A large number of industry experts also believe that 50% of the world's telephone traffic will be based on VoIP by 2006.⁶ Table 1 provides data on the past growth of VoIP traffic compared to PSTN traffic.⁷

Table 1. International VoIP traffic

	1998	1999	2000	2001	2002	2003
VoIP traffic (millions of minutes)	150	1 655	5 954	10 147	18 045	24 519
PSTN traffic (millions of minutes)	93 000	108 000	132 027	146 095	155 165	166 615
Total traffic (millions of minutes)	93 150	109 655	137 981	156 242	173 210	191 134
VoIP share of international traffic	0.2%	1.5%	4.3%	6.5%	10.4%	12.8%

Source: TeleGeography Inc. 2004, PriMetrica Inc.

10. There are several developments that are expected to boost the uptake of VoIP services. The growing diffusion of broadband Internet access will accelerate the use of voice over broadband resulting in a lesser need to depend on traditional PSTN for telecommunications. In turn, the lower prices for VoIP are likely to stimulate demand further and encourage the replacement of PSTN networks. The ability by new entrants to provide voice over IP as a stand alone service, and without the need to obtain access to an incumbent's network will act to increase competition in the voice market. VoIP is not itself a network, but rather an application that rides on a network. Therefore, there needs to be an underlying infrastructure for VoIP to operate. If an IP platform exists, then its costs can be covered with revenues from various applications including VoIP, then the additional cost of the VoIP application is less than the cost of a traditional voice network. Also, activities such as moving or adding, or changing phone and phone numbers are cheaper on an IP network than on a circuit switched network. For example, some operators such as MCI in the United States or NTT in Japan have announced that they will shift almost all voice traffic to IP-based networks over the next several years. These developments are leading to some policy makers to consider policies for the deployment of IP-based network infrastructure in the future. For example, the Japanese government established a research group on next generation IP infrastructure in February 2004.⁸

I. VOIP SYSTEMS

11. VoIP is a technology that uses Internet Protocol (IP) networks to deliver voice services. It takes voice communications and transmits it as packets of data, particularly over broadband networks. In this context, VoIP can be regarded as a form of packet communications which is distinguished from other packet-based technologies such as Asynchronous Transfer Mode (ATM) and Frame Relay (FR).

12. To date voice services have been provided by circuit-switched networks, *i.e.* PSTN or ISDN. Circuit-switched networks provide users with a dedicated end-to-end connection for the duration of a call. In IP networks, however, sound (voice) is converted into packets of data when a call is made, and the packets are dispersed over any number of possible paths, around the Internet or private networks, similar to e-mail. The packet gets reassembled at the receiving end. When end-users place and receive calls via a PC or a phone that is connected to a broadband network, the calls can be routed to other broadband subscribers as well using software applications.⁹ The system is considered more efficient than circuit-switched telephone networks.

Box 1. What is IP?

Traditionally, connections for voice communications using circuit switching require a physical path connecting the users at two ends of the network. That path must stay open until the communication session ends thus resulting in users having dedicated access to a direct connection.¹⁰

Over the Internet data (including voice data) is delivered using the Internet Protocol. With this technology when users send or receive data, the message gets divided into packets. Each of these packets contains both the sender's and receiver's IP addresses that identify them. Any packet is sent to a router that understands the destination address and forwards the packet to an adjacent router that in turn reads the destination address. This process will continue across the Internet until one router recognises the packet as belonging to within its immediate domain. That router then forwards the packet directly to where the address is specified. Since a message is divided into a number of packets, it can be sent by a different route across the Internet when necessary.¹¹ The routes that packets will take to the same destination can vary depending on the routing information available to the routers. In this way, IP networks allow communication traffic without requiring the establishment of an end-to-end path.

Thanks to the technological development, these packets can transmit not only voice information but also various applications providing different functions. As a result, a variety of platforms, including wireline and wireless communications standards and gaming systems, have evolved to include IP as a key component. For example, personal digital assistants (PDAs) have a capability to transmit voice and other data using IP technology. Software developers are also upgrading traditional IP-enabled services to provide new features that will enhance consumer experience. Hence, IP networks are currently used by a wide range of users from enterprise customers to residential VoIP subscribers.

The most widely used version of IP today would be Internet Protocol Version 4 (IPv4), but Internet Protocol Version 6 (IPv6) is under development. IPv6 is expected to add a number of improvements to IPv4 in that the function of multicast is installed as a default and that it could ensure quality of services in telecommunications with a configuration where voice and image has a higher priority than data.

Source: SearchMobileComputing.com

13. There are different forms of VoIP services. One approach to categorising VoIP is to distinguish by the configuration of terminals connected to the network:

Phone-to-phone

14. Traditional telephones can be connected to an IP network through routers which change the telephony signals into IP and vice versa. This form eliminates the need for a PC altogether.

PC-to-PC

15. As long as the compatible VoIP communications software is installed in two PCs, users can use VoIP via their PCs. Both users are required to stay online before any connection is set up. This form is often used over the public Internet. Some specialised customer premise equipment (CPE), including adaptors for traditional telephones, may be more like a PC than a traditional telephone for the purposes of categorising VoIP services in this manner.

Phone-to-PC

16. When traditional telephones are connected to an IP network through gateways, which remove the need for a PC in placing a call over the Internet, it will enable users to conduct a voice call with PC users that are also connected to the IP network. The gateway compresses voice traffic from the PSTN, places it on an IP network, and assembles and decompresses traffic in the other direction.

Box 2. VoIP services to corporate users
<p>VoIP services are also being used by corporate users as an alternative means to enable voice communications. There are mainly three types of corporate VoIP services.</p> <p>(a) Gateway type</p> <p>This type adds gateways to a traditional private branch exchange (PBX), which is a telephony system within an enterprise to switch calls between corporate users on local lines while allowing all users to share a certain number of external telephone lines.¹²</p> <p>(b) IP-PBX type</p> <p>This type allows all controls for switching calls which have been implemented by PBX to be dealt with over IP.</p> <p>(c) IP Centrex type</p> <p>This type implements outsourcing installation, operation and management of IP networks to telecommunications operators. While the initial cost of this system may be high, it is also expected to generate high cost savings.</p>

Source: DIR

17. In addition to the above classifications, it would be possible to categorize the services according to the form of addressing they use: PSTN phone numbers, Internet addresses, and some private numbering scheme.

Mobile VoIP

18. In the past, most VoIP solutions did not interoperate with mobile telephone networks. Recent technological innovation is beginning to allow users to make voice calls over either mobile networks or WLAN technology using IP. While 2G mobile systems have fundamentally used circuit-switched networks to provide voice services, they are now being replaced by 3G (IMT-2000) systems that could have capabilities to provide multimedia services built on packet switching and IP routing, although those have not been realized completely. Code Division Multiple Access 2000 (CDMA2000), one of the main 3G standards, uses enhanced mobile IP in its core network architecture. CDMA2000 1x EV-DO, the enhanced

version of CDMA2000, supports all IP-based voice, data and video communications capability. W-CDMA, another 3G standard, also comprises of IP Multimedia Systems, which supports VoIP as well as other broadband audio-visual services, in its core network architecture.¹³ In some countries, the industry's attempt to accommodate VoIP technology in mobile services is salient. In the United States, for example, Verizon Wireless and Sprint PCS have launched push-to-talk service using VoIP technology.

Box 3. Push-to-talk services

Push-to-talk service enables instant walkie-talkie communications over mobile phones, often by using VoIP technology. In order for their voice to be heard by the recipient, the service users select someone from their list, push a button on the handset and speak instead of dialling a number. Callers cannot talk over each other and must wait for their turn to speak in the same manner as a walkie-talkie. Push-to-talk service is expected to enhance telephone service and may potentially provide mobile operators with new sources of revenue from existing infrastructure.¹⁴ In recent years, push-to-talk service is spreading rapidly in some OECD countries. In the United States, for example, Fastmobile provides unlimited push-to-talk service worldwide with a monthly charge of USD 3 to USD 4. Nextel Communications is also providing push-to-talk services as the fastest means to connect with over 13 million walkie-talkie users nationwide on its network.¹⁵ Verizon Wireless's cheapest mobile service plan includes unlimited push-to-talk service sold mainly to business with a monthly charge of USD 59.99.¹⁶

19. TD-CDMA standard, one of the 3G (IMT-2000) standards, is expected to facilitate the development of mobile VoIP services. TD-CDMA technology uses IP to connect base stations, and hence the investment for infrastructure might be less than other 3G technologies such as W-CDMA. Some operators are reportedly attempting to utilise this technology for mobile VoIP services. In the meantime, some governments such as Japan has started open discussion about IMT-2000 technologies including TDD technologies.

Box 4. Time Division Duplex (TDD)

Unlike push-to-talk services, regular mobile telephone services allow simultaneous two-way communications, a situation known as duplex. While wireless duplex communications have traditionally been implemented by Frequency Division Duplex (FDD), dedicating two separate frequency bands (one band for the uplink and one band for the downlink), they can also be achieved in time rather than frequency. In this approach, the uplink and the downlink operate on the same frequency, but they are switched rapidly. This is called Time Division Duplex (TDD). It has been proposed by the ETSI Delta group, and uses a combined time division multiple access (TDMA) and code division multiple access (CDMA) scheme. Since the TDD mode does not allow long range transmission, it can only be used in environments where the propagation delay is small.¹⁷

IMT-2000 3G mobile technologies based on TDD system would use TD-CDMA and TD-SCDMA. TD-SCDMA (Time Division Synchronous Code Division Multiple Access) supports data transmission at speeds of up to 2 Mbps. This specification puts emphasis on high-speed data rather than voice communications. Although commercialisation of this specification remains to be seen, some operators are attempting to adopt this standard for future mobile VoIP services. Both TD-CDMA and TD-SCDMA combine support for both circuit-switched data and packet-switched data from the Internet.

Wireless VoIP

20. Developments are also taking place with respect to wireless VoIP. For example, IP technology for transmitting voice communications can be combined with wireless LANs (WLANs). Although WLANs was originally envisioned as a means to expand data networks, they are being considered as a voice alternative.¹⁸ IP telephony using wireless technology, which is often called Wi-Fi telephony, has developed in recent years although the market is still small. For example, VoIP provider Vonage will make available portable Wi-Fi telephones that will allow subscribers to make and receive telephone calls within a range of WLAN access points during 2004.¹⁹ Verizon Wireless, the largest mobile telephone service provider in the U.S., is building a USD 1 billion wireless network that is fast enough to create a high-quality VoIP services using its existing cellular network and frequencies.²⁰ For the development of wireless VoIP systems,

vendors will have to work on improving the computer power and battery life of such devices. Network quality of service and security will also be important issues.

21. In recent years, a dual Wi-Fi/mobile handset is being developed in the industry, which may facilitate 'voice over Wi-Fi' as an alternative voice service. For example, Motorola and Texas Instruments are currently working on a dual-mode voice-over-WLAN mobile phone, and will test a device during 2004.²¹

Box 5. Standardisation of VoIP

In a public network environment, VoIP services from different providers need to be interoperable. In order to ensure this interoperability, standards are being developed. Such standards also have the advantage in reducing costs for manufacturers since they are assured that their terminals are compatible with those of other manufacturers. There are several standards that make VoIP services possible. A summary of some of the main standards is given below. Since they are not interoperable, calls initiated using one standard can terminate on another standard via a gateway.

(a) ITU H.323

This is a fully standardised VoIP specification. It was initially designed in the late 1980s. While not all features are implemented universally, this standard addresses call control and management for point-to-point and multipoint conferences as well as gateway administration of media traffic and user participation.²² Since this specification was originally a videoconferencing standard, it defines more functionality than would be necessary for most VoIP applications.²³

(b) ITU H.248

This standard is used extensively in the network to implement Bearer Independent Call Control (BICC). While it does not include a voice specification, it is an important element in the IP pathway when more than one provider's equipment is in use.

(c) ITU H.350

This standard was newly ratified in September 2003 for videoconferencing using VoIP.

(d) Telcordia GR-203

This is a packet voice over cable specification that links the PSTN with voice over cable.

(e) IETF SIP (Session Initiation Protocol)

Session Initiation Protocol (SIP) is a real-time signalling protocol for VoIP services developed in the mid-1990s by the Internet Engineering Task Force (IETF). It is used in applications to establish and terminate communication sessions over IP. SIP provides signalling inviting a user to participate in a call session, and confirming that the client has received a final response.²⁴ With these capabilities, this protocol allows users to provide more features in a peer-to-peer fashion. This standard was initially deployed only for PC-to-PC calls, but is currently used as the base for the majority of VoIP products. Some analysts predict that SIP will be the successor to H.323.²⁵

Source: VoIP and IP VPN Solutions Market Survey

II. MAIN FEATURES OF VOIP

Benefits of VoIP

22. VoIP services have a number of compelling advantages. First of all, VoIP services are cheap and cost effective. VoIP is characterised by lower infrastructure deployment costs, provided that VoIP networks already exist, as well as higher bandwidth utilisation whereas traditional circuit-switched networks are based on large fixed infrastructure costs and fixed calling bandwidth. With VoIP, voice data is compressed and transmitted over an IP-based computer network, which means that VoIP uses up to 90% less bandwidth than a traditional PSTN call. Such efficiency has important implications for the pricing of calls. VoIP also enables free internal calls among those who share the same computer network, just like in the case of a leased line company network based on PSTN.²⁶

23. Associated with this, VoIP also has an advantage in simplifying network structures. Provision of VoIP services does not need high-cost equipment such as exchanges. A VoIP 'exchanges' require different types of equipment compared to the PSTN, which is easier to alter and maintain, and helps reduce operation costs. Some claim that installing a packet-switching network costs about a third of a circuit switching system and that one can save about 50-60% in operating costs.²⁷ The potential cost saving through consolidating voice and data applications in one network makes VoIP attractive for enterprises that have already deployed an IP network.²⁸ For network operators, they can save funds by using their expensive data networks to make phone calls. In addition, billing and technical support will be easier once they can use one network to provide data and voice services. Portability for users will also potentially be enhanced as broadband voice customers may take their telephone adapter outside their residences or offices. Plugging the adapter into any broadband connection including Ethernet and wireless LANs will enable users to make and receive calls via the same number and service they use at home.

24. VoIP has no geographic boundaries unlike the PSTN. Irrespective of national borders, VoIP operators simply process voice calls on a local line and then digitise them to send over an IP network before converting them to voice again at the other end of the local network. It means that, once the large majority of subscribers have been shifted to IP networks, VoIP may potentially benefit from the pricing model of the Internet, where there are usually no time-sensitive or distance-sensitive charges, although in some countries circuit switched networks are also moving to this pricing model.²⁹ In the medium-term, interconnection charges between PSTN and IP networks will have to be recovered.

