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THE FUTURE OF VOICE

CHAIRMAN'S REPORT

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All comments and remarks on this document,
to be reflected in the final version of the Chairman's Report
should be sent via email
to SPUmail@itu.int no later than the 19th February 2007.

February 2007

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1 INTRODUCTION

An ITU Workshop, The Future of Voice[1], was held at the headquarters of ITU[2] in Geneva, Switzerland, from 15 to 16 January 2007. The event was organized within the framework of the New Initiatives Programme[3] and was chaired by Dr. Glenn Woroch[4], Executive Director of the Center for Research on Telecommunications Policy[5] at the University of California at Berkeley, USA.

The two-day meeting was structured to debate the challenges raised by the transition to an all-IP environment for the information and communication technologies (ICT) sector and, in particular, the future role of voice, which has hitherto been the mainstay of telecommunication service revenues. An introductory session was held framing the debate[6], with further sessions on innovation dynamics[7], market dynamics[8] and shaping an enabling regulatory paradigm[9]. A final roundtable[10] session presented some concluding views and contributions from participants.

The resources website[11] prepared for the event provides links to the final agenda[12], all of the commissioned background papers and regional case studies[13], presentations[14], webcast audio archives[15], background resources[16] the Chairman's Report[17] and weblog[18]. The website also provides links to a wealth of other resources and related materials and represents a valuable source of fresh thinking on this subject.

Approximately 100 participants took part in the meeting, including renowned experts from industry and academia, government policy-makers and regulators, international organizations, telecom operators, communication service providers, ICT companies and other stakeholders.

This Chairman's Report summarises the debate and proceedings at the Workshop, and complements the presentations, background papers and the webcast, which are available from the event website[19]. It follows the structure of the chairman's concluding remarks and overviews key current trends in the industry, as well as possible future developments. It outlines areas where participants were broadly in agreement, as well as areas where participants diverged in their outlook on the potential prospects for voice. It concludes by summarising the likely implications of the migration to an all IP-based network for the future of voice and future of the ICT industry.

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2 OPENING REMARKS

Mr. Houlin Zhao[20] welcomed participants to the meeting. In his speech[21], Mr. Zhao noted that, for many years, voice services have been the principal driver of operators' revenues. Nevertheless, convergence and the migration to an all Internet Protocol (IP)-based communications environment pose significant challenges to traditional business models. The delivery of multiple different services over a single network is increasingly seen as the main goal for the industry. Operators are responding to this transition with multi-billion dollar modernisation programmes, reengineered business models and new services with the potential to generate future revenues.

Nevertheless, significant uncertainties surround the migration to IP-based networks. It is questionable whether voice services will remain a marketable commodity. Existing regulatory models may need to be adjusted. Policy-makers and regulators have to consider how best to protect public interest in a converged environment. Mr. Zhao emphasized the interest of ITU in providing a forum for dialogue to exchange views and experiences and helping to frame current thinking on the industry response to the transition to an all IP-based environment. He introduced Dr. Glenn Woroch[22] as the Chair and expressed his hope for an open debate and a successful workshop.

In "The Future of Voice: A View from the Past"[23], Dr. Woroch[24] outlined the evolving relationship between voice and data. Data came first (with the invention of the telegraph), before being displaced by voice (in the form of the ordinary telephone) in the last part of the 19th Century. The rise of the Internet reasserted the role

of data. Mobile telephony has promoted voice, but also enabled data as well (e.g. SMS). Voice and data can be *competitors* on either platform (e.g. email/chat can replace fixed calls, SMS can replace mobile calls). He suggested that data is taking hold and displacing voice, but questioned to what extent? He suggested that they will increasingly be used together as "*complementors*" in converged services (e.g. E-bay buying Skype, voice-matching services). Voice can also complement data services (e.g. in online dating, telemedicine, distance learning and customer service).

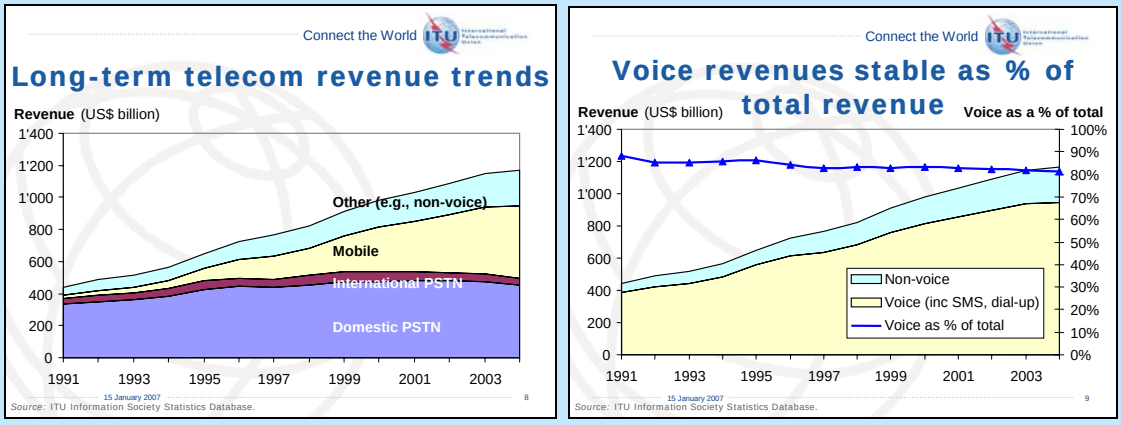
Dr. Woroch concluded by asking, "Why should we care?" The interplay of data and voice will impact the pace and direction of innovation in communications (e.g. when TV was invented, people saw no future for radio, but radio is still a force to be reckoned with). The transition to IP can open up new markets and help close the digital divide. It will also impact regulatory policy and *vice versa* (e.g., regulation could accelerate moves towards the convergence of voice or data).

3 AREAS WHERE PARTICIPANTS WERE BROADLY IN AGREEMENT (*CONSENSUS*)

3.1 Voice is at the core of telecoms revenue – fixed voice revenue is still huge, but declining slowly as a percentage of the total

Jaroslaw Ponder and Tim Kelly[25] examined long-term trends in telecom revenue. Total telecom revenue grew by 7-8% p.a. on average from 1991-2004 (Figure 1, left chart). The highest growth has been in mobile telephony, with domestic and international PSTN revenues declining slightly. Voice services are roughly stable as a proportion of total revenue, at around 85% in 1991 and 82% in 2004 (Figure 1, right chart). Even in the highly developed countries of the OECD, voice still accounts for 79% of total telecom revenues (Dr. Reynolds[26]).

Figure 1: Trends in telecom revenues
Long-term trends in telecom revenue worldwide (US$ billion), 1991-2004 (left chart); and voice revenues as a proportion of total revenue worldwide, 1991-2004 (right chart).



Source: Kelly & Ponder, "The Future of Voice: Framing the Debate". ITU World Information Society Statistics database.

In the EU, fixed voice revenues declined from 89 bn Euros in 2003 to an estimated 83 bn Euros in 2006 (Banable[27]), but still account for 30 per cent of the total 283 bn Euros revenues of the EU communications sector. In his presentation, Review of the EU regulatory framework for Electronic Communications, Banable[28] attributed declines in voice revenues to greater competition and declines in the market share of incumbents. Local call prices have fallen, while national call charges remain, on average, the same. It is difficult to assess the gains that VoIP is making in the market, as data derive mainly from incumbent operators.

Voice has been a key driver of growth in ISDN, freephone and now in 3G. However, debate focuses on whether voice will emerge as a key driver of revenues in Next-Generation Networks (NGN). *The*

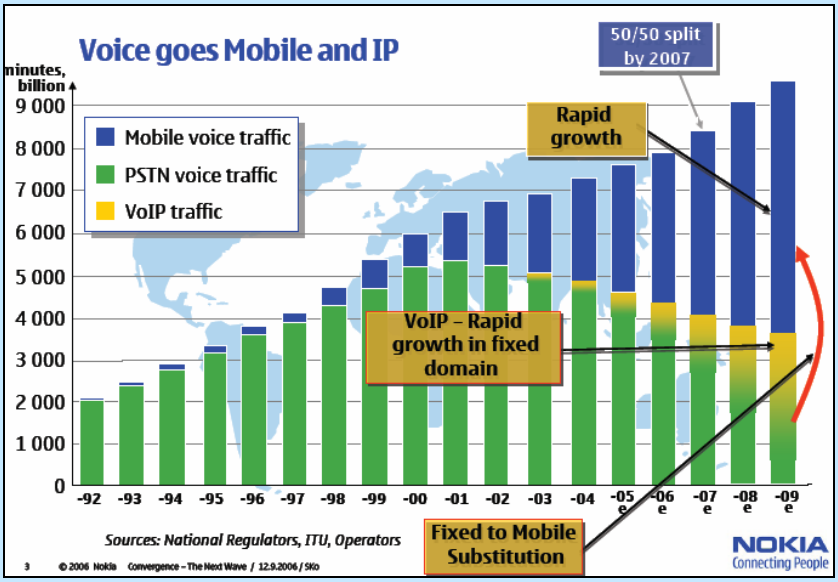
Economist[29] suggests that broadband internet access will become the core revenue-earning service offered over fixed lines by telecom operators [12 Oct 2006]. There is scope for voice services to be profitably extended e.g., by offering premium quality, chat, integration with other services (including online social networking and telemedicine etc), universal access. In his address WiMax and the Future of Voice[30], Chris North[31] suggested that voice also provides "stickiness" to reduce churn amongst competing providers.

Dr. Reynolds[32] argued that voice is still key to telecom revenues. However, he concluded that, given the near-negligible marginal cost associated with voice, voice communications may soon be given away for free over a ten-year time horizon - consistent with the declines in price. Operators must wean themselves off their dependence on voice. Dr. Eric Burger[33] agreed, noting that it is technically very difficult to identify a voice call (for tariff and tax purposes), so operators and governments should expect to give up voice calls as a source of revenue.

3.2 Voice is on the move (1) from fixed to mobile

Mobile has been the principal source of growth in voice telephony in recent years—in terms of access and usage. Dr. Reynolds[34] noted that growth in 3G is mirroring early growth in 2G cellular. Mobile revenues were 40% of total telecom revenues in 2005 in OECD countries. The future of voice is likely to be mobile and based on IP – Nokia projects a fifty-fifty split between fixed-mobile traffic will be achieved in 2007 (Figure 2).

Figure 2: The Future of Voice – voice goes mobile and IP
Growth in voice traffic (bn minutes), total PSTN, mobile and VoIP traffic and projected future trend, 1992-2009.



Source: NOKIA, based on data from the ITU, national regulators and operators.

In his presentation Fixed-Mobile Convergence and Universal Service[35], Dr. Woroch[36] explored the evidence for users' willingness to substitute mobile phones for fixed lines in response to a monthly discount provided by a US universal service program called "Lifeline." He found a high substitution between the two technologies confirming that mobile should enter the design of universal service programmes that aim to expand access to voice services.

3.3 Data is small, but growing

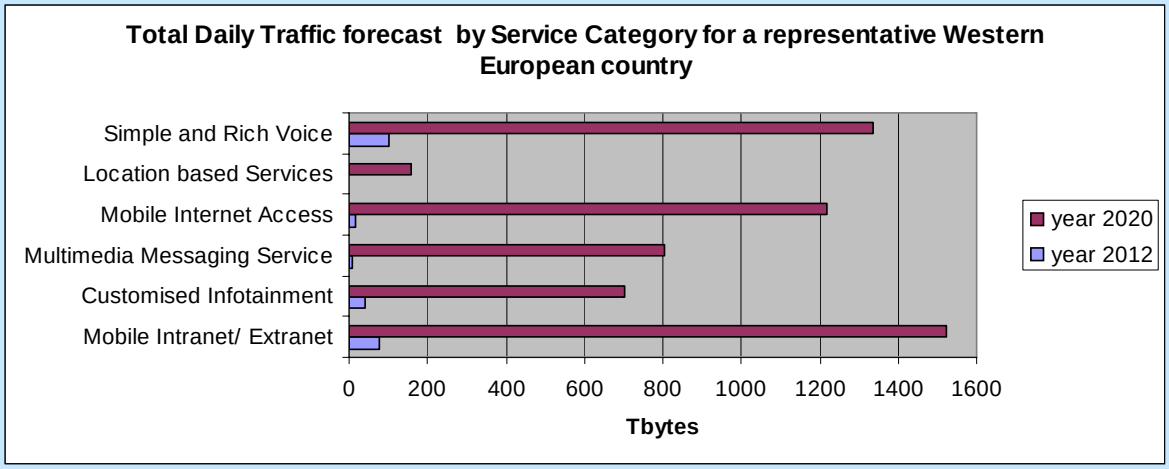
Dr. Reynolds noted that, of Verizon's USD 75 billion in revenues in 2005, only 14% were from data services. In "FoV: A View from the Past"[37], Dr. Glenn Woroch[38] cited an OFCOM report ("The International Communications Market, 2006"[39]) which notes that mobile data services grew as a proportion of total

telecom revenue in OECD countries from 2001-2005 (although voice ARPU still dwarfs data ARPU). Data now accounts for around 20% of *mobile operators' revenue* in the EU (Banable[40]). Correspondingly, Dr.Gruber[41] argued that data will rise from 33% of *fixed line revenues* in the EU in 2003 to a projected 43% of fixed line revenues in the EU in 2007 (mainly as a result of revenue from DSL broadband).

