Background Paper

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"NGN and Broadband: Opportunities and Challenges"

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0. Introduction

Over the past few years, telecommunication industry has been rigorously exploring the contour of Next Generation Networks (NGN). International standardization bodies, including ITU-T [1], are actively discussing the overall architectures and standard recommendations for NGN, while the industry players, both operators and manufacturers, are offering continuous flows of more intelligent and efficient NGN solutions and services. While ITU has placed 'The networks of the future – i.e., NGN and Global Standards Initiative (GSI)' as one of the high focuses and implemented various activities on NGN, many countries are taking proactive measures to ensure smooth planning and migration from legacy networks to NGN.

Nowadays, NGN is no longer a possibility, but becoming a given direction towards the future of telecommunication network and services. In fact, the decision to move towards NGN is neither based on the emergence of a single technology nor influenced by overheated industry competition; rather, it is the consequence of the recent transformations that have occurred in our telecommunication environment, which demand a fundamentally different approach to designing the network and services.

The migration to NGN requires clear visions and strategic preparations from both industry and regulators. There are also many issues lying on the road to NGN which need to be resolved through collaborative actions in order to make a faster and smoother migration. This paper aims to provide the background knowledge in the current activities relating to NGN migration, in particular in the Asia Pacific region.

1. What is NGN?

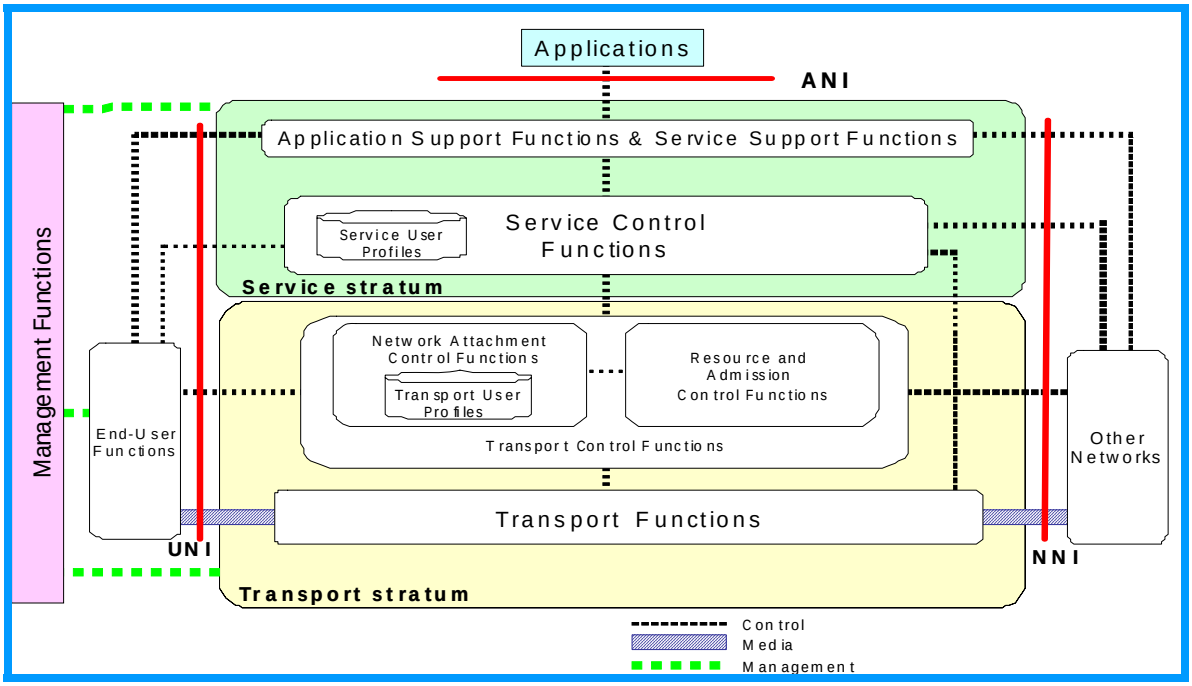
Next Generation Network is a term indicating the new approach to the network architecture and service environment. It is not restricted to a particular set of technologies as any newly emerging technologies and solutions that serve the key ideas can be included into the NGN category. ITU-T Rec. Y.2001 defines an NGN as the following:

[1] ITU-T NGN Global Standards Initiative: (NGN-GSI) http://www.itu.int/ITU-T/ngn/introduction.html

> "*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, Quality of Service-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different services providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users*".

To put it simply, the fundamental idea behind NGN is one big network that delivers all types of data and services encapsulated in packets. The network consists of two main layers; transport stratum and service stratum. The architecture is *service-agnostic*, that is, the delivery of services is independent from transport network and any services (voice, data, audio, video, etc.) can be carried while there is no need to build another network for the new services in the future. NGN is an *open architecture* that can be continuously renewed and upgraded over time.

[Figure 1: NGN Architecture Overview]



NGN offers the convergence of various existing communication services. In the current environment, each service requires a separate infrastructure; for instance, voice via PSTN/ISDN, Internet via xDSL, mobile via GSM/CDMA, television via terrestrial/satellite/ cable, and Mobile TV via DMB/DVB-H, etc. In the NGN, all these services can be delivered over one network while encouraging the development of new converged services.

NGN also serves general mobility, creating the real convergence between fixed and mobile services. This consolidation of network can reduce the cost of network implementation and maintenance and enables a better management of the network and services. On the other hand, the path towards NGN is more likely to be evolutionary steps than a revolution since NGN is designed to work with existing legacy networks. Some of the current services will remain or become integrated into the NGN system. Others, for instance voice over PSTN, may extinct in the near future.

Table 1: Key Characteristics of the NGN (defined by ITU-T Rec. Y.2001)

- Packet-based transfer
- Separation of control functions among bearer capabilities, call/session, and application/service
- Decoupling of service provision from transport, and provision of open interfaces
- Support for a wide range of services, applications and mechanisms based on service building
- Broadband capabilities with end-to-end QoS (Quality of Services)
- Interworking with legacy networks via open interfaces
- Generalized mobility
- Unrestricted access by users to different service providers
- A variety of identification schemes
- United service characteristics for the same service as perceived by the user
- Converged services between fixed/mobile
- Independence of service-related functions from underlying transport technologies
- Support of multiple last mile technologies
- Compliant with all regulatory requirements, for example concerning emergency, communications, security, privacy, lawful interception, etc.

