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## Aiming at ideal network for 30 years in the future

New generation networks created from new values will produce more new values

Hiroshi Miyabe, Masayuki Murata, Mizuhiko Hosokawa, Naoto Kadowaki, Hiroaki Harai

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# Aiming at ideal network for 30 years in the future

## The New Generation Networks created from new values will produce more new values

Participants

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**Mizuhiko Hosokawa**  
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Executive Director, New Generation Wireless Communications Research Center

**Hiroaki Harai**  
Group Leader, Network Architecture Group, New Generation Network Research Center

**We invited five leaders promoting one of the most important themes, "The R&D of New Generation Networks", to an open, round-table discussion regarding current problems and future possibilities in R&D together with their dreams and hopes for networks 20 and 30 years in the future.**

### Applications needed for New Generation Networks

—We would first like our guests to introduce themselves, and say a little about initiatives NICT is taking in R&D for New Generation Networks and give their views on what New Generation Networks will be like 30 years from now.

**Miyabe:** I contribute to promotion of R&D at the New Generation Network Research Center, and also arrange contract research projects related to New Generation Network R&D with the Collaborative Research Department. I am also a Vice President of the New Generation Network R&D Strategic Headquarters at NICT.

**Murata:** I am an Executive Researcher, and like Vice President Miyabe, I am also a Vice President of the Strategic Headquarters. More specifically, I have been working on setting strategy through the Strategy Working Group (WG).

**Hosokawa:** I am the director of the New Generation Network Research Center. At the Center, we cover a very wide range of topics, from network architecture and design down to the most basic

technologies. We handle mostly wired technologies, but we also cover a wide range of new basic technologies, other than wired, which support networks, mostly in the area of optical technologies. Now in our fourth year, our research is filling out well.

**Kadowaki:** I am the director of the New Generation Wireless Communications Research Center. Our research targets the wireless communication, but in the last year or two, we have gradually moved from so-called wireless transmission.

As a concrete example, with the interconnection between cognitive wireless connections and the JGN2plus network, we imagine that the whole network will become a cloud, a "cognitive wireless cloud" as we term it. We expect that wireless transmission will play the central role in the access part of the network.

**Harai:** I am the Leader of the Network Architecture Group at the New Generation Network Research Center.

From the beginning with this group, I have been involved in the AKARI Architecture Design Project, which has been designing networks to support future society, in 2015 and beyond. Originally I was working on optical network design and optical switch design, but now I am working on creating a vision of future networks that goes beyond this, including wireless, mobile, and even sensor networks.

—You are advancing R&D on Networks beyond "Next Generation Networks", 10 or 15 years in the future, but what sorts of applications do you envision will be used with these future networks?

**Miyabe:** In 15 years, I'll be over 70 years old. I probably will not be able to walk very well, and my mobility will be limited. Considering what I will want from a network at that time, it would be great if it could show me places and things that I cannot go to or experience myself, and provide knowledge, as though I had experienced it myself.

I'm talking about the ability to enter a 3D real-time virtual world on the Web using an avatar, but rather than a make-believe society, I think experiencing the real world, overcoming time and distance to easily see what actually exists in the real world, will take center stage in the future. People will be able to get up in the morning and the system will immediately provide the information they need when they want to do something, without even entering keywords on a special keyboard,



Hiroshi Miyabe

and based on it they will make decisions while carrying on their other activities. A world in which this is possible without impediment is what I would like to see.

**Murata:** I think the essence of future networks will be the intellectual society. Google says they will digitize everything, but beyond that, how we can take all of that data and acquire it as knowledge will be very important. Technically, as a way of creating ties between the real society and the networked society, it will be important to interact with sensor data from around the world.

**Hosokawa:** The work being done on super virtual reality is good, but I think in 20 or 30 years, real experience will still be more important.

This is my personal dream, but I would like to see access to whole libraries from home. I'd like to be able to access ancient and modern classics freely, reading one after another without having to move, and to advance beyond that, even.

**Harai:** Maybe we will have solved the food problem in 10 years, but for example, if we could build a system that could tell me if the meal I was about to eat really was safe using databases and the network, that would be good. Now, we watch TV and get ideas about what to have for dinner, but it would be better if we could get a wider variety of information about the food we eat.

### Three visions for realizing the ideal network

**Miyabe:** 3D real-time virtual worlds on the Web are great for games, but we also hear that it is spoiling young people. It will be important to guide young people so that they develop soundly. I was raised in the country, and whenever we did anything bad, the old men in the neighborhood would hit us. As part of the local community they would scold us, even if we were not their kids. I think we need more of this sort of thing. I'm not sure what kind of network could provide this sort of emotional education, but the network will need to provide some kind of minimum basic mechanism for it.

**Murata:** What I feel from meeting students at University is that there is a complete difference in values between



Masayuki Murata

the generations. There are students that have nothing to do with on-line games, and others that are addicted. "Prof" is a personal profile Web site that is very popular with elementary and junior high school students right now, but even university students don't know anything and aren't interested in it. There are differences in values even between young people now, so it doesn't seem that people of our generation can force our values on them. Rather, we need to adopt a position of watching over them carefully to ensure that the negative possibilities are not realized.

### —I'd like to ask now about your visions for New Generation Networks.

**Miyabe:** I am guessing you mean the three visions published in "Diversity and Inclusion: Networking the Future". Since he was involved in creating them, I think we should let Executive Researcher Murata introduce those points.

**Murata:** The first vision was "Minimize the Negatives", meaning that first, we need to resolve problems actually in society, such as energy, security, and food.

However, this alone will not be enough, so the second vision is to create new values. In anticipation of networking in the future, we have called this "Maximize the Potential". Our third vision is "Inclusion", as a concept to bind the others together. The idea is to include everyone through ICT. That is the vision for New Generation Networks being promoted by the Strategic Headquarters.

**Miyabe:** The last problem mentioned, about inclusion, has been addressed before, but so far it hasn't worked well. The culture of the English world is continuing to spread relentlessly under

the guise of globalization of society, and just as discussed in "The Clash of Civilizations and the Remaking of World Order" (by Samuel Phillips Huntington), regionalization will start to be more important, so I think the type of local community I was talking about earlier will be important.

### Resolving the energy problem with new values and communication principles

—The global environment and energy problems came up again at COP15. What do you think of the point discussed, whether through use of networks, the overall energy consumed by society could be reduced?

**Kadowaki:