In his presentation on Voice Evolution and Fixed-Mobile-Internet Convergence[42], Jean-Pierre Bienaimé[43], Chairman of the UMTS Forum[44], projected that, between 2012-2020, total daily traffic in a representative Western European country will grow from 250 Tbytes to 5750 Tbytes, due to the increasing number of multimedia services (e.g. photos and videos). In 2020, total traffic is forecast to be approximately 34% mobile, 52% stationary/ nomadic and 14% Machine to Machine (Figure 3).

Figure 3: Traffic forecasts

Total daily traffic forecasts for an average representative Western European country, 2012-2020.



Source: UMTS Forum, "Magic Mobile Future 2010-2020"[45], quoted by JP Bienaimé, Voice Evolution & Fixed-Mobile-Internet Convergence[46] presented to the ITU workshop, The Future of Voice[47].

In The role of VoIP in telecommunications[48], Dr. Kim[49] noted the subsequent migration of value in global communications, away from fixed line/traditional carriers towards the wireless, satellite and cable sectors and the ISP industry, in terms of their market value.

3.4 Voice is on the move (2) from PSTN to IP

The channels by which voice is offered are changing. *The Economist*[50] argues that VoIP will soon overtake voice over PSTN in usage. The transformation of the telecom industry includes:

- the emergence of alternative communication platforms (e.g., mobile, VoIP);
- the migration to an all-IP environment;
- the influence of the Internet, especially in VoIP and peering
- The emergence of Peer-to-Peer (P2P) technologies (e.g., Skype).

Dr. Kim[51] suggested that voice is also being 'integrated' into Internet applications (e.g. IM, Skype, Jajah, etc.). Dr. Skouby[52] discussed Next Generation Core Networks (NGCN), NG access networks (NGAN) and convergence. VoIP is resulting in vertical separation of networks and services and greater competition. Intelligence is moving to the network's edges, with decentralized control.

Dr. Burger[53] pointed out that VoIP traffic is indistinguishable from other IP traffic, unless techniques such as port-blocking or deep packet inspection are used – but now, Skype even encrypts transmissions so it is

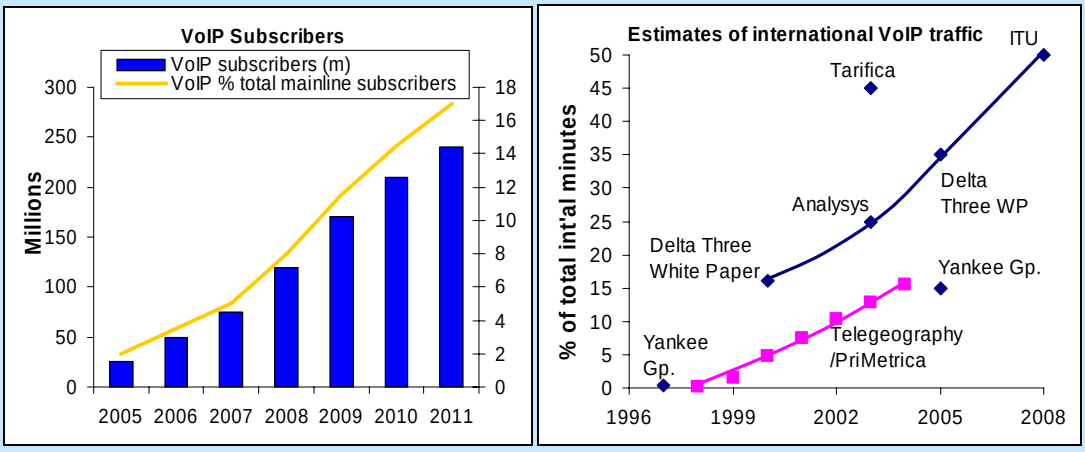
impossible to identify packets as being voice. Previously, convergence meant using IP interfaces with TDM equipment (e.g. H323, H248). Service control points and intelligent peripherals became servers. However, in "first generation VoIP", proprietary systems were slow to improve and equipment was expensive. "Second Generation" VoIP uses real-time multimedia extensions of Web applications (e.g. SIP, VoiceXML, CCXML, MSCML), making voice applications open to user-generated content and generating new opportunities for wealth creation.

Mr. Bienaimé[54] agreed that UMA access technology and implementation of SIP are the first steps towards fixed-mobile convergence (FMC), before migration to an IMS architecture supporting a range of new combined services on an all-IP network such as voice, video, videoconference, IM and presence indicators. Dr. Kim[55] noted that advanced VoIP services include video telephony, premium-quality voice telephony and FMC. Web applications with voice include voice enabled e-commerce and vertical applications, such as Real Estate, etc.

The ITU's Background Paper on the Status of VoIP worldwide in 2006[56] found evidence of strong growth in VoIP subscribers, traffic and number of minutes, despite difficulties in estimating 'soft' traffic volumes, for instance for PC-to-PC services (Figure 4). Drivers of VoIP include growth in broadband, falling prices for consumers and reduced costs for operators. However, Dr. Alleman[57] suggested that VoIP services as a stand-alone service are not that useful, because consumers still need a broadband connection and a sufficiently big telecom bill to justify the move to VoIP.

Figure 4: The rise of VoIP

Estimates of VoIP subscribers, total and as a proportion of mainlines worldwide, 2005-2011 (left chart); and estimates of VoIP traffic worldwide 1996-2008 (right chart).



Source: iDATE (left chart), various estimates (right chart). ITU's Background Paper on the Status of VoIP worldwide in 2006[58].

Note: In the right chart, the ITU estimate refers to IP telephony. Telegeography/PriMetica estimates (shown by the pink line) are considerably lower, as they draw mainly on traffic estimates from US operators.

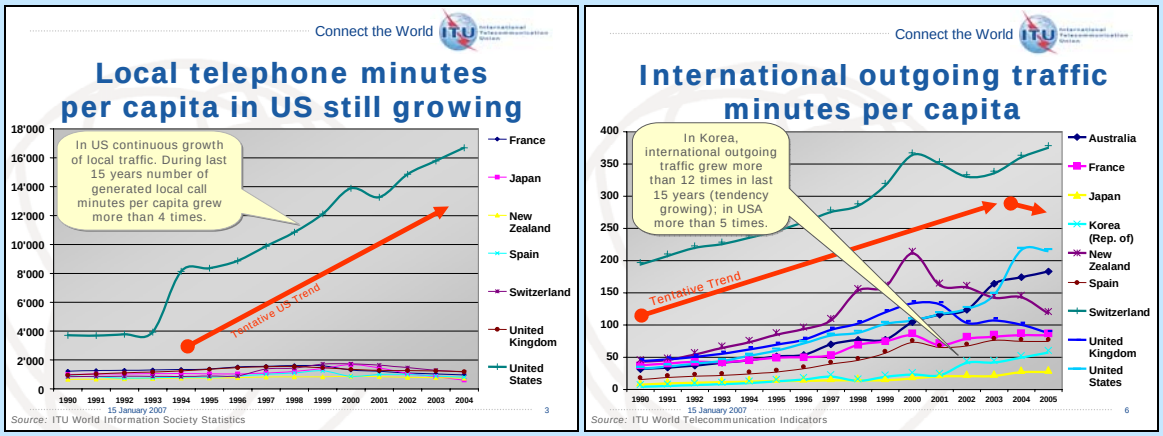
3.5 Voice is vital and demanded by users. However, voice trends vary by country

The number of fixed lines is falling in some regions, but still rising worldwide. Dr. Reynolds noted that the number of fixed lines in OECD countries has declined marginally. However, in his concluding comments, Dr. Kelly noted that, globally, fixed lines grew in excess of 5 per cent last year and that growth in fixed lines by developing countries such as India, China and Vietnam still offers opportunities for the fixed-line telecom operators.

Mr. Bienaimé[59] gave a presentation on Voice Evolution and Fixed-Mobile-Internet Convergence[60]. The report of the UMTS Forum[61] -- "Magic Mobile Future 2010-2020"[62] -- predicts that voice will remain a key service: *"In 2012, voice (simple and rich) is still the first service category in terms of daily traffic volumes. Simple voice duration will remain flat in both consumer and business segments. However, total call duration will be higher in 2020 than in 2012 thanks to the increase of rich voice and VoIP calls"*.

Kelly and Ponder[63] showed that, while demand for local telephone minutes has fallen in Europe and some Asian countries, since the late 1990s, in the United States local telephone traffic has more than quadrupled from 4'000 in 1990 to over 16'000 minutes per capita in 2004. National fixed line traffic has generally fallen since the late 1990s. This is in contrast to international outgoing traffic, which has generally risen (Figure 5), although revenues have fallen.

Figure 5: Trends in national and international voice
National long-distance telephone minutes per capita, 1990-2004 (left chart); international outgoing traffic minutes per capita, 1990-2004 (right chart), in selected countries



Source: Kelly & Ponder, "The Future of Voice: Framing the Debate", ITU World Information Society Statistics database.

In "Voice is not replaceable"[64], Loso Judijanto[65] suggested that voice will continue to be the core service for dominant operators that can follow a high volume/low-cost strategy in developing markets, which offer the most growth potential as higher-income markets saturate. Niche service providers can also target low-income consumers with innovative pricing strategies, coupled with the most appropriate distribution networks.

In "ETP's View on the Future of Voice", Dr. Brandl[66] noted that convergence poses strong challenges to telecom operators – there is already a sharp decline in the number and the percentage of voice minutes that are carried over PSTN. She suggested that core boundaries between networks could disappear by 2012 and voice could become just another data application. Distinct fixed/mobile services could continue to exist in parallel to converged networks.

Voice ARPU is still generally high, but falling. In "FoV: A View from the Past"[67], Dr. Woroch[68] cited a recent OFCOM report[69] which found that Voice ARPU far exceeds data ARPU in the mobile market in the major Western European countries—though growth in data ARPU is faster than that for voice. Dr. Alleman[70] pointed out that competition drives down prices, but elasticity means that there has to be greater increase in demand to compensate.

In The role of VoIP in telecommunications[71], Dr. Kim[72] considers that voice customers can be retained through segmentation, branding and bundling to suit customers' needs. Voice ARPU can be increased by focusing on 'rich' voice in voice applications, VoIP-enabled IT applications and integrated voice/internet services, such as personalized context-aware services.

In his presentation on Investment incentives in an environment of dwindling voice revenues[73], Dr.Gruber[74] attributed stagnant or declining fixed line revenues to:

- reductions in unit prices, not compensated by increase in traffic;
- Flat-rate pricing;
- Competition from the mobile sector and fixed-mobile substitution, which has stolen traffic;
- The share of data, which is increasing, thereby resulting in diminished margins.

Mobile and SMS termination and international roaming pricing, however, remain exorbitant. Dr. Reynolds[75] pointed out that interconnection is generally unclear to end-users. Why does it cost 15 cents to connect to mobile networks but virtually 0 cents to connect to fixed-line ones? The European Commission has so far resisted including data (especially SMS) within the regulations on roaming, because the roaming problem revolves primarily around voice (Banable[76]).

The incremental cost of voice is nil. Dr. Reynolds[77] noted that, with the transition to VoIP, there is practically no marginal cost for a call. Sergio Antocicco[78], Chairman of INTUG[79], suggested that, consequently, voice tariffs will fall. Operators are trying to offset these declines by offering new applications. He suggested that, with reductions in price, operators are in fact transferring most of the IP cost savings to users.