25. Since VoIP is based on IP technology, it can encourage providers to create new types of IP applications, which are overall characterised as advanced call management functionality and provide access to them via the Internet.³⁰ One of the typical VoIP applications would be video telephony by sending voice along with video images through the Internet. Videoconferencing can also be available in a similar way. VoIP also enables users to attach data documents to voice messages. These applications may promote the integration of voice, data, and video capabilities. The box below summarises the main IP-based applications associated with VoIP services. It is important to note that these IP-based applications are transmitted over a variety of platforms, primarily broadband networks, which will erode their links with facilities.

Box 6. Examples of IP-based applications

Connecting telephone calls over the Internet opens the door to a variety of advanced communications applications that link with voice communications services. Some potential IP-based applications are noted below:

(a) Unified messaging

This application is designed to put a variety of different messaging formats such as e-mail, faxes and voice mail into a single mail box, which can be accessible from PCs or telephones. With this application, voice mail can be forwarded like e-mail messages. It will be useful particularly for those who try to listen to their e-mail messages on the move.

(b) Instant messaging

This application allows users to send messages to each other in real time once they know that they are on-line at the same time. The messages include both text and voice.

(c) Voice recognition

With appropriate software, verbal commands can be analysed by a PC, which can then follow a set of commands.

(d) Personal virtual assistant

This application manages a user's calls which are routed directly to the most convenient terminal. It can track down the phone number of certain users and contact them at any given time.

(e) Video calls / Video conferencing

VoIP will allow users to conduct video calling and videoconferencing.

(f) File sharing

VoIP will allow users to transfer files to other parties during a voice call.

(g) Online games

Some companies have created online game applications for VoIP services. For example, Microsoft's Xbox and Sony's Playstation 2 have provided online gaming services as an application for VoIP services.³¹

Source: Commission for Communications Regulation of Ireland

26. IP networks allow for the integration of a number of applications and the expansion of voice on these networks will provide a further impetus for further integration of different platforms. Integration of mobile and wireless LANs with VoIP would be a typical example and as already noted some companies are developing associated technologies. For example, Motorola is attempting to deliver handsets that support multiple forms of access by partnering with VoIP gear maker Avaya and Wi-Fi equipment manufacturer Proxim. The company intends to develop products that combine mobile, VoIP and wireless technology.³²

27. VoIP services may also encourage the uptake of broadband Internet use because a number of VoIP services use broadband networks including DSL, cable, fibre-optic, wireless LANs and 3G. Some providers are offering a service which includes both broadband Internet access and VoIP in a single package. This is because VoIP services can be a means to target the growing number of broadband Internet users who are seeking to simplify their voice and data communications by operating them over one network.³³ Bundling different services into packages will also help retain existing customers for operators. The development of such services is likely to promote further deployment of various forms of broadband facilities that are capable of offering IP-enabled services, which will encourage consumers to demand more broadband connections. This process will lead to broader functionality as well as greater consumer choice at competitive prices. Some analysts even argue that voice could be the killer application for broadband by encouraging the replacement of dial-up connections to high-speed Internet access.³⁴

28. In recent years, the development of a technology known as multi-protocol label switching (MPLS) has accelerated the convergence between voice and video applications as well as between communications and computers. This technology is expected to meet the growing demand for services that combine voice, video and data on a single network. Since MPLS can handle most types of traffic, VoIP operators can use it in their core infrastructure to converge traffic from all their networks. Some operators are attempting to invest in and use this technology in order to bridge the gap between diverse technologies to provide a seamless backend capable of supporting all the latest applications. For example, Verizon Communications in the US announced in February 2004 that much of its 2004 capital budget would be spent on MPLS-enabled equipment rather than circuit-switched networks. The company plans to use a converged voice and data network with an IP/MPLS infrastructure in the fourth quarter of 2004. Newer operators such as Equant and Level 3 have also essentially built their backbone network using MPLS.³⁵

Box 7. Multi-Protocol Label Switching (MPLS)

Incoming packets are assigned a label by a router in an MPLS network. Packets are forwarded along a label switch path where each router makes forwarding decisions on the basis of the contents of the label. In each communication, the label is eliminated and a new one is added that shows the next router how to forward the packet. There are many similarities in the label switched paths of MPLS with circuit-switched paths in traditional technologies such as ATM or Frame Relay networks. However, the important difference would be the fact that MPLS are not dependent on a particular transmission technology. In other words, MPLS can be used with any transmission technology including ATM, Frame Relay and Ethernet. Therefore, MPLS is capable of creating end-to-end circuits across any type of transmission system without overlay networks. The demand for MPLS is growing rapidly: for example Cisco's high-end MPLS router grew 50% in the second quarter of fiscal year 2004 compared to the same period a year earlier.³⁶

Source: ZDNet

29. From the perspective of business, the effect of cost reductions could be significant especially where corporations have many affiliates or interlinkages with other businesses. Using VoIP technologies, PCs' and telephony networks can be integrated and thus networking becomes very simple, resulting in low cost telephony within corporations. In addition, VoIP can be easily combined with video conference based on IP technologies. It provides users with a number of functions including exchanging voice or images but also sharing documents or database simultaneously on screen.

30. From the perspective of competition, VoIP can provide an opportunity to remap the market share of different operators. Low barriers to entry in VoIP service markets will give an opportunity for a number of diversified operators to compete for market share. VoIP providers can differentiate their services not only by pricing but also offering completely new services as mentioned above. Commercialisation of VoIP services may promote international competition in voice telephony because VoIP providers in a specific country are not bound to operate within that country thanks to IP's flexibility. Indeed, there are a number of VoIP providers that offer commercial services across countries, such as Tiscali and Net2Phone. A further incentive for companies to offer VoIP applications is that they often realize substantial cost advantages by avoiding international settlement charges, national interconnection charges and other regulatory fees. However these savings may be small compared to the cost advantages of IP networks over the long run.

31. From a regulatory point of view, VoIP services are, unlike traditional PSTN services, currently unregulated or have little regulatory requirements in a number of OECD countries. If this tendency continues, it will be much easier for operators to enter the market.

Challenges of VoIP

32. There are several important challenges in providing VoIP services. The first problem would be the quality of service. While quality of service depends on congestion and transmission speeds of the

network for VoIP, there are inherent difficulties in transmitting a voice stream over a packet network. In addition, it is difficult to provide over VoIP some services, such as call waiting, which are offered over the PSTN. Problems, when the VoIP services are provided through ADSL networks, include interruption of communications and noise. Overall, the quality of some VoIP services is still inferior to traditional PSTN at the current technological level. This voice quality problem had been a great challenge for VoIP in the past, but it has been improving in recent years and is expected to improve. Some wireline operators intend to use protocols such as multi-protocol label switching, which runs on an IP network's routers, provides switching capability, and gives priority to quality of service to certain IP packets. Some cable operators also have developed technology that will overcome this challenge. For instance, CableLabs has developed PacketCable specifications that are designed to provide quality of service to a variety of IP-enabled services including VoIP, interactive gaming and broadband audio-visual services.³⁷

33. The second challenge is reliability. The major reliability issue is that the VoIP service provider may not control the reliability of the underlying physical network. For example, if router A cannot send packets to router B, these packets will be dropped. Or, if there is network congestion, the router can see the network congestion and will try, best effort, to route around it. But it is best effort only. Thus, the quality of the VoIP application depends on the quality of the underlying network. As a result, lost packets or crowded networks can be common. Therefore, there might be less reliability than the PSTN. A solution to this problem would be to use peer-to-peer version of VoIP, which has been adopted by some companies such as Skype.³⁸ It could be argued that if VoIP quality is poorer than traditional telephony services, then pricing the service at a lower level is an effective way to signal this to consumers, who will then be free to choose the mix of price and quality that best serves their needs. The market may segment itself into different types of VoIP offerings. Best-effort services will offer lower prices, and somewhat lower quality. Other providers, most likely including network operators, will seek to differentiate their VoIP products by offering quality of service, making use of managed networks to do so.

34. The third difficulty lies in security issues. Since voice is transmitted as packet-based data in VoIP services, it is potentially more vulnerable to attack than a traditional PSTN telephone system that only allows a call to be made on a dedicated circuit from one point to another. In addition, the ability for VoIP to support emergency calls can also be a problem due to the inherent nature of IP that makes location and distance irrelevant to users. While the PSTN supports extensive emergency call services under almost any conditions, these have not yet been implemented effectively for VoIP. Currently, identifying the physical location of users making VoIP calls is difficult since providers do not necessarily establish a physical connection with their customers, and it is difficult to give priority to transmitting emergency calls as is done on the PSTN. Moreover, most emergency call centres rely on circuit-switched telephone technology, which is not compatible with IP. Special steps have to be taken to ensure that VoIP systems can connect to emergency call centres. Some operators are attempting to obtain limited emergency call services via VoIP. In the United States, for example, AT&T has worked with Intrado to develop a way in which its VoIP customers can make emergency calls.³⁹ Vonage also has an emergency call service with its VoIP, but requires the users to programme their physical location into the phone. With that service, it may still be difficult to identify the place where VoIP users are actually calling in case of emergency because the service allows customers to move their phone to other locations. This may also be because the call will be first connected to the place where the relevant Internet server is rather than where the user actually is. However, as the cost of devices using Global Positioning System (GPS) has fallen, carriers and manufactures have been examining the possibility of employing such devices in handsets to provide location information to emergency services. This approach may prove useful for VoIP services delivered over wired platforms, as well as for wireless services generally. Another security challenge facing VoIP is that the PSTN provides its own electrical power to end users whereas most VoIP services rely on electric utility service or batteries for power. Power outages may impact VoIP services and applications more severely than PSTN service.

35. Other technical and administrative difficulties may arise where VoIP services are subject to government regulation for purposes such as local number portability, interconnection, customer privacy, emergency calling, disabilities access, or law enforcement access. Such mandates have been traditionally imposed with circuit-mode technology in mind, thus requiring carriers to make technical adjustments to remain compliant in the packet-mode age. For example, a local exchange carrier subject to rules requiring the transmission of emergency calling location data may need to deploy a different solution when it migrates to a DSL-based VoIP network because VoIP callers are not limited to fixed geographic locations. Similarly, a voice provider upgrading to IP may need to incorporate lawful electronic surveillance capabilities in its IP service design to remain compliant with its law enforcement assistance obligations.

36. The initial set-up cost for VoIP is viewed by some as a factor which may slow growth. Some companies have expressed concern that they will have to invest heavily in VoIP devices such as voice gateways and the time factor in rolling out a VoIP network. In recent years, however, technologies and applications that are supposed to reduce set-up cost are being developed in some countries. In the United Kingdom, for example, Inclarity launched its Broadband Telephony System Management Tool, a web-based application developed to simplify the route to the market for channel partners and to reduce hardware investments for VoIP services, in November 2002.⁴⁰ Another relevant challenge would be the fact that VoIP technology used today may require more management and maintenance than traditional circuit-switched networks in that VoIP telephones need software updates. This might slow VoIP roll-outs, which will mean that companies will not spend as much on VoIP gear over the short term as some have predicted.⁴¹

37. Incompatibility may also be an issue for VoIP. Some VoIP providers, especially for PC to PC services, require that both the caller and the receiver subscribe to their service, and some software programmes require that both parties have the same software installed. Since there are different VoIP used by equipment makers, softswitches and IP gateways from one vendor may not interoperate with equipment from another.⁴² This lack of interoperability at a technological as well as operational level has slowed end-to-end deployment of VoIP. The acceleration of retail VoIP services will increase the challenges of VoIP interoperability for service providers. However, there are evolving services or programmes that allow different software users to call using IP.⁴³ For example, VoIP session controllers such as Acme Packet and Ingate Systems can be deployed between two operators' networks.⁴⁴ A wholesale VoIP provider Level 3 has installed session controllers from Netrake and NexTone Communications to facilitate interoperability.

Interrelationship between VoIP and PSTN

38. The diffusion of VoIP services is expected to have a significant impact on the PSTN telephony market. Nevertheless, it is expected that the two markets will need to coexist over a period and will clearly need to interoperate. Although some view the markets as different, it needs to be recalled that they are serving the same purpose which is to provide connectivity, although features and prices may differ. The fact that DSL, and voice over broadband, is provided over PSTN lines provided at present by incumbent carriers is a primary example of where the two markets converge. Nevertheless, there are a number of areas where VoIP will impact on traditional PSTN markets.

39. VoIP is an application and can be provided on a number of platforms so that its diffusion will help in creating more competitive conditions in the voice markets in that cable networks, WLANs and perhaps power networks, will be able to provide this service. Such platform competition will serve to threaten the access dominance PSTN incumbents have had in this market. This, however, does not imply that the PSTN access infrastructure will be under threat. Rather such competition may help to enhance the infrastructure, for example, by investing in fibre optic networks.

40. While growth in VoIP traffic may have a negative impact on PSTN traffic in the future, today PSTN traffic erosion appears primarily due to the rise in e-mail and mobile phone traffic. In Japan, for example, PSTN traffic between October and December 2003 decreased 15% compared with that in the same period of 2002.⁴⁵ In the US, demand for switched access minutes on incumbent wireline networks has been falling. However, this is not primarily attributable to VoIP, which has not yet developed on a large scale. It is mostly due to substitution with wireless, and substitution of Internet communication (email, instant messaging, and e-commerce) for voice communication generally. Growth of VoIP in the next few years may be expected to erode wireline voice traffic.

41. The diffusion of VoIP and changes in the traffic volume is also likely to have a negative impact on revenues of PSTN carriers and could reduce their revenue from access interconnection charges. In some cases arguments have been put forward that access charge reform, by bringing access charges down to true cost, will negate access charge arbitrage opportunities and eliminate access charges as a VoIP issue. In other cases, it has been argued that such charges may need to increase to offset reductions in volume. For example, in Japan, it is anticipated that interconnection charges per three minutes (Group Center (GC) Interconnection) will rise from JPY 4.37 (USD 0.04) to JPY 6 (USD 0.055) if PSTN traffic decreases by 26.4% in three years, which will theoretically drive PSTN operators to increase call charges.⁴⁶ The foundation of universal service funds, which some countries established to maintain universal services of fixed telephony, may also be impacted if the revenue base of traditional PSTN carriers is affected. The effect on universal service contributions will depend on how a country has chosen to fund its universal service system. Where this is done through general revenues, there will be little effect. Where contributions are drawn from users of traditional telecommunications services, there may be a significant effect. In the meantime, the costs of PSTN operators are expected to decline as they start using IP backbones to carry traffic.

42. At present DSL is not available to all users in most OECD countries although the reach is extending as telephone exchanges are enabled in small towns and rural areas and technology is improved. As an example, BT, the UK incumbent, recently announced that DSL will be available to 99.6% of households by 2005. Recent technological innovations on wireless LANs have also shown that high speed Internet access can be brought to rural and remote areas relatively cheaply, and in some cases at better prices than urban areas. Thus, the issue of access to high speed networks, at the national level, is less of a concern than it was several years ago.