2. Why NGN?

NGN reflects the paradigm change in the telecommunication industry. Over the last decade, significant transformations have occurred in our technical, market, and societal environment. These changes have revealed the limitation of the conventional network system and called for a new approach. NGN is the answer to these increasing demand for new multimedia services, mobility and ubiquitous access and it is the most efficient and optimized form of network system that can serve the needs of tomorrow.

Change 1: Multimedia Contents and Emergence of IP

Over the last decade, telecommunication services have evolved from simple voice telephony to interactive rich multimedia and various value-added applications. Digitization enabled all kinds of multimedia data (text, voice, photos, music, game, video or TV contents, etc.) to be delivered efficiently on the network, providing the basis for service convergence. At the same time, the advancement of the internet showed an efficient way to deliver these multimedia contents and services by encapsulating them into packets. The internet also proved that the IP-based system is the key to foster innumerable innovative services to the end users. Conventionally over PSTN networks, for promotions purposes, some of the value added services used to be offered for free, whereas with the packetized networks, rich multimedia services are becoming more and more important and voice services are being offered free. This trend heralds a key paradigm shift in the way that the services could be provisioned in NGN.

Change 2: Network diversifications and Service Convergence

With the accelerated development in technologies, several alternative access technologies have emerged, especially wireless networks. The emergence of mobile communication has experienced a phenomenal growth in its subscriber numbers, jumping from 500 million in 2000 to 4 billion in end 2008[2]. Mobile communication is also equipped with the increasing data capacity throughout the rapid network evolution from GPRS, EDGE, 3G to IMT-2000, and IMT-2000 advanced. Mobile broadband are rapidly catching up with the speed and quality of the fixed line internet experiences. On the other hand, wireless technologies, such as Wi-Fi and WiMAX, are expanding its service territory, offering high quality mobility

[2] ITU Press Release, 'Worldwide mobile cellular subscribers to reach 4 billion mark late 2008', 25 September 2008, http://www.itu.int/newsroom/press_releases/2008/29.html

for wireless broadband access. While the networks have been diversified, the services offered on the networks are increasingly converging, creating ubiquitous access to any services, on any networks through any device.

Change 3: Differing User Demands

With the introduction of market competition, the telecommunication industry, which used to be operated by government-owned monopoly, has become one of the most dynamic and competitive market. Previously, most business models were focused on the technology itself, assuming that innovative technologies will automatically induce early adopters, and naturally reach the mass market over the time. However, a plethora of service possibilities and fierce market competition have altered the business approach, locating user needs at the centre of the business model. Currently, the user demand for innovative multimedia services is shaping the market. As the internet has been deeply integrated into people's everyday life, today's users are increasingly in demand of high-speed networks that provide rich multimedia experiences, convenient services, and seamless mobility.

Change 4: Global Information Society

Globalization and the emergence of the internet are binding the world as one networked society. The services on the internet can float regardless of national boundaries and innovative services from one country can affect and bring benefits to the rest of other countries, if the network is available. In fact, migration to NGN is not only applicable to the high-income developed countries. As discussed in section 3, the provision of efficient networks and well-designed services can bring significant benefits to social and economic development within countries. Acknowledging the potentials of ICTs for development, UN Millennium Development Goal (MDG) has set its target to "*in cooperation with the private sector, make available the benefits of new technology, especially information and communications*" (MDG Goal 8)[3] by 2015. World Summit on the Information Society (WSIS) in Geneva 2003, followed by Tunis 2005, also declared its goal towards global knowledge-based society and urged the needs for bridging the global digital divide. Therefore, the migration to NGN also needs to be considered in a broader context of global information society, in a way that the future benefits of NGN can be shared by all.

[3] United Nations, Millennium Development Goals http://www.un.org/millenniumgoals/

3. Current Market Trends

3.1. High Speed Broadband: FTTH

Broadband network has been rapidly evolved from analogue ISDN to ADSL, VDSL, and finally to Fibre networks. Currently, the industry is busy with brining fibre networks closer to the end users through FTTH (Fibre-to-the-Home), FTTB (Fibre-to-the-Building), FTTC/K (Fibre-to-the-Curb/Kerb), FTTN (Node) or FTTCab (Cabinet).

FTTH was first commercialized by Japan in 1999 and has now gained over 13 million subscribers, finally exceeding the DSL subscribers in 2008 (See ANNEX 2: Japan Case Study). The Republic of Korea also introduced FTTH in 2006 and now reached over 31.4% of the total households (See Table 3). Hong Kong/China, Western Europe and United States are also making significant investments to upgrade their networks towards a faster broadband service.

Since the network upgrade requires a significant investment and a competitive market dynamics, there is a clear gap between developed countries and developing countries. However, several operators from developing countries have announced its plan for FTTH, including India's UTStarcom, Brazil's Telesp.

[Table 3: Examples of top ranking FTTH and Broadband Countries]

	FTTH per Household	Broadband per Household	FTTH Focus
South Korea	31.4 %	92.0%	Urban
Hong Kong	23.4 %	80.1%	Urban
Japan	21.3 %	55.6%	All region
United States	2.3 %	55.5%	All region
Sweden	7.1 %	58.7%	Low dense
Norway	6 %	68.7%	Low dense
Denmark	2.5 %	76.4%	Low dense
The Netherlands	1.4 %	78.0%	Urban

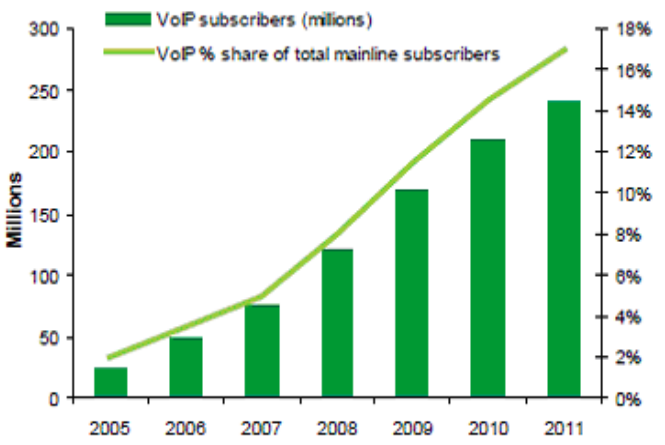
<Source: Adjusted from Alcatel-Lucent, 2009[4]>

[4] Presentation at ITU-TCI Workshop on New Technologies and Application, June 2009

3.2. Voice Service Convergence: VoIP

VoIP and Voice over Broadband (VoB) symbolizes the convergence between traditional voice services and the internet. The initial service of 'internet phone' appeared as early as the late 1990s (i.e. Freeworld, Dial-up, and DialPad). In the early 2000s, VoIP began to offer a cheaper telephony over IP-based networks (e.g., Net2Phone, iBasis, and Skype). Currently, the global VoIP market is rapidly expanding both to residential and business market and is expected to reach over 230 million subscribers by 2011 (See Figure 2).