3.6 Voice pricing is moving toward flat rate and bundles.

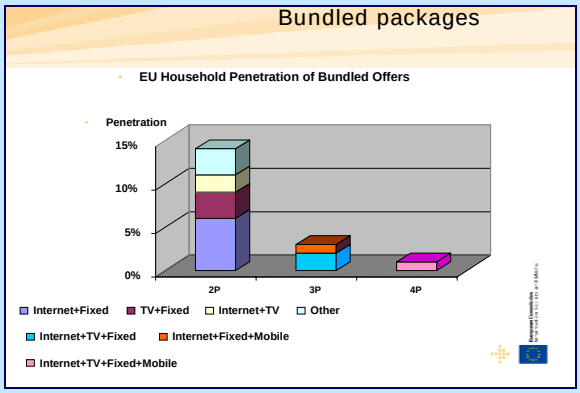
Dr. Kelly[80] observed that telecom markets are adopting flat-rate pricing, rather than time-based and data-capped pricing models (Figure 6). With converged services and bundling, voice is increasingly offered "free" with Internet and multi-channel TV services, often through competitive pricing strategies. Although the traditional telco business model of pricing per minute is well understood and enables service differentiation, nevertheless it is based on scarcity of resources and may not be sustainable now there is a relative abundance of bandwidth. Dr. Kan[81] observed that there is a massive surplus of optical bandwidth, while the cost of bandwidth is approaching zero. ITU (1996) calculated that the cost of bandwidth is <0.0001/min. However, now the cost of bandwidth has reduced even further.

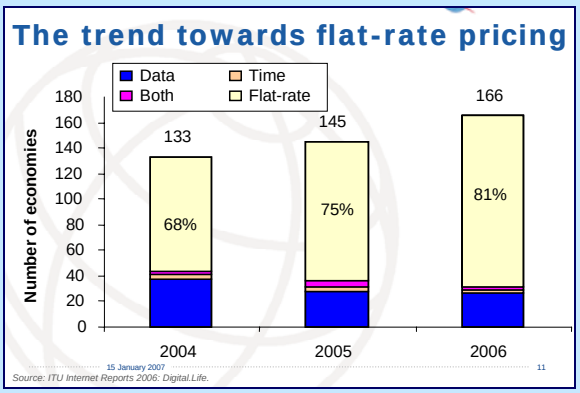
Dr. Kelly[82] observed that users want predictable monthly bills (e.g. prepaid mobile). Pricing per minute inhibits the take-up of data/content services, which means that it may be incompatible with the goal of reducing dependency on voice revenues. In "Voice and video, content and connectivity"[83], Dr. Odlyzko[84] showed evidence from AOL suggesting that flat-rates stimulate usage (users tripled after AOL's introduction of flat-rate tariffs for dial-up internet access in 1997). The United States has a very high volume of wireless minutes per day per subscriber, which is priced on an 'almost' flat-rate basis.

However, Dr. Brandl[85] foresaw a continuing role for per minute billing for some time yet, due to different termination rates and worldwide interconnection agreements. There is a steady migration from Triple-play (voice, data and video) to Q-play (high-speed data, telephony, TV and mobility).

Mr. Davide Gallino[86] of the European Regulators' Group (ERG)[87] outlined his views on the regulatory approach to bundling in his presentation, Bundling and Regulatory Issues[88]. Bundling is inevitable, as voice revenues are reducing and vertically integrated operators are trying to steal each other's customers and multiple new players are entering the industry. Mobile network operators are also in the game and new platforms are emerging.

Figure 6: Market moves towards bundling and flat-rate pricing
Proportion of EU households with bundled offers (left chart); flat-rate pricing packages as a proportion of commercial broadband offers worldwide, 2004-2006 (right chart).





Source: Benable, "Review of the Regulatory Framework for Electronic Communications" (left chart); Kelly & Ponder, "The Future of Voice: Framing the Debate" (right chart).

In "VoIP Peering and Federations- The New Paradigm"[89], Eli Katz[90] suggested that a subscription-based methodology is increasingly relevant to cross-federation in VoIP peering, allowing connectivity on a settlement-free basis (another example of the classical model of settlement per minute migrating towards flat-rate capacity-based interconnection).

3.7 Voice can be enhanced by combining with data (e.g., online social networking services or telemedicine)

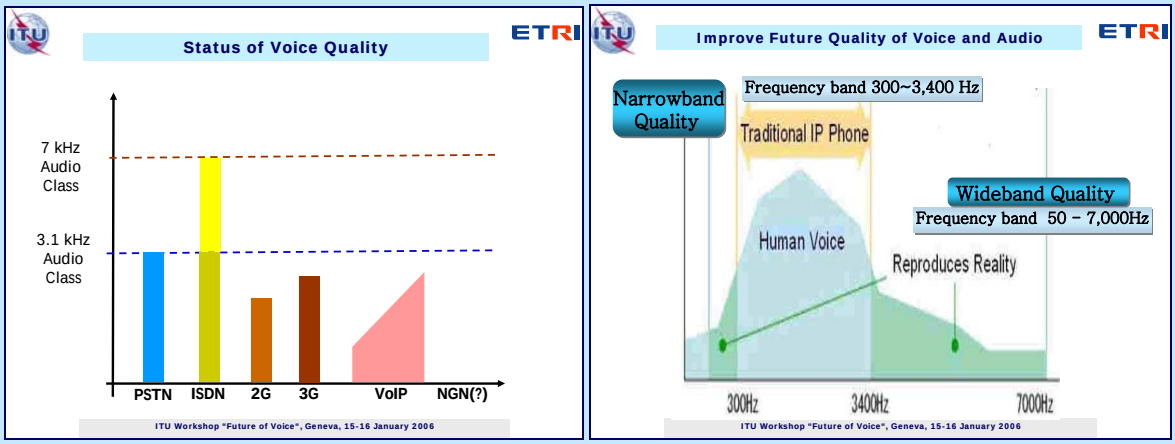
Dr. Odlyzko[91] pointed out that narrowband mobile voice still has twice as many users and revenues as broadband fixed Internet, so voice should not be neglected. Future avenues of opportunity in voice include higher-quality, differential quality and toll-free calling (successful in fixed line networks, so why not offer it in the mobile environment too?) and voice messaging, which could be exploited further.

Participants agreed that "premium voice" services[92] are promising. In "Convergence and its Impact"[93], Dr. Eric Burger[94] asked, "what is a voice application?" There are now innovative group applications (such as teamspeak in World of Warcraft and Vivox in Second Life) which look like voice (using person-to-person, real-time, audio communication), but are not. For example, the implementation of VoIP in World of Warcraft is proprietary, with no connection to PSTN other than the fact it runs over IP (Lozinski[95]). The extension of voice into online social networking sites offers new commercial opportunities (e.g. the acquisition of Skype by e-Bay).

Premium voice entails a high, guaranteed quality of voice service over an IP-based network greater than that currently available. In "Global Standards for Converged Communications Services"[96], Dr. Chae-Sub Lee[97] observed that there have been large gains in voice usage over the last 20 years, but no gain in QoS of voice, which remains audio class. NGN is a broadband-managed IP network, but quality of VoIP is poor (Figure 7, left chart) with multiple VoIP speech codecs (G.729, G.729.1, G.711, G.723.1, G.726, ILBC) preventing VoIP interoperability. Quality of voice could be improved with wideband (Figure 7, right chart). Trans-coding reduces quality and raises costs and should be minimized (no trans-coding by the media gateway should be target of NGN). There are too many standards development organisations for the media codec[98] and a convergence codec(s) is needed. The latest codecs have high flexibility (from scalability) and high robustness to packet loss. At the NGN-GSI event in Beijing in January 2007[99], it was agreed that the codecs should be developed to support mobility, seamless handover and a range of services, including FMC.

Figure 7: Quality of voice services, present and future

Status of voice quality for different technologies, 2006 (left chart); and the need to improve the future quality of voice and audio into the 50 – 7,000 Hz frequency bands (right chart).



Source: Chae Sub Lee, "Global Standards for Converged Communications Services"[100], presentation to the ITU workshop, The Future of Voice[101], 15 January 2007.

Dr. Odlyzko[102] quoted the IEEE Communications Magazine, May 2006 special issue on "Wideband speech coding standards and wireless services"[103] as predicting that "wideband speech will be the major differentiation and attraction of 3G network services in both the circuit- and packet-switched domains. Increased audio bandwidth introduces a significant leap in perceived QoS, compared to currently utilized narrowband telephony in 2G mobile communications and the PSTN".

In "Telecom Sector on the Edge: Driving the Future of IPTV"[104], Jaroslaw Ponder[105], ITU Policy Analyst, noted that market expectations are high that IPTV can replace lost voice revenues. IPTV offers the possibility of triple-play offerings. PCCW in Hong Kong offers one the most successful development of IPTV to date (NOW). Drivers of IPTV include broadband, competition, convergence and user demand. Obstacles to IPTV include regulatory environment, standardization and margin redistribution.

In "The Convergence of Voice and Web 2.0"[106], Zygmunt Lozinski[107] observed strong growth in social networking sites and user-generated content (e.g. Facebook, MySpace). Social networks focus on the sharing of media (e.g. Flickr for photos, YouTube for video). There is an audience of around 57m people for social networking sites, mainly people from industrialised economies using broadband. People will still communicate, but the mechanisms will change. There is increasing use of applications using the web as a platform (e.g. Google maps). Business models are changing (e.g. outsourcing and the breaking down of business systems into their components). Telecom operators have not thought through how to build applications on very valuable networks. Operators must decide whether to be a pure network operator or offer services in addition.

The UMTS Forum[108] predicts the development of more personalised services, from entertainment to life coaching. For mobile, according to the UMTS Forum's report "Market Potential for 3G LTE", he suggested that videotelephony could grow fast by integration with applications such as IM, VoIP, file sharing and other applications enabled through 3G LTE high performance networks (e.g. enabling deaf users to use mobile devices for sign language and remote surveillance).

In "Voice is not replaceable"[109], Loso Judijanto[110] pointed out that most people still use their mobile phone to make simple telephone calls, however, and that telecom players are overlooking the mass market for voice and are tending to concentrate on the most advanced services, which are not necessarily needed by the majority of consumers.

3.8 Price discrimination and product differentiation are needed

In VoIP Driving the Restructuring of Telecommunications[111], Dr. Kan[112] suggested that price discrimination has been a telco strategy for survival, by selling high price narrowband voice and low price for video and data. Price is inversely proportional to price demand elasticity. For this type of price discrimination, a shortage of supply is necessary (as happened twenty years ago). But this is no longer the case today (with alternative competing networks in fibre, 3G, WiFi, WiMax). The precondition of shortage of scarcity is no longer relevant.

Personalised/differentiated products and customised services (e.g. personal portals) can be used to sell services to customers. In The role of VoIP in telecommunications[113], Dr. Kim[114] suggested that voice is evolving from a price-driven operator-centric market to an application-driven user-centric market (Table 1). As VoIP offers enhanced features and becomes more widespread, customers' usage pattern will differ significantly and customers will become more segmented. Voice customers can be retained through segmentation, branding and bundling to suit customers' needs.

In the concluding discussions, Dr. Woroch[115] noted that product differentiation by network currently exists, with poor-quality voice in VoIP and higher quality voice on PSTN and cellular networks. He asked what are the commercial opportunities for premium voice and whether the incremental value to consumers could justify investment?

Howard Williams doubted that suppliers will lock in higher quality service and associate it with higher prices anytime soon. Dr. Woroch[116] noted that Sprint broke away from other long distance carriers by emphasizing quality of voice over its fibre optic long-distance network. Dr. Odlyzko suggested that premium voice is based on marketing, with more discretionary products on offer. Russell Southwood noted that quality is very

valuable in the corporate sector in group conference calls with worldwide coordination (at rates of $600/hour).