III. MARKET DEVELOPMENTS OF VOIP

VoIP market trends

43. Even though VoIP services have existed for several years, it is only recently that they have been commercially exploited to provide voice data over the Internet. The development of recently emerging VoIP market has largely been promoted by several factors. The first factor has been the relatively high prices for calls, especially time-based charges, and in particular the price of international calls. The ability to provide charges not based on geographic distance helped promote the use of VoIP services. The call market for domestic calls has recently become the target for VoIP services.

44. The development of broadband Internet access has also rapidly changed the landscape providing an opportunity for VoIP. A number of broadband access providers have started to launch VoIP services with attractive pricing plans. In Japan, for example, more than 10 providers launched VoIP services during February - April 2003 based mainly on broadband connections. The provision of voice services over broadband has become more attractive as broadband penetration rates increase across the OECD. Some broadband providers view VoIP as a service to attract new broadband clients who are less concerned with web surfer but are looking for cheaper access to telephony services.

45. VoIP services are becoming highly competitive with traditional PSTN markets. In turn this is having an impact on the PSTN market and especially on prices. The extent to which operators providing VoIP services will have an impact depends on how competitive the PSTN market is and how expensive PSTN tariffs are. For example, the take up of VoIP services in Japan has been relatively high (about four million subscribers) partly because prices from the existing PSTN operators are still comparatively high. In contrast, in the US calling plans that offer large amounts of (or unlimited) usage for a flat rate have already become very popular among customers of circuit-switched services, both wireline and wireless. This may have mitigated the price incentive for customers to adopt VoIP offerings.

46. Alliances among VoIP operators have been formed in order to boost the development of VoIP services. In the United Kingdom, for example, 13 companies formed the Internet Telephony Service Providers Association (ITPSA) to promote and represent the needs of the VoIP industry. The association intends to lobby the UK government and European Commission as well as to encourage the development of the industry through the promotion of self-regulation and competition.⁴⁷ In Korea, the VoIP Forum was created by among industry insiders.⁴⁸ In Japan, a forum has been established in April 2003 by major VoIP providers, such as NTT Communications and KDDI, to expand the diffusion of the services.⁴⁹ Such alliances have also been created between vendors and network operators on a bilateral basis. For instance, Alcatel and Siemens reached an agreement with T-Com on future collaboration to develop VoIP services in March 2004.⁵⁰ By using T-Com's nationwide network, they plan to implement a pilot project to demonstrate the feasibility of network infrastructure that can meet the short-term VoIP market demand. In April 2004, wireless broadband equipment maker Navini decided to sell Net2Phone's VoIP services to its broadband provider customers. It is said to be the first partnership between a provider of wireless broadband equipment and a provider of VoIP services.⁵¹

47. Despite a number of developments of VoIP, the market is still limited and far from matured. Thus estimates indicate that at the global level only about 10% of all voice traffic is classified as VoIP and less than 1% of this traffic originates on a VoIP phone. Many VoIP subscribers seem to be trying to use VoIP

services as a second telephone line in their homes. For example, it is reported that only half of Vonages's 220 000 customers (in August 2004) use VoIP services as their primary telephone. This immaturity may also be exacerbated by the fact that current VoIP services may not guarantee the bandwidth required to handle calls and associated services effectively. For instance, even though AT&T recommends a maximum speed of 90 Kbps for both uplink and downlink VoIP services, actual connection speeds are said to be affected by a number of factors and rarely operate at the maximum level. Some analysts note that VoIP services provided by operators without having their own broadband networks would only be a best-effort service.⁵²

48. Clearly the regulatory environment will influence the development of the VoIP market. Some operators view VoIP as a means to reduce costs, in particular by not having to pay interconnection charges to PSTN operators, but as well to reduce the regulations they may be subject to. Whether they achieve these aims will depend on the outcomes of a number of regulatory procedures which have started or which are expected to commence in the near future.

Providers of VoIP services

Non-incumbents

49. There are mainly three types of VoIP providers. The first type consists of non-incumbent telephony providers that offer VoIP services over broadband networks such as DSL, cable, fibre-optic, and 3G mobile networks. For example, Free Telecom (Iliad group) in France provides VoIP services through its ADSL networks whereas Time Warner in the United States offers them using its CATV networks. FastWeb in Italy provides VoIP services via their fibre-optic networks to ensure the quality of services, but Softbank in Japan is reportedly planning to vie with other VoIP providers in that country by offering VoIP services over 3G (TD-CDMA) networks. The growth and penetration of broadband in each OECD country will determine the market reach of these providers. In addition, the availability of other networks, such as for cable TV, will also help grow the market. For example, in the United States, where diffusion rate of CATV reaches about 85% of households, VoIP via CATV is expected to grow dramatically.

50. In some cases, interrelationship between VoIP and broadband services encourage partnerships between operators. Independent providers have to rely on networks that other facilities-based operators have. Even in those cases where the provider has its own networks, it attempts to partner with other operators in order to reduce investment and operation costs. For instance, provision of Time Warner's VoIP services has been provided with a support from other telecommunications operators such as Sprint and MCI. This partnership has been achieved by separating business areas among the three operators.⁵³ In the United Kingdom, Yahoo teamed up with BT to offer a VoIP service in March 2004, and the service is expected to launch during 2004. The service is intended to allow an instant-messaging customer to make a voice call to any telephone in the world. Yahoo also plans to make BT Communicator a part of all Yahoo Messenger subscribers distributed in that country.⁵⁴

51. Some providers are targeting corporate users rather than residential customers as an initial step. For example, a provider Covad in the United States is planning to focus on the small-business segment first while eventually offering VoIP services to residential subscribers.⁵⁵ The Forval Group in Japan has also provided VoIP over fibre-optic networks exclusively to small and medium sized corporate users since October 2003.⁵⁶ Additionally, equipment makers such as 3Com, Avaya, Cisco Systems, Nortel Networks and Siemens, are also vying to sell equipment in the corporate VoIP market.⁵⁷

52. For cable companies, VoIP can provide a momentum to enter the telephony market. Although some cable operators in OECD countries offer telephony this has not been through VoIP. The development and diffusion of cable modems has provided a new market opportunity for cable companies to provide

telephone services at a much lower cost than previously. Cable companies offering cable modem access to their customers can use VoIP to offer voice, video and data services. Such 'triple play' packages are viewed as having an advantage in tying a customer closer to a service provider thus reducing customer churn. There is also an advantage for cable companies in that they have an existing billing relationship with the customer before commencing VoIP services.

Incumbents

53. The second type of VoIP providers would be incumbent local telephone operators. One of the motivations for them to enter the VoIP market is to maintain their current position in the telephony market. They are presumably attempting to pre-empt other competitors, over which they have an advantage in terms of possession of access networks. Another incentive for incumbents would be to provide subscribers with IP-enabled data features that will enhance the telephony experience by offering VoIP services. Major incumbents in some countries such as the U.S. are already committed to plans to evolve their networks over the next few years to broadband and IP-based networks, which will also enable them to take advantage of reduced transmission costs and greater efficiencies in the face of competition.

54. In some OECD countries, incumbent operators have already begun to provide VoIP services. In the United Kingdom, for example, British Telecom has become the first incumbent telephone company in Europe to launch, in December 2003, a VoIP service over broadband networks named Broadband Voice.⁵⁸ The company also announced plans for a trial of a new service named BT Communicator, which will enable users to make VoIP calls together with providing additional applications using their broadband connections, in March 2004.⁵⁹ In Sweden, TeliaSonera launched VoIP telephony services named Telia Broadband Telephony as a compliment to Telia's fixed telephony services in February 2004.⁶⁰ In Japan, NTT East and NTT West started corporate VoIP services in October 2003 and announced in April 2002 that they would stop new investment in PSTN facilities. They also plan to start residential VoIP services to their fibre-optic network subscribers in the summer of 2004.⁶¹

55. An increasing numbers of incumbent operators are beginning to provide bundled services that combine voice, data and video transmitted over high-speed IP networks. For example, Bell Canada plans to accelerate the provision of VoIP services by bundling voice, data and video in an IP-based network. British Telecom also announced its BT Communicator package, which will enable users to have converged multi-media experience using VoIP technology, in March 2004.⁶²

56. VoIP services provided by some incumbent operators have limited coverage for international calls. In the United Kingdom, for example, BT's international VoIP call services are limited to 17 countries, most of which are developed countries. Nevertheless, recent trends show that IP infrastructure is extended abroad. Indeed, BT announced in January 2004 that it would extend its new MPLS node in Toronto, Canada.⁶³

Independent providers

57. The third type of VoIP providers are application service providers that do not themselves offer network access services and where the access services must be acquired from a third party. They simply offer services without transmission facilities, by which they can reduce investment and personnel costs as well as costs to acquire new subscribers and offer competitive prices and services. They are often small operators, but can be a threat to large operators.

58. There are a number of examples of this type of VoIP providers. In the United States, for example, Pulver.com (Free World Dialup) offers VoIP services and had 75 000 subscribers within their first year. Yahoo has been providing VoIP call on its Messenger product since 2001. By entering into a partnership

with Net2Phone, the company provides VoIP services not only to the instant-messaging subscribers but also to any PSTN subscribers residing in the United States.⁶⁴ Microsoft has enabled VoIP capability in Windows CE devices by incorporating SIP into the system.⁶⁵ Reportedly, major manufacturers such as NEC and LG Electronics intend to create new Windows CE software, version 5, which contains much improved technology for making VoIP calls.⁶⁶ Vonage plans to create a 'soft phone' that can be added to any devices that use the Windows CE version 5 system.⁶⁷ Skype Technologies, S.A., founded by creators of Kazaa, launched a VoIP software application in 2003, which has been downloaded by 12 million users all over the world. Also in this category are carriers whose business model is to provide VoIP services as wholesalers, in conjunction with other firms such as network operators. For example, Level 3 is providing wholesale network functionality to a variety of VoIP retailers.

Pricing of VoIP services

59. Pricing is one of the key factors in the development of commercial VoIP services. VoIP services are normally priced much lower than traditional PSTN services. In Norway, for example, VoIP provider Telio's initial one-off cost and tariffs for a fixed telephone is much less than those of the incumbent Telenor as shown in the following table.⁶⁸ Calling price differences are usually much larger in the case of international calling.

Table 2. Comparison of tariffs between Telenor and Telio in Norway (NOR)

	Telenor	Telio
Initial one-off cost	990	495
Monthly charges	159 for a line and 239 for two lines	159 for a line and 239 for two lines
Call charges to a fixed telephone (domestic)	0.6 per call	Free
Call charges to a fixed telephone (international)	0.89 per minute for Finland, 0.53 per minute for Denmark and Sweden, 0.63 per minute for the UK	Free up to 100 minutes per month
Call charges to a mobile telephone (domestic)	0.6 per call	0.95 per minute
Call charges to a mobile telephone (international)	2.52 per minute for Finland and Denmark, 3.53 per minute for Sweden, UK, and Switzerland	More than 25% reduction to Telenor's prices

Source: DIR

60. One of the important differences between PSTN and VoIP in pricing would be the fact that VoIP calls are usually not priced according to distance and are often not time-based compared to PSTN charging practices.

61. An increasing numbers of VoIP providers are offering unlimited call service plans to attract subscribers. For example, US-based Voiceglo is also offering a free calling plan, which is included in its basic plan charged at USD 12.99 per month.⁶⁹ This fixed pricing scheme may affect PSTN pricing as well as 3G mobile pricing models. Flat-rate IP-based voice tariffs may gradually replace time-sensitive and distance-sensitive tariffs.⁷⁰ In addition, it will be increasingly difficult to distinguish between local and long-distance calls under VoIP services.

62. It is also important that a number of VoIP providers offer PC-to-PC voice calls between their subscribers (or subscribers of affiliated operators' services that have the same software installed) free of charge. This is one of the universally salient features of commercial VoIP services. Some of them offer free PC-to-PC VoIP services regardless of the use of different ISPs. Net2Phone and PhoneFree in the United States are examples of these providers. VoIP providers normally charge customers to call to circuit-switched telephone numbers, while the tariff is mostly still cheaper than that of PSTN. As a result, price competition is taking place among VoIP providers with services that let subscribers seamlessly connect from a traditional telephone handset to any telephone number in the world.

63. 64. Some incumbents tend to be less competitive in pricing than non-incumbent operators because of the existing tariffs of PSTN services. In the UK, for example, BT's VoIP calls between subscribers, which are mostly free of charge in case of other non-incumbent operators, require almost the same tariff as for the PSTN. Presumably, this pricing policy intends to avoid competition with the company's PSTN services.⁷¹ The difficulty for local carriers if they decide to offer VoIP services is how to schedule and price their offers to remain competitive while minimising the 'cannibalisation' of their existing PSTN customer base. In addition to the possible cannibalization, another challenge to existing retail services is the continued obligation to pay access charges. New entrants are often able to find ways to skirt these charges that are not available to incumbents.

VoIP markets in the OECD

65. Service providers have begun to offer VoIP across national borders. For example, Tiscali, based in Italy, launched VoIP services in August 2000 and signed a partnership with NetCentrex for the launch of residential VoIP services using ADSL networks across Europe in February 2004.⁷² The US VoIP provider Net2Phone has also made available a commercial VoIP service based on SIP in Europe since March 2004. Vonage is also planning to provide VoIP services in the United Kingdom, Switzerland and other parts of Europe during 2004.⁷³ Skype provides software to enable free peer-to-peer VoIP services around the world. Skype had about three million users three months after its launch in September 2003. This section will survey VoIP market developments in OECD countries.

Australia

66. Within the corporate and government markets a number of carriers and service providers have been active in providing IP telephony services for some time. One of the earlier deployments was in 2001 by Neighbourhood Cable, a regional HFC cable carrier, which provided the Mildura Council (a local government) with a VoIP service that linked seven separate sites and included 300 VoIP handsets. By mid-2003 Cisco Systems reported that it had installed more than 50,000 IP telephones in to more than 200 corporate and government customers across Australia and expected strong growth in 2004. The adoption of DSL broadband services by small and medium enterprises, the unbundled local loop regime and declining equipment prices are contributing to decisions by a number of carriers, including Comindico, AAPT, Optus, Primus and PowerTel to extend their DSL networks and in turn the availability of VoIP and VoDSL services. These carriers are delivering voice services to corporate and medium size enterprises. VoIP services are also being made available to residential consumers. Neighbourhood Cable launched its residential VoIP service over its HFC cable network in December 2003.⁷⁴ In May 2004 Mobile Innovations launched a VoIP service, providing customers with an adapter that allows them to use their existing telephone to make and receive calls over a DSL broadband connection. Unwired Australia, a new wireless broadband service provider, announced in early 2004 that it has successfully trialled VoIP and plans to offer the service to customers following the launch of its commercial service in late 2004. Telstra announced that it would launch a VoIP solution to small and medium businesses in the first half of 2004.⁷⁵ Optus is testing VoIP services as of February 2004.⁷⁶

Austria

67. Telekom Austria started VoIP services named IP Voice Services. By the second quarter of 2004, Telekom Austria DSL subscribers would have the option to rent a special IP handset which will enable free VoIP calls over the Internet.⁷⁷

Canada

68. In November 2002, Telus announced that it would migrate from their long-distance PSTN network to VoIP using Nortel Succession softswitch equipment. In line with this announcement, Telus officially launched its VoIP service named IP-One™ to business customers in Ontario and Quebec in November 2003. This service is the first carrier-grade hosted and managed IP telephony service in Canada, and provides VoIP services combining local and long-distance voice with new IP-enabled features. It also provides business customers with a full suite of IP-based advanced application services as well as the ability to integrate voice-mail, e-mail, data and images.

