| INVITED LETTER | *Special Section on New Generation Network towards Innovative Future Society* |

NICT New-Generation Network Vision and Five Network Targets

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SUMMARY The National Institute of Information and Communications Technology (NICT) vision and five network targets of research and development (R&D) of the NeW-Generation Network (NWGN) are presented in this letter. The NWGN is based on new design concepts that look beyond the next generation network (NGN). The NWGN will maintain the sustainability of our prosperous civilization and help resolve various social issues and problems by using information and communication technologies (ICTs). NICT's vision for NWGN is also presented in this letter. Based on this vision, 19 items concerning social issues and future social outlook are analyzed, and the functional requirements of the NWGN are extracted. The requirements are refined and categorized into five network targets that must be developed for realizing the vision.

key words: *new-generation network, vision, technological strategy, vision driven*

Fig. 1 NWGN concept.

1. Introduction

The remarkable advances in telecommunications technology in recent years have brought about a new information revolution that ranks alongside the industrial revolution. Today, the Internet is an essential part of our social infrastructure not only in the business world but also in our everyday lives. The Internet, however, is facing a critical crisis. The thin veneer of expansion of the Internet has come off, and the Internet finds it difficult to respond to newly emerging social demands. [1] said that the Internet is broken and a new type of routing architecture called flow based routing must be introduced into the new network system. Therefore, a new network that can overcome the several drawbacks of the Internet is required.

The NeW-Generation Network (NWGN) is based on new design concepts that look beyond the next generation network (NGN). In short, it aims to fundamentally resolve difficult issues and overcome the limitations by creating a comprehensive Internet network using a clean slate approach unconstrained by existing technologies. A similar initiative is being actively pursued in the U.S. [2] and Europe [3]. The concept of NWGN is shown in Fig. 1. The NWGN will be introduced between 2015 and 2020.

The National Institute of Information and Communications Technology (NICT) launched the strategic headquarters of NWGN research and development (R&D) on October 1, 2007, to strategically promote the R&D of the NWGN. The aims of the strategic headquarters include (1)
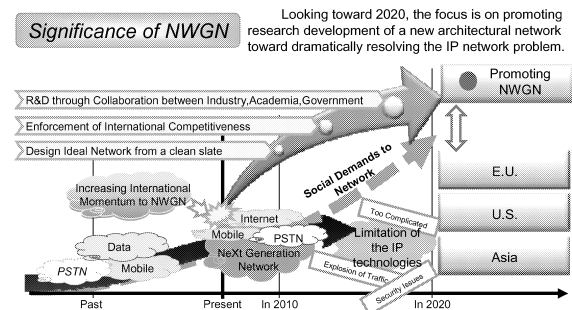
planning the medium- and long-term R&D strategy for the NWGN, (2) playing a leading/guiding role in international cooperation and competition, and (3) promoting R&D human resources related to Information and Communication Technology (ICT) with a long-term/global perspective. The organization is headed by the NICT president and ensures consistency and efficiency in the R&D policies of NICT, in addition to enabling the provision of strategic guidelines for R&D carried out by NICT.

Following its launch, the strategic headquarters developed a system for promoting industry/academia/government cooperation and built relations with other countries or future international cooperation. Moreover, the strategy Working Group (WG) was set up following the establishment of the strategic headquarters, and it was organized with not only NICT stuff but also several external researchers. The WG concentrated on examining the R&D strategy in the ICT sector. Since April 2008, the strategy WG has been conducting focused discussions on (1) the directions and technology requirements for solving social problems using the NWGN and (2) a vision for a future society based on the NWGN, and (3) the technology requirements for achieving this vision. The results were summarized in October 2008 in "Diversity & Inclusion: Networking the Future—Vision and Technology Requirements for the NWGN." A revised Japanese edition was published on February 21, 2009 [4].

Thereafter, the various technology requirements required to solve the social problems cited in the abovementioned report and to achieve the future vision were summarized into five network targets [5]. They are "Value Creation Network," "Trustable Network," "Ambient/Ubiquitous Network," "Self-* Network," and "Sustainable Network." This report presented the R&D strategies of these networks, that is, how they should be achieved technically, various impor-

tant technologies. It should be noted here that our technological strategy is not "seeds-oriented" but "needs-oriented." General technological strategies and road maps are established using an incremental approach that is an extension of today's technology. However, our technological strategy is directly derived from the vision and considers how to realize the vision using ICT. The results obtained from the investigations of the WG are presented in this letter.

The planning of the testbed strategy/technology transfer strategy, R&D funding strategy, standardization strategy/internationalization strategy, human resource development strategy, and innovation strategy that serve as the backbone of these technology R&D strategies has already begun, but they are not included in this letter due to space limitations. We are confident of our contribution to the development of the NWGN in Japan through these comprehensive strategies.