Table 1: The Evolution of Voice

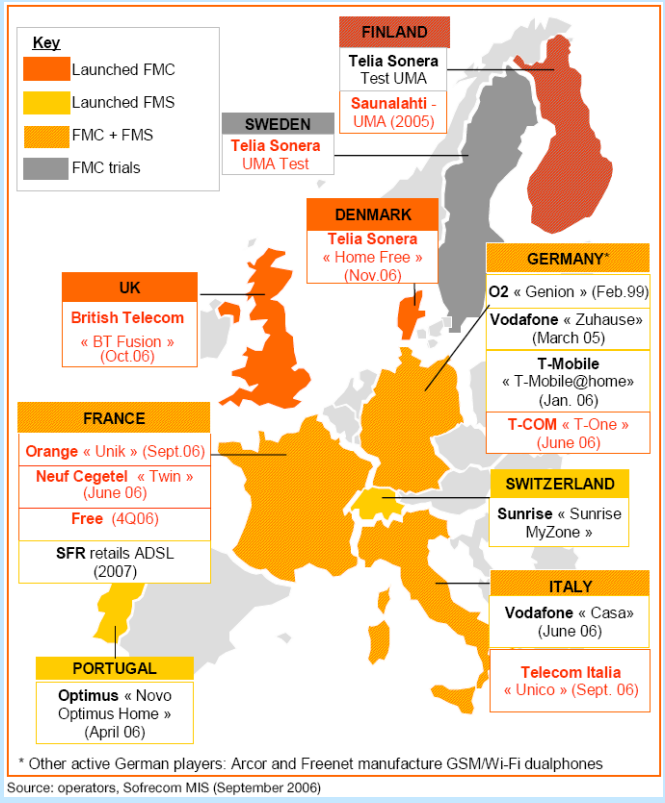
Operator-centric	User-centric
• voice over telephone • same services & phone for everyone • *price*-driven • *separation* of communication, information, entertainment • *Unified communications:* voice PBX, Audio Conferencing, data, IM, E-Mail, web conferencing.	• voice will be 'embedded' in many applications and services • customized services & GUIs • *application*-driven • *convergence* of communication, information, entertainment • *rich communications* :e.g. community, blogs, Information, Entertainment, education, medical care, security

Source: The role of VoIP in telecommunications[117], presentation to the ITU Workshop, The Future of Voice[118], by Dr. Kim[119], Korea Telecom, Geneva, 15 January 2007.

3.9 Fixed-mobile convergence is a growing reality

Consumers benefit from convergence (bundled offers, service integration and device convergence) in convenience, simplicity, cost savings and advanced content-based services. In Europe, Fixed-Mobile Substitution and convergence are conflicting (Figure 8). Jean-Pierre Bienaimé[122] cited the example of Unik in France (convergence is also underway in Germany, Denmark, UK and Italy).

Figure 8: Substitution versus convergence in Europe
The advance of Fixed-Mobile Substitution (FMS) or Fixed-Mobile Convergence (FMC) in Europe.



Source: JP Bienaimé, Voice Evolution & Fixed-Mobile-Internet Convergence[120] presented to the ITU workshop, The Future of Voice[121].

Convergence offers are available in:

- Brazil: Brasil Telecom–Unico (dual GSM/Bluetooth handset)
- China: China Telecom, China Netcom–QBox (Personal Access/mobile/Internet)
- Czech Republic: Telefonica Internet Komplet (Q-play fixed/mobile/Internet/TV)
- India: BSNL, Airtel, MTNL – One India (fixed/mobile/WLL)
- Jamaica: MiPhone (MNO)/Flow (ISP) (fixed/mobile)

Substitution offers are available in:

- Cameroon: Camtel–CTPhone (fixed/mobile/Internet)
- Hungary: Vodafone – Otthon Classic (fixed/mobile)
- India: Airtel Mega (FMS)
- Jamaica: Digicel (FMS).

Jean-Pierre Bienaimé[123] concluded that convergence has a bright future, subject to handset availability and user perceptions.

3.9.1 Mobile VoIP, Fibre-To-The-Home and Broadband Wireless Access

In his presentation, Voice Evolution and Fixed-Mobile-Internet Convergence[124], Jean-Pierre Bienaimé[125] introduced the UMTS Forum[126]'s report "Market Potential for 3G LTE", which predicts that the efficiencies realized through 3G LTE will slash overheads for operators in mobile VoIP. Presence information, messaging and multimedia will be among the first applications. Single handset solutions have a bright future: Analysis has predicted that, by 2015, VoIP on mobile will account for 23% of fixed and mobile calls in Western Europe. However, Mr. Sutherland[127] pointed out that instant messaging over mobile IP threatens SMS revenues. VoIP is both an opportunity and a threat to mobile operators. Jean-Pierre Bienaimé[128] replied that mobile VoIP as a sudden transition is likely to be very disruptive, but that progressively bundled offers are part of operators' response.

In Asia, telecom services are moving to broadband and increasingly Fibre-To-The-Home (FTTH[1]). Dr. Hanatani[129] introduced the work of the FTTH Council Asia-Pacific[130]. Asia leads the world in broadband, with 56m or 43% of all broadband subscribers in 2004 and 82% of all FTTH subscribers. FTTH offering up to 100 Mb/s is forecast to grow to 26m by 2009, but ADSL will dominate at 88m by 2009. Total broadband subscribers are projected to amount to 130m by 2009. Factors driving FTTH include government policies and influence, competition, new services, housing and population density, the access loop network and cultural issues. Currently, Japan is the only country that has unbundled FTTH access. Japan and Korea have been investing in FTTH networks for 15 years, so operators can make a return on their investments, despite the low prices. This is in contrast to the situation in the US, where many operators are building FTTH from scratch.

Monika Podplonska[131] spoke on VoIP and its impact on competition in the telecom sector[132]. She suggested that VoIP over Broadband Wireless Access (BWA) could be an attractive service but this is still too new to make a big impact. Incumbent fixed operators are focusing on developing VoIP over fixed broadband access. Mobile operators will probably not use BWA systems to compete with fixed DSL/cable services for Internet access. The only barrier is lack of spectrum for BWA. Currently, BWA can also compete with cellular coverage.

3.9.2 Mobile WiMax

Melinda Tan[133] gave an overview of global trends in voice, including WiFi, in Singapore. In his presentation on Mobile WiMax[134], Dean Chang[135] presented the work of the WiMax Forum and cited the benefits of Mobile WiMax as delivering a broadband experience similar to fixed, being easy-to-use, affordable, handling a variety of user devices and usage models and supporting multiple applications (data, voice, video) over IP. It is also capable of global roaming. WiMax has a common standard that delivers a global platform for mobile Internet services. WiMax's system requirements are based on IP and control jitter, using spectrum in a more efficient way.

Wireless technologies are evolving to OFDM and OFDMA. OFDMA has better spectral efficiency, does not need a line of sight and delivers the highest capacity/greatest throughput at lowest cost. Mr Chang argued that WiMax should not be regarded as a mobile voice replacement, but a complement to cellular/3G, although he conceded that "WiMax is probably in competition with where 3G is headed". WiFi was designed as a local area access technology. WiFi is a big pipe giving bandwidth contention at 50% efficiency. WiMax gives 70-80% of bandwidth capability and resolves contention. WiFi will survive (as it is cheap and inexpensive and will always be included), but WiMax will be added in. He cited the examples of Sprint, Samsung, KT and M-Taiwan as investors in WiMax.

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[1] Also including Fibre-to-The-Building (FTTB) and Fibre-to-The-Curb (FTTC).

4 AREAS WHERE THERE WAS UNCERTAINTY (*CONFUSION*)

Areas where considerable uncertainty was expressed by participants included:

4.1 How best to regulate VoIP services

In New Regulatory Paradigm or More Plain Old Telephony?[136], Ilsa Godlovich[137] presented the work of European Competitive Telecommunications Association (ECTA). She asked whether VoIP is a new market and whether customers will switch PSTN fixed voice for VoIP. VoB[138] is usually a substitute for PSTN, whereas VoI[139] is currently not a full substitute. Substitution is likely to be good (as it offers more choice), so how can we get more? More competitive markets support growth in VoIP (re France, Japan). Regulators need to ensure that markets are as competitive as possible.

Phillippa Biggs[140] presented the ITU's Background Paper on the Status of VoIP worldwide in 2006[141]. Regulatory approaches across 130 countries range from legalisation of VoIP to outright bans on the use of VoIP (often to protect incumbents' revenues). Regulators seem to be following the market, with many countries holding public consultations. Strong differences are evident in regional approach to regulation – Europe and the CIS have mostly sought to liberalise VoIP services, in contrast to Africa and the Arab States. In the Americas and Asia-Pacific, around 45% of countries have moved to instigate partial or full competition for VoIP in their telecom markets. In his background paper "The Future of voice in Africa"[142], Russell Southwood[143] noted that VoIP has been legalized in 7 out of 54 African countries[144], and should be legal everywhere in five years.

In his presentation, "Convergence and its Impact"[145], Dr. Burger[146] noted that resisting VoIP may inhibit the development of new, wealth-creating applications, often worth more than the displaced voice revenues. He noted that it is now technically very difficult to identify a voice call (for tariff and tax purposes), so operators and governments should expect to give up voice calls as a source of revenue, and should look for alternatives for universal IP access. Otherwise, significant consequences could arise in loss of innovation, national wealth generation and competitiveness.

In "ETP's View on the Future of Voice"[147], Dr. Brandl[148] noted that VoIP is a challenge to the current licensing regime – there are very different definitions for voice (PATS) services and voice-like services (ECS). Whether operators are regulated or not depends on whether they meet certain criteria. Only traditional operators are regulated – new entrants do not meet criteria and can avoid regulation. Regulation within the EU has tended to focus only on Voice over Broadband (VoB) services (i.e. omitting Voice over Internet or VoI) and especially from established operators. This is 'biased regulation', as international large VoIP providers remain unregulated and out of the scope of the European legal framework. Regulatory discrimination has to be avoided but general rules (e.g. emergency calls) and QoS obligations for VoIP providers are vital.

Monika Podplonska[149] spoke on VoIP and its impact on competition in the telecom sector[150]. She observed that there are many different approaches in the EU. The EU has generally adopted a light regulatory touch. Issues include number portability, consumer awareness, directory services and numbering. Mr.Langmantel[151] from the Austrian regulator, Rundfunk und Telekom Regulierungs[152], spoke on Internet/Next Generation Emergency Calls[153] showing how service architecture differs in PSTN, GSM, Internet, VoIP and NGN in how emergency calls are handled/located in each network.

4.2 How to structure interconnection pricing of asymmetric networks, VoIP services.

In his presentation, "I think I'm losing my voice"[154], Dr. Reynolds[155] suggested that interconnection may be moving from Receiving Party Pays (RPP) to Calling Party Pays (CPP) to No Party Pays (NPP). However, the high charges involved in a "terminating monopoly" mean that there are few incentives for change – every operator gets its cut, so why change?

Ilsa Godlovich[156] suggested that VoIP/PSTN termination remains a bottleneck. Operators with large customer bases have a lot of bargaining power – why would they interconnect? This is one reason why there

have been few/no explicit VoIP termination agreements to date. Regulatory intervention seems essential, where there are dominant operators.

In "VoIP Peering and Federations - The New Paradigm"[157], Eli Katz[158] argued that scalable cross-network VoIP interconnection can only be achieved multilaterally through federated peering[159]. Currently, "IP on-net" calls are possible within a single VoIP network (an "IP Island"). However, the launch of new services needs cross-network availability and end-to-end IP connectivity, making VoIP peering inevitable (he cited SMS, which grew exponentially once it became available cross-network). The challenge is how to connect the many IP Islands that are now emerging. VoIP Peering is more than IP Peering, as it must ensure signalling interoperability, trust and security, despite different protocols. Bilateral VoIP Peering is workable only for a few direct interconnections, but cannot be extended due to trust, signalling and security concerns. A neutral, trusted federation provider could:

- Protect sensitive data by eliminating open sharing of data between peers;
- Resolve the N2 interoperability problem through a single interoperability test to access peers;
- Ensure security by protecting the VSP and its subscribers from SPIT, vishing etc.;
- Simplify Contractual Issues with a single contract.
- Give VSP greater control and the ability to set peering policies.

It is unclear whether, based on policy and traffic profiles, VoIP interconnection should still be settlement-based or settlement-free (Bill & Keep), although it seems likely that it will move to settlement-free in future. For video, 3G users are potentially the most numerous video endpoints. The 3G business model relies on settlement rate charging, but in future, traffic volumes will be more balanced between service providers, so settlement-free interconnection should become more economically feasible.

Dr. Reynolds[160] asked what numbering will mean in a future environment in which there is no longer any geography associated with the network. Geography matters less in a VoIP service, since Internet routing is not based on a geographical hierarchy. Users may be associated with a PSTN number, an IP-number as well as a network identifier, which seems redundant. Are numbers just an excuse for a billing relationship? Nevertheless, the OECD recommends sticking to geographic numbering at present. In "ETP's View on the Future of Voice", Dr. Brandl[161] noted that ETP's current membership do not consider any changes are necessary to the current numbering scheme over the medium-term.