69. Bell Canada announced a deal with Nortel in September 2003 to build a new IP-based softswitch infrastructure. The aim is to provide hosted services for large customers by mid-2004 as well as IP Centrex features to prevent erosion of service revenues to corporate IP PBX markets. In the longer term, Bell Canada envisages a situation where VoIP can be a replacement for PSTN services. As of January 2004, Bell Canada also plans to accelerate the delivery of IP services through an integrated data, voice and video IP-based network by entering into partnerships with Cisco Systems. This joint venture will encourage Bell Canada to build on its network capability and align its investments towards a single IP/MPLS service delivery network with a national footprint.⁷⁸

70. Primus Canada⁷⁹ started VoIP services named TalkBroadband using its broadband Internet link in January 2004. The basic phone service starts at USD 19.95 per month (excluding the broadband connection fee) with extra fees for such options as call-answer and call-waiting.⁸⁰ Primus estimated that its VoIP service would save 25% of the bill of the average customer using traditional telephony services.⁸¹

71. Vonage is planning to provide Canadians with the same VoIP services that it offers in the United States. It plans to offer a full service package tailored for Canadians by the summer of 2004. Vonage is partnered with a Canadian CLEC, 360 Networks, which provides Canadian phone numbers and interconnection with the PSTN.

72. AOL Canada, formed by America Online and the Royal Bank of Canada, plans to offer VoIP services. It reportedly began testing the service in January 2004 and hopes to commercialise it by mid-2004.

73. Cable companies are also beginning to provide VoIP services. For example, Rogers Communications and Roger Cable announced in February 2004 that they have decided to deploy an advanced broadband IP network to support VoIP and other services across the Roger Cable service areas. They intend to launch services in mid-2005 with initial availability to approximately 1.8 million households and with availability to the vast majority of customers by 2006.⁸² Rogers mentioned that the deployment plan is conditional upon supportive regulatory conditions.

74. A CATV company, Shaw Communications Inc., is reportedly considering entering the VoIP market as of October 2003. It indicated that it was stimulated by the provision of VoIP services by US companies such as Cablevision Systems Corp. of Bethpage, Cox Communications Inc. of Atlanta, and EastLink of Halifax.⁸³

Denmark

75. An increasing number of service providers are offering VoIP services based on PC calls which are patched into the PSTN at low tariffs, primarily for international calls. The providers of ADSL and cable modem services have not yet offered VoIP services themselves. However, the incumbent TDC announced in January 2004 that the company needed to enter the VoIP market within the next one or two years to maintain its current position in the market. TDC predicts that there will be approximately 500 000 VoIP subscribers in Denmark within five years.

76. A rising number of larger enterprises and municipalities are implementing VoIP services particularly for international calls. Some of the larger community-owned or municipality-owned CATV networks are also offering VoIP services for international calls. The fact that outgoing international PSTN traffic has been decreasing since 2001 in Denmark might be partly due to VoIP development.

Finland

77. Two major telecommunications operators offer VoIP services to business users. TeliaSonera's VoIP services include wide-ranging solutions to meet companies' VoIP communications and customer relationship management needs. The core of the service is the servers and gateways of TeliaSonera's service centre, which are made available to the customer. Elisa delivered its largest VoIP solutions to the MELTA (Finish Forest Research Institute), which have 20 offices all over the country and employ approximately 1 000 people. Other major operator Finnet Group offers also VoIP services. Its largest VoIP solution delivered in spring 2004 to burger chain Hesburger, which has more than outlets in Finland, Estonia and Germany. New operator Ipon Communications has launched VoIP services to business and private users in November 2003.

France

78. Free Telecom, one of the largest ISPs in France and subsidiary of the Iliad group, launched VoIP services in August 2003. The service is provided as a free add-on to the company's ADSL service which costs 29.99€ per month. The service package includes unlimited free calling to any wireline number within France (except special numbers) and to other Free Telecom subscribers, in addition to a charge of EUR 0.19 (USD 0.23) per minute to call mobile phones and a charge of EUR 0.03 per minute to call any wireline number in Germany, United Kingdom, USA, Hong-Kong, Italy, Portugal, Australia,. However, this system will be replaced by 10 hours of free calling with charges of EUR 0.01 (USD 0.01) per minute for calls above that amount after one year of the service commencement. Although the service does not include voice mail, it provides call forwarding as well as three-way calls.⁸⁴ Free Telecom acquired about 635 000 subscribers as of December 2004.

79. Following Free, Neuf Télécom announced the launch of its own VoIP services in September 2003. However, only businesses could, in the first instance, subscribe to these services and individual subscribers from 15 June 2004. A local call costs 3 eurocents a minute and a national call 9 eurocents a minute. Calls to mobiles were priced at 5 to 25 eurocents a minute. Calls are free between clients that subscribe to the high speed 2 mega option and have a n9uf modem. There is also an offer (*Forfait France Illimité*) priced at 29.90€ a month for high speed Internet access and telephony which allows for unlimited calls to all fixed telephones.

80. In December 2003, Telecom Italia launched its high speed DSL offer "Alice" including telephony (from 2004 with total unbundling). With their telephone offer (*Alice Téléphone Libre*), a local call was priced at 1 eurocent a minute and a national call at 3.1 eurocent a minute and in addition, Alice

has an unlimited call offer. Telecom Italia has commercialised these offers in the main urban centres in France: Paris, Marseille, Nice, Lyon, Nantes, Bordeaux, Strasbourg and Lille.

81. Cegetel implemented a pilot project to deploy VoIP telephony for the Sabre Travel Network in March 2004. This project is regarded as an initial step before commercializing VoIP services to enterprises.⁸⁵ In May 2004, Cegetel announced an unlimited ADSL and telephony offer for local and national calls for residential customers.

82. France Telecom announced that it would launch a full range of VoIP services for business users in May 2004.

83. Equant, a France Telecom Group IP-based service provider, started PC-to-PC international VoIP services in July 2002. The service has been available in more than 60 countries.⁸⁶ One of the first corporate customers was the European Space Agency (ESA), which signed a USD 1.5 million contract for the company's Voice for IP VPN services for ESA space missions.⁸⁷

84. Tiscali France launched its VoIP service in France with a monthly charge of EUR 30 in June 2004. Subscribers are required to sign up for a broadband contract of 12 months at minimum.⁸⁸

Germany

85. Quality Service Communications AG (QSC) launched commercial residential VoIP services named IPfonie to its existing DSL subscribers in December 2003. The services cut all incumbent DT's voice tariffs by more than two thirds. Voice calls between IPfonie subscribers are free. While QSC's basic DSL service costs EUR 49.9 (USD 57.4) per month, the subscribers can use VoIP services if they pay an extra charge of EUR 4.99 (USD 5.74) (plus a one-off setup fee of EUR 9.99).⁸⁹

86. Telefonica Deutschland announced its plan to launch commercial business VoIP services in August 2003. The services target large enterprises and small and medium businesses and comprises internal and external calls to the networks of other operators as well as mobile operators.⁹⁰

87. Kabel NRW, a Cologne-based private cable network company, upgraded its network to deliver video, high-speed Internet access and VoIP to subscribers in 2001.

88. Kabel BW has launched telephony over cable services based on VoIP technology. Reportedly, 75% of the 15,000 broadband Internet customers of the company use the service.⁹¹

89. German ISP freenet.de offers its VoIP services, freenet iPhone to all German DSL users. The company launched the iPhone plus and basic services in May 2004 for all freenet.de DSL customers. The service enables users to call via their broadband connection to other DSL users and all German fixed networks. Freenet iPhone costs EUR 2.95 (USD 3.62) per month including 100 free minutes for calls to German fixed networks and a telephone number. Calls to other iPhone users are free and calls to German fixed networks normally cost EUR 0.049 (USD 0.06) per minute.⁹²

90. Reportedly, Deutsche Telekom plans to launch VoIP services by viewing the services not as replacing PSTN but as a value-added service to complement existing broadband offerings. However, the launch date was not known as of March 2004.⁹³

Hungary

91. The incumbent Matav launched a field trial for international VoIP services by applying the T-NetCall project of Deutsche Telekom in 1999. It started to provide VoIP services, which are card-based services named IP Tel.⁹⁴

92. Other operators are also providing VoIP services in certain markets. PanTel Rt. started to provide business VoIP services named PanTalk in 2000. There is neither a subscription fee nor a set-up fee charged for this service. The company has also launched another VoIP services named PanPhone. The initial price for the services is HUF 50 000 (USD 237.3), but no monthly fee is charged.⁹⁵ EuroWeb Hungary, a subsidiary of PanTel, provides VoIP services known as NeoPhone. In this service, voice traffic routes through PanTel's IP infrastructure.⁹⁶ Novacom also started VoIP services named NovaCall in November 1999, which offer about 40% lower international call tariffs than those of Matav's PSTN international services.⁹⁷

Ireland

93. Although VoIP services are being deployed in Ireland, they are still limited. Eircom started to use the Net2Phone VoIP services for some international traffic in June 2000. After BT's launch of VoIP services in the UK in December 2003, its subsidiary in Ireland, EsatBT, began to look at how such offerings could be rolled out within the country in the future. International IP telephony services are available through some providers such as ePhone.⁹⁸ Some VoIP wholesalers such as ITXC and iBasis have installed gateways to transmit locally dialled calls to international IP networks.

94. VoIP Ireland launched VoIP services targeted both at residential and corporate customers in Ireland in February 2004. According to the company, the service can reduce telephone charges by up to 90% of other traditional telephone services.⁹⁹

95. VoIP technology is being introduced in a number of private networks. For example, the National Software Centre in Cork deployed a VoIP network provided by Nortel. The LUAS transport network in Dublin is also being deployed VoIP technology.¹⁰⁰

Italy

96. Telecom Italia has been restructuring its network for a number of years. Since 2002 all calls between Rome and Milan and 50% of the company's international calls were run over a converged IP network. In April 2003, the company announced that it expected to complete full network migration to IP networks by the end of March 2004.¹⁰¹

97. FastWeb started VoIP services using fibre-optic connections in October 2002.¹⁰² Voice calls between FastWeb subscribers are free of charge, and national calls are charged at EUR 0.12 (USD 0.15) per minute.¹⁰³ There is also a flat-rate plan named 'voce senza limiti' (limitless voice). Beyond the basic call capabilities, the company offers supplementary services with additional charges (for example, EUR 1 (USD 1.2) per month for call blocking) including unconditional call forward, call waiting and voicemail.¹⁰⁴ FastWeb reportedly acquired about 340 000 VoIP subscribers as of December 2003.¹⁰⁵

98. Pan-European Internet service provider Tiscali announced the launch of VoIP services to its residential ADSL subscribers by cooperating with NetCentrex, a platform where new generation services are made possible, in February 2004.¹⁰⁶ As a result, subscribers in Italy should be able to make voice and video calls using their broadband service by the autumn of 2004.¹⁰⁷

Japan

99. Japan is a leading country in offering commercial VoIP services in that a number of Internet service providers have started services, particularly since March 2003. The market is becoming competitive to allow some of them to provide VoIP bundled with broadband Internet access to attract customers who want the two services at cheaper prices.

100. One of the examples of a new service provider of VoIP in Japan is Softbank, which launched VoIP services named BB Phone as early as April 2002. The service offers free calls among subscribers as well as voice calls with fixed telephones at JPY 7.5 (USD 0.071) per three minutes throughout the country.¹⁰⁸ As of November 2003 there were 3.3 million subscribers of BB Phone.¹⁰⁹ In November 2003, Softbank allocated special numbers for Japan's VoIP services (which starts from 050) to its BB Phone subscribers.¹¹⁰ The company announced in February 2004 that it would commence interconnection between BB Phone and mobile telephones with the same tariff.¹¹¹

101. FreeBit also launched VoIP services named YourNet Phone using facilities provided by NTT East and NTT West in March 2003. Users of the services have to be a subscriber of ADSL or fibre-optic network services provided by the NTTs. With a monthly basic charge of JPY 280 (USD 2.65), it offers free voice call services between its subscribers or with VoIP subscribers using the same platform. Voice calls with a fixed network is charged at JPY 7.5 (USD 0.071) per three minutes.¹¹² In October 2003, FreeBit developed a new VoIP service named FreeBit OfficeOne IP Business Phone designed for corporate customers based on IPv6 technology.¹¹³

102. Excite Corporation launched VoIP services named BB.excite Phone that correspond to ADSL or fibre-network services provided by NTT East and NTT West in March 2003. With a monthly basic charge of JPY 277 (USD 2.63), it offers free voice call services between its subscribers or with VoIP subscribers provided by affiliated operators. Voice calls with a fixed network is charged at JPY 7.5 (USD 0.071) per three minutes.¹¹⁴

103. NEC's Internet service BIGLOBE launched VoIP services named BIGLOBE-Phone using facilities provided by NTT East and NTT West in March 2003. With a monthly basic charge of JPY 280 (USD 2.65), it offers free voice call services between its subscribers or with VoIP subscribers provided by Plala Networks. Voice calls with a fixed network is charged at JPY 8 (USD 0.076) per three minutes.¹¹⁵ In January 2004, the company started to offer voice communications between BIGLOBE-Phone and mobile phones within the country.¹¹⁶

104. Panasonic hi-ho launched VoIP services using NTT Communications networks in April 2003. Voice calls between its subscribers and with subscribers of other providers using NTT Communications' networks are free of charge. Voice calls with a fixed telephone is charged at JPY 8 (USD 0.076) per three minutes.¹¹⁷ In November 2003, the company enabled subscribers to make a call with subscribers of mobile phones provided by NTT Communications, which is charged at JPY 19 (USD 0.18) per minute.¹¹⁸ It also expanded the services to use VoIP networks provided by Plala Networks in January 2004.¹¹⁹

105. ASAHI Net launched two types of VoIP services in March 2003. The 'IP Telephone C' service uses VoIP networks provided by NTT Communications whereas 'IP Telephone F' service uses those provided by NTT-ME as well as NTT East and NTT West. Both services provide free voice call services within affiliated networks and charge JPY 8 (USD 0.076) per three minutes for calls with fixed telephone within the country.¹²⁰ The company offered campaign service between September 2003 and March 2004, during which subscribers can enjoy free registration fee as well as free three-month basic charges.¹²¹

