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STUDY GROUP REPORT

Outline of Report from Study Group on Next-Generation Broadcasting Technology

On the establishment of the study group

Broadcasting is among the media that have thoroughly penetrated people's lives and it is expected to make daily life for people even richer through linkages with communications as a result of technological advances. At the present time, Japan is in the process of shifting to terrestrial digital broadcasting, but it is also very important to establish a vision concerning medium and long term research and development directions for building an even more efficient broadcasting system once the move to digital technology is complete. For this purpose, MIC established the Study Group on Next-Generation Broadcasting Technology (Chair: Prof. HARASHIMA Hiroshi, Graduate School, the University of Tokyo) in September 2006 in order to investigate concepts of the kind of next-generation broadcasting system that can be imagined 5 to 20 years from now, at a time of full-scale digital broadcasting, as well as the research and development topics essential to bring this about. The study group compiled its report in June 2007. The study group investigated 5 themes within the framework of an initial phase in 5 to 10 years time (2011-2016) following the shift to digital broadcasting when the various applications can be expected to become entrenched, and a secondary phase in 11 to 20 years time (2017-2026). These themes are (1) the development of a ubiquitous reception system, (2) the development of linkages between broadcasting and communication, (3) advances in mobile multimedia enjoyment, (4) the realization of highly-realistic sensations and (5) the maintenance of safety and security.

The points that should be kept in mind when investigating next-generation broadcasting systems

Along with the growing ubiquitousness of reception systems, the ever faster linkages between broadcasting and communications due to the digitalization of broadcasting technology, and the stratospheric rise in mobile media enjoyment thanks to the rapid penetration of mobile phones, all in conjunction with the revolutionary advances in information communications technology of the past few years, there have also been developments in the technologies that form the base of broadcasting with highly-realistic sensations such as ultra-high definition and 3-D images, and the environment surrounding broadcasting has also

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been changing a great deal. In addition, the role of broadcasting in maintaining safety and security has been increasing, leading to much higher expectations than in the past for the broadcasting of the future.

On the other hand, it can be said that the basic premise which characterizes broadcasting, in that it can simultaneously bring the same information to a large number of people regardless of who they are, has not changed.

Because of all this, it is necessary to keep in mind, when investigating next-generation broadcasting systems, the fact that broadcasting has widely penetrated people's lives, that recipients are basically passive, that the choice of the convenience made possible by technology is a free one, that there is a desire for progress in the direction of highly-realistic sensation, and the increase in convenience on the side of those producing broadcast programming.

What is expected in next-generation broadcasting systems

(1) The development of ubiquitous reception systems

The current hard disk capacity of several hundred gigabytes is expected to move to the 10 terabyte class in 10 years' time, and to capacities of a thousand terabyte in 20 years' time, and along with the increase in storage volume capacity, the rate of time shifting and enjoyment on mobile devices will increase. In addition, with developments in user interfaces and various types of sensor technology, services will appear in 10 years' time that will enable the use of program selection guides that consider user preferences through simple interactive interfaces. Further advances in interfaces in 20 years' will enable concierge services that will select and automatically generate the most appropriate programming based on analyzing users' psychological state of mind and moods.

Also, it has now become possible, thanks to the appearance of reconfigurable processors and multicore processors and developments in compiler technology, to alter image and audio codecs. In 10 years' time, there will be application rewrite services, and in 20 years' time, cognitive radio that presupposes a configurable architecture will probably be in wide use. What is more, the receiver functions that are currently limited by hardware will see in 10 years' time a standardization into modules of CPUs, memory, displays, power supplies and the like where the necessary hardware component alone can be exchanged, making it possible to enhance functions through the exchange of individual units, so that we can expect to see environmentally-friendly receivers generating fewer waste products.

The metadata that will define the substance of contents for future broadcasting systems will play a very important role, and in 10 year's time the automated creation, attachment and broadcasting of metadata that will make it possible to search contents and enjoy digests will be widespread. 20 years from now, automated creation of metadata based on individual preferences will be possible on the receiver side so that it will be possible not just to search the most appropriate contents but to create automatically contents that will bring together various scenes with no incoherences in situation or meaning.

(2) The development of linkages between broadcasting and communications

The situation at the moment only goes as far as the establishment of formats to provide multi-scenario contents using broadcasting networks only, but in 10 years' time there will be formats whereby basic contents will be transmitted by broadcasting networks and these will be combines with additional contents individually transmitted by communications networks, opening up the way for the broadcasting of multi-scenario contents that are compatible with existing broadcasts, as well as program requests and search portal services. 20 years from now could see the development of high-precision input-output and encoding technologies as well as virtual reality technology and global contents search technology which would enable broadcasts where users could remotely participate in casting through computer graphics, virtual reality broadcasts that convey scents and touch, and real-time searching and enjoyment of global contents.

In addition, at the present, one can just coordinate broadcast programs with web pages on the Internet, but in 10 years' time, there will be technology to upload viewer information and merge it with programs, and in 20 years' time, there will be even more real-time merging technology using computer graphics so that services would appear that would make it possible to be not just a viewer but to become a real-time remote participant in a program and change the program instantly.

Also, in 10 years' time, technology is likely to be available for individuals to edit easily and scenario description language will be developed, followed in 20 years' time by technologies for automated attachment of metadata and copyright maintenance, as well as automated assessment of reliability, so that it will become possible for people to transmit programming to one another within a community, as well as to broadcast on an individual level.