[Figure 2: Worldwide VoIP Subscribers]



<Source: ITU Telecommunication Regulatory Survey 2006, The state of VoIP worldwide 2006>

Compared to PSTN voice services, VoIP has a comparative advantage in lower cost that are charged regardless of distance including long-distance and international calls, and openness for additional value services. While the early services had issues in the voice quality and connection reliability, the recent services are offering much improved quality of services, acceptable to the mass market users. The industry is also providing an aggressive marketing such as flat-rate or even free price bundling with other web services. Although VoIP used to be thought as a threat to the revenue of incumbent PSTN operators, some operators have begun to offer its own VoIP services or acquire a VoIP provider (i.e. China Telecom, Teleglobe).

In the future, VoIP is expected to converge with other communication services such as VoIM (Voice over Instant Messaging) or other web services (eBay chat). Business VoIP is also combined with data exchanges and further corporate services. Finally, VoIP on mobile is another emerging business that may emerge as a significant competitor to mobile operators.

3.3. Multimedia Services : IPTV

IPTV offers a full-live stream of multichannel TV contents, a variety of video-on-demand (VOD) services, and interactive applications over broadband connection. IPTV is considered as one of the key NGN services that can trigger the adoption of a higher-speed broadband connection as well as create a new revenue stream for operators.

IPTV is the true convergence among big industries: i.e., broadcasting, telecommunication, and information technology, of which services are offered not only by telecommunication operators, but also by cable TV and even satellite broadcasters, who provide the services normally through a partnership with broadband service operators. Consequently, IPTV contributes to the increase of industries' convergence and market competition. It also raises several issues for regulators such as converged regulatory frameworks, content monitoring, quality assurance, unauthorized redistribution, intellectual property protection, and so forth.

As of end 2008, the global IPTV subscribers reached 21.7 million[5] (Broadband Forum 2009), 64% increase from 2007. Almost all developed countries now launched a commercial IPTV services, while Europe is the biggest market with 10.3 million subscribers (see Table 4). Developing countries are also joining the race as Telecom Egypt, PTCL (Pakistan Telecommunication Company), India's Bharat Sanchar Nigam are also launched the service.

[Table 4: Global IPTV Subscribers by Region]

Region	2009 Q1	2008 Q1	Yearly Growth
Western Europe	11,375,200	7,799,449	45.85%
North America	4,435,102	2,283,601	94.22%
Asia-Pacific	3,005,015	2,619,035	14.74$
South and East Asia	3,990,000	2,086,000	91.28%
Eastern Europe	1,158,673	553,394	109.38%
Latin America	23,467	11,183	109.85%
Middle East and Africa	10,000	10,000	0.00%

<Source: Broadband Forum, 2009>

Despite the global economic slowdown, IPTV is expected to continue its growth rate over the next few years. Currently, DSL is the main platform for IPTV (65% of total subscribers)

[5] Broadband Forum (2009) Western Europe IPTV subscribers top ten million, March 25 2009, http://www.broadband-forum.org/news/download/pressreleeases/2009/YE08_Europe.pdf

and IPTV over FTTH network is remained as 12%. However, with the expansion of FTTH around the world, FTTH is expected to key driver that accelerates the future take up of IPTV.

3.4. Wireless Broadband

Mobile broadband network also continuously evolved from analogue GSM to GPRS(2G), EDGE(2.5G), WCDMA(3G/IMT-2000), and HSDPA, or for CDMA system, to CDMA2000 1x, CDMA2000 2x EV-DO, WCDMA, and HSDPA. The network is now advancing towards IMT-2000 Advanced, so called 4G network system. Ultimately, IMT-2000 Advanced will enable over 100Mbps of IP-based data transmission moving at vehicular speeds over 60km/h. In the IMT-2000 Advanced, it is expected that the speed and quality gaps between fixed and mobile communication will remarkably disappear.

Currently, several wireless technologies are competing for the future IMT-2000 Advanced services, including LTE-A, mobile WiMAX, and 802.11 VHT. LTE (Long Term Evolution) is in the continuation of the GSM network evolution, which is currently supported by various mobile operators. Over 20 mobile operators committed the LTE deployment including Sweden's TeleaSonera, which already implemented LTE network in Stockholm and Oslo in May and June 2009 respectively. On the other hand, mobile WiMAX, evolved form a fixed wireless broadband, has been already implemented in several countries including the Republic of Korea (in the form of WiBRO) in 2007, United States in 2008, Algeria, Angola, Namibia, and Peru[6].

3.5. Operator Convergence

Converged NGN services require a new business model and innovative pricing. In many developed countries, multiple-play (e.g., Triple-play, Quadruple-play etc.) is dominant trend in developed countries as telecommunication operators increasingly offering a bundled service of fixed-line telephone, internet, mobile and IPTV. Mergers and acquisition and strategic partnership became a common strategy for today's telecommunication operators. Users are getting used to pay a packaged service with a discounted price on a single bill. With the market saturation and increasing competition, many operators are aggresively adopting flat rates rather than time-based or data-capped pricing models as affordable and attractive pricing is the key driver for customer acquisition.