106. Nifty Corporation launched VoIP services named '@nifty phone' to its broadband subscribers in March 2003. With a monthly charge of JPY 280 (USD 2.65), voice calls between its subscribers and with subscribers of other affiliated providers are free of charge. Voice calls with a fixed telephone are charged at JPY 8 (USD 0.076) per three minutes.¹²² Customers who subscribed to this service during March 2003 could enjoy the benefit of no monthly charges for initial six months.¹²³

107. Fusion Communications launched VoIP services named Fusion IP-Phone to both residential and corporate customers in February 2003.¹²⁴ With a monthly charge of JPY 380 (USD 3.51), voice calls between its subscribers and with subscribers of other affiliated providers are free of charge. Voice calls with a fixed telephone are charged at JPY 8 (USD 0.076) per three minutes.¹²⁵

108. Media Corporation, established in December 2000, launched VoIP services named 'M-Line' using fibre-optic networks in January 2002. The service enables subscribers to use both IP telephony and fibre-optic broadband Internet access simultaneously. Voice calls between subscribers are free of charge. Monthly basic charge starts from JPY 63 000 (USD 567.16), and voice calls with a fixed telephone within a city are charged at JPY 6 (USD 0.054) per three minutes and JPY 10-18 (USD 0.095-0.162) for across a city.¹²⁶

109. Forval officially started VoIP services named FT Phone to small-and-medium-sized corporate users using fibre-optic networks in October 2003. With a monthly charge of JPY 5500 (USD 49.1), voice calls to a fixed telephone is charged at JPY 7.5 (USD 0.071) per three minutes. Subscribers of the service do not need to change existing fixed-telephone numbers and can also enjoy high-speed Internet access services using fibre-optic networks at the same time.¹²⁷

110. IPTalk launched VoIP services named IPTalk-Pro to corporate customers in December 2002. Voice calls between its subscribers are free of charge. Voice calls to a fixed telephone are charged at JPY 8 (USD 0.076) and to a mobile phone at JPY 49 (USD 0.44) per three minutes nationwide.¹²⁸

111. Usen Broad Networks started a VoIP service, Gate Call, using fibre-optic networks to collective residential customers in selected markets in November 2002. With a monthly charge of JPY 315 (USD 2.9), voice calls between its subscribers are free of charge. Voice calls to a fixed telephone is charged at JPY 4.2 (USD 0.039) per two minutes.¹²⁹ This service uses the same types of telephone numbers as for traditional PSTN. In March 2004, the company expanded the service area nationwide.¹³⁰

112. Moranet Inc., funded by ITX and Usen Broad Networks, started VoIP services named Mora-Phone using its fibre-optic networks in February 2004. Users of the services do not have to change their existing telephone numbers. With a monthly charge of JPY 1800 (USD 17.2) excluding connection fee for Internet access, voice calls between its subscribers and with subscribers of other affiliated providers are free of charge. Voice calls to a fixed telephone is charged at JPY 8 (USD 0.076) per three minutes.¹³¹

113. Asia Internet Holding Co. (AIH) launched wholesale VoIP services named 'A-Bone' in June 2003. The services targets telecommunications operators including ISPs by providing VoIP services to 239 countries and regions around the world. The company is also planning to launch a VoIP service for corporate users in Japan.¹³²

114. There are rising numbers of regional operators that provide VoIP services in selected markets. For example, Kyushu-based QNet launched VoIP services named BBIQ using fibre-optic networks in December 2002. With a monthly basic charge of JPY 300 (USD 2.72) as well as monthly BBIQ terminal usage fee of JPY 300 (USD 2.72), voice calls between subscribers are free of charge. Voice calls to a fixed telephone are charged at JPY 8 (USD 0.076) per three minute within Kyushu region and JPY 15-30

(USD 0.14-0.27) without the region. The first two-month monthly basic charges were free for those who joined the services before the end of March 2003.¹³³

115. NTT Neomeit Nagoya started to provide residential VoIP services to its existing customers in February 2004. With a monthly charge of JPY 280 (USD 2.6), voice calls between its subscribers and with subscribers of other affiliated providers are free of charge. Voice calls with a fixed telephone are charged at JPY 8 (USD 0.076) per three minutes.¹³⁴

116. Large operators are also actively entering the VoIP market. For example, NTT Communications launched VoIP services named OCN.Phone in March 2003. With a monthly basic charge of JPY 380 (USD 3.6), voice calls between its subscribers and with subscribers of other providers using the company's network are free of charge. Voice calls with a fixed telephone is charged at JPY 8 (USD 0.076) per three minutes throughout the country.¹³⁵ In April 2003, NTT Communications substantially started another VoIP service named Phone IP Centrex for corporate users.¹³⁶ With a monthly basic charge of JPY 1,100 (USD 10.43), subscribers can make an external call at JPY 8 (USD 0.076) per three minutes.¹³⁷ NTT Communications is currently expanding and enriching VoIP services. For instance, it started to provide bundled services with fibre-optic networks, where the fibre-optic subscribers are exempt from initial fee as well as monthly basic charges of OCN.Phone, in November 2003. By these services, customers can use both high-speed Internet connection and VoIP services with a single monthly rate starting from JPY 1 880 (USD 17.82).¹³⁸ Subsequently, it allowed its VoIP subscribers to make a call to mobile phones in the same month.¹³⁹ At the same time, it began to offer special telephone numbers for VoIP calls in Japan, which starts from 050.¹⁴⁰ This measure has allowed its VoIP subscribers to receive calls from fixed and mobile telephones. In January 2004, it started interconnection between its VoIP services and those provided by Plala Networks with maintaining the existing call rate of JPY 8 (USD 0.076) per three minutes. In March 2004, NTT Communications started international VoIP services available for 88 countries to corporate users, which might drive existing international telephone operators to reduce the tariffs.¹⁴¹

117. NTT-ME started VoIP services named 'XePhion Call Pro' in December 2002. Subscribers of this service must be a subscriber of NTTs' ADSL or fibre-optic services as well as NTT-ME's Internet access service called WAKWAK. Voice calls between subscribers are free of charge. Voice calls to a fixed telephone are charged at JPY 10 (USD 0.095) per three minutes and international calls to about 240 countries and areas are available. Monthly charges depend on the number of telephone numbers, JPY 2 200 (USD 19.8) or a single number and JPY 5 000 (USD 45.0) for two numbers.¹⁴²

118. Japan Telecom launched VoIP services named ODN IP Phone to its ODN ADSL subscribers in March 2003. With a monthly basic charge of JPY 400 (USD 3.79), which was free between March 2003 and September 2003 because of a campaign, voice calls between its subscribers are free of charge. Voice calls with a fixed telephone is charged at JPY 8 (USD 0.076) per three minutes throughout the country.¹⁴³ The company also began to offer VoIP services for corporate users named IP-One IP Phone with a monthly basic charge of JPY 2 000 (USD 18.96) and charges of JPY 8 (USD 0.076) for calls to a fixed telephone per three minutes throughout the country in July 2003.¹⁴⁴ It further commenced another VoIP services for corporate users named IP-One Centrex, which will enable calls within affiliated companies as well as 24 hour maintenance services from service bases. The monthly charge of the services is JPY 1 100 (USD 10.43), and the service can be combined with IP-One IP Phone.¹⁴⁵ In December 2003, Japan Telecom started interconnection between VoIP services and mobile phones.¹⁴⁶

119. KDDI launched VoIP services to corporate users in November 2002 and to individual customers in April 2003. For VoIP services to individual customers, subscribers are required to pay a monthly basic charge of JPY 2 980 (USD 28.25), which also includes the fee for ADSL services, whereas corporate users have to pay JPY 600 (USD 5.688) per channel per month. Both services provide free voice calls within the subscribers. Voice calls to a fixed telephone are charged at JPY 8 (USD 0.076) per three minutes for

corporate users and JPY 8 (USD 0.076) per three minutes for individual users throughout the country.¹⁴⁷ The bundled service of VoIP and ADSL for individual customers is provided with a monthly basic charge of JPY 2 980 (USD 28.25), except JPY 780 (USD 7.4) of IP telephony modem rental fee.

120. PowerdCom started VoIP services named 'POINT Phone' to its ADSL or fibre-optic service users in May 2003. With a monthly fee of JPY 100 (USD 0.95), voice calls between subscribers are free of charge. Voice calls with a fixed telephone are charged at JPY 7.5 (USD 0.071) per three minutes.¹⁴⁸ In August 2003, the company started a corporate VoIP service named 'Powered IP Centrex'. The service allows corporate users to make a voice call by using IP Centrex facilities without installing PBX. Monthly basic fee is JPY 1 100 (USD 9.9) and voice calls to a fixed telephone are charged at JPY 7.5 (USD 0.071) per three minutes.¹⁴⁹ In December 2003, PoweredCom further launched another corporate VoIP service named 'Powered IP Phone' using broadband networks such as ADSL and FTTH (fibre-to-the-home). With a monthly basic fee of JPY 350 (USD 3.18), voice calls with subscribers of PowerdCom's VoIP services are free of charge. Voice calls to a fixed telephone are charged at the same as POINT Phone, JPY 7.5 (USD 0.071).¹⁵⁰

121. Incumbent telephone operators are not reluctant in offering VoIP services. For example, NTT East and NTT West announced in April 2002 that it would freeze new investment in local exchanges for PSTN networks in prospect of the development of IP telephony, although they will continue to maintain existing facilities. Subsequently, they launched VoIP services to corporate users in October 2003.¹⁵¹ The basic monthly charge will be JPY 80 000 for up to 100 channels. Voice call to a fixed telephone is charged at JPY 6 (USD 0.057) per three minutes within a prefecture and JPY 10 (USD 0.095) per three minutes across prefectures.¹⁵² In the same month, they also allowed calls from a fixed telephone to an IP telephone that has a special number for VoIP services in Japan starting from 050 by interconnecting its PSTN networks with IP networks provided by ISPs.¹⁵³ In March 2004, NTT East and NTT West announced that it would offer VoIP services using their fibre-optic networks to individual users as well.¹⁵⁴ Reportedly, NTT West will also launch a service for corporate customers integrating networks for fixed-line VoIP and mobile phones.¹⁵⁵

Korea

122. A number of providers are offering VoIP services with a variety of services in Korea. The Korean domestic VoIP service market is estimated to be worth around KRW 42.5 billion (USD 36 million) in 2003 and anticipated to grow 86% annually to reach KRW 320 billion (USD 272 million) by 2007.¹⁵⁶

123. Hanaro Telecom launched in April 2002 a bundled service named 'HanaFos Cable + Phone' using CATV networks, which allows its residential customers to use high-speed Internet as well as VoIP. The subscribers can enjoy local and long-distance call services with charges of KRW 39 (USD 0.03) per three minutes and monthly basic charge of KRW 1 000 (USD 0.86). It also offers free call services among subscribers.¹⁵⁷

124. Onse Telecom entered into an agreement with Startec Global Communications Corporation, a leading VoIP service provider, for the provision of VoIP services in June 2000. Under the agreement, Onse Telecom will use Startec's network to provide VoIP services and Startec will in turn provide VoIP services to Koreans living in North America.¹⁵⁸

125. Korea Thrunet, the largest cable modem broadband Internet access service provider in Korea, launched VoIP services for residential and small-office-home-office (SOHO) customers in September 2001. Since January 2000, the company had offered free local, long-distance and international telephone service on a trial basis under the brand name 'True Phone'.¹⁵⁹ With a monthly basic charge of KRW 3 000 (USD 2.6), phone-to-phone domestic VoIP calls are charged at the same rate as local telephone calls. The

gateway at a customer premise enables users to access the service using circuit-switched telephones even if the PC is turned off.¹⁶⁰

126. The Korean Information Service Corporation (KOIS), a subsidiary of Korea Telecom (KT), awarded Fortinet, a network protection system provider, with a two-year contract to supply FortiGate TM Network Protection Gateways for converged data and VoIP virtual private network (VPN).

127. Kagoor Networks, a VoIP traffic management company, announced its entrance into Korean VoIP market through a value-added-reseller agreement with A.T.M. Networks Inc., in December 2001.¹⁶¹

128. A Korean ISP, HansoliGlobe launched VoIP services together with Net2Phone, a U.S. leading VoIP provider, in February 2003. The main target of the services is corporate users. With this joint venture, HansoliGlobe can integrate Net2Phone's services with its data offerings whereas Net2Phone is capable of expanding its service offerings without investing heavily in capital expenditures.¹⁶²

129. Telecom.114 provides VoIP services named 'Good Phone'. The service allows unlimited calls with monthly charges of either KRW 39 600 (USD 34.2) or KRW 49 500 (USD 42.8) depending on the coverage areas of international calls.¹⁶³ The company also provides 'Couple Phone' VoIP services. With a monthly charge of KRW 5 000 (USD 4.3), subscribers can make unlimited calls with specified persons.

130. Tellfree provides VoIP services. Although voice calls between subscribers over its IP networks are free, calls to PSTN are charged by special cyber money called Guild.

Luxembourg

131. Luxembourg-based Skype Technologies, S.A. (Skype) started to offer peer-to-peer VoIP software throughout the world in September 2003. The company does not provide servers, routers, switches or other transmission facilities since its product is purely a software application. Users are able to communicate with other Skype user by installing this software. It has been reported that 4.5 million people have downloaded Skype's free software as of April 2004. While Skype users are unable to connect to the PSTN as of April 2004, the company is expected to offer its users a means to do so before long. However, the software will not permit PSTN-to-PSTN communications.

132. In April 2004, Skype launched a test version of its new VoIP application named PocketSkype, which is designed for personal digital assistants (PDAs). PocketSkype is also meant for devices that use mobile phone standard GPRS (General Packet radio Service). These services are not able to make voice calls but can use an instant-messaging feature that accompanies all version of Skype software.¹⁶⁴

Netherlands

133. In March 2004, Scarlet Netherlands started VoIP services over DSL named SpaarTotaal to its existing ADSL subscribers. Voice calls to other subscribers of the service are free of charge for at least the first year. Subscriptions charges are about 20% lower than the incumbent KPN's tariffs for fixed telephones and 30% lower for ISDN connections. Subscribers need to buy a special modem for EUR 139 (USD 170), but will be able to use their existing telephone equipment without changing their telephone numbers.¹⁶⁵ KPN plans to offer VoIP services in late 2004 or early in 2005.¹⁶⁶

Norway

134. Telio started testing VoIP services in October 2003 and launched commercial services in February 2004.¹⁶⁷ Voice calls to fixed telephone within the country are free of charge, and across the

country are free up to 100 voice minutes (except some countries). Voice calls to mobile phones are charged at NOK 0.95 (USD 0.13) per minute.