(3) Advances in mobile multimedia enjoyment

Current digital broadcasting aimed at portable and mobile terminals consists mainly of using the terminal as a receiver of one-segment services, with functions for interactive services. In addition, mobile phones are beginning to be fitted with various functions such as electronic money and personal authentication. In the future, these services are expected to gradually become linked with one another and become more advanced.

At present, viewing is limited to small 3-inch displays with QVGA images but in 10 years' time will appear ultra-small projector technology followed in 20 years' time by high-quality ultra-small projector technology and flexible display technology, so that, even in mobile environments it will be possible to shift from enjoyment on a small screen to high-quality large-screen video enjoyment.

It is also possible at the moment to revise partly car navigation map information using the Internet but, fundamentally, ITS, digital broadcasting and the Internet all exist as separate services. The move to wider bands and frequency usage efficiency in 10 years' time, and the fact that, in 20 years' time, it will be possible to receive data when the vehicle is stopped at 10 times the speed and volume of when it is in motion will mean a shift from "using ITS" and "enjoying digital broadcasts" to "delivering driving support information data" and "coordination between broadcast programs and automated navigation."

(4) The realization of highly-realistic sensations

A system is currently being developed for the movie industry in the 2000 scanning line range, and trials are taking place for contents delivery using networks. A 4000 scanning line range system that supplies ultra-high-definition images is also being tested. Research and development is under way for the basic technologies to realize broadcast services using ultra-high definition images, and 10 years from now, it will probably be possible to view publicly in public facilities and theaters all over the country ultra-high definition images beamed from broadcast satellites. This will be followed by the installation of facilities and the development of home-use receivers with the aim of making ultra-high definition images available to general households, so that it can be expected that these will be starting to penetrate general households in 20 years' time.

3D video has already been partially realized and if research on the twin-lens format progresses, it could be current in movie theaters in 10 years' time. In addition, use of formats such as the multi-lens or volume display type is also moving ahead while making use of the particular characteristics of each and possibly leading to commercialization. Integral imaging and holography which replicate shapes are ideal systems that actually create optical images but they place high demands on the image and display devices so that an enormously high pixel count and pixel density become necessary. In 20 years' time, systems that will merge ultra-high-definition image technology and 3D image technology are expected to make their appearance. Other than that, advances are also anticipated in 3D sound as well as the development of senses broadcasting that can convey touch and smell, with fusions in research that will also include human science aspects so that, in 20 years' time, the transmission of multi-sense information that is natural and easy on people could become possible.

(5) The maintenance of safety and security

It is necessary to have in place an installation environment that makes it possible to receive broadcasts at any time and anywhere by taking full advantage of the characteristics of broadcasting which are suited to becoming information lifelines since it is resistant to channel disruptions in emergency situations. Research is ongoing on re-broadcasting to closed spaces such as underground malls and tunnels and it should be possible in 10 years' time to receive broadcasts in closed spaces. It is expected that, in 20 years' time, ad-hoc relays between mobile terminals will make it possible to transmit information such as emergency broadcasts to locations where reception has become impossible due to a disaster. In addition, the length of time during which mobile terminals can be continuously used will improve in 10 years' time due to lower power consumption batteries and it will become possible to use these continuously for 10 to 12 hours, with the time factor increasing considerably to several days, even up to one week, in 20 years' time.

On the other hand, the merging of contents distribution routes due to the shift to digital technologies has progressed and functions such as the securing of the reliability and safety of contents, guarantees of provenance, and automated detection of harmful contents are being sought. In 10 years' time, it will become possible to verify the provenance of contents and check whether they have been tampered along with their distribution route, and in 20 years' time, there will be broader contents provenance verification and it will be possible to determine the character of those distributing contents, from professionals working on creating broadcast contents to individuals creating and distributing contents. Also, in terms of technology to protect intellectual property, it should be possible in 10 years'

time to automatically monitor illegal contents circulating on closed circuits, the Internet and movie posting sites and prevent their uploads.

- Development image of next-generation broadcasting systems

The realization image of next-generation broadcasting systems is of using a simple process to provide concierge-type programming that grasps the person's physical characteristics as well as their moods. It would come from a perspective of caring and relaxation and would not be affected by time or location and would provide high-quality programming on an ongoing basis. It would come with simultaneous transmission of uniform information and finely-tuned responses to needs. The technology would bring the feeling of being present in faraway places as events are taking place. It will be a technology for building next-generating broadcasting systems that will maintain people's safety and security.