Sergio Antocicco[162], Chairman of INTUG[163], spoke on Shaping an Enabling Regulatory Paradigm[164]. Mr. Antocicco presented INTUG, its aims and work as a consumer interest group. He suggested that regulations are necessary for emergency call location. He suggested that some regulators are limiting the use of geographic (E-164) numbers for VoIP calls, but consumers want flexibility, not limitations. He suggested that a worldwide VoIP numbering scheme, with a number for each citizen, could be overseen by the ITU to guarantee flexibility.

4.3 Voice delivered by circuit-switched fixed networks will disappear

Participants differed in their views as to whether there is still a role for circuit-switched networks. Dr. Glenn Woroch[165] pointed out that operators are now building data networks, which may not be ideal for voice. He raised the unpopular scenario that, in 20 years time, circuit-switched networks might persist because they provide voice services well?

Dr. Chae-Sub Lee responded that there are already clear directions for the successful development of NGN and the launch of a full packet-based network. If real-time data is realised, voice and TV streams become possible. Dr. Skouby suggested that there will probably still be some circuit switches in 20 years' time, if only because they are cheaper and some users will resist complex technology. Mr. Sutherland pointed out that operators in developing countries are still trying to roll out PSTN and could struggle to make the necessary investments to upgrade to NGN.

4.4 Imbalance between rich and poor users, and between rich and poor countries.

In "Voice is not replaceable"[166], Loso Judijanto[167] suggested that leading operators must not ignore lower-income mass markets in developing countries, as growth will be fuelled by expansion into underserved markets. As the high-end market saturates, developing countries offers many opportunities, despite difficulties with affordability. It is wrong to assume that the poor are not a profitable sector. Consumption will remain strong: globally, voice minutes will reach 16 trillion minutes in 2015 or an average of 11 minutes per day for each of the world's 4 billion or so people that are phone users (Pyramid Research, 2006).

According to Loso Judijanto[168], voice will be a core service for operators that can follow a high volume/low-cost strategy in developing markets offering the most growth potential. Niche service providers can target low-income consumers with innovative pricing strategies and appropriate distribution networks. Most people still use their mobile to make simple telephone calls. Sadly, some telecom players are overlooking the voice market and moving into more advanced services, which are not necessarily the most demanded by most consumers. The keys to tap into mass markets are to understand the market, find the right segment and then innovate to serve the targeted markets. If the economic and physical bottlenecks to distribution can be broken, huge and previously neglected markets open up. He illustrated this strategy for mobile user groups in Indonesia, where 60m or 25% people live on less than US $2/day and the greatest untapped potential revenue is in the low-income segment (Table 2). Governments need to support infrastructure investment and promote infrastructure-sharing to reach this part of the population.

Table 2: The mobile market in Indonesia

Segment	High-End Users	General / Urban	Sub-District or Village Outskirts	Rural Cluster
Typical Users	High-income spenders	Monthly fixed-income	Low Income First-time Users	Low-inc shared home phone
Local: Long-D	80:20	80:20	90:10	95:5
Data/SMS Uses	High-Heavy MMS, video stream, games, mobile TV, high-speed Internet	Moderate-High, MMS, SMS, Internet	Limited voice/SMS	Limited voice/SMS
Roaming	High	Moderate	Occasional	No
Monthly ARPU	USD 22-30	USD 9 - 16	USD 4-12	USD 4-12
Technology	3G (WCDMA)	2G (GSM,CDMA)	2G, CDMA450	2G, CDMA450
Market (est.)	10m	50m	80m	
Served (est.)	3m	45m	2m	
Potential MR*	USD 220-300m	USD 450-1,100m	USD 320-1,440m	
Tapped MR*	USD 66-90m	USD 405-720m	USD 8 – 24m	
Untapped MR*	USD 154-210m	USD 45-380m	USD 312-936m	

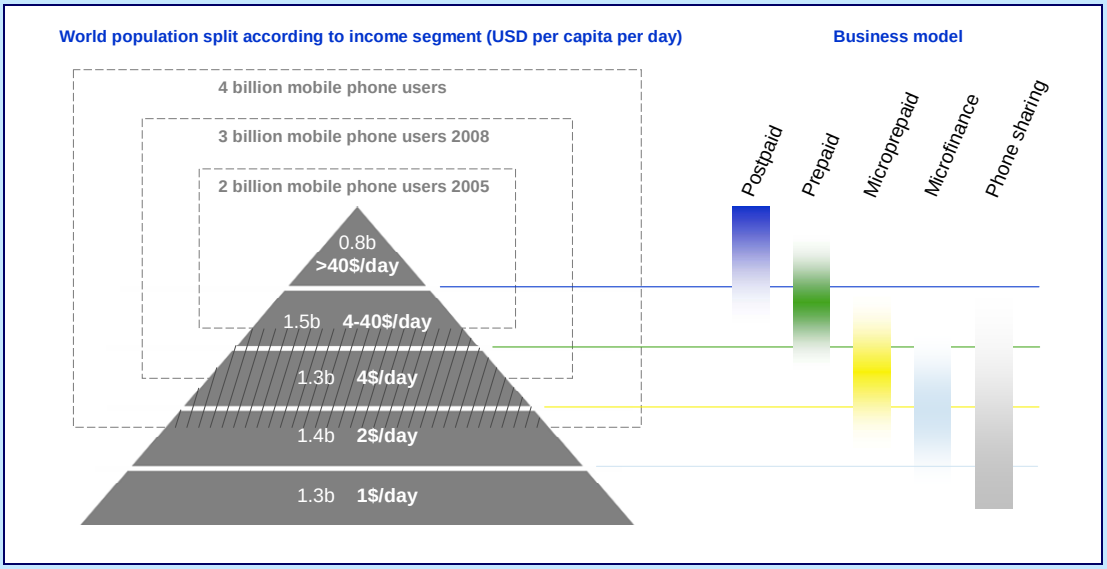
Note: * MR = Monthly Revenue.*Note:* SPU_note

Source: "Voice is not replaceable" [169], presentation to the ITU Workshop, The Future of Voice[170], by Loso Judijanto[171], Geneva.

In "Voice services in new growth markets"[172], Rauno Granath[173] predicted that global mobile subscribers will reach 3bn in 2007 and 4bn by 2010. Around 80% of new market growth will come from lower-income emerging markets. Affordability comprises both the total cost of ownership and cash flow ("cash-barrier") aspects. New business models can match spending to erratic incomes through micro-financing, shared phones and micro-prepaid, with low denomination top-ups and balance transfers between subscribers (Figure 9). He described India as the fastest-growing mobile market in the world, with around 7m new mobile

subscribers being added each month. Airtel offers twenty options for prepaid denominations ranging between 0.17-61 EUR, with a minimum monthly spend of 1.7 EUR. He pointed out that mobile operators are in a good position to offer other services (banking, data and internet access) to the mass market, due to the lack of substitutes.

Figure 9: Evolution of business models to reach low-income consumers
Growth in worldwide mobile subscribers from 3bn in 2007/2008 to 4 bn in 2010 means that new business models must be developed to meet the needs of lower-income subscribers in emerging markets.



Source: "Voice services in new growth markets" [174], presentation to the ITU Workshop, The Future of Voice[175], by Rauno Granath[176], Nokia.

In his presentation on Mobile WiMax[177], Dean Chang[178] pointed out that the most promising markets for WiMax are in fact in developing countries without existing wireline broadband access.

Dr. Reynolds[179] raised the point of whether data lines should be included in definitions of universal service. Dr. Eric Burger[180] suggested that universal services may come to mean IP access, rather than an analogue voice line or basic cable video service. In Transformation of Voice Services: Implications for Future of Regulation[181], Tomas Lamanauskas[182] considered that universal service policy should be part of common social policy – users should choose where to spend the money.

In Fixed-Mobile Convergence and Universal Service[183], Dr. Woroch[184] explored the impact of universal service programmes on the growth in mobile. He asked whether mobile access should be counted towards the goal of universal service and whether the subsidies favoring fixed line service should be eliminated. Universal service programs such as the "Lifeline" discount for fixed voice service retards the spread of mobile service.

4.5 Impact of vertical separation on fixed voice delivery.

In "The Future of voice in Africa"[185], Russell Southwood[186] noted that the introduction of IP has decoupled services from transport and infrastructure in vertically separated layers. In Africa, new VoIP service providers effectively "rent" the network through interconnection agreements. The African market is moving from a "small number of big players" to "big players plus many smaller players", with the growth of locally-owned SMEs.

Dr. Garry Madden[187] and Dr Aniruddha Banerjee[188] presented their Background Paper on Regulatory Trends: A New Enabling Environment[189]. The access markets are still subject to inter-modal competition. Structural separation means that maintenance of vertically integrated markets is even more difficult (Table 3). Easier

entry with less vertical structure creates Price competition (static efficiency) and Innovation in all markets (dynamic efficiency). They suggested that allocative efficiency may become less relevant and dynamic efficiency is becoming more relevant.

Table 3: The Consequences of Key Trends in Telecom

Key Shift	Consequences
1. *Market Structure*: Structural separation of networks, services and applications	• Network access bottlenecks can be avoided by inter-modal competition • Strategic positioning of firm in single or multiple markets • New business models needed to identify/maintain revenue sources • Maintenance of vertically integrated markets is even more difficult.
2. *Network Intelligence*: Intelligence moves to the network's edge	• Consumer is sovereign and determines access, service and application bundle. • Service provider/application developer can reach targeted consumers • Innovations in applications stimulated
3. *Broadband*: broadband technology is scalable.	• Barriers to entry attenuated • Aggregated demand for under-serviced markets • VoIP market growth • Other applications stimulated

Source: "Regulatory Trends: New Enabling Environment" [190], presentation to the ITU Workshop, The Future of Voice[191], by Gary Madden[192] and Aniruddha Banerjee[193], Geneva.

5 AREAS OF DISAGREEMENT (*CONTENTION*)

Workshop participants differed in their opinions on the following key issues:

5.1 Traditional fixed (and possibly mobile) service providers are "doomed".

Participants differed in their opinion on the outlook for traditional fixed line providers. Given the shift of voice towards mobile and IP, some participants thought that traditional fixed line providers would be condemned to a future as 'hollow pipe' providers. Others thought that the main challenge for traditional fixed line providers is to adapt their business model to become a converged services provider. In "The Convergence of Voice and Web 2.0"[194], Zygmunt Lozinski[195] suggested that operators must decide whether to be a pure network operator or offer services in addition. The challenge to operators is to transform their networks into platforms offering voice, location and presence to drive future growth.

In VoIP Driving the Restructuring of Telecommunications[196], Dr. Kan[197] observed that there is a massive surplus of optical bandwidth, while the cost of bandwidth has reduced to nearly zero. Oversupply is killing suppliers (in China, telcos are building their own fibre networks with massive redundancy and do not allow any other operators to use their network, which has reduced the price even further). Given the oversupply of fibre networks, Dr Kan argued that operators could:

(i) Build less bandwidth and encourage greater usage, by opening up their 'hollow pipes' to other service provider or

(ii) Insist on vertical integration and try to squeeze out more profit. (Most telcos in China have chosen this option).

However, he argued that the surplus of supply and the blurring of the edges between markets has in fact eliminated the second option. So telcos have no choice except to share their fibre-bandwidth with other service providers and become hollow pipes providers. Dr. Kan[198] predicted that mobile operators will become extinct, as they have nothing to sell (not even hollow pipes), compared to WiFi or WiMax.

5.2 Unbundling incumbent fixed networks is antithetical to the investment necessary to maintain the voice network and to innovate

Mr. Bartholomew[199], Director of European Telecommunications Network Providers' Association[200], noted that *ex ante* regulation and access regulation rules are not adapted to the high-risk investments involved in NGN. Regulation reduces incentives for investment in NGN. Investment by new entrants in new networks in fact fell in 2005. Operators should be able to negotiate access to their networks on their own commercial terms. The European Commission has stated that its next review could end sector-specific regulation. However, the introduction of mandatory structural remedies (functional or structural separation) is inappropriate in an environment of rapid technological change. No one will invest in company under threat of a structural remedy.

In his presentation on Investment incentives in an environment of dwindling voice revenues[201], Dr. Gruber[202] noted that the regulatory remedy to bottlenecks in local loop access has been to open access at cost-based prices. The "ladder of investment" theory states that, at first, competition will be realised through service-based competition (i.e., opening up access through bitstream access and resale). As entrants and competitors invest, facility-based competition arises over the long-term (where opening up the local loop can be achieved through full LLU and shared access). Evidence from the United States indicates that inter-platform competition has significant positive effects on diffusion of broadband and in reducing prices. However, in the EU, DSL is becoming more dominant (from just over 70% of the broadband market in 2003 to 80% in 2005) and inter-platform competition is reducing. Platform competition is not relevant to all EU countries, due to the lack of cable networks. In the EU, regulation must encourage more investment and should not represent a permanent claim on incumbents' assets, but rather stimulate facility-based competition. Dr.Gruber[203] noted that investment in fixed line telecommunications in the EU has fallen from 25m Euro in 2001 to 15m Euro in 2004.