[6] ITU (2007) Trends in Telecommunication Reform 2007: The Road to NGN http://www.itu.int/ITU-D/treg/publications/trends07.html

4. NGN for Asia and the Pacific

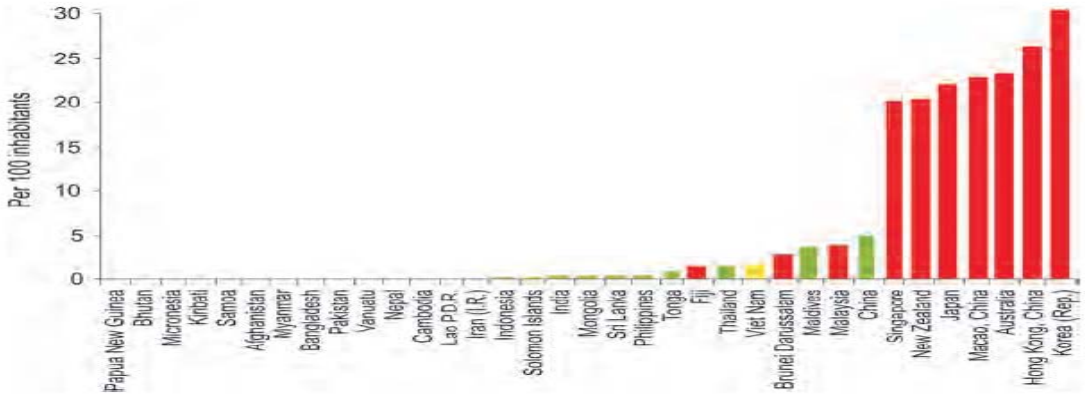
4.1. ICT in Asia and the Pacific

Asia-Pacific region has with the largest populations including those of the most populous countries such as China, India, and Indonesia as well as the least in the Pacific. Accordingly, it has the highest share of fixed telephone, mobile subscriptions, internet and broadband users. As of end 2007, 1.4 billion mobile subscribers (42% of the world), almost 600 million fixed-telephone lines (47%), and over 500 million internet users (39%). The region is also mixed with the most advanced ICT countries such as the Republic of Korea and Japan, Singapore, and Hong Kong/China, and many developing countries including 13 Least Developed Countries (LDCs), 11 Small Island Developing States (SIDS), and 10 Low Income Countries.

Like other regions in the world, Asia-Pacific has experienced a significant growth in ICT adoption over the last decade. The uptake of mobile phones, in particular, was remarkable as the number of mobile subscribers increased by almost six times from 2000 to 2007. Together with China and India, mobile phones are now widely adopted in Indonesia, Thailand, Pakistan, the Philippines, and Bangladesh.

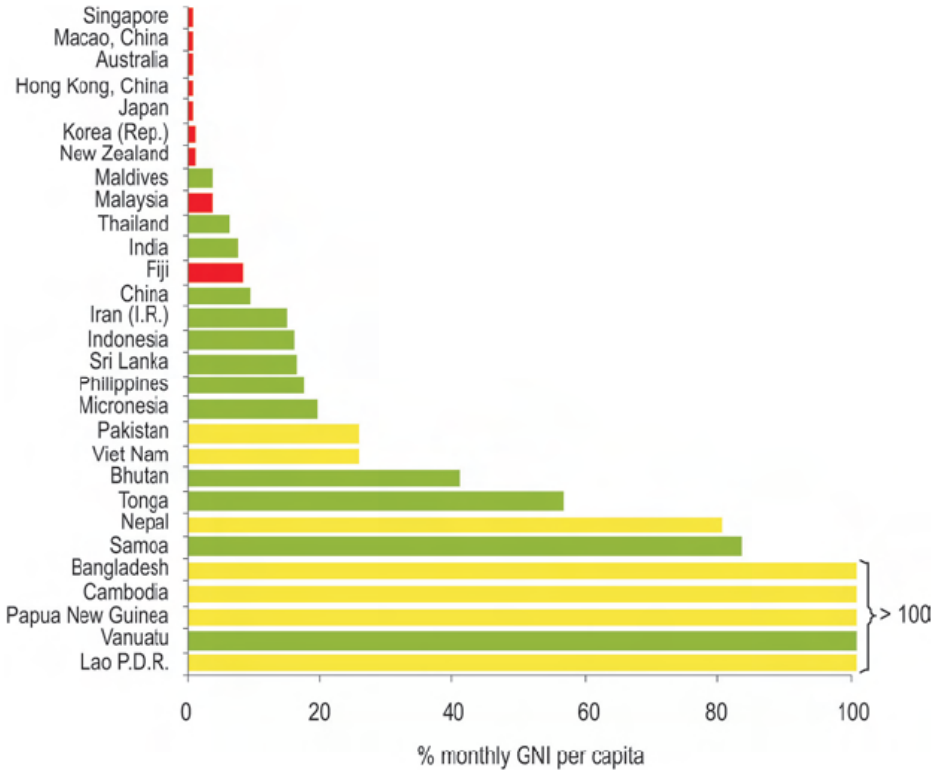
However, the digital divide persists according to income levels. In the case of the internet and broadband penetration, there is a considerable gap between different economies (See Figure 3) and most of the recent uptakes were from a few populous or high-income countries.

[Figure 3: Fixed Broadband Subscribers in Asia Pacific, 2007]



<Source: ITU Information Society Statistics Profiles 2009, Asia Pacific>

[Figure 4: Fixed Broadband prices as a percentage of monthly GNI per capita, 2008]



<Source: ITU Information Society Statistics Profiles 2009, Asia Pacific>

Moreover, the speed and price of broadband service also differ significantly between countries. In some low-income countries, broadband speed is as slow as less than 1 Mbps while the subscription price is more than 100 per cent of the monthly GNI per capita. (See Figure 4) Even within countries, the digital divide is growing between urban and rural areas where some rural residents are completely left out from the internet and other communication services.

4.2. NGN for Developing Countries

Some may suggest that NGN could be too early for developing nations. However, NGN is an efficient system that has benefits not only for the countries with the advanced ICT sector, but also for developing countries. As discussed earlier, NGN has significant cost-reduction effects in implementation, operation management and maintenance. Compared to traditional networks, the simplified nature of NGN architecture requires fewer but more powerful network elements. According to Analysis, for instance, even though both a

traditional backbone router and an NGN backbone router cost around USD 36,000 per core unit, the NGN router has a capacity of 32 port cards compared to 8 on an ATM backbone router[7]. In addition, NGN can be easily upgraded or re-used for additional services, which enables significant long-term savings. In a country-level, as one network can serve several different services, NGN prevents overlapping network investments and increasing the efficiency in overall national infrastructure.

In fact, many developing countries have a late-comer advantage that they can bypass the trials and errors made by developed countries and leapfrog with the latest technologies. Unlike developed countries, where there are already several legacy networks, many developing countries have less concern on the consolidation of existing legacy networks for NGN.