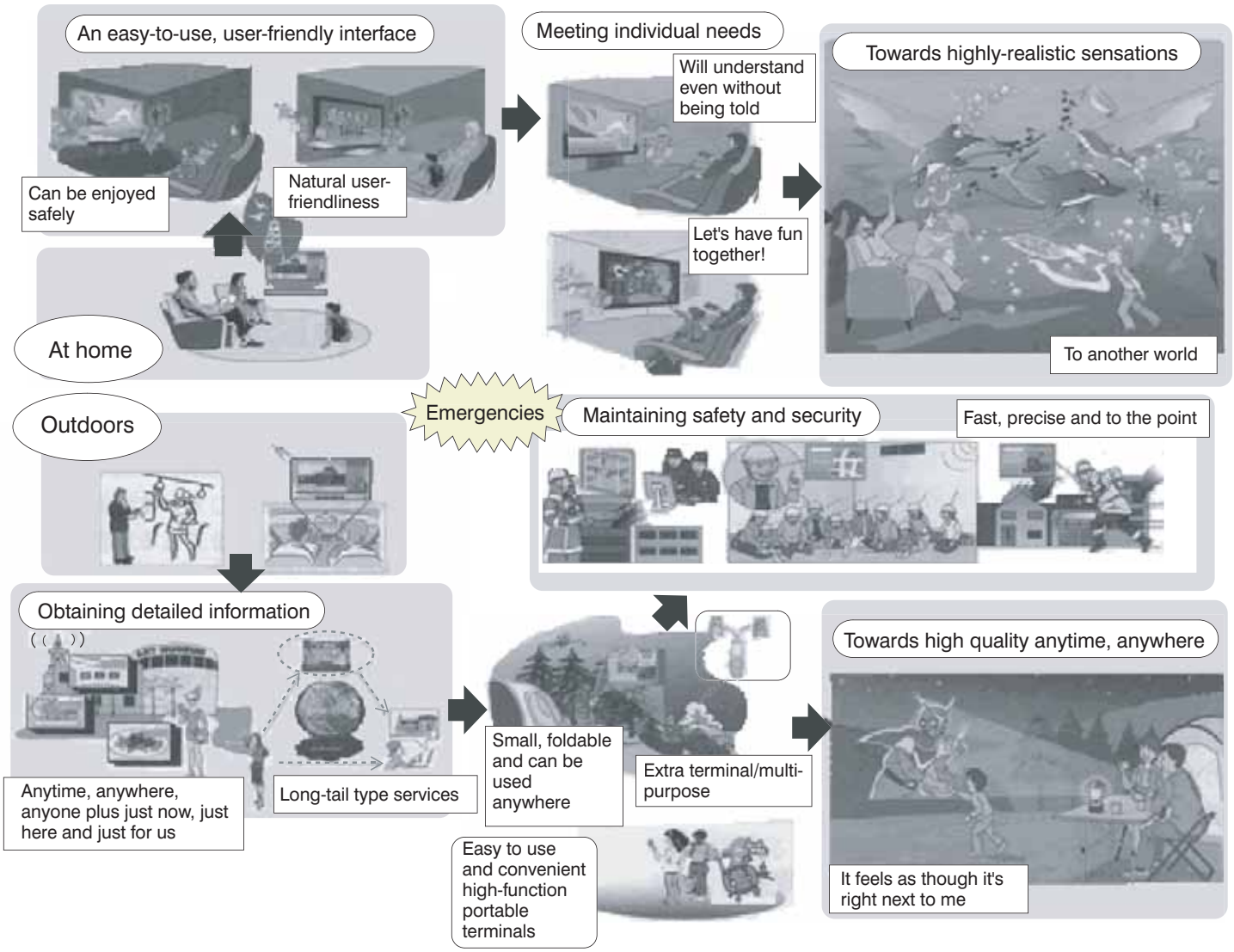
As for an image of how next-generation broadcasting systems would be enjoyed at home, adjustments can be made for the elderly, the handicapped, foreigners or children, increasing the size of fonts, automatically generating sign language, changing the language, and filtering harmful information, to create an interface that is both easy to use and easy on people. It is also conceivable that, ultimately, something that should be described as a concierge service will become reality, in which individual receivers offer programming tailored to a particular person. Furthermore, other conceivable developments include better handling of individual needs such as providing programming tailored to people's likes and dislikes, and virtual audience participation, leading, ultimately, to turning the user space into a highly realistic sensation space.

In terms of enjoying next-generation broadcasting systems out of doors, it will be possible to obtain detailed information about relatively small areas, such as tourist spots, on mobile terminals. There will also appear sophisticated function terminals that are both convenient and flexible, such as easy-to-carry paper displays or terminals where the broadcast format can be changes depending on the broadcast bandwidth. Ultimately, the development is conceivable of ultra-small high-function projectors that will make it possible to enjoy highly realistic broadcasts outdoors, even if there is no display, bringing in the age of high-quality broadcasts at any time and anywhere.

- What is expected of future approaches

With regard to images of next-generation broadcasting systems and technological issues, having investigated these for the mid to long term, setting about research and development that will enable the inauguration of such services ahead of the rest of the world is very important both in terms of improving people's lives and also improving Japan's international competitiveness. This report compiles an image of next-generation broadcasting systems and the necessary research and development topics, as well as development target schedules, and it is hoped that it will become a reference for future research and development for the state, broadcasters, manufacturers, universities and other related organizations, with the aim of bringing about visionary broadcasting systems that will make people's lives even richer.

Image of the development of next-generation broadcasting systems



STUDY GROUP REPORT

Report from the Study Group on Network Architecture

Introduction

MIC set up the Study Group on Network Architecture (Chair: Prof. TOKUDA Hideyuki, Keio University) in January 2007 with the aim of investigating concepts for new-generation networks as well as the necessary technological issues and promotion measures for their realization from many different points of view. This study group brought together not just researchers and operators in the field of state-of-the-art networks but also specialists from sectors such as automotive, finance, performing arts and construction, as representatives of those actually using networks. The group compiled its report on August 8 and its contents are introduced here.

The background to investigating new-generation networks

Japan has been seeing rapid technological innovation in the field of information and telecommunications and the promotion of competitive policies has resulted in the realization of the world's fastest and also cheapest broadband environment while, at the same time, there has been a rapid diversification and improvement in ICT services such as IP phones, triple play and FMC (Figure 1). In addition, along with connecting electrical appliances and sensors to home networks, there has been progress in the functionality of terminals and new types of interactions have emerged with highly convenient services and networks. Networks have now become vital to people's lives, providing an important social infrastructure for social and economic activities.