Poland

135. Netia announced the introduction of its new data transmission service (IP VPN) for business customers using IP in December 2003.¹⁶⁸

Portugal

136. Cabovisao, the second largest cable operator in Portugal, deployed Nuera Communications' VoIP gateways to offer IP telephone services. While the company has provided voice services to more than 180 000 subscribers using Constant Bit Rate technology, it plans to grow its voice services using VoIP to take advantage of a converged voice, data and video network.¹⁶⁹

Spain

137. Telefonica de Espana announced in March 2004 that it signed a contract with Hughes Network Systems, provider of broadband satellite solutions, to add VoIP services to its existing DIRECWAY network. Telefonica is implementing the DIRECWAY VoIP solution in order to replace the existing rural telephony networks.¹⁷⁰

138. Tiscali is providing VoIP services using Lucent Technologies' APX 8000 and MAX TNT Softswitch Internet Call Diversion systems.¹⁷¹

139. Peoplecall is providing VoIP services using ADSL or cable networks.¹⁷² Voice calls within Spain are charged at EUR 0.05 (USD 0.06) and to rest of the world in Europe at EUR 0.08 (USD 0.1) per minute.

Sweden

140. There are some VoIP service providers, which offer IP telephony over a broadband connection using telephony adapters. For example, Bredbandsbolaget (B2) launched VoIP services in August 2002 and has about 18 000 subscribers as of December 2003.¹⁷³ Digisip has also been providing VoIP services since August 2002 with about 2 000 subscribers.¹⁷⁴ Another provider IP Only is mainly targeting the enterprise market, although some estimate that only about 1 000 enterprises in Sweden use VoIP in their networks as of the end of 2003.

141. In February 2004, TeliaSonera launched its Telia Broadband Telephony service, which features a chat function, video calls and the possibility to send messages.¹⁷⁵ With a one-off fee of SEK 250 (USD 33) and a monthly fee of SEK 80 (USD 10.6), subscribers to this service can make calls free while calls outside the service (to fixed and mobile networks) costs the same as traditional PSTN calls. This service requires a broadband connection of more than 128 Kbps for upstream and downstream.¹⁷⁶ Subscribers are given a telephone number with the 075 dialling code. The application of the Telia Broadband telephony has been developed with TeliaSonera Finland and the Swedish software company Hotsip AB.

Switzerland

142. Cablecom, the largest cable network operator in Switzerland, started limited VoIP services for public telephony in February 2003, although interconnection to other operators, particularly to the incumbent, is implemented based on traditional TDM (Time Division Multiplexing).¹⁷⁷ The subscriber is estimated at about 32 000 as of June 2004.

143. Econophone, offering voice and Internet services in Switzerland since 1998, launched its Econostream product in March 2004. Subscribers receive a VoIP converter in which the analogue telephone can be plugged. Like Cablecom, Econophone is offering number portability throughout Switzerland.

144. E-fon, a new entrant, has launched a new VoIP product. The subscriber can choose between soft-fon (software on PC), box-fon (VoIP converter) or a combination of it. Whereas telephone calls among e-fon subscribers are free of charge, the monthly fee includes 100 minutes of telephone calls with the Swisscom fixed network.

145. Besides the offers for residential subscribers, several operators are offering VoIP products for business clients including local and regional administrations.

United Kingdom

146. British Telecom (BT) began to provide subscribers of two cable companies, Telewest and NTL, with VoIP services named Broadband Voice in December 2003. The service costs GBP 7.50 (USD 14.28) per month, allowing customers to make as many UK evening and weekend calls of up to an hour for no extra charge. Daytime calls will be charged at GBP 0.03 (USD 0.05) per minute, with a GBP 0.05 (USD 0.09) minimum charge.¹⁷⁸ The company claims that cable subscribers who take up Broadband Voice package will be able to save up to 57% on calls to mobiles and up to 25% on UK daytime calls.¹⁷⁹ In March 2004, BT created a 'converged communications' service package named BT Communicator, which will allow users to make VoIP calls, a digital content platform to help individuals distribute broadband content, and a remote management system for fault-finding and fixing home networks.¹⁸⁰ It will be made available for trial in May 2004.¹⁸¹ The package combines voice services with the features and functionality of Yahoo Messenger, which will provide VoIP calls from an instant-messaging subscriber to any (circuit-switched) telephone in the world.¹⁸² The full integration is expected to commence during 2004, and the two companies plan to share revenue from the service.¹⁸³ In the same month, BT announced the launch of a range of VoIP services in key European countries. The services mainly consist of two products. BT Multimedia VoIP (MM VoIP) provides advanced multimedia communications embedded with services such as real-time video-to-the desktop, unified messaging, file sharing and white boarding. BT VoIP Port is a corporate VoIP services that work with companies' TDM PBXs and handsets, by which companies do not have to invest in expensive IP equipment. Both services will be available in Ireland and Spain in the summer of 2004 with other countries including Germany and the Netherlands later in the year.¹⁸⁴

147. Other providers of broadband Internet access are also beginning to provide VoIP services. For example, Broadreach announced in November 2003 that it would launch VoIP services named ReadytoTalk TM in the second quarter of 2004. The services will enable customers to make calls at any of Broadreach's hotspots across the UK to anywhere in the world.¹⁸⁵ NPlusOne launched VoIP services to small and medium sized business users in June 2003.¹⁸⁶

148. Cable & Wireless Cayman Islands selected Nortel Networks to deploy VoIP network for the purpose of helping drive increased network efficiency as well as reduced network costs in January 2004.

149. Vonage Holding Corp. is reportedly set to launch a service in the U.K. in the fourth quarter of 2004 with a cable firm with a number of broadband subscribers.¹⁸⁷

United States

150. There are a number of VoIP providers in the United States and some forecasts estimate more than five million customers by 2007 (a fivefold increase over 2002 levels) in that country. As of March

2004, there are about 100 000 lines provided through IP PBXs, but by 2007 the number is expected to increase to more than 1.7 million lines.¹⁸⁸

151. Local carriers, or RBOCs, are beginning or planning to launch VoIP services. For example, Qwest Communications International, the fourth largest local telephone operator in the United States, launched VoIP services in Minnesota, mainly targeting residential customers, in December 2003. The Minnesota public utilities commission issued a decision that Vonage was a regulated telephone service; in response Vonage requested that a federal court block the Minnesota decision. A subsequent decision was made by the U.S. District Court that Minnesota cannot treat VoIP providers as regular telephone companies or collect regular fees.¹⁸⁹ To date, incumbent operators in the U.S. have sold their DSL services as adjuncts to their existing voice offerings. In order to purchase DSL, a subscriber would first have to have a POTS line. Qwest recently announced that it would provide DSL to a subscriber who did not order POTS service, thus making it possible for a VoIP offering to displace traditional voice service altogether.

152. SBC Communications started VoIP service, SBC Premier SERVSM Hosted IP Communication Service (HIPCS), mainly aimed at business customers in November 2003.¹⁹⁰ It has rolled out the service in 18 metropolitan areas and plans to deploy it to 30 metropolitan areas by the end of 2004. The service includes unified messaging, 'find me, follow me' that enables business employees to forward calls to a mobile phone, remote office or another extension, and 'click to call' that enables one-click calling from a telephone set or PC Web browser. The price of HIPCS starts at USD 30 a month per phone for unlimited local calls and USD 40 for unlimited local and long-distance calls.¹⁹¹ Table 3 shows the main RBOCs' plans for VoIP services.

153. Verizon announced its plan in November 2003 to offer an unlimited VoIP service, called Broadwing with a flat fee by the second quarter of 2004 and started them in July 2004. The company will also target small and medium sized businesses with more expensive VoIP plans.¹⁹² Verizon announced that it would invest up to USD 13 billion in 2004, and a similar amount each year for the next several years, in upgrading its network with fibre, 3G wireless, and IP-based technology.¹⁹³

Table 3. Main RBOCs' plans for VoIP services in the United States (as of February 2004)

Providers	Services	Availability
BellSouth	Managed VoIP for small businesses	Currently available
	Centrex IP market trials	Later in 2004
	Network-based, softswitch-enabled VoIP services	Later in 2004
Qwest	VoIP in Minnesota to DSL residents in Minneapolis-St. Paul	Currently available
	Additional residential and small-and-medium-sized business and corporate customers	First half of 2004
SBC	PremierServ Hosted IP Communications Service: nationwide managed VoIP for small-and-medium-sized businesses	Currently available in 18 metropolitan areas. At the end of 2004, it will be available in 30 metropolitan areas.
Verizon	Non-QoS VoIP service for consumer broadband customers (This is not limited to DSL because it is not limited to Verizon customers.)	Second quarter of 2004
	Managed service offering for residences and businesses	Fourth quarter of 2004

Source: NetworkWorldFusion¹⁹⁴

154. A leading broadband service provider Covad Communications announced plans in February 2004 to offer VoIP services to business customers in the majority of the country's top Metropolitan Statistical Areas by the fourth quarter of 2004.¹⁹⁵ In 2004, the company completed its acquisition of GoBeam Inc., a

privately-owned provider of VoIP services and is offering service to business.¹⁹⁶ Covad claims that it would ensure quality of services on an end-to-end basis with its own IP networks while most emerging VoIP providers rely on networks provided by other operators.

155. Some long-distance telephone companies are also entering the VoIP businesses. This may be linked to the recent decline in long distance PSTN revenues, partly resulting from the growing use of mobile services for long distance. For example, AT&T announced in September 2003 that it would introduce VoIP service offered over a VPN (Virtual private Network) that it sells to business customers.¹⁹⁷ Subsequently, AT&T launched VoIP services named Callvantage available to any broadband subscribers regardless of where they are located in March 2004. Subscribers pay USD 29.99 per month to make unlimited local and long-distance calls as well as voicemail. A comparable unlimited calling plan with AT&T's circuit-switched telephone service is USD 49.95 (excluding taxes) in New Jersey.¹⁹⁸ The service features also include sending incoming calls to up to five different telephone numbers simultaneously. However, the tariff plan does not cover broadband connections, and customers have to subscribe to either DSL or cable network, which will add USD 35 to USD 60 per month to a consumer's total cost. AT&T expects to have one million business and residential subscribers in 100 U.S. markets by the end of 2005.¹⁹⁹ AT&T is also offering to partner with cable operators in the US to provide turnkey VoIP cable modem connections. The retail service might carry the cable operator's brand, or be co-branded.

156. MCI has been offering network-based business VoIP services named MCI Advantage since 2001, with a hosted service and other features available since October 2002.²⁰⁰ It has also announced plans to shift nearly all of its voice traffic to IP-based networks by 2005. In March 2004, MCI announced that it would integrate MCI Advantage service with VPN service named Private IP in order to deliver enhanced voice and data applications in a corporate network environment.²⁰¹ With the expansion of its hosted PBX and IP Centrex capabilities, the company is attempting to add new functionality such as call screening, simultaneous ring, auto attendant, and third-party conferencing. Reportedly, MCI Advantage will also support emergency call (911) capabilities.²⁰²

157. A number of small operators have been attempting to introduce VoIP services in an effort to prevail over competitors that are providing similar services without having to deploy new networks.²⁰³ For example, Net2Phone started VoIP services named Net2Phone Direct as early as in November 1996.²⁰⁴ With a Net2Phone Direct Calling Card, subscribers can make voice calls within the U.S. and Canada without a connection fee.²⁰⁵ In June 2001, the company launched VoiceLineSM service, which enables subscribers to place and receive telephone calls over broadband networks using standard telephones without the need for a PC. For USD 9.99 – 49.99 per month, subscribers can choose the calling plan ranging from USD 0.029 per minute for 1,700 domestic minutes per month to USD 0.039 per minute for 250 domestic minutes per month.²⁰⁶

158. Vonage Holding Corp., founded in January 2001, offers VoIP services, mainly targeting residential users.²⁰⁷ It is currently expanding service coverage areas. Since the inception of the company through December 2003, Vonage has handled more than 100 million calls over its VoIP network and the activation of 100,000 total lines on its VOIP network by February 2004.²⁰⁸ Vonage reportedly acquired more than 50,000 VoIP subscribers as of September 2003, 150,000 as of February 2004,²⁰⁹ and it expects to get one million subscribers by late 2005.²¹⁰ Vonage does not provide its subscribers with Internet access, but supplies software and a multimedia terminal adapter that will allow them to use circuit-switched telephones to place calls over broadband Internet connections.²¹¹ Thus, Vonage bridges the gap between the World Wide Web and the PSTN by permanently converting information from one transmission format to the other, which distinguished it from any traditional "telecommunications services." With regard to numbering, Vonage's VoIP services allow subscribers to choose their long-distance code. Therefore, subscribers can, for example, use the long-distance code of New York even if they live in New Jersey. In March 2004, Vonage unveiled its plan to make portable Wi-Fi telephone available during 2004. Vonage is

already offering services to residential customers in Canada and will begin to provide its VoIP call services in some other countries in late 2004.²¹²

159. 8x8 launched a VoIP service named Packet 8 in November 2002. The service include several plans starting at USD 5.95 per month, which provide subscribers with unlimited voice calls between Packet 8 subscribers, voicemail, Internet-based account management, bundled long-distance minutes and calling features such as caller ID and call forwarding. The service can be combined with a broadband videophone, DV325, which enables high-speed video calls over the IP network anywhere in the world.²¹³ 8x8 also announced the immediate availability of enhanced emergency call (E911) services for subscribers to the Packet 8 VoIP services.²¹⁴

160. Pulver.com launched a peer-to-peer VoIP services named Free World Dialup (FWD) in December 2002 and it acquired more than 75 000 subscribers one year later. FWD subscribers use a SIP telephone or a PC to make calls to other FWD subscribers that do not use PSTN, and they can make toll-free international calls. In February 2004, the FCC ruled that Free World Dialup would remain free of traditional telephone regulations in response to the company's request.