In addition, advanced multimedia services available on NGN, such as IPTV and mobile broadband, can be a key driver to increase the demand and revenues for broadband services in developing countries. One of the reasons for the low broadband penetration in developing countries is low penetration of PC at home and the lack of demand for general internet services such as emails, web search, downloading, etc. On the other hand, the penetration of television and pay-TV subscription is relatively higher, which shows that the familiarity and demand for television contents. Therefore, new multimedia services that can be delivered better on NGN can drive the adoption of broadband in developing countries as well as become a reliable revenue source for operators.

Finally, developing countries can strategically implement NGN network according to their particular geographic, demographic, and economic conditions, in a way to facilitate social and economic development. For instance, countries can deploy fibre networks in urban areas while installing cost-effective wireless broadband networks to cover rural areas. In parallel, countries can also design specific broadband-based contents and applications that can facilitate the development, such as e-agriculture for rural areas, e-government system to enhance the provision of public services, e-education to deliver high-quality, low-cost educations to schools and library.

[7] Analysis (2006) Leap-fogging the divide: Next Generation Networks in developing countries, www.analysysconsulting.com

Therefore, several developing countries have already begun the move towards NGN. For instance, Telecom Regulatory Authority of India (TRAI) has been investigating the country's strategic implementation of NGN since 2005 and created an expert committee (i.e.NGN-eCO) to deal with regulatory issues such as licensing, interconnection, and quality of services (QoS) and recommendations on the NGN service provision. Currently, most of the telecommunication operators in India have deployed an IP network in their backbone and is working on the provision of access network to end users. In Bangladesh, telecommunication operators have already installed NGN based soft-switch network, including three international gateway operators and two national gateway operators, various private mobile and PSTN operators.

5. ITU Activities on NGN

ITU has been working on the realisation of NGN for many years. ITU-T is actively involved in the establishment of NGN architectures, interface specifications, and implementation guidelines in the form of ITU-T international standards (Recommendations). ITU-D is also actively working on indentifying the role of NGN for the global information society and assisting the specific needs of developing countries for NGN deployment.

5.1. ITU-T Activity

In 2003, a *Joint Rapporteur Group on NGN* (JRG-NGN) was created by brining together experts from all Questions of Study Group 13. The main subjects studied by the JRG-NGN were: NGN requirements, the general reference model, functional requirements and architecture of the NGN, and evolution to NGN. The JRN-NGN activities resulted in two fundamental Recommendations, Y.2001, *General Overview of NGN*[8] and Y.2011, *General principles and general reference model for next generation networks*[9]

[8] ITU-T Y.2001, General overview of NGN http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-Y.2001
[9] ITU-T Y. 2011, General principles and general reference model for next generation networks http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-Y.2011

In May 2004, in order to continue NGN activities initiated by the JRN-NGN, ITU-T established a Focus Group on NGN (FGNGN) which provides an effective response mechanism for accelerating the work of the ITU-T. The FGNGN addressed the urgent need for an initial set of global standards for NGN that can enable interoperability and encourage market investment. Its activity has attracted a significant participation and trust from a wide range of the world's telecommunication equipment manufacturers, network and service providers and government. The FGNGN's mandate was extended through November 2005 and its work resulted in FG Proceeding Release 1[10], which provided a foundation for the industry can start the shift to NGN.

Since the formation of FGNGN, there has been a series of intensive and dynamic meetings to discuss the issues in the NGN migration. Currently, the work is carried out by ITU-T's NGN-Global Standards Initiatives (NGN-GSI), which overseas all NGN work across ITU-T Study Groups (SG). The study topics under NGN-GSI include the network evolution to NGN, Quality of Service (QoS), Interoperability, Security, Generalized Mobility, Service Capabilities and Architectures and so forth. In addition, ITU-T provides a web-based NGN Project Management Tool, which delivers an overview of the NGN progress across the standardization world[11].

5.2. ITU-D Activity

After the WTDC (World Telecommunication Development Conference) in 1994, ITU-D has established two Study Groups (SG1, SG2) to deal with specific questions and needs to developing countries. While ITU-T deals with technical standards, ITU-D Study Groups works for telecommunication development strategies, including policy recommendations, service and network management issues, specific problematic areas for ICT development[12]. ITU-D SGs are working on several questions relating to NGNs and investigating strategic solutions for regulatory issues as well as the challenges for developing countries.

[10] NGN-Focus Group Proceedings (Release 1) www.itu.int/ITU-T/ngn/release1.html
[11] ITU NGN Project Management Tool http://www.itu.int/ngnproject/
[12] See ITU-D Study Group Activities http://www.itu.int/ITU-D/study_groups/index.html

[Table 2: ITU-D Study Group Activities on NGN]

Study Group 1	**Q 6-2/1**	Regulatory impact of next-generation networks on interconnection
	Q 12-2/1	Tariff policies, tariff models and methods of determining the costs of services on national telecommunication networks, including next generation networks
Study Group 2	**Q 19-1/2**	Strategy for migration from existing networks to next-generation networks for developing countries

5.3. ITU Asia Pacific Regional Initiatives

ITU-D BDT (Telecommunication Development Bureau) operates many regional offices around the world. At the WTDC in Doha 2006, BDT decided the implementation of regionally approved initiatives (Resolution 17) which allowed ITU Asia Pacific regional office to implement the following five regional initiatives through mobilizing resources: e.g.,

- RI 1) Telecommunication/ICT policy and regulatory cooperation in Asia-Pacific
- RI 2) Rural Communications – Infrastructure Development
- RI 3) Next Generation Networks Planning
- RI 4) The unique telecommunication/ICT needs of Pacific islands and small island developing states (SIDS) in the Asia Pacific region
- RI 5) Strengthening the collaboration between ITU-T and ITU-D

Under the initiative 3, ITU Asia Pacific regional office has been actively assisting its member state in the region in smooth migration into NGN by studying specific NGN questions requested by member states, developing NGN migration strategies specifically for the Asia-Pacific countries, preparing 'Handbook, Guidelines and Case Studies on NGN Migration Strategies and Planning Methodologies using advanced models and software tools', and developing pilot projects on NGN applications and service deployment under global network planning initiatives. In 2009, for examples, ITU Asia Pacific office organized two trainings and three workshops or forums, which are specifically designed for the NGN including: e.g.,