On the other hand, Europe and the United States in particular have been carrying out full-scale investigations under government guidance concerning new networks, with an eye on the next generation of IP networks from the medium to long-term perspective. For example, the United States is promoting projects to study subjects such as new network architectures by PlanetLab and GENI, under the support of the National Science Foundation. Europe is also pursuing this topic strategically. The 7th Framework Programme (2007-2013) which is a program to support research and development with the aim of maintaining technological strength and competitiveness within Europe has the information and telecommunications field marked as one of its special programs. Within this, a budget of 580 million euros has been allocated to issues related to future networks.

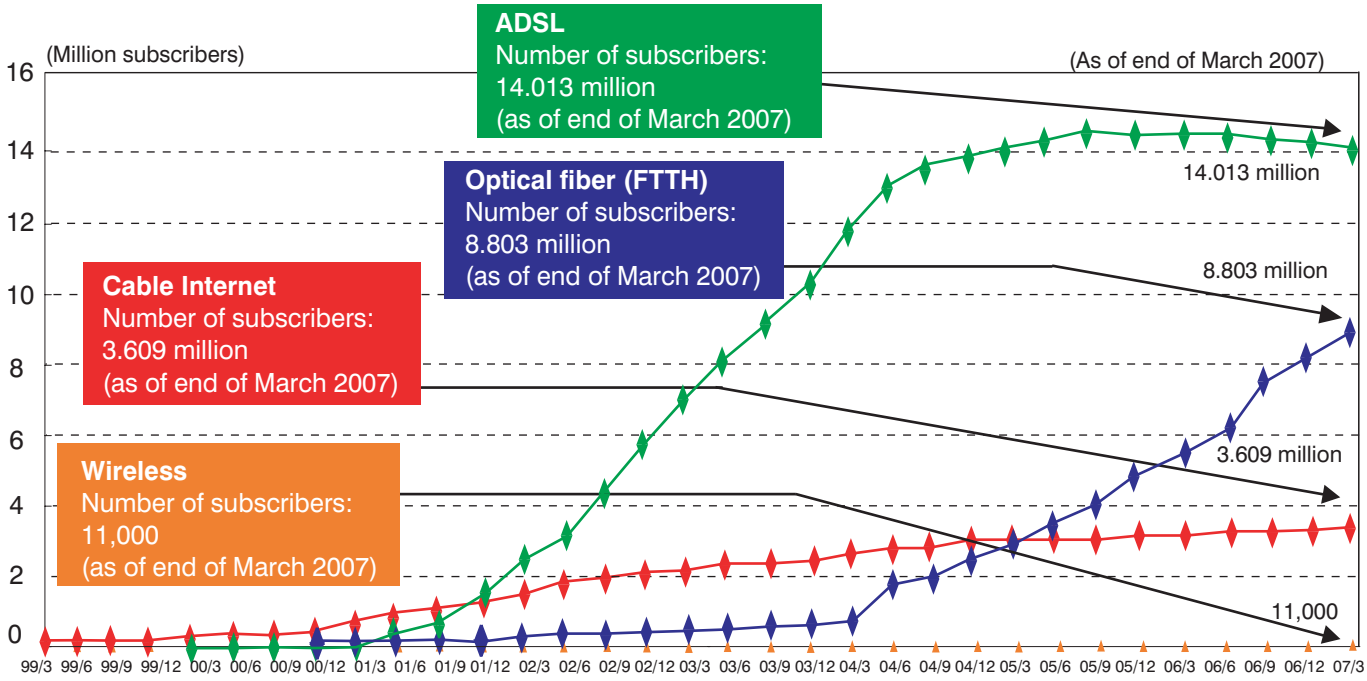
Against such a background, Japan too will continue to put to use its varied experiences in IP-based networks and will promote an approach from an early stage, not for an extension of existing technologies but for the realization of a network infrastructure based on new design concept and technology (new-generation networks). Along with overcoming the issues that are facing current networks, it is also important to link this with strengthening Japan's international competitiveness.