The remaining letter is organized as follows: Sect. 2 describes the NWGN vision and technology requirement for NWGN, and Sect. 3 presents the five network targets. Finally, Sect. 4 summarizes this letter.

2. NICT Vision for the NWGN

2.1 The Vision

The NWGN aims to maintain the sustainability of our prosperous civilization by looking beyond the NGN and resolving various social issues and problems by using ICTs. Further, by unfolding the potential ability of individuals and the society, the network aims to realize an affluent life of higher quality. Furthermore, by accepting human diversity, the network aims to lay the cornerstones for information and communication, which perpetually develops the human society.

To achieve these aims, we need to (1) construct a vision or a concept, (2) define the goals and values of the NWGN, (3) share consciousness of issues concerning future social problems, and (4) create a new image of the future society. To create such an image, we need to understand the roles and directions of each individual researcher or organization, and as a result, contribute to achieving a sustainable and rich human society and world, bearing fruit as a significant activity.

The three values required to form the NWGN are as follows.

(1) Solving Emerging Social Issues (Minimizing the Negatives)
Serious issues such as energy shortage and aging demographics have left people increasingly concerned about their future safety and well-being. ICT should contribute to resolving these serious issues. The NWGN aims to help resolve challenging issues such as energy shortage, aging demographics, and natural disasters, that is, to minimize the negatives of society at both the domestic and global levels.

(2) Creating New Values (Maximizing the Potential)
If humankind is to have a bright future, it is essential that

Fig. 2 Investigated items.

new values be created by improving industrial productivity and the quality of life and by empowering the latent potential of humans and society. Of course, this requires an environment wherein the driving principle of the economic society will not be comprised with increased focus on information and a radically new social information infrastructure. The NWGN aims to explore the world's potential abilities in this broad sense.

(3) Contributing to Inclusion
As globalization progresses, excessive development results in disparities that manifest themselves in the forms of regional disputes and confrontations, urbanization and depopulation, clashes between different generations, and the technology gap between the "haves" and the "have-nots." Future societies are expected to permit the coexistence of cultural, geographical, and individual diversities in order to help the global culture to develop in new ways. In other words, there is a need to allow diverse situations in people's lives and social economies and on various scales from region to region.

The NWGN aims to support the construction of an inclusive society wherein such diversity is respected and cooperation is promoted.

2.2 Technological Requirements of the NWGN

In the process of deriving concrete network images that realize the vision, the technological requirements of the NWGN were first derived from emerging social issues (social perspective), issues related to achieving a future knowledge society (future perspective), and respect for diversity and cooperation (inclusion perspective). Figure 2 lists 19 items investigated in this process. According to the requirements obtained, they were classified into network technologies. Since these items vary in size from small to large, there is a wide range of technology requirements of the NWGN. Due to space limitations, the result of this process cannot be described in this letter. Please refer to [4].

3. NWGN Five Targets

As described in the former section, social issues and social outlook covering 19 items were analyzed, and the technology requirements of the NWGN were extracted. At the same time, we investigated technology requirements of the network; however, this could not be achieved using the expansion of the existing Internet technology or the NGN technology. As a result, more than 100 technology requirements for the NWGN were extracted and were classified into several abstract categories. The classification was carried out by considering the links between the network and all the entities on the earth, relation between the earth and the sustainable society, trust between people and the networking society, and support relationships. As a result, it was consolidated into five network images, as shown in Fig. 3. These network images are network targets that show the NWGN the ways in which the vision can be realized. As for these five network targets, each technology development element is made conditional on being a technology requirement that contributes to resolving social issues and to the future social outlook. Hereafter, an overview of each target is described. It is noted that some names of targets (target C, D and E) are not literally translated from Japanese names in [5], but the classification in this letter is identical to [5].

● A: Value Creation Network

The aim of this network is to bring new service innovation in the network, growing beyond services simply offering connections. The issues concern the creation of a new value chain for offering services from the standpoint of users and the coexistence of diversifying user needs with sharing of functions for service execution. Moreover, in the future, it will contribute to the productivity of services by collecting and accumulating related information that flows through the network, combining business and human knowledge, aiming at building a platform that generates new services that were previously unavailable. There are two sub-targets in this target: service creation network and media creation network. The former aims to make the network itself the platform for services innovation and the latter aims at becoming

Fig. 3　NWGN five network targets.

an information and communication platform for the network to bring about new media innovation.

● B: Trustable Network

The network is absolutely essential in all the social activities of individuals and organizations, and the stability and trustworthiness of the network are important in maintaining continuous network functions. Here, achievement of new infrastructure to trust the society-wide network becomes an issue: Advanced failure tolerance and prompt recovery from failure, guarantee for services that provide stable operations in case of human error or cyber attack, and a network usage environment in which safety and trust are secured.