Dr. Margit Brandl[204] noted operators' desire for a level playing-field, technology neutrality and a light regulatory touch. However, operators' investments in NGN are threatened. How can operators use their new networks? Will they be forced to become bit-pipes, or can they offer new services? Regulation must not hamper growth, but should encourage the roll-out of new infrastructure and new business models. ETP's current membership thinks that the present licensing regime is broadly acceptable. However, there are currently very different definitions for voice services and voice-like services (ECS and PATS). Only traditional operators are regulated – new entrants do not meet criteria and can avoid regulation.

Mr. Banable[205] argued that the principles of the EU regulatory framework remain sound, with its objectives of promoting competition, consolidating the single market and protecting consumers. Regulation focuses on markets where competition is not effective and on market players with Significant Market Power (SMP). The "three-criteria" test is applied cumulatively to identify markets where *ex-ante* regulation may be justified[206]. Regulation should be removed once competition is effective. Structural separation could comprise divestiture; separate legal entities; functional separation or accounting separation. ECTA has called for 'explicit NRA powers to apply functional separation'. ERG has called for "the strengthening of non-discrimination obligations by… allowing NRAs to oblige functional separation where necessary". Conversely, ETNO argues that "forced… separation of networks and services… risks discouraging investment… and damaging harmonisation and innovation in the single market".

Mr. Banable[207] argued that a market-based approach facilitates convergence. Options for improving the framework include: more detailed provisions (achieving a right balance between general principles and detailed provisions), giving more power to the National Regulatory Authorities (NRAs); or making greater use of guidelines. There are split views on Commission approval of remedies, a stronger role for ERG, continuance or abolition of Article 7 and/or the creation of a pan-European regulator.

5.3 How competitive is the voice access market?

Ilsa Godlovich[208] observed that operators with control over largest customer base have valuable assets and the greatest bargaining power, proving an incentive to deny interconnection. Migration from the PSTN to NGN will extend this power.

Dr. Gruber[209] noted that the regulatory remedy to bottlenecks in local loop access has been to open access at cost-based prices. For IPTV, in "Telecom Sector on the Edge: Driving the Future of IPTV"[210], Mr Ponder[211], noted it is unclear whether NGN will result in re-monopolisation (through control of the access network) or the growth of competition with new entrants. Dr. Reynolds[212] pointed out that market power has serious consequences for VoIP, as traffic prioritization is a big issue with VoIP. Traffic prioritization is a question of network neutrality. These debates are especially relevant to VoIP, because VoIP is very sensitive to traffic prioritization by operators to avoid jitter and lag. Traffic prioritization can either smooth these out or deprioritise voice and make it much more difficult to hold a conversation. One of the important topics, therefore, in network neutrality debates is there the relative priority that should be afforded to voice (VoIP).

Dr. Alleman[213] presented the ITU Background Paper on the Market Potential of Voice and Next Generation Services[214]. He argued that, in the United States, there is still no effective competition in the last mile. This is because of the high investment costs required for the last mile, creating economies of scale and scope, but with a significant sunk cost component. Most new services are built on top of the last mile element, so the last mile has to be regulated, until competition develops.

In his presentation, New Markets and Regulatory Forbearance[215], Dr. Müller[216] discussed what makes a new market new. There has been a decline in investment incentives in Europe. New markets in Europe should be left unregulated, he argued, citing the example of FTTC and VDSL2 as new markets in which regulatory forbearance is justified.

Mr. Bartholomew[217], Director of European Telecommunications Network Providers' Association[218], noted that bundled offers are also a challenge for regulation - bundling voice with other services should not lead to the whole bundle being subject to regulation to ensure investment in new services. Mr. Davide Gallino[219] of the European Regulators' Group (ERG)[220] outlined his views on the regulatory approach to bundles in his presentation, Bundling and Regulatory Issues[221]. Questions for regulators on triple play include:

- are component services completely below cost or is it replicable (totally or partially)?
- Is content distributed over IPTV bound by exclusive contracts?
- Even if individual components are not below cost, is the overall offer replicable?

Where the bundled offer is not replicable, market definitions of the relevant market may not cover the offer or each segment is relevant.

Russell Southwood[222] noted that the transition to IP in Africa is happening on four levels: international, national, local loop, user level. 25% of African incumbents have an international gateway and IP connections. About 20 carriers are already engaged in national trunking, with a further ten to follow over the next year. In The role of VoIP in telecommunications[223], Dr. Kim[224] noted that there has been unbundling of the local loop in the Rep. of Korea, so new entrants into the VoIP market do not have to provide their own access network. However, they must pay for the use of other operator's access network.

In "ICT for Europe: Challenges for EU competitiveness"[225], Tapani Mikkeli[226] reviewed innovation in Europe. New markets are characterized by innovation, rapid market growth and volatile market shares. Emerging business contexts should not be over-regulated (as firms are still defining their models) and self-regulation should be explored to avoid disproportionate and restrictive regulation.

In her presentation, "The Role of Government in the Future of Voice?"[227] Melinda Tan[228] of Singapore's regulator, Infocomm Development Authority (IDA)[229] observed that, to encourage investment in new technology, Singapore has established a light-touch regulatory framework in order to promote competition and to educate user and consumers.

6 CLOSING CEREMONY

In his remarks summarizing the workshop, Dr. Woroch[230] put forward several comments and reflections on The Future of Voice[231], summarising areas of consensus, confusion and contention (see structure of the discussion above). He invited all participants to comment on the draft Chairman's Report before it is published on the event website. This particular event was held in the context of ITU's New Initiatives Programme[232] and other work on NGN[233], so the results and outcomes of this meeting will strengthen ITU's work in this area.

ANNEX 1: REGIONAL CASE STUDIES

The Status of Voice over Internet Protocol Worldwide, 2006
Phillippa Biggs, *Economist, Strategy and Policy Unit, ITU*

Phillippa Biggs presented the ITU's survey and Background Paper on the status of VoIP. This survey reviewed the status of VoIP in 130 countries at mid-2006. Regulatory approaches range from explicitly legal to explicit bans on VoIP, with many public consultations. In many countries, the regulator is following the market. Strong differences in regulatory approach are evident– Europe and the CIS have widely liberalised VoIP services, in contrast to Africa and the Arab States.. Drivers of VoIP include growth in the extent and availability of broadband, cheaper costs for consumers, and reduced costs for operators. Strong growth is registered in VoIP subscribers, traffic and number of minutes, despite difficulties in the estimation of 'soft' PC-to-PC services.

The Future of Voice in Africa (Background Paper)
Russell Southwood, *Chief Executive, Balancing Act Africa*

In his background paper "The Future of voice in Africa", Russell Southwood[234], CEO of Balancing Act Africa, highlighted the importance of the grey market in Africa and suggested it is acting as a surrogate for competition, driving significant reductions in retail call charges. VoIP was originally viewed as a criminal technology that challenged the existing order, but incumbents are now consider it as a engine of growth and are deploying international VoIP gateways. VoIP has been legalized in 7 out of the 54 countries, and should be legal nearly everywhere in five years. Legal VoIP means the use of international gateways for both voice and data, with workable interconnect agreements and long-term VoIP peering agreements. African VoIP service providers are squeezing a margin between wholesale and retail business.

Communications: Government and Business Practices in the Asia Pacific Region
Khelia Johnson, *JD and* Oluwaseun Oyeyipo, *ITU Consultants*

Khelia Johnson presented the ITU Background Paper on Communications: Government and Business Practices in the Asia Pacific Region[235]. The Paper analyses trends in the Asian telecom market on the basis of five case studies. The paper found declines in revenue and subscriber base in traditional voice services. Consumers prefer mobile to voice, due to its flexibility and mobility. There is some preference for mobile data over mobile voice in some countries. Broadband infrastructure is the basis for converged services. Value-added and converged services have been embraced by consumers and operators, but are encountering difficulties in regulation. Convergence is happening on different levels (operators, services, technology, markets and regulation).

Status of the VoIP in Central, Southern and Eastern Europe
Anna Riedel, *Consultant, Germany*

Anna Riedel presented the ITU's Background Paper on the status of VoIP in Central, Southern and Eastern Europe at 2006. CEE is a promising region - there was 11% growth in telecom markets in CEE between 2003-2005, compared to 3.4% in EU-15. There is strong growth in mobile and Internet in the region, but still very low penetration. There is some limited regulation of VoIP by Romania, but no special regulation of VoIP in Bulgaria, Croatia or Turkey. In Turkey, VoIP requires a long distance license. It is difficult to foresee the future of VoIP in SEE, depending on the EU accession process, but the low BB penetration means that mobile VoIP is a strong possibility.

An additional presentation, on the Status of VoIP in Latin America, by Nathaly Rey, is available on the ITU website, but was not presented at the meeting.

ANNEX 2: LIST OF ACRONYMS

API	Application Programming Interfaces
BWA	Broadband Wireless Access
CAPEX	Capital expenditure
CEPT	European Conference of Postal and Telecommunications Administrations
CITEL	Inter-American Telecommunication Commission
CPNP	Calling Party's Network Pays
DSL	Digital Subscriber Line
EC	European Commission
ECTA	European Competitive Telecommunications Association
ERG	European Regulators' Group
ETP	European Telecommunications Platform
ETSI	European Telecommunications Standards Institute
FTTH	Fibre-To-The-Home
FTTC	Fibre-To-The-Curb
FTTx	Fibre-To-The-XX
FMC	Fixed Mobile Convergence
GATS	General Agreement on Trade in Services
GSM	Global System for Mobile Communications
ICANN	Internet Corporation for Assigned Names and Numbers
ICT	Information and Communication Technology
IDA	Infocomm Development Authority of Singapore
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ITU	International Telecommunication Union
LAN	Local Area Network
LLU	Local Loop Unbundling
MIC	Ministry of Internal Affairs and Communications of Japan
M2M	Machine to Machine
MSAN	Multi-Service Access Node (part of NGN access layer)
NAT	Network Address Translation
NGN	Next Generation Network
NRA	National Regulatory Authority
NRF	New Regulatory Framework (of the European Union)
OPEX	Operating Expenditure
OSS	Operating Support Services
PAN	Personal Area Network
PATS	Pretty Advanced Telephone Service (referring to new, digital telephone system)
PoI	Point of Interconnection
POTS	Plain Old Telephone Service (referring to the analogue telephone service)
PC	Personal Computer
PSTN	Public Switched Telephone Network
P2P	Peer-to-Peer
QoS	Quality of Service
R&D	Research & Development
RPP	Receiving Party Pays
SDO	Standards Development Organisation
SIP	Session Initiation Protocol
SMP	Significant Market Power
SNO	Second National Operator
Tbytes	Terrabytes
TDM	Time Division Multiplexing
TELMIN	Telecommunication Ministers Meeting (APEC)
UMA	
UMTS	Universal Mobile Telecommunications System (3G)
USO	Universal Service Obligation
VAS	Value-added services
VoB	Voice over Broadband
VoIP	Voice over Internet Protocol

VDSL	Very High Bit Rate Digital Subscriber Line
VSAT	Very Small Aperture Terminal
WLL	Wireless Local Loop
WTO	World Trade Organization

ANNEX 3: GLOSSARY

Asymmetric regulation – regulation that distinguishes in its treatment of operators, network and/or service providers (usually on the basis of market power and the historical dominance of an incumbent over competing entrants).

Bill and Keep – No payment of origination and termination fees are charged to other networks.

Calling Party Pays – the arrangement in which the mobile subscriber does not pay for incoming calls. Instead, the calling party (party originating the call) pays the entire end-to-end cost of the communication.

Calling Party's Network Pays – Network operators compensate each other for the traffic they exchange through bilateral interconnection agreements, specifying settlement terms, as well as physical interconnections between the two networks (at the network level). There is a net settlement payment from the net originating network (the Calling Party's Network) to the net terminating network (the called party's network).

Convergence – the merging of telecommunications, broadcasting and information technologies, e.g. the merger of fixed, mobile, terrestrial and satellite communications and including the merge of location systems and systems of establishment of places and liaisons [In Regulation of N-Play Bundling of Services: Proposing a concept of regulation[236], Mr. Tomas Lamanauskas[237] points out there is also convergence in services, networks, devices and markets, as well as in technologies].