- ITU Asia-Pacific Centre Of Excellence Training course; NGN Planning and Migration (Republic of Korea, March 2009)
- ITU NTC Training: Regulatory Impact of NGN (Thailand, April 2009)
- ITU-T and ITU-D Workshop: NGN (Sri Lanka, April 2009)
- ITU-MICT Workshop: New Technologies and Applications (Iran, June 2009)
- ITU Regional Development Forum: NGN and Broadband (Indonesia, July 2009)

For instance, at the five-day Workshop in Iran[13] (14-18 June, 2009), ITU Asia-Pacific Office provided a series of comprehensive sessions to study the NGN technology requirements and business and regulatory issues as well as to discuss specific migration strategies for developing countries including Lao PDR, Maldives, Mongolia, Nepal, Pakistan, Philippines, Sri Lanka and many others. Earlier in December 2008, ITU Asia-Pacific Regional office and Ministry of Information and Communication (MIC) of Japan co-organized the Training on Bridging the Standardization Gap[14], specifically aiming a knowledge transfer on the NGN strategies among the Asian-Pacific nations. The training offered updates on the key developments of NGN and several discussion sessions to exchange ideas and experiences on NGN implementation.

ITU Asia-Pacific regional office also carried out first ever case study of NGN Access Network Planning for TOT Public Company Limted, Thailand and will be publishing guidelines for operators for NGN migration.

6. Issues, Challenges and Ways Forward

Converged Regulatory Frameworks

Increasing convergence between different services raises new regulatory challenges. Regulators may need to re-assess the legacy policy that may hinder efficient response to the market innovation. The converged services, especially a new service created from a merger between existing markets such as IPTV often requires close collaboration between previously distinct regulatory bodies. However, in some cases, the collaboration may

[13] See http://www.itu.int/ITU-D/asp/CMS/Events/2009/NGN-MICT/ngnmict.asp
[14] See http://www.itu.int/ITU-D/tech/network-infrastructure/index.html

increase inefficiency and can create regulatory overlaps or conflicts. Therefore, converged and harmonized regulatory frameworks that can effectively deal with converged services are urgently required. In the UK, five separate regulatory bodies were converged into the one independent authority called OFCOM in order to provide more efficient and specialized services for the future communication services. In the Republic of Korea, after long discussions and restructuring, a new converged regulatory authority called KCC was also created in 2008, overseeing the broadcasting, telecommunications, contents and software market. Likewise, there are many countries with converged regulators including, but not limited to, Australia, Bhutan, Malaysia, Mongolia and so on in the Asia-Pacific region alone.

Enabling Environment and Competition

Regulators also need to provide an enabling environment that can reduce market uncertainty and encourage investments, while ensuring fair and unbiased market competition. NGN requires heavy investment and foreseeing strategies through uncertainty. Thus regulators need to understand the needs of the industry and to assist their migration activities, by providing a clear vision on the ICT sector in its key national policy agenda and a set of clear guideline to the industry. At the same time, regulators need to ensure the market is healthy and efficient with fair competition, open entry and a level playing field for various market players.

Licensing

Conventional approach to specified licensing is increasingly viewed as unsuitable for the NGN environment, since it can often act as a barrier to market entry and restrict a further innovation. Therefore, more and more regulators are developing horizontal, technology and service-neutral licensing. For instance, India has recommended a unified license for all types of services, while Malaysia also converged existing 31 specific license types into four technology-neutral categories.

Local loop unbundling

Local loop unbundling (LLU) is another method to reduce the entry barrier and increase market competition. By unbundling the local loop of the incumbent operator or dominant market power, other service providers can access the network and provide competitive

services and attractive prices to consumers. In Europe, regulators have enforced local loop unbundling and more than 80 per cent of unbundled lines are available.

Interconnection

Flexible and accurate interconnection models between operators can also create fair competition. Interconnection is an arrangement between operators to access to the customers of other operators and to share the revenues and billing. In the NGN environment, traditional interconnection models based on per-minutes charges are expected to diversify into per-volume, per-service, or per-capacity. At the wholesale level, traditional Calling Party's Network Pays (CPNP) arrangement may find the difficult to sustain in the NGN environment and some suggest trends towards 'Bill and Keep' model[15]. At the retail level, bundling and flat-rate billing is expected to increase on NGN. Reflecting the transition, regulators also need to monitor closely the industry behaviours and provide public access to reference interconnection offerings in order to ensure the transparent market environment.

QoS and Consumer Protection

Unlike the well-established and reliable PSTN voice service, emerging NGN services requires assurance of its quality and consumer protections, including service disruption during the NGN migration, assurance of end-to-end quality of services, access to emergency services and emergency call location, number portability, differentiation of QoS guidelines, and cybersecurity.

During the migration to NGN, regulators need to ensure there is no service loss or damage to the existing services as well as to **inform consumers** about this transition and their rights and benefits through public campaign or public websites. Meanwhile, as VoIP is rapidly replacing the existing PSTN telephony, regulators also need to assure the voice quality, service reliability, and security of VoIP. It is possible that some VoIP may not provide a reliable access to **emergency call** and, since it is delivered over the internet, the service can be severely affected by power cut or broadband line-loss in the situation of disasters. **Number portability** enables consumers to switch between different operators or even different access platform, such as mobile and fixed lines, with a single number. It is an

[15] For further discussions, see Marcus, S. (2007) '*Interconnection in an IP-based NGN Environment*' in ITU (2007) Trends in Telecommunication Reform: The Road to NGNs, ITU Publications.

important tool to introduce the dynamic market, as well as further service convergences. Finally, the all-IP, one-network environment raises a concern on its **cybersecurity**, and therefore needs to be combined with robust security protection. A stronger and more effective legislation and policy actions are required and, as cyber-crimes floats across national borders, there is a growing need for collective international actions and close collaboration between nations.

Capital Expense and Universal Service

The transition to NGN requires a shift in infrastructure budgeting and additional Capital Expense (Capex) funding. The large Capex becomes problematic especially in the provision of rural communications. Private operators cannot often find enough justification for their investment in rural areas, where there is sparse population with low-income, and low-demand users. Despite the potential benefits of the NGN in rural development, the NGN and its services tend to centred in lucrative urban areas, whilst the gap between rural and urban divide is widening. Therefore, regulators need to review their universal service obligations and devise new effective policy schemes to ensure the equal share of the NGN benefits within the nation, by preserving a special funds for universal service deployment, or encouraging private-public partnerships for rural communications.