161. VoicePulse, a New Jersey-based technology company, launched VoIP services to broadband subscribers (typically cable or DSL) in April 2003.²¹⁵ For example, its 'America Unlimited Calling Plan' is priced at USD 24.99 per month (with minimum contract term for a year) to allow unlimited local and long-distance calls in the U.S.²¹⁶ The company's services also include some advanced features such as voicemail and anonymous call rejection in addition to traditional features such as call waiting and call transfer.²¹⁷ VoicePlus entered into an agreement with Information and Communication Systems to provide unified messaging services named MyVoicePlus in Arizona in October 2003.²¹⁸

162. Florida-based Voiceglo has been providing peer-to-peer VoIP services named GloPhone. While the company offers free software to let customers make voice calls from PCs, it is different from other peer-to-peer service providers such as Pulver.com and Skype in that it does not limit use to a specific device but allow customers to reach PSTN. There are mainly five types of tariff plans. For example, GloPhone Blue costs free with unlimited VoIP calls but does not allow subscribers to make a call to fixed and mobile telephones. GloPhone Green costs USD 9.99 per year with unlimited VoIP calls between subscribers and USD 0.039 per minute to make calls to US and Canadian circuit-switched telephone numbers.²¹⁹ The company announced in November 2003 the expansion of its VoIP services into 42 additional area code markets.²²⁰ Its 'Free To Talk' subscribers can receive a free telephone number and talk to each other anywhere in the world free of charge.²²¹

163. Fonality started to provide VoIP services in 2003. Service plans include 'Gofree' that allows unlimited VoIP calls using existing telephones without monthly charge, 'GoLocal' that allows unlimited local calls and certain minutes of long-distance calls with a monthly charge of USD 9.99, 'GoBig' that allows unlimited local calls and 500 minutes of long-distance calls with a monthly charge of USD 19.99, and 'GoNon Stop' that allows unlimited local and long-distance calls with a monthly charge of USD 29.99. International call charges are waived for the calls to Canada, and start from USD 0.03 per minute in major European countries such as the UK and France.²²²

164. An integrated communications provider DSLi has been providing VoIP services with competitive tariff plans. Together with BroadSoft Inc., the company announced deployment of Broadsoft's BroadWorks platform to take broadband and VoIP services to a new level in October 2003. DSLi's Virtual Office Exchange (Vox3) broadband VoIP services include bundled local and long-distance packages starting at USD 9.95 per month and a set of enhanced voice features for small businesses.²²³

165. Deltathree provides SIP-based VoIP services. In August 2002, the company launched residential VoIP services to allow subscribers to receive inbound VoIP calls using a regular telephone number.²²⁴

166. A facilities-based provider Primus Telecommunications started SIP-based PC-to-phone VoIP services branded 'PrimusTalk' to MSN Messenger customers in August 2003. Residential subscribers can choose from three pre-paid service plans including USD 10, 20, and 50. Plans for USD 20 or more allow subscribers to receive free 200 voice minutes to several countries including Canada, Australia and the United Kingdom.²²⁵

167. Wholesale communications provider Level 3 launched 'VoIP Marketplace' service, which is designed for a local calling, in September 2003. Subsequently, it launched a new service named 'VoIP Toll Free' in January 2004, which allows businesses to use VoIP technology to handle calls to their toll-free numbers.²²⁶ In March 2004, Level 3 announced that it would launch its new voice service strategy in the United States as well as in Europe. Level 3's new residential VoIP services will be provided in more than 300 markets across the United States by the end of 2004. The company also plans to introduce VoIP services in Europe during the second half of 2004.²²⁷ The services will allow U.S. cable operators, ISPs and enhanced service providers to offer local and long-distance VoIP communications service to consumers with broadband connections.²²⁸

168. GlobalNet Corporation has provided wholesale VoIP services to Tier 1 carriers such as AT&T for years. It announced in January 2004 that it would launch consumer VoIP services based on SIP specification, initially targeting broadband providers in Latin America. According to the company, it achieved positive results in the test launch.²²⁹ GlobalNet plans to expand its consumer VoIP services to ISPs as well as broadband providers worldwide. It also intends to provide its VoIP services directly to consumers in the United States through an E-Commerce initiative during the second quarter of 2004.

169. Other newly-established operators are intensively providing VoIP services. For example, iBasis, founded in 1996, is providing VoIP services on a large scale. It announced that Telecom Malaysia, the national carrier of Malaysia, had established a direct VoIP interconnection with the iBasis network for exchanging inbound and outbound international voice traffic.²³⁰ ITXC is also providing VoIP services. Since the first minute carried in April 1998, ITXC claims to have delivered nearly ten billion minutes of voice service to carrier customers around the world over its VoIP network.²³¹ Go2Call provides PC-to-phone VoIP services in more than 50 countries.²³² Some vendors are also promoting the development of VoIP services. For example, Viper Networks Inc. announced in February 2004 that it was testing VoIP devices named vPhone, which will allow users to place calls worldwide from any PC with an Internet connection.²³³ Mamakall has been providing VoIP telephone devices that consist of K1100, K1120, and K1130 USB Netphones, which allow calls to any circuit-switched telephone in the world.²³⁴

170. Cable companies were generally hesitant in entering VoIP market, but in recent years a number of them are also deploying VoIP services. For example, Armstrong has partnered with VoIP service provider Vonage to offer Zoom phone service to its cable subscribers. The residential package range from a USD 24.99 product with unlimited local and regional calling and 500 minutes of long-distance calling across the US and Canada to USD 34.99 product with unlimited local and long-distance calling across the US and Canada. A potential Zoom user has to subscribe to its broadband service and use a digital phone adapter which plugs into the DSL or cable modem.²³⁵ Cablevision Systems launched Optimum Voice, a VoIP-based service, throughout its New York City metropolitan service area of four million households in the fourth quarter of 2003. Charter Communications launched commercial VoIP services in Wausau in September 2002. It plans to launch VoIP services in several other markets in 2004. Comcast, the largest cable company in the U.S. with 1.3 million existing circuit-switched telephone subscribers nationwide, is testing VoIP near Philadelphia. It plans to test the service in Indianapolis as well in 2004.²³⁶ It will offer telephone service to more than 40 million households in 2006, having 21 million cable television

subscribers.²³⁷ Cox Communications Inc. started to offer VoIP services named Cox Digital telephone over fibre cables that carry cable television in the Roanoke region, Virginia area in December 2003. The service in Roanoke is being provided with two plans, which consist of unlimited local and long-distance call for USD 49.95 per month²³⁸ and unlimited local and 60 minute long distance call for USD 34.90 per month.²³⁹ While it was the 12th market in which the company has introduced telephony service, it relies on traditional circuit-switched technology in other markets. GCI Cable Inc. plans to deploy a hybrid VoIP/circuit-switched service in Anchorage in April 2004. The service will be packet based from the subscriber premises to a gateway and whereas it will use circuit-switched facilities in other parts of the network. Time Warner Cable, a unit of Time Warner Inc., launched its VoIP service named Digital Phone to subscribers in Portland in May 2003 and also in North Carolina in January 2004. It plans to deploy the service to most of the major markets for its 11 million cable TV subscribers in conjunction with two long-distance telephone company partners, Sprint and MCI by the end of 2004.

ANNEX. REGULATIONS ON VOIP SERVICES IN OECD COUNTRIES

171. This annex provides an overview of the current regulatory landscape for VoIP services among OECD countries. As noted in the main part of this paper, regulatory frameworks will significantly impact the market development of VoIP services. A number of countries have recently started a consultation process and review of existing regulations relevant to VoIP services.

172. In the early stages of diffusion of dial-up Internet there was speculation of the potential to use the Internet to offer voice services to the public. The fact that voice services using the Internet were not in real time (signal latency) led a number of OECD policy makers to treat Internet telephony as a value-added service (enhanced service) which was not subject to regulation. Several countries considered that as long as VoIP was not offered to the public at large it would not need to be regulated.

173. Although VoIP challenges existing policy frameworks it also may provide opportunities for regulators to begin a more active process of regulatory forbearance if VoIP manages to stimulate more effective competition in the market. It is thus important for regulators to examine developments in VoIP from a wide perspective and not to be limited in their consideration by legacy policy and regulatory frameworks.

174. Some OECD countries have, so far, imposed only minimum regulations or have no special regulations pertaining to VoIP services. These countries include Austria, Belgium, Czech Republic, France, Germany, Hungary, Ireland, Italy, Slovak Republic, Turkey, and United States. On the other hand, other countries essentially regard VoIP services, if they are offered to the public, as a form of telecommunications service and hence make the services subject to the same or similar regulations as those for traditional PSTN services. These countries include Australia, Canada, Denmark, Finland, Greece, Iceland, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

Australia

175. The current regulation of voice services in Australia does not distinguish between the underlying infrastructure and/or the technology that is used to provide the service. Providers of voice services classified as a 'standard telephone service' (Core concept in Australian telecommunication regulation having three elements: it is a service provided for the purpose of voice telephony; it is a service that allows an end-user to communicate with any other end-user who is supplied with the same service irrespective of whether the end-users are connected to the same network; and bear any service characteristic prescribed in regulations) are required to meet a range of regulatory and self-regulatory requirements (e.g. numbering arrangements, untimed local calls, Customer Service Guarantee (CSG), National Relay Service, access to emergency services). Notwithstanding an assessment that a voice service is a standard telephone service, Australia's regulatory regime provides the Australian Communications Authority (ACA) with flexibility in terms of various exemption powers in relation to some of the regulatory obligations that are attached to the provision of a standard telephone service (eg. number portability, pre-selection, and the Customer Service Guarantee). The ACA has used these powers to assist the deployment of VoIP services in the case of Neighbourhood Cable.

Austria

176. VoIP service providers are subject to loose regulations. There is no need for a license for the provision of VoIP services over the Internet. These services have only to be notified according to the Telecommunications Act.

Belgium

177. VoIP is considered as a simple voice service which is distinguished from traditional telephony. Therefore, VoIP providers have only to declare when they start services.

Canada

178. The regulator Canadian Radio-television and Telecommunications Commission (CRTC) previously determined that most VoIP providers are not facilities-based telecommunications carriers as they do not own and operate PSTN facilities. As a consequence, they were essentially not regulated. However, the regulator indicated that it would be subject to the same conditions and obligations as the facilities-based operators if they should wish to become a facilities-based carrier.

179. In April 2004, CRTC provided its preliminary views on the regulatory framework applicable to VoIP services and initiated a proceeding to examine the regulatory requirements for the provision of these services. In the preliminary view, VoIP services have characteristics that are functionally the same as circuit-switched voice communications services. Consistent with its principle of technological neutrality, the view claimed that the existing regulatory framework should apply to VoIP services. The CRTC also considered that VoIP services should be treated as local exchange services and be subject to the regulatory framework governing local competition to the extent that they provide subscribers with access to/from the PSTN along with the ability to make and/or receive calls that originate and terminate within the geographic boundaries of a local calling area as defined in the incumbent local exchange carriers' (ILECs') tariffs.²⁴⁰ These CRTC's views could impact not only Canadian VoIP providers but also US ones such as 8x8 and Vonage that provide VoIP services across North America. Indeed, some US VoIP providers such as Pulver.com claim that the views are complicating an already confusing VoIP regulatory landscape.²⁴¹

Czech Republic

180. VoIP services, including their prices, remain unregulated as a data service. VoIP providers need not to be an owner of a telecommunications license for provision of PSTN services.

Denmark

181. No specific regulations would apply to VoIP providers.

European Commission

182. The European Commission (EC) has issued two previous Communications on Voice over IP (in 1998 (OJ C6, 10.1.1998, p.4) and in 2000 (OJ C369, 22.12.2000, P.3)), but those have been superseded by the EU regulatory framework that came into effect in July 2003. Under the new EU regulatory framework, players (including those offering VoIP services) are free to enter the market for electronic communications services without prior authorization, provided that they abide by the conditions set out in the general authorisation applicable in each Member State. The framework is essentially technology neutral, and sets out rights and obligations that apply to the delivery of different types of services, which are independent of the underlying network infrastructure.

183. The degree to which a provider of VoIP-based services will face obligations under the EU framework will depend on the type of service offered, rather than on the technology used to provide it. The overall objective is to have a light regulatory touch taking into account the emerging nature of the technology, while preserving consumer interests such as access to emergency services. The European Commission has issued an information and consultation document on the treatment of VoIP under the EU regulatory framework.²⁴² This document provides clarification on the rules and obligations that fall on undertakings offering VoIP services and seeks further input on issues such as numbering of VoIP services, emergency access, interconnection and so forth. Taking the public comments into account, the document will be adapted as necessary and re-issued in the form of (non-binding) guidelines.

Finland

184. In the past there were no obligations for VoIP providers to have license or make notifications, but most ISPs preferred to notify because was easier to enter into commercial relations with network operators. In October 2003, however, the regulator imposed regulations in part on VoIP service providers using broadband networks similar to those imposed on PSTN operators. Generally speaking, any political decision how VoIP services should be regulated has not yet been made in Finland. At the moment, VoIP is classified as enhanced services, which are not regulated, if service providers do not make any subscription agreement with the user.

France

185. Under the French framework, and in accordance with EC Directives, telecommunication operators, including VoIP operators, from 25 July 2004 are subject to a general authorisation framework which replaces the individual licensing requirement. Operators have only to make a declaration to the regulator, ART.

Germany

186. VoIP is not regarded as a voice telephony service as defined in the Telecommunications Act or by the European Union. Therefore, VoIP providers are not subject to a license and they must only be notified.

187. In April 2004, the Regulatory Authority for Telecommunications and Post (RegTP) opened a public consultation on VoIP. The regulator will formulate its initial position on the regulatory classification of VoIP services in light of the comments received.²⁴³

Greece

188. A general authorisation from the government is required in order to commence VoIP services.

Hungary

189. VoIP providers need no licence and only registration is required. Although there were some voice quality restrictions between 1998 and 2002, they are lifted since the liberalisation of the telecommunications market.

Iceland

190. VoIP providers are treated in the same manner as any other from of voice telephony operators. Therefore, obligations are similar to those of traditional PSTN operators including license requirements.

Ireland

191. VoIP would be unregulated as far as the service is provided by an operator other than the incumbent. Obligations on the incumbent would include network requirements such as provision of access to its own network via interconnection agreements with other operators and provision of service level agreements for provision of facilities/services to customers, as well as other service obligations such as performance related to consumer protection, publication of prices and itemised billing (for the call).

192. The regulator ComReg published a consultation paper on numbering for VoIP services in Ireland in June 2004.²⁴⁴

Italy

193. VoIP is generally unregulated and is allowed according to the EU Communication 98/C6/04 (Voice communication over Internet), which equates the service with data transmission and includes it in the set of liberalised service subject to the general authorisation.

Japan

194. The Telecommunications Business Law classifies VoIP services as a voice transmission service. However, VoIP providers have only to register or notify to start their services and are only subject to the minimum quality-of-service regulation. It appears that this minimum level of regulations has contributed to the diffusion of VoIP services in Japan.

195. With regard to numbering, traditional circuit-switched telephone numbers principally start from 0AB. However, the government has provided special telephone numbers starting from 050 for VoIP services since 2002. VoIP providers have to ensure minimum voice quality as a telephony service in order to acquire this special telephone numbers. As of January 2004, 10,610 000 numbers were allocated to 25 providers. VoIP providers have to ensure access lines to subscribers, together with the same quality as that of circuit-switched networks by using such networks as fibre-optic, in order to have the same type of telephone numbers as those for traditional PSTN services (*i.e.*, 0AB type numbers).

196. This numbering policy has a linkage with obligations for emergency calls. The government decided to enforce emergency call obligations to traditional telephone numbers starting from 0AB whereas it exempted 050 VoIP numbers from the obligations at present.

Korea

197. Facilities-based telecommunications operators who already have a license for providing voice telephony services are also eligible for provision of VoIP services. When providing VoIP services over the network of a facilities-based service provider, the operator has to meet the registration qualification in the areas of technological capabilities, financial capabilities, plans for consumer protection and so forth.

Luxembourg

198. Following the recommendations of the European Commission on VoIP issues, no differential treatment is planned except for the incumbent. A license will be necessary for an interconnection with PSTN networks.