Figure 1 Background to investigation on new-generation networks

Changes in network structure

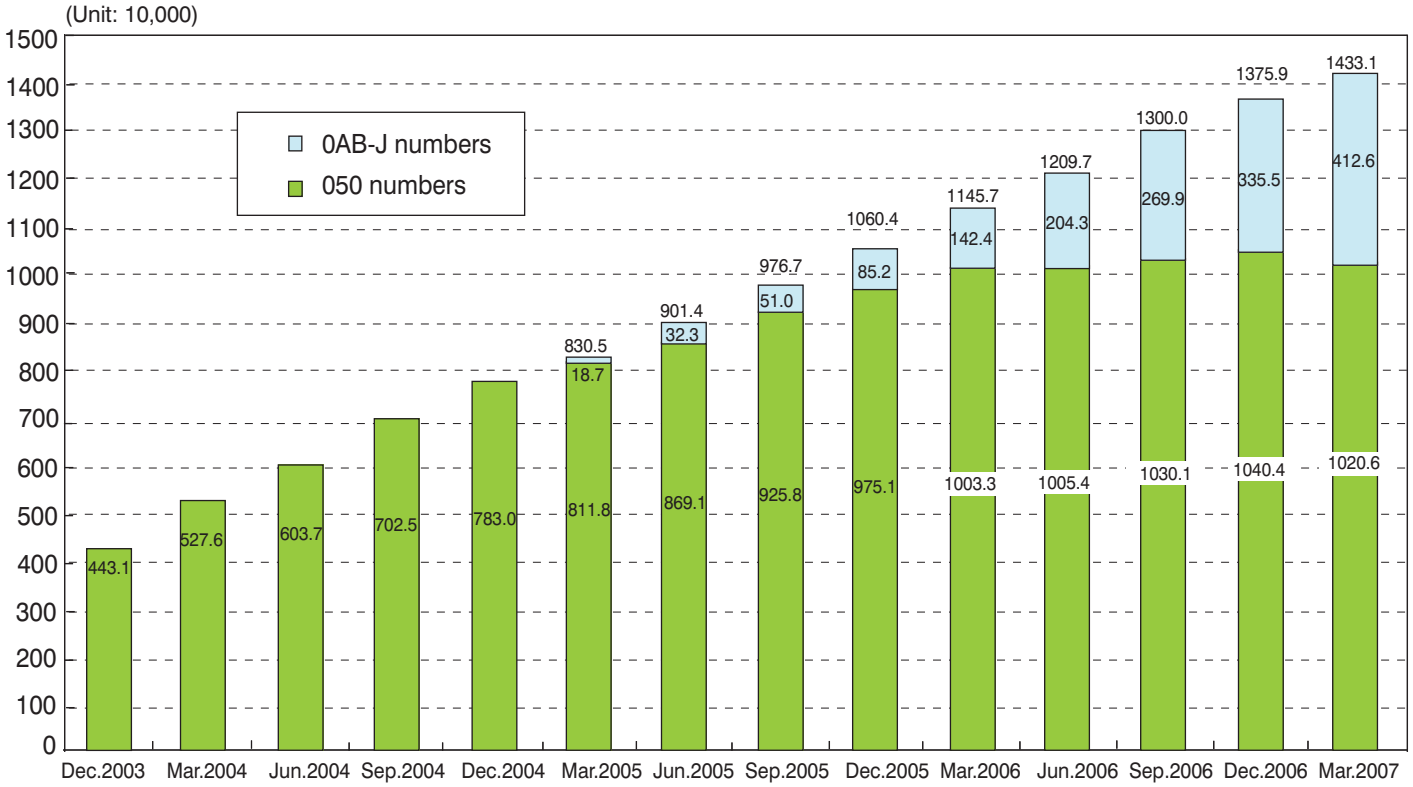
(1) Progress in move to IP, appearance of FMC (Fixed-Mobile Convergence) services, higher-speed mobile networks
(2) Improved performance in home networks and terminals, advances in ubiquitous networks
(3) Penetration of Internet and broadband
(4) Greater degree of dependence on networks in people's lives and economic activity

Trends in broadband service subscriber numbers



* Survey based on voluntary survey up until May 2004 and revised Rules for Reporting on Telecommunications Business from the end of June 2004

Trends in IP phone user numbers



* Survey results for fiscal year 2003 based on FY2004 Details of Implementation for Evaluating the State of Competition in the Telecommunications Business Field. From fiscal year 2004, based on ministerial ordinance announcements.
* The numbers are calculated from the number of 050 and 0AB-J phone numbers that were used by final users (they are not accurate subscriber numbers).

Current network issues

The first step in investigating new-generation networks was for the study group to discuss the issues and limitations facing current networks.

The Internet with its rapid penetration and current use as the main player in networks is recognized to face a number of serious issues. First of all, since its development to date has been based on best efforts basis, the care given to security and quality of service has been insufficient, and its low availability as a social infrastructure is a problem. From the social point of view as well, there is the problem of no proper mechanism being put in place to bear its costs, and there are also social problems of private information leaking and anonymous bullying, as well as the difficulties of investigating major revisions in networks and challenging technologies since the Internet is widely used as social infrastructure.