A strategic use of NGN technologies can also be a solution as rural areas can be covered by more cost-effective networks such as wireless broadband or mobile communications. Some developing countries also recommends infrastructure-sharing between operators. Sharing can bring several benefits such as increasing the speed of network roll-out, reducing costs, expanding coverage, enhancing competition, cheaper consumer prices, and minimizing the environmental impact. It is an effective and cost-efficient tool to deliver universal service in rural areas, so that operators can collective work through the challenges such as poor roads, lack of electricity, and sparse populations.

In addition, regulators need to ensure the network provision is combined with effective service and applications for rural development, which can deliver effectively various public services such as public information, education, health, gender and youth development programmes to the last mile users including the persons with disabilities and elderlies. Well-customised and innovative development programmes using ICTs can also trigger the

latent demands for ICT services among the low-income, rural populations.

7. Conclusion

In this era of shifting paradigms, we are faced with the dynamic changes that are currently shaping the future of our telecommunication networks and services. In order to move forward, industry, policy makers and the regulators need to be proactive to the current and future developments in NGN, while fully understanding the key elements of NGN technologies, the scope of innovative services as well as the uprising challenges that lie ahead on NGN migration. The recent transformations, such as convergence, changing business models, and opportunity to launch new revenue generating services through broadband applications, have all significantly contributed to migration towards NGN both in developed as well as developing countries. While technical challenges such as interoperability, standardisation, quality of service are being progressively being addressed through various standards setting bodies, what is more challenging is to ensure security, regulatory framework that is technology/service neutral and encourage investment in infrastructure with equality of access, are some of the concerns that still remain to be addressed effectively.

No one solution can be applied to every country, customised solutions need to be developed taking into account unique conditions of the countries concerned. Asia Pacific region have seen significant deployment of NGN including some developing countries. All these lessons can be learned through information sharing, capacity building initiatives for training and skill development, resulting the benefits of the future networks can be shared by all.

ANNEX 1: Country Case Study – Republic of Korea

For the last four decades, the Republic of Korea (South Korea) has made a remarkable growth in the ICT sectors and became one of the exemplary nations with ubiquitous broadband services. In 1960, South Korea was one of the least developed countries with a telephone penetration of only 0.36 per 100 inhabitants. Today, it became the world leader in the fixed broadband penetration and the internet access is available in 94 per cent of South Korean households. South Korea is also a well-known global test-bed for many latest technologies and services such as mobile TV, IPTV, WiBro, Telematics, and home networking.

South Korea does not have particular advantages in its geographic, demographic, economic conditions that will make it easier to achieve the highest penetration. Nearly 70 per cent of lands in South Korea are mountains and hills, while its income-level is lower than many other Asian countries like Singapore, Hong Kong/China, and Australia. Korean language and alphabets are not used anywhere else, while English is not widely used in the country, which hinders access to the vast amount of web contents from the developed countries.

Strong Government's Vision

One of the key drivers of the South Korean success is the strong government policy in promoting the importance of ICTs and its strategic involvement in guiding the market growth and ensuing universal services. South Korean government implemented its vision for information society as early as 1987, launched two projects aiming in nurturing IT manufacturing sector and promotion of computer networks. The 'National Basic Information System Project' (1987-1996) emphasized five sectors (administration, defence, security, finance, and education) for IT adoption, followed by 'Korean Information Infrastructure Initiative (1995-2005)' which pushed the establishment of national information superhighway.

In 2004, the South Korean Ministry of Information and Communication launched the comprehensive 'IT 839 Strategy' which addressed 8 key services (WiBro, DMB, Home Networking, Telematics, RFID, WCDMA, Terrestrial DTV, VoIP), 3 infrastructures

(Broadband Convergence Network(BcN), Ubiquitous Sensor Network(USN), IPv6), and 9 new growth engines (Next generation mobile, Digital TV, Home Networking, IT SoC, Next-generation PC, Embedded Software, Digital Contents, Telematics, Intelligent service Robot) for the future ICT sector (See Table 5). These government strong visions became a clear guideline for the market players to invest in the future products and services, while driving the rapid ICT adoption in various sectors in society.

<Table 5: Korea's ICT Plans>

Duration	ICT National Projects	Purpose
2004 – 2007	IT 839 Strategy	Announcing 8 services, 3 infrastructure, 9 growth engines for ubiquitous network society
2002 – 2006	E-Korea Vision 2006	Maximise ability of all citizens to use ICTs
1999 – 2002	CYBER Korea 21	Vision of a creative knowledge-based society
1996 - 2000	National Framework Plan for Information Promotion	Ten priority areas Annual action plans
1995 - 2005	Korea Information Infrastructure Initiative	National Information Superhighway
1987 – 1996	National Basic Information System	Key five areas for ICT adoption

<Source: ITU, Strategy Policy Unit presentation>

Dynamic Market

South Korea has a dynamic and organic ICT market that involves not only telecommunication operators, but also large IT manufactures such as Samsung Electronics and LG, as well as various small-medium ventures companies that provides innovative hardware components and solutions. The consumer broadband market was began in 1998 with the cable modem service, followed by Hanaro Telecom and KT's ADSL service in 1999. Since then, the broadband network has advanced consistently from ADSL to VDSL in 2002, and finally to FTTH in 2006. Recently in April 2009, the government announced its plan to invest USD 24.6 billion in UBcN (Ultra Broadband Convergence Network) by 2013, which is a all-IP converged network that can deliver 10 times faster both fixed and wireless connections than current networks. IPTV is currently offered by three major telecom operators (Hanaro Telecom, SK Broadband, LG Dacom) and has already reached 500,000 subscribers in mid-2009.

In the mobile market, three operators (SK Telecom, KTF, LG Telecom) are competing with various value added services such as mobile TV via DMB or Satellite, mobile banking, video calls, etc. WiBro, the technology developed in South Korea, was launched in Seoul and has currently gained 200,000 subscribers. With the increasing needs for convergence, the Korean telecommunication market is currently restructuring. SK Telecom, the dominant mobile operator, has acquired Hanaro Telecom in 2008 and now equipped with both mobile and broadband services. On the other hand, in early 2009, KT and KTF, previously separate arms, are now merged into one massive telecommunication company, which is now able to provide a true convergence offering between fixed and wireless services.