In fact, the presence of threats typified by cyber attacks is unavoidable, in addition to failures, including human errors, associated with its larger scale. Although such vulnerabilities are expected, it is important to develop a sustainable and stable network. In a networked living environment and a society-wide network environment, users demand (1) improvement in the reliability of various services and (2) a network usage environment with both high level stability and user-friendliness for privacy protection.

To achieve a trustable network that deals with these issues, the following two topics should be focused upon as sub-targets: social infrastructure for trustable network and trustable network for humans and society.

● C: Ambient/Ubiquitous Network

Issues concerning the environment, food, and ageing can be considered social problems that are closely related to the society and are foreseen at the time of the NWGN. In such an environment, to achieve a life supporting society in which humans can lead decent, high-quality lives, the support of ICT is required with respect to all living situations. This target is called "network for living supporting" in [5]. There has been internationalization of distribution and progress in international cooperation, especially with respect to environment- and food-related issues. Thus, it is believed that cross-border food distribution management, environmental monitoring, traffic accident prevention using networks, remote health care for senior citizens, and support for humans by network robots, can be achieved if it becomes possible to perceive, pursue, and collect and process necessary sensor information generated by humans, things, and living environments on a broad global scale. Further, NWGN should help resolve the abovementioned social issues. Achieving the above requires a global environmental sensing system, that is, a global sensor/actuator cloud infrastructure to universally connect and manage sensor actuators in the living environment, and middleware that can adaptively and flexibly handle data in the cloud infrastructure. There are two sub-targets: global-scale sensor/actuator cloud and real-world information processing platform.

● D: Self-* Network

This network is used for data transfer like Web and e-mail and to transfer sensor data and streaming data like audio and
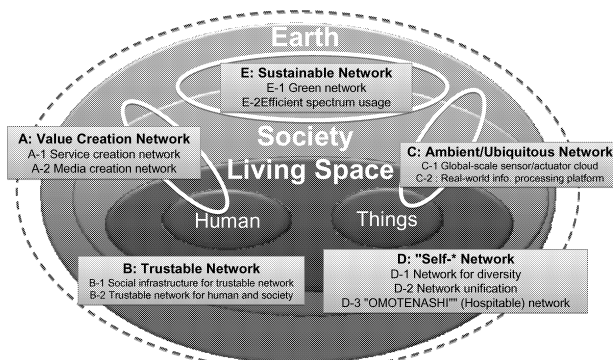
video. There is also rapid progress in the diversification of services, such as offering applications and platforms through the network, called PaaS (Platform as a Service). On the other hand, although the accompanying conditions required for services are also diversifying, they are not satisfactory, and drastic problems are foreseen. A network that can be used freely by everyone and that responds flexibly to conditions requesting services shall be achieved. This target is called "network of constraint unaware for users" in [5]. "*" in the target's name is a wild card character. It is substituted by "management," "configuration," or "organizing." In order to achieve a network society focusing on individuals and services that are free from network restrictions, the NWGN shall achieve three sub-targets: network for diversity, network unification, and "OMOTENASHI" (hospitable) network.

• E: Sustainable Network

Information and communication systems such as cellular phones, Internet, e-mail, and search engines have already become indispensable infrastructure for the modern society. These information and communication systems were achieved through the synergistic effects of breakthrough innovative technologies, especially extra-large capacity (high data rate) communication technology typified by optical fibers, Internet technology, mobile telecommunication technology typified by cellular phones, and computer technology such as CPUs and memory. On the other hand, with the rapid innovation and spread of these technologies, this field is now facing many problems that can be termed as limitations of the earth (resource), and these problems are being considered constraints for the further development of telecommunications. Therefore the NWGN must be earth friendly and it is necessary to find methods for solving the global problems that surround such information and communication networks and to achieve sustainability of the networking society and make further developments. There are two sub-targets: green network and efficient spectrum usage.

4. Conclusion

NICT vision for NWGN and five network targets were presented in this letter. They will be revised through active discussions with several experts on elemental technologies in order to share this strategy among industry, academia, and government, hereafter.

This letter presented a technological strategy with the aims to define the innovative network required after 10 to 20 years and to propose the execution of its R&D. However, the execution of this strategy requires planning and execution of strategies other than the technological strategy, for example, testbed strategy, technology transfer strategy, R&D funding strategy, standardization strategy/internationalization strategy, human resources development strategy, and technology innovation strategy. Therefore, we have already begun such planning. In particular, in R&D on network technologies for the new-generation, both deskwork investigations and testbed demonstrations are necessary, and its investigation proceeds toward building the testbed strategy.

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