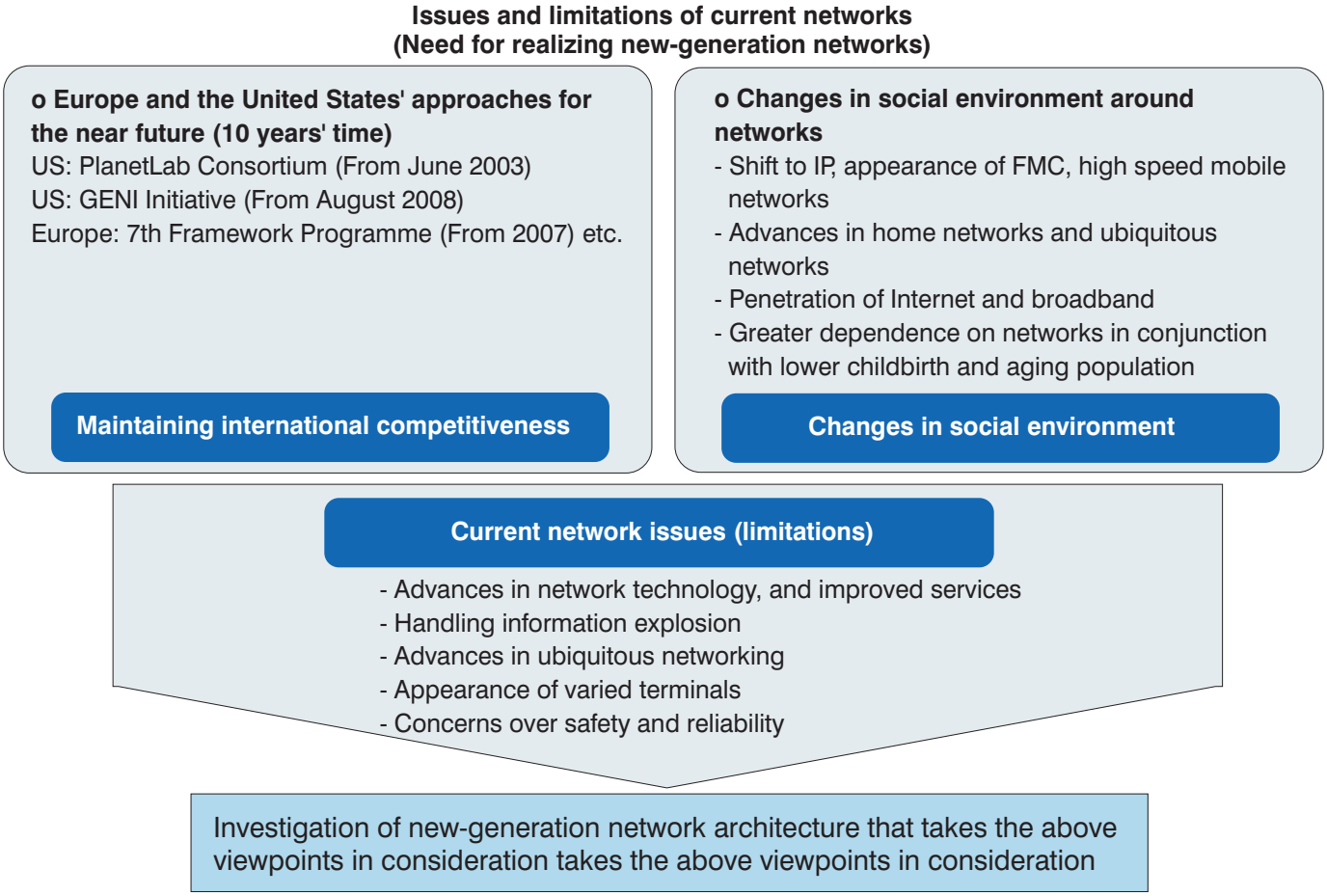
Recently, user-service related demands have become more sophisticated and more complicated while, at the same time, demands to networks have increased from a simple "fast networks" to "higher performance", making networks more and more complicated as the respond to these. With the current network topology which has continued to expand the Internet, it is likely, in the near future, that a limit will be reached both in expansion and performance of networks that continue to grow more complicated.

There are also issues related to the sharp increase in network traffic. In conjunction with the progress of broadband, network traffic continues to grow very rapidly, with Japan's major Internet exchange seeing a 3.5 fold increase in the past 3 years, and a 30 fold increase in the past 5 years. It is expected that growth will continue at an annual rate of 1.5 times to twice a year, and so it is necessary to have networks that can handle these future increases in traffic.

In addition, various kinds of terminals and uses for these are expected to appear in bringing about a ubiquitous society. In part, various types of telecommunications terminals have already begun to appear in response to user needs, making the construction of flexible networks that can handle them an issue.

In order to find solutions for these issues, it is vitally important to construct networks based on a totally new architecture that has greater safety, reliability, availability and flexibility than the current one (Figure 2).

Figure 2 Need for realizing new-generation networks



Future image realized by new-generation networks

The study group carried out investigations on what kind of society would be built in the future using new-generation networks, how people would relate to networks within their daily lives, and also what people would like to see from networks. Four possible "desirable future images" presented themselves as a result.

(1) Networks that blend into daily lives and society

Ubiquitous appliances such as sensors will be widely positioned both indoors and across town to give support to daily life. Robots and avatars will be developed as new interfaces so that, even without specialized knowledge or skills, people will be able to use networks just by conversation. It will be as though the network is a kind of advisor that one can always easily consult.

(2) Flexible and environmentally-friendly networks

The network's resources, from ultra high-definition images to ubiquitous sensors, regardless of whether the data is large or small, are distributed in the most appropriate way so that the user does not need to choose networks depending on the type of contents or application. The burden on the global environment will be reduced due to lower power consumption by network equipment, more efficient transmissions, and total energy management of society as a whole using network agents.

(3) Changes in terminal concepts

There will be further advances in the miniaturization and diversification of information and telecommunications terminals, so that all things will be connected. Systems will be constructed so that these diverse terminals can be used safely, even without complicated initial setting or instructions for use. New types of communications systems will emerge as a result of the development of ultra high-definition images, 3D images and telecommunications with ultra realistic sensations.

(4) Networks as a safe and reliable social infrastructure

On the assumption that day-to-day safety is a given, communications networks that can carry auto-diagnostic and auto-repairs when there is damage by accidents and disasters, and networks that do not stop (dependable networks) will become the standard. Systems will be put in place so that networks can be used anytime and anywhere without any worries about security and privacy. A consensus will be obtained on bearing the costs of maintaining and operating networks and their securities based on usage, with new business models emerging, and industry also benefiting from the expanded use of networks.