Mexico

199. VoIP providers are required to get a license as any other voice telephony operators. In addition, they would have to comply with the voice telephony regulatory framework, which might have to be adapted to the technology.

Netherlands

200. In the consumers market, VoIP is still a rather marginal phenomenon. The existing VoIP-like services are, in the terms of the Dutch legislation so far, not qualified as public telephone services.

New Zealand

201. VoIP providers are defined and treated the same as PSTN operators and are subject to the same regulations.

Norway

202. VoIP providers are regulated in the same way as telecommunications operators on the basis of the notion that 'voice is voice' regardless of technologies used.

Poland

203. Provision of VoIP is basically liberalised. VoIP services are not covered by separate regulation from traditional telecommunications services. Under the Telecommunications Law, international telephone services including VoIP may not be provided by entities other than public telecommunications operators.

Portugal

204. VoIP service providers are subject to license, as so far they are classified as fixed telephone service providers, whereas 'Voice over the Internet' service providers are subject to registration.²⁴⁵

Slovak Republic

205. There are no particular regulations on provision of VoIP services.

Spain

206. VoIP service providers will require some forms of authorisation depending on the technology and the type of network that are used. In general, an individual license is required if the communication is made between two telephone terminals. If it is made between two terminals of data, a general authorisation is required whereas a provisional authorisation is needed if it is carried out between both types of terminals.

207. The General Telecommunication Act was published in November 2003, which transposed the new European regulatory framework (Telecom package). On the basis of policy to ensure technological neutrality, the regulator does not control the technology to be used and operators are not required to declare it irrespective of administrative act or a general authorisation.

Sweden

208. The same regulations apply to VoIP service providers as those to PSTN services.

Switzerland

209. VoIP is generally regarded as a public telecommunications service, and consequently is subject to the regulations on traditional telecommunications including ensuring interoperability and emergency calls (at fixed location for the moment). However, VoIP is currently not regarded as a service to be provided as a universal service. Following the rising importance of VoIP services, the Federal Office of Communications is leading a working group on VoIP and IP interconnection, which is discussing quality of service parameters and interconnection related issues.

Turkey

210. There are no particular regulations on provision of VoIP services.

United Kingdom

211. The regulator Ofcom enshrines a regulatory principle of technological neutrality: relevant regulation depend on the nature of service rather than the technology used to provide the service. In addition, treatment of services would not depend on whether it is being provided by a public telecommunications operator or not. Provision of VoIP services is likely to fall within the wide scope of existing and future regulatory frameworks, and is therefore subject to some general conditions. However, significant additional obligations are only relevant for those services considered to be publicly available telephone services. For example, many existing PC-to-PC VoIP services are unlikely to be considered as a publicly available telephone service, and therefore the regulation relevant to them is likely to be minimal.

212. While the regulator issued a VoIP guideline in April 2002, it implemented a new regulatory framework for the regulation of electronic communications under the Communications Act 2003 in July 2003. The new regulatory framework is based on new EC Communications Directives that are intended to converge and harmonise communication regulations throughout the EC. This regime aims to be technologically neutral and is applied to all electronic communications services and networks including VoIP. From this perspective, regulation that is relevant to publicly available electronic communications networks and services as well as interconnection is likely to be relevant irrespective of the technology, whether they may be circuit-switched networks or IP networks. This does not mean that the commercial provision of VoIP services is entirely unregulated. The regulator established criteria as a basis to determine whether a VoIP service should be regulated as a publicly available telephone service.²⁴⁶

- The service is marketed as a substitute for the traditional public telephone service’.
- The service appears to the customer to be a substitute for the traditional public telephone service over which they would expect to access emergency calls, Directory Enquiries and so forth without difficulty.
- The service provides customer’s sole means of access to the traditional circuit-switched public telephone network.

213. In line with this legislation, Ofcom renewed the 2002 VoIP guidelines in November 2003. Ofcom is currently considering the provision of appropriate numbering resources for VoIP and consumer protection issues, particularly regarding access to emergency calls and special measures for end-users with disabilities.²⁴⁷

214. At the same time, Ofcom launched a consultation to determine the appropriate numbering resource for VoIP services in February 2004. One of Ofcom’s proposals is that VoIP service subscribers

use '056' numbers and '055' numbers should be determined as available for allocation for corporate numbering.²⁴⁸ Ofcom is also consulting on whether geographic numbers are suitable for VoIP services.²⁴⁹

United States

215. The regulatory status of VoIP is currently under examination. Specifically, the regulator FCC has two major regulatory categories, 'telecommunications services' and 'information services.' The FCC April 1998 'Report to Congress on Universal Service', widely known as the 'Stevens Report,' issued in April 1998, recognized that the services provided by Internet access providers, including VoIP services, are an information service and therefore not regulated. However, the report noted that phone-to-phone VoIP services bore the characteristics of telecommunications services, which are more regulated than information services, but the FCC refrained from making a definitive pronouncement on this matter at the time.

216. The FCC has considered the regulatory classifications of relevant platforms that can support VoIP services, and made some policy decisions. In February 2002, for example, it drew a tentative conclusion that broadband access to the Internet provided over domestic wireline facilities is an information service with a telecommunications component. In March 2002, it further determined cable modem service is properly classified as an information service and that there is no separate offering of telecommunications services. This FCC decision was reversed by a federal court. The FCC has requested U.S. Supreme Court review of this decision.

217. Up to the middle of 2003, the U.S. government approach had generally been not to intervene in VoIP regulation issues to avoid impeding the emergence of that innovative service. This is the same position as a number of companies who are attempting to initiate VoIP services, most of which are emerging Internet telephony service providers or wholesalers. However, while some traditional PSTN telephone operators see the services as a telecommunications service subject to the same rules as circuit-based technologies and others have argued it is an information service, most agree that VoIP should not be regulated like traditional phone networks and should not be subject to economic regulation.

218. Another task for policy makers is to decide whether VoIP services are interstate in nature and thus regulated primarily by the FCC or they should be regulated by state public utility commissions in the same manner as PSTN telephone services. The debate over VoIP regulations has actually intensified since late 2003 as several states have attempted to regulate the service as a traditional telephony service. In the United States, each state has its own right to impose its own regulations on local calls and they have taken widely different approaches to VoIP services). For example, Minnesota ruled in August 2003 that Vonage's VoIP service is a telecommunications service not an information service. However, a federal judge in Minnesota overturned the state's attempt to regulate VoIP services in November 2003, while Vonage is asking that its VoIP services be regulated by the FCC instead of state governments. Regulators in Wisconsin informed VoIP provider 8x8 in September 2003 that its Packet8 offerings was subject to the same rules as traditional telephone services.²⁵⁰ Florida is attempting to impose minimum regulations on VoIP stating that the provision of VoIP should be free of unnecessary regulations regardless of providers. Despite these policy initiatives, state regulators, in general, appear to be reluctant to pursue VoIP regulations pending further deliberation by the FCC.

During the process of discussion, the regulator has facing pressures from various stakeholders. A number of VoIP operators, including AT&T, Verizon, SBC Communications as well as VoIP specialists such as Vonage, have attempted to lobby the FCC to maintain the position it has taken so far. For example, Vonage's petition specifically referenced the Minnesota Commission's decision in arguing that VoIP regulation was contrary to the FCC's long-standing policy of deregulating information services.²⁵¹ Free World Dialup also asked the FCC to keep its VoIP service regulation free.

219. The regulatory path that the U.S. government will take may have significant impact on how other countries determine their own policy. The actions that the FCC has taken so far seem to be favourable to VoIP providers because it places much importance on the point not to impede VoIP market development. In February 2004, the FCC ruled that Pulver.com, a small Internet company that provides VoIP services named Free World Dialup, should not be subject to the same regulations, such as access charges, as traditional telephone operators. It claimed that Internet-based services should continue to be subject to minimal regulations but that mechanisms to implement important social objectives such as public safety, emergency calls, law enforcement access, consumer protection and disability access may change as communications migrate to Internet-enabled services.²⁵² However, this decision did not address whether traditional telephone regulations might apply to VoIP services that interconnect with the PSTN system because Free World Dialup allows voice communications to take place between PCs but not between PCs and fixed telephones.²⁵³ Subsequently, the FCC issued a notice of proposed rulemaking to seek comments on the impact of IP-enabled services in March 2004. The FCC rejected AT&T's petition that its phone-to-phone VoIP services are exempt from the access charges applicable to circuit-switched inter-exchange calls in April 2004.²⁵⁴

220. In March 2004, the FCC initiated a rulemaking to determine the appropriate regulatory framework for IP-enabled services including VoIP.²⁵⁵ That proceeding will help decide which of the FCC's many telecommunications mandates should apply to VoIP services. Some of the relevant mandates include universal service, inter-carrier compensation and interconnection, local number portability, customer privacy, emergency calling, and disabilities access. Apart from the matters under consideration in the IP-Enabled Services NPRM, another federal mandate that may apply to U.S. VoIP providers is the Communications Assistance for Law Enforcement Act ("CALEA").²⁵⁶ CALEA, like the electronic surveillance laws of numerous other countries, essentially requires telecommunications carriers to make their networks technically capable of provisioning lawful electronic surveillance on suspected terrorists, spies, and criminals who may use those networks. The telecommunications carriers themselves are permitted to design the CALEA capabilities as they see fit, subject to FCC review,²⁵⁷ and the U.S. Attorney General plays a consultative role in the process.²⁵⁸ The FCC has ruled that CALEA applies to all types of telecommunications carriers (including wireline, wireless, cable, satellite and utility companies) and that CALEA is technology neutral.²⁵⁹ Accordingly, the FCC has generally acknowledged that CALEA applies to packet-mode services²⁶⁰ and has specifically ruled that CALEA applies to packet-mode wireless "push-to-talk" services to the extent they are offered in conjunction with interconnected service.²⁶¹ In March 2004, the U.S. Department of Justice filed a petition for rulemaking asking the FCC, among other things, for an express declaration that CALEA applies to broadband access service and broadband telephony services such as VoIP. In August 2004, the FCC reiterated and clarified that push-to-talk services offered by CMRS carriers in conjunction with interconnected service to the PSTN are subject to CALEA's requirements regardless of the specific technology employed in the carrier's network. The FCC simultaneously tentatively concluded that CALEA applies to all forms of broadband Internet access and some types of VoIP services, and sought comment on that and a range of other proposals designed to strengthen CALEA implementation. The FCC is expected to initiate the requested rulemaking very soon. Meanwhile, various VoIP industry sectors have already commenced the process of designing CALEA technical standards to provide the needed public safety assistance.

221. Currently, VoIP providers obtain telephone numbers from telecommunication carriers such as RBOCs or CLEC's and provide them to users. It is also possible for customers to use the same number for VoIP as that of PSTN services. This 'number portability' might accelerate the subscription of VoIP services by terminating a contract of PSTN. Most VoIP services also allow a subscriber to choose their own area code. This feature, together with the ability to use a VoIP terminal in different locations, using the same number, is reducing the traditional geographic significance of telephone numbers.

NOTES

- 1 The location-identification issue has been a challenge for mobile phones as well.
- 2 Most market analysts use the terms VoIP, IP telephony and Internet telephony interchangeably.
- 3 Also referred to as voice over DSL (VoD).
- 4 <http://www.silicon.com/comment/0,39024711,1000604600.htm>
- 5 Merrill Lynch, Everything over IP, p.20, 12 March 2004.
- 6 http://www.idii.com/wp/axiom_voip.pdf
- 7 <http://www.telegeography.com>, http://www.lightreading.com/document.asp?doc_id=44715
- 8 http://www.soumu.go.jp/s-news/2004/pdf/040428_3_a.pdf
- 9 These applications will include Skype peer-to-peer telephony or MSN messenger.
- 10 The most popular technology for circuit-switching would be Time Division Multiplexing (TDM).
- 11 http://searchnetworking.techtarget.com/sDefinition/0,,sid7_gci21403100.html
- 12 This system allows enterprises to save the cost of requiring a line for each user to the telephone operator's central office.
- 13 FCC, FCC 04-28, Notice of Proposed Rulemaking, March 10 2004,
http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-28A1.pdf
- 14 <http://www.theregister.co.uk/content/68/36316.html>
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25 <http://www.nwfusion.com/news/2002/0415sip.html>

26 For example, users can call others for free with an IP-based Virtual Private Network (VPN).

27 New York Times, January 12 2004,

<http://www.nytimes.com/2004/01/12/technology/12phone.html?th=&pagewanted=print&position=>

28 However, it should be noted that packet switching was invented precisely because data has different traffic requirements from voice. Therefore, IP data would be most efficient on a network that is not necessarily the best condition for voice. See <http://zdnet.com.com/2100-1107-5153814.html>.

29 <http://zdnet.com.com/2100-1107-5153814.html>

30 http://news.com.com/2100-1037_3-1024883.html

31 <http://zdnet.com.com/2100-1103-5154140.html>

32 <http://zdnet.com.com/2100-1105-5167782.html>

33 http://www.infoworld.com/article/03/12/11/HNATTVOIP_1.html

34 See <http://www.theregister.co.uk/content/22/36342.html>.

35 <http://zdnet.com.com/2100-1103-5155033.html>

36 <http://zdnet.com.com/2100-1103-5155033.html>

37 FCC, FCC 04-28, Notice of Proposed Rulemaking, March 10 2004

38 Sony's SOCOM series uses a similar peer-to-peer VoIP system to enable voice chat. The company claims that one of the keys to making a peer-to-peer system work would be to develop efficient software codes to compress and decompress voice traffic. See <http://zdnet.com.com/2100-1103-5154140.html>.

39 http://news.com.com/2110-7352_3-5148219.html?tag=prntfr

40 http://www.boardwatch.com/document.asp?doc_id=47339&print=true

41 <http://zdnet.com.com/2100-1105-5133200.html>

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46 Nikkei Communications, February 23 2004, pp.138-141

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- 53 Nihonkeizai shimbun, December 10 2003, p.10
- 54 http://news.com.com/2100-1038_3-5172299.html?tag=prntfr. With regard to 'BT Communicator' service, see 'incumbents' part of the same section as well as Annex of this paper.
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- 68 See <http://privat.telenor.no/dinesider/default.aspx?a=goProduktTelefonabonnement> and http://www.telio.no/?_p=81.
- 69 Users will be charged USD 0.03 a minute when they make calls to PSTN telephone in North America. See http://news.com.com/2100-7352_3-5104410.html?tag=prntfr.
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- 71 See http://www.bt.com/Choices/index.jsp?showsub=products_call_packages&showsub2=PCP_BT_Together_options&obsPage=/Choices/faq.jsp&vStore=1112&obsOID=-24471&obsType=LINK&obsNoSee=true.
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- 90 http://www.boardwatch.com/document.asp?doc_id=38931
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'green number' based on local numbers. See <http://www.itu.int/osg/spu/ni/iptel/countries/hungary/hungary-iptel-hif.doc>.
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