Core NGNs – an integrated IP-based network with multi-service capabilities and differentiated quality of service, offering generalized mobility and unrestricted access by users to different service providers (as distinct from ordinary IP-based networks, e.g. the public Internet.

Facilities-based competition – competition in services based on self-deployed local loops, where services are provided according to network deployment e.g. mobile and FTTH (in contrast to services-based competition). This often arises between firms with large initial investments, economies of scale and 'natural monopoly' characteristics.

Fibre-To-The-Curb – The deployment of optical fibre from a telephone switch to within 1,000 feet of a home or enterprise.

Fibre-To-The-Home – The deployment of optical fibre from a telephone switch directly into the subscriber's home or enterprise.

Fibre-To-The-XX – The deployment of optical fibre from a telephone switch to any location (Fibre-To-The-Premises, FTTP, and Fibre-To-The-Building, FTTB).

Forbearance – See "*Regulatory forbearance*".

Foreclosure – prevention of access by other operators to the network (and thus competition with downstream end-to-end services) through e.g. network design decisions.

Fixed Mobile Convergence – the merging of fixed line telephony with mobile technologies, e.g. the "One Phone" service from Korea Telecom (KT) that functions using CDMA technology outside the home and Bluetooth inside the home to access the Internet (see Figure 3) and BT's Fusion Phone.

Horizontal integration – refers to the structure of NGN whereby layers are separated into core, access, transport, control and service/application layers, with each layer dealing with a specific function of the integrated network. (This is in contrast to end-to-end, vertically integrated PSTN and mobile systems, where the system deals with all functions from start to finish, or user to user).

Interconnection – the physical connections between networks that are the basis for the exchange of traffic, under interconnection agreements.

Jitter – the weighted average of the latency difference between every pair of consecutive packets received, affecting the performance of real-time applications such as streaming video and audio.

Latency – the time it takes a bit of data to get through a network link.

Legacy networks – refers to existing networks (including PSTN and others) that may continue to run and be incorporated into NGN, where the 'overlay' approach is adopted in the migration to NGN, so the PSTN and IP network run in parallel.

Local Loop - The part of the network comprising the connection between the Public Telephone Operator's exchange and the subscriber's home [ITU's Glossary of Technical Terms at http://www.itu.int/newsarchive/press/WTPF98/Glossarytechnterms.html].

Local Loop Unbundling – mostly within liberalisation, competitors are allowed to use the local loop twisted-pair telephone connections from the central exchange's office to customer premises, so the incumbent's local loop is opened to use by other operators.

Media gateway – formed by the split of the traditional switch into the media gateway (relating to the transport layer) and the soft switch (for call control). The media gateway ensures control of the physical layer of the network and converts incoming TDM signals into an outgoing IP signal. However, it is not an "intelligent" component as such.

Net bias – discrimination/degradation of specific bitstream traffic, or generators of a bitstream by ISPs without operational justification. It occurs when an ISP denies access despite ample capacity to switch and route traffic. It includes blocking ports and "snifting" bits to identify/block e.g., a competitor's VoIP traffic. It does not include dropping of bits and or denial of service based on congestion and the operational inability to route bits. It is the deliberate degradation of service by an ISP by partitioning/under-utilisation of bandwidth, so public transit routes become unreliable.

Net neutrality – the argument that the owner of the access network must not restrict the ability of its end-user customers to access specific content or to running specific applications. More specifically for the Internet, this means that ISPs should not discriminate against, or in favour of, specific bitstreams for upstream ISPs or downstream ISPs or end-users, including blocking or deliberate degradation of traffic.

NGN - A Next Generation Network (NGN) is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users (ITU Recommendation, 2001, Study Group 13 [238]).

Next Generation Access Network (NGAN) - new *access* networks, as deployment of optical fibers, and the associated challenges

Next Generation Core Network (NGCN) - the new switching, gateways and transmission equipments in the core network, enabling several access networks to use the same core network

Non-replicable assets – assets requiring significant investment, time or effort to establish/recreate, so they are essentially non-replicable (often access bottlenecks). It does not make commercial sense for an entrant to replicate these assets. They often constitute barriers to market entry.

Peering – an agreement between ISPs to carry traffic for each other and for their respective customers. Peering does not include the obligation to carry traffic to third parties. Peering is usually a bilateral business and technical arrangement, where two providers agree to accept traffic from one another, and from one another's customers (and thus from their customers' customers).

Receiving Party Pays – the party receiving a communication pays all/most of the end-to-end cost of the call. For mobile telephony, this refers to the case where the receiving party pays the "airtime charge" for termination on the mobile handset (the calling party may still pay for a local call).

Regulatory holidays ("Access Holidays") – commitment of a regulatory authority not to intervene for a specified period in order to protect operators' investment incentives (generally most beneficial for established operators and monopolists).

Regulatory forbearance – regulatory restraint, where regulators refrain from action or intervention.

Replicable assets – assets that are easily recreated and duplicated. Replicability of infrastructure is already used to choose between infrastructure-based and service-based competition in determining proportionality. There are different types of replicability – e.g. technical and functional replicability.

Sender Keeps All – for telephony, the party (Public Telephone Operator) originating the call/datastream keeps all of the revenues it collects[239]. For the Internet, Sender Keeps All (SKA) peering arrangements are those in which traffic is exchanged between two or more ISPs without mutual charge (an interconnection arrangement with no financial settlement).

Services-based competition – competition in services dependent on incumbents' local loops, e.g. Carrier pre-selection (Resale, long distance) and ADSL (shared access). This is generally characterized by an open choice of service areas through existing line, relatively small initial investments, and greater flexibility regarding market entry, expansion and withdrawal.

Significant Market Power – definition of a significant (or critical) degree of market power by an operator (or consortium), as measured by a short-run market power test, the "joint dominance SMP test" that may, according to the legislation, act as the trigger point for action e.g. regulatory intervention, in some markets.

Soft switch – This is the part of the traditional switch that relates to the control layer and still carries out the switching function. However, contrary to TDM networks, it is not associated with any physical point in the network and no longer controls the physical links of the network.

Sunset clause (also "*sunset provision*") – a provision or clause in the legislation, whereby all of it or parts of it cease to apply after a specific date, unless further legislative action is taken to extend it.

Symmetric regulation – regulation that applies equally to all network and/or service providers in the long-run, regardless of their market power i.e. all providers are required to provide emergency calls, universal service, intercept, data retention, consumer protection, etc. equally.

Technological neutrality – the argument that regulation should not 'pick winners' in terms of technology e.g. regulation should not favour cable over copper or fibre, or vice versa.

Transit – is an agreement where an ISP agrees to carry traffic on behalf of another ISP or end user. In most cases transit will include an obligation to carry traffic to third parties. Transit is a bilateral business and technical arrangement, where one provider (the transit provider) agrees to carry traffic to third parties on behalf of another provider or an end user (the customer).

Trusted Federations – the possibility of enhanced interfaces between specific groups of operators for collaborative interconnection and the joint delivery of services, resulting in collaborative partnerships for improved services [ITU background paper Ruling the New and Emerging Markets in the Telecommunication Sector[240] by Professor Christian Wey & associates from DIW Berlin[241]].

Vertical Integration – refers to industry structure whereby service providers provide the full range of services along the length of the entire value chain from network infrastructure to end-user and/or consumer.

Voice over Broadband (VoB): Offered over private IP access. Usually a substitute for PSTN voice, sometimes with additional functionality

Voice over Internet (VoI): Offered as an application over the public Internet. Not a full substitute for PSTN voice at present, may evolve

Walled gardens – the possibility of restricting access to certain addresses or services through service access control and restriction of interconnection e.g. through the use of proprietary standards or standards foreclosure through proprietary or legally protected Application Programming Interfaces (compared to end-to-end).

ENDNOTES

[1] http://www.itu.int/osg/spu/ni/voice/meeting.phtml

[2] http://www.itu.int/

[3] http://www.itu.int/osg/spu/ni/index.html

[4] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch

[5] http://groups.haas.berkeley.edu/imio/crtp/ . The Center for Research on Telecommunications Policy (CRTP) is a multi-university research and outreach program designed to foster business and public policy research on communications issues of regional, national and international importance.

[6] *Session Description:* For more than 100 years, voice traffic has been the mainstay of the telecommunications sector, in terms of customers, revenues and traffic. But the gradual migration to an all-IP network environment is having a significant impact on the provision of voice service over the public switched telecommunication network (PSTN). In this respect, the concept of "voice", as a universal service, is also evolving rapidly. The purpose of this session is to outline the background and to frame the debate from different perspectives, in particular drawing attention to the main trends in technologies, markets, regulation and policies that are likely to have an impact upon the traditional paradigm of the communication business.

[7] *Session Description*: The telecommunication/ICT sector is one of the most dynamic of all economic sector, especially in terms of innovation and the evolution of products and services. It is currently marked by a convergence that is operating at three distinct levels: voice/data, fixed/mobile and telecoms/broadcasting. The coexistence of diverse infrastructures with similar or substitutable technical capabilities (e.g. fixed telephone, broadband internet and cable TV networks; cellular and non-cellular wireless networks) - adds to the competitiveness of the sector. Nevertheless, the preservation of interoperability and interconnectivity remains one of the main challenges for all stakeholders, in particular for international standards development organisations, such as ITU. The purpose of this session is to discuss recent technical advancements relevant for the provision of the voice communication in the new converged environment, including issues such as next generation networks, network performance, quality of service, numbering, emergency call handling, etc.

[8] *Session Description*: The communications environment is changing rapidly, not only in terms of technology, but also in terms of the basic business model. Service providers need to respond to changing user needs, as well as to competitive pressures in both the PSTN and alternative infrastructures. For a long time, voice communications have been the cash cow of the industry, constituting the largest share of the revenue streams in the telecommunication sector. Indeed, the share of voice traffic is even higher on cellular mobile networks than on the PSTN. However, new "multiple play" service offerings combining voice with other applications--typically fixed-line voice plus broadband internet, video entertainment and mobile voice--are changing this situation. This session assessed the changing market dynamics of voice services; investigated new business models and revenue streams; and examined developing country markets.

[9] *Session Description*: The migration towards an all-IP environment is progressively changing the nature of the telecommunication industry. Converged IP networks—delivering voice, data, text and video—are creating synergies and economies of scale and spawning new services that would have been inconceivable in a circuit-switched world. Regulatory reform is necessary to reflect the changed environment and to redefine service definitions, taking into account the increased substitutability of services. The purpose of this session is to examine the regulatory challenges resulting from the move to an all-IP environment, in particular focussing attention on the regulation of VoIP, licensing, universal service concepts and competition policy.

[10] *Round Table*: The Chairman will invite selected participants to participate in a round table to provide their "takeaways" from the workshops discussions and suggest pragmatic next steps. In particular: what are the issues that market forces may not fully address? What are the issues that need to be addressed at the national and international levels? How do these issues interrelate with ITU's NGN Global Standards Initiative, and what are the next initiatives that should be undertaken by ITU to promote an enabling environment on the global level?