Figure 3 New-generation network concepts

The shape of new-generation networks (new types of networks that will resolve issues)

1. Networks that are user-friendly and simple to use

The realization of an interface that is user-friendly and makes it possible for anyone to use networks intuitively

2. Scalable networks

The realization of networks that respond to the diversification of information and telecommunications equipment and contents, are fully flexible, and use little power

3. Networks with portable services

The realization of technologies so that users can make use of networks anytime and anywhere in the way they are used to

4. Networks that don't stop

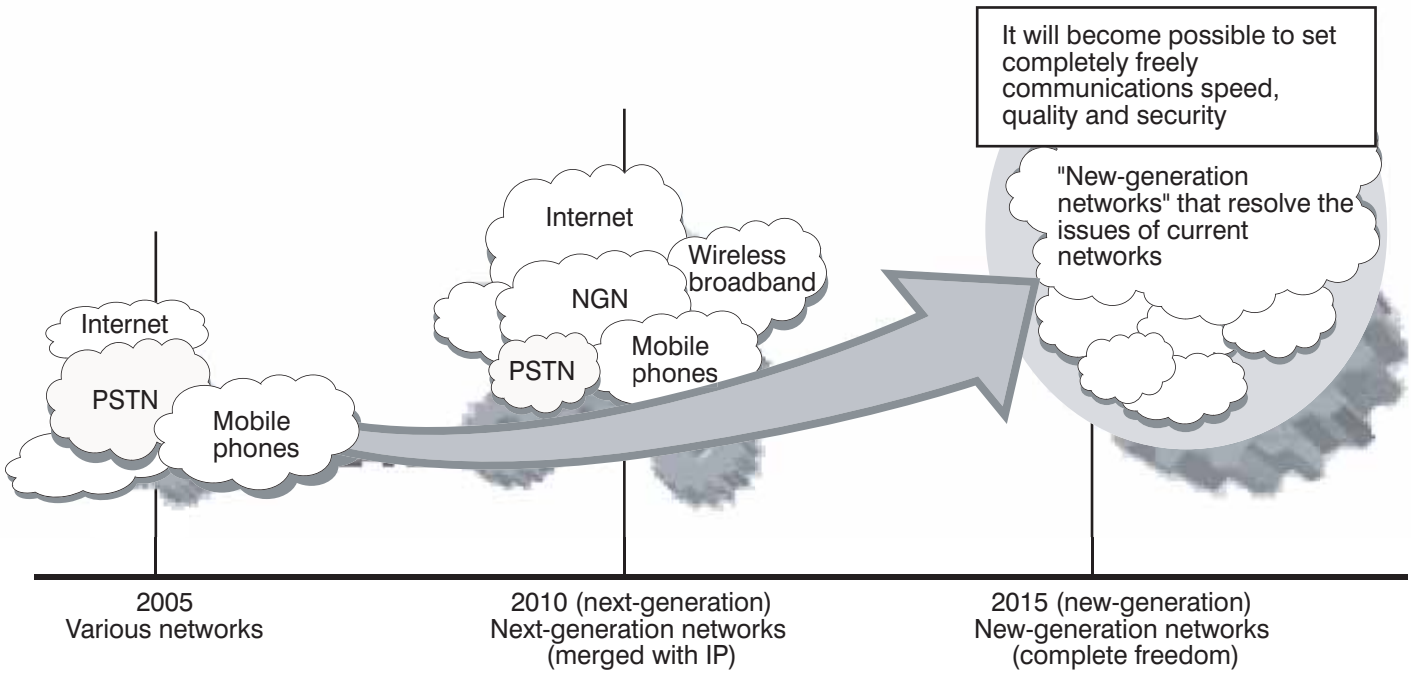
The realization of networks that don't stop, with a high level of reliability as social infrastructure and security that is suited to the importance of the information

5. Networks in which the real and virtual are linked seamlessly

A new type of communication mode will appear in which the real world and the virtual world are linked seamlessly

6. Networks that can predict the future

Predicting and supporting users' actions based on information from sensor networks and knowledge and experience gained on the network



Concepts for new-generation networks and technological issues

Taking into account issues and limitation of present networks that have been listed until now and expectations from future networks, the study group selected six concepts for new-generation networks, particularly seen from the user viewpoint, as shown in Figure 3. Also, based on these concepts, it laid out the technological issues that will arise in the realization of new-generation networks, based on these concepts. In concrete terms, these are as shown below:

(1) Dynamic network technology that will realize networks that are user-friendly and simple
- Technology that will make redundant complicated settings according to the user's level of knowledge.
- Technology for the network to gather information automatically in response to user demand.
- Technology for the visualization of the level of safety in service quality and security functions.

(2) Scalable network technology
- Technology for the efficient transfer of all types of data, from minute data to large volume contents.
- Architecture technology to bring about lower power consumption for networks as a whole.
- Technology that would reduce as much as possible unnecessary traffic that is flowing through networks.
- Technology for flexible network topology construction.
- Technology to bring about controlled openness and transparency.

(3) Network portability technology
- ID portability technology that would bring about seamless access through high-level network connection and appropriately taking over user verification results.
- Technology for keeping data concerning the user environment of numerous users safe on the network and supplying the data to terminals.
- Technology for automatic prevention of harmful information and attacks in response to user settings.
- Technology to make it so that networks do not feel like networks to users.

(4) Dependable network technology (networks that don't stop)
- Technology that will, in response immediately to new requests or changes in requests made to network resources, divide and manage resources in the most appropriate manner.
- When a network problem arises, technology that will carry out an auto-diagnosis and will independently recover functions, and technology that will seamlessly re-route to a different network.