ANNEX 2: Country Case Study - Japan

Japan is one of the early movers in the NGN migration and has by far the most advanced FTTH and mobile broadband market in the world. The country has the strong ICT industry, which contributes over 40% of Japan's GDP growth, and it R&D expenditure in science and technology accounts for over USD 128 billion[16]. The migration to NGN has the top priority in Japan's ICT strategy and the country has a clear vision to become a world leader in the NGN and create the ubiquitous network society by 2010.

Strategic Government Plans

Over the last decade, Japanese government has implemented a series of national ICT strategies to foster the ICT infrastructure and services. Since its launch in 2001, 'IT Strategy Headquarters' provided various strategic plans, including e-Japan (2001, 2003), e-Japan Acceleration package (2004), IT Policy package (2005), and IT New Reform strategy (2006). In parallel, MIC (Ministry of Internal Affairs and Communications) also announced 'u-Japan' policy in December 2004 that aims to create the true ubiquitous network society by 2020. The policy included five sub-strategies; 1) development of ubiquitous network, 2) advanced usage of ICT, 3) upgrading enabling environment, 4) international strategy, and 5) technology strategy. Its goals include the deployment of 100% broadband network, mostly based on FTTH. In 2007, MIC also launched the Ubiquitous Network Society (UNS) Strategic programme that consists of three primary technologies (e.g., NGN, Security and

[16] Myoken, Yumiko (2009) Overview of ICT Strategy in Japan, Science and Innovation Section, January 2008 http://ukinjapan.fco.gov.uk/resources/en/pdf/5606907/5633632/Overview_of_ICT_Strategy.pdf

Safety technologies, and Universal communication technologies) and ten specific research projects with the total investment of over USD 400 billion[17].

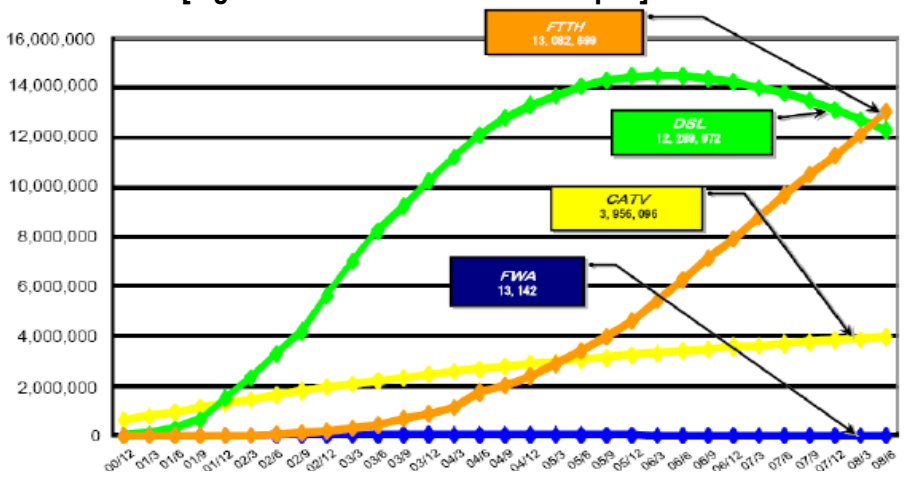
[Figure 6: Japan's Major ICT strategies]

Announced Year	National Strategy	Focus Areas
2001 Jan	e-Japan Strategy	Infrastructure development
2003 Jul	e-Japan Strategy 2	Infrastructure development and valuing IT applications
2004 Feb	e-Japan Strategy 2 Acceleration Package	
2004 Dec	U-Japan Policy (MIC)	Five strategic policy packages
2005 Feb	IT Policy Package	IT utilization
2007 May	UNS Strategic Program (MIC)	Universal Communications, NGN, Security
2008 Jan	IT New Reform Strategy	Ubiquitous network society by 2010

Advanced Market

The Japanese market is moving fast towards the NGN and its services. FTTH is promoted aggressively by the major network operators such as NTT, KDDI, USEN and, as a result, the number of FTTH subscribers increased rapidly up to 13 million in 2008. The number of DSL subscribers has been gradually declining since 2006 and is now finally surpassed by FTTH. Strong competition in the market is also bringing down the ADSL and even FTTH prices around USD 20 - 25 per month.

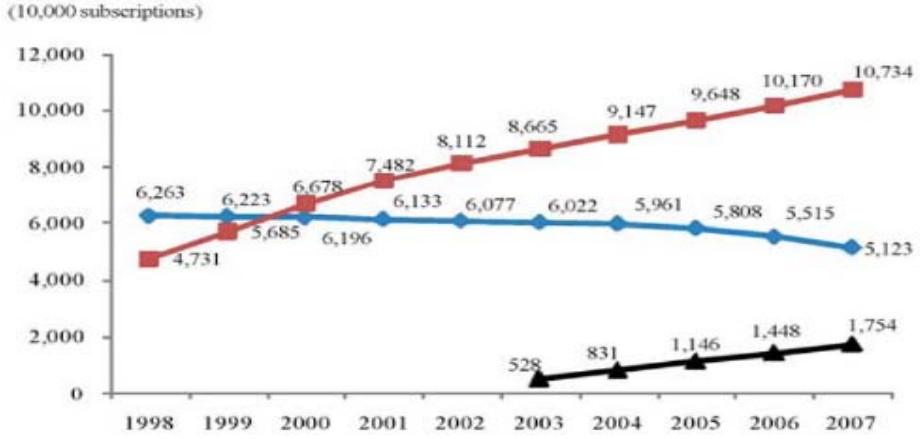
[Figure 5: Broadband Market in Japan]



Source: ITPS, MIC 2007

[17] Myoken, Yumiko (2009).

[Figure 6: Voice communication Market in Japan]



Source: KDDI, MIC, 2008

NTT is the most active play in deploying NGN in Japan. In March 2008, it became the world's second NGN operator to launch commercial NGN services after British Telecom. It aims to migrate 20 million to FTTH based NGN services by 2010, and develop fixed-mobile convergence services, while deploying an open network structure that enable active collaboration with other carriers and ISPs.

The trend in voice communication service also shows the rapidly increasing usage in mobile and VoIP services. The growth of mobile subscribers has been consistent over the last ten years while the number of fixed line users is continuously decreasing. VoIP service was launched in 2003 and has now reached over 17 million users in Japan. The mobile market is competitive with various operators, including NTTDoCoMo, KDDI, Softbank, eMobile, as well as various MVNOs.

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