[11] http://www.itu.int/osg/spu/ni/voice/

[12] http://www.itu.int/osg/spu/ni/voice/agenda.html

[13] http://www.itu.int/osg/spu/ni/voice/meeting.phtml

[14] http://www.itu.int/osg/spu/ni/voice/agenda.html

[15] http://www.itu.int/ibs/sg/spu/200701voice/index.html

[16] http://www.itu.int/osg/spu/ni/voice/background.phtml

[17] http://www.itu.int/osg/spu/ni/voice/papers/chairmans_report.pdf

[18] http://www.itu.int/osg/spu/newslog/

[19] http://www.itu.int/osg/spu/ni/voice/meeting.phtml

[20] http://www.itu.int/officials/Zhao.html and http://www.itu.int/newsarchive/pp06/elections/bios/zhao/index.html

[21] http://www.itu.int/osg/spu/ni/voice/presentations/S0-1-Opening-Remarks-DSG-ITU.pdf

[22] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch

[23] http://www.itu.int/osg/spu/ni/voice/presentations/S0-Woroch-Opening-Remarks.pdf

[24] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch

[25] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kelly

[26] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds

[27] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banable
[28] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banable
[29] http://www.economist.com/surveys/displayStory.cfm?story_id=7995312
[30] http://www.itu.int/osg/spu/ni/voice/presentations/S3-4-North.pdf
[31] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#North
[32] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
[33] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Burger
[34] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
[35] http://www.itu.int/osg/spu/ni/voice/presentations/S7-1-Woroch.pdf
[36] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[37] http://www.itu.int/osg/spu/ni/voice/presentations/S0-Woroch-Opening-Remarks.pdf
[38] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[39] http://www.ofcom.org.uk/research/cm/icmr06/icmr.pdf
[40] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banable
[41] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gruber
[42] http://www.itu.int/osg/spu/ni/voice/presentations/S3-3-Bienaimé.pdf
[43] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime
[44] http://www.umts-forum.org. The UMTS Forum is an international, cross-sector industry body comprising operators, manufacturers, regulators, application developers, research organisations and IT industry players.
[45] http://www.3gpp.org/ftp/PCG/PCG_14/DOCS/PDF/PCG14_17.pdf
[46] http://www.itu.int/osg/spu/ni/voice/presentations/S3-3-Bienaimé.pdf
[47] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[48] http://www.itu.int/osg/spu/ni/voice/presentations/S4-3-Kim.pdf
[49] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[50] http://www.economist.com/surveys/displayStory.cfm?story_id=7995312
[51] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[52] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Skouby
[53] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Burger
[54] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime
[55] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[56] http://www.itu.int/osg/spu/ni/voice/papers/FoV-VoIP-Biggs-Draft.pdf
[57] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Alleman
[58] http://www.itu.int/osg/spu/ni/voice/papers/FoV-VoIP-Biggs-Draft.pdf
[59] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime
[60] http://www.itu.int/osg/spu/ni/voice/presentations/S3-3-Bienaimé.pdf
[61] www.umts-forum.org. The UMTS Forum is an international, cross-sector industry body comprising operators, manufacturers, regulators, application developers, research organisations and IT industry players.
[62] http://www.3gpp.org/ftp/PCG/PCG_14/DOCS/PDF/PCG14_17.pdf
[63] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kelly
[64] http://www.itu.int/osg/spu/ni/voice/presentations/S4-4-Judijanto.pdf
[65] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Judijanto
[66] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Brandl
[67] http://www.itu.int/osg/spu/ni/voice/presentations/S0-Woroch-Opening-Remarks.pdf
[68] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[69] http://www.ofcom.org.uk/research/cm/icmr06/icmr.pdf
[70] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Alleman
[71] http://www.itu.int/osg/spu/ni/voice/presentations/S4-3-Kim.pdf
[72] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[73] http://www.itu.int/osg/spu/ni/voice/presentations/S4-6-Gruber.pdf
[74] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gruber
[75] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
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[78] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Antocicco
[79] http://www.intug.net/

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[81] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kan
[82] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kelly
[83] http://www.itu.int/osg/spu/ni/voice/presentations/S2-3-Users-BURGER.ppt
[84] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Odlyzko
[85] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Brandl
[86] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gallino
[87] http://www.erg.eu.int/
[88] http://www.itu.int/osg/spu/ni/voice/presentations/S7-Gallino.pdf
[89] http://www.itu.int/osg/spu/ni/voice/presentations/S2-5-Katz.pdf
[90] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Katz
[91] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Odlyzko
[92] Participants differed as to how they defined premium voice, but it was defined by Tim Kelly as either referring 'premium quality' or to 'premium content'. He pointed out that the broadcasting sector is one of the major users of ISDN because of their requirement for high quality of transmission. Some participants thought that premium voice could refer to 'rich' voice, which was defined by Dr. Kim as including voice applications, VoIP-enabled IT applications and integrated voice/internet services, such as personalized context-aware services.
[93] http://www.itu.int/osg/spu/ni/voice/presentations/S2-3-Users-BURGER.ppt
[94] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Burger
[95] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Lozinski
[96] http://www.itu.int/osg/spu/ni/voice/presentations/S2-2-Convergence-STD-CSLEE.ppt
[97] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Lee
[98] Including ITU-T, 3GPP, 3GPP2, IETF and MPEG.
[99] http://www.itu.int/ITU-T/ngn/events/index.asp
[100] http://www.itu.int/osg/spu/ni/voice/presentations/S2-2-Convergence-STD-CSLEE.ppt
[101] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[102] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Odlyzko
[103] http://www.comsoc.org/ci1/Public/2006/may/
[104] http://www.itu.int/osg/spu/ni/voice/presentations/S4-2-Ponder.pdf
[105] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Ponder
[106] http://www.itu.int/osg/spu/ni/voice/presentations/S3-2-Lozinski.pdf
[107] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Lozinski
[108] www.umts-forum.org. The UMTS Forum is an international, cross-sector industry body comprising operators, manufacturers, regulators, application developers, research organisations and IT industry players.
[109] http://www.itu.int/osg/spu/ni/voice/presentations/S4-4-Judijanto.pdf
[110] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Judijanto
[111] http://www.itu.int/osg/spu/ni/voice/presentations/S5-3-Kan.pdf
[112] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kan
[113] http://www.itu.int/osg/spu/ni/voice/presentations/S4-3-Kim.pdf
[114] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[115] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[116] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[117] http://www.itu.int/osg/spu/ni/voice/presentations/S4-3-Kim.pdf
[118] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[119] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[120] http://www.itu.int/osg/spu/ni/voice/presentations/S3-3-Bienaimé.pdf
[121] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[122] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime
[123] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime
[124] http://www.itu.int/osg/spu/ni/voice/presentations/S3-3-Bienaimé.pdf
[125] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime
[126] www.umts-forum.org. The UMTS Forum is an international, cross-sector industry body comprising operators, manufacturers, regulators, application developers, research organisations and IT industry players.
[127] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Sutherland
[128] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bienaime

[129] http://www.itu.int/osg/spu/ni/voice/speaker_bio.htmls#Hanatani
[130] http://www.ftthcouncilap.org. This is a Not-for-Profit organization that has been established to educate, promote FTTH and the resulting quality-of-life enhancements.
[131] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Podplonska
[132] http://www.itu.int/osg/spu/ni/voice/presentations/S5-4-Podplonska.pdf
[133] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Tan
[134] http://www.itu.int/osg/spu/ni/voice/presentations/S5-5-Chang.pdf
[135] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Chang
[136] http://www.itu.int/osg/spu/ni/voice/presentations/S6-5-ECTA-Godlovitch.ppt
[137] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Godlovich
[138] Voice over private IP access.
[139] Voice over the public Internet.
[140] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Biggs
[141] http://www.itu.int/osg/spu/ni/voice/papers/FoV-VoIP-Biggs-Draft.pdf
[142] http://www.itu.int/osg/spu/ni/voice/presentations/S4-6-Africa-SOUTHWOOD.ppt
[143] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#southwood
[144] Algeria, Kenya, Mauritius, Somalia, South Africa, Tanzania and Uganda, with anomalies elsewhere.
[145] http://www.itu.int/osg/spu/ni/voice/presentations/S2-3-Users-BURGER.ppt
[146] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Burger
[147] http://www.itu.int/osg/spu/ni/voice/presentations/S5-1-Brandl.pdf
[148] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Brandl
[149] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Podplonska
[150] http://www.itu.int/osg/spu/ni/voice/presentations/S5-4-Podplonska.pdf
[151] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#ELangmantel
[152] http://www.rtr.at/
[153] http://www.itu.int/osg/spu/ni/voice/presentations/S2-6-Langmantel.pdf
[154] http://www.itu.int/osg/spu/ni/voice/presentations/S1-3-Reynolds.pdf
[155] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
[156] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Godlovich
[157] http://www.itu.int/osg/spu/ni/voice/presentations/S2-5-Katz.pdf
[158] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Katz
[159] A federation is a group of Service Providers which agree to receive calls from each other via SIP under administrative rules (settlement, abuse-handling etc.) and technical rules governing interconnection [IETF WG on SIP peering].
[160] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
[161] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Brandl
[162] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Antocicco
[163] http://www.intug.net/
[164] http://www.itu.int/osg/spu/ni/voice/presentations/S6-3-Antocicco.pdf
[165] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[166] http://www.itu.int/osg/spu/ni/voice/presentations/S4-4-Judijanto.pdf
[167] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Judijanto
[168] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Judijanto
[169] http://www.itu.int/osg/spu/ni/voice/presentations/S4-4-Judijanto.pdf
[170] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[171] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Judijanto
[172] http://www.itu.int/osg/spu/ni/voice/presentations/S4-5-Nokia-Granath.ppt
[173] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Granath
[174] http://www.itu.int/osg/spu/ni/voice/presentations/S4-5-Nokia-Granath.ppt
[175] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[176] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Granath
[177] http://www.itu.int/osg/spu/ni/voice/presentations/S5-5-Chang.pdf
[178] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Chang
[179] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
[180] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Burger
[181] http://www.itu.int/osg/spu/ni/voice/presentations/S6-6-Lamanauskas.pdf

[182] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Lamanauskas
[183] http://www.itu.int/osg/spu/ni/voice/presentations/S7-1-Woroch.pdf
[184] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[185] http://www.itu.int/osg/spu/ni/voice/presentations/S4-6-Africa-SOUTHWOOD.ppt
[186] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#southwood
[187] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Madden
[188] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banerjee
[189] http://www.itu.int/osg/spu/ni/voice/papers/FoV-Madden-Banerjee-Tan-Draft.pdf
[190] http://www.itu.int/osg/spu/ni/voice/presentations/S6-1-Madden-Banerjee.pdf
[191] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[192] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Madden
[193] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banerjee
[194] http://www.itu.int/osg/spu/ni/voice/presentations/S3-2-Lozinski.pdf
[195] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Lozinski
[196] http://www.itu.int/osg/spu/ni/voice/presentations/S5-3-Kan.pdf
[197] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kan
[198] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kan
[199] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bartholomew
[200] http://www.etno.be/
[201] http://www.itu.int/osg/spu/ni/voice/presentations/S4-6-Gruber.pdf
[202] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gruber
[203] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gruber
[204] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Brandl
[205] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banable
[206] The 3-criteria test is applied cumulatively to identify markets where ex-ante regulation is justifiable on the basis of:
1. the presence of high and non-transitory barriers to entry;
2. no tendency towards effective competition (in the absence of regulation); and
3. The insufficiency of competition law to address the market failure.
[207] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Banable
[208] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Godlovich
[209] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gruber
[210] http://www.itu.int/osg/spu/ni/voice/presentations/S4-2-Ponder.pdf
[211] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Ponder
[212] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Reynolds
[213] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Alleman
[214] http://www.itu.int/osg/spu/ni/voice/papers/FoV-Alleman-Rappoport-Final.pdf
[215] http://www.itu.int/osg/spu/ni/voice/presentations/S7-3-Mueller.ppt
[216] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Muller
[217] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Bartholomew
[218] http://www.etno.be/
[219] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Gallino
[220] http://www.erg.eu.int/
[221] http://www.itu.int/osg/spu/ni/voice/presentations/S7-Gallino.pdf
[222] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#southwood
[223] http://www.itu.int/osg/spu/ni/voice/presentations/S4-3-Kim.pdf
[224] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Kim
[225] http://www.itu.int/osg/spu/ni/voice/presentations/S2-1-Mikkeli.pdf
[226] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Mikkeli
[227] http://www.itu.int/osg/spu/ni/voice/presentations/S7-6-Tan.pdf
[228] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Tan
[229] http://www.ida.gov.sg
[230] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#Woroch
[231] http://www.itu.int/osg/spu/ni/voice/meeting.phtml
[232] http://www.itu.int/osg/spu/ni/
[233] http://www.itu.int/osg/spu/ni/voice/meeting.phtml

[234] http://www.itu.int/osg/spu/ni/voice/speaker_bios.html#southwood

[235] http://www.itu.int/osg/spu/ni/voice/papers/FoV-Asia-Pacific-Johnson-Draft.pdf

[236] http://www.itu.int/osg/spu/ngn/documents/presentations/lamanauskas-23-march-2006.ppt

[237] http://www.itu.int/osg/spu/ngn/speaker_bios.html#lamanauskas

[238] ITU's working definition of a Next Generation Network (NGN) is as a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users, at http://www.itu.int/ITU-T/studygroups/com13/ngn2004/working_definition.html.

[239] http://www.itu.int/osg/spu/intset/whatare/wtdr/wtdr.html

[240] See http://www.itu.int/osg/spu/ngn/documents/Papers/Wey-060323-Prem-v1.1.pdf . The authors of this paper are Professor Christian Wey, Dr. Pio Baake and Sven Heitzler of the Deutsches Institut für Wirtschaftsforschung, the German Institute for Economic Research, at www.diw.de.

[241] http://www.diw.de