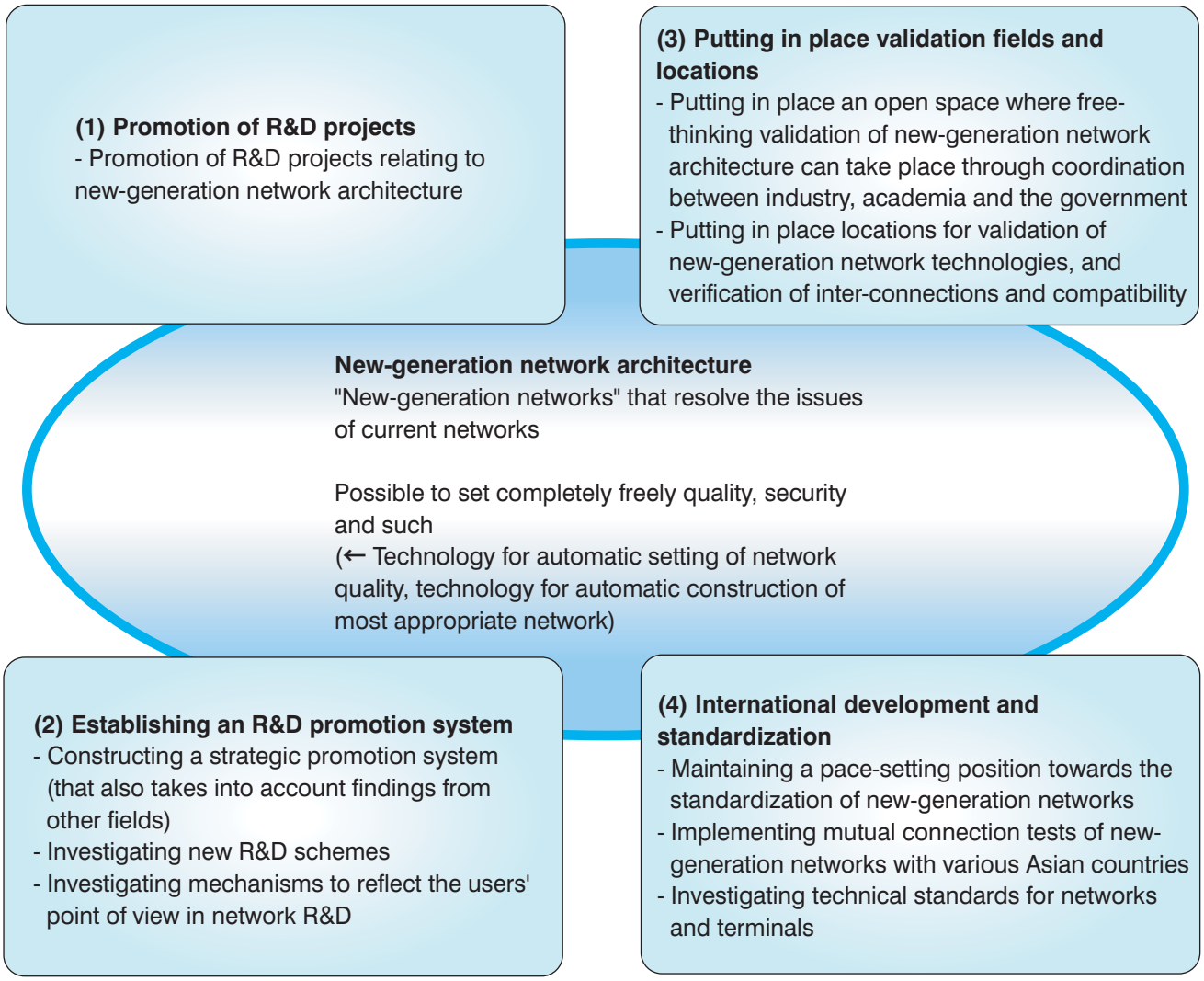
(5) Technology for linking the real and virtual and technology to predict the future
- Technology to link the real and virtual.
- Technology that would automatically gather and analyze a history of actions and environmental information, and would come up with appropriate advice and predictions of the future in response to user requests.

Integrated promotion measures for realization

In order to find solution for these technology issues, it is necessary to take a strategic approach to research and development, and, in order to promote this, it is necessary to put in place and operate a system to bring together Japan's knowledge capital for close coordination between industry, academia and the government. It is also necessary to actively promote standardization activities and work towards strengthening Japan's international competitiveness.

This study group has formulated promotional measures from the four pillars that are shown in Figure 4. In concrete terms, it is necessary to realize the concepts that have described until now and conduct research and development necessary to overcome the limitations of the current Internet. In doing this, it is also necessary to construct a strategic promotional system which brings together industry, academia and the government, to implement R&D and standardization activities, as well as make every effort to strengthen Japan's international competitiveness while working towards cooperation with other countries, starting with Asia. It is also desirable to put in place a test bed network that can verify technologies coming out of research and development. Within this test bed network, from the perspective of innovative creation, it is necessary to take a problem-solving approach from diversified viewpoints.

Figure 4 Promotion measures for new-generation network architecture



Conclusion

The meetings of this study group saw some unusual approaches for this kind of group, such as free discussion on pre-determined subjects leading to numerous frank opinions. These very animated discussions tied in to the report. In addition, investigations of new-generation network architecture took place with a firm gaze on the future, but network-related technologies are constantly progressing and it will be necessary to renew investigations on the latest technological trends in the future.

Based on the report that was compiled, MIC will take action with a view to realizing new-generation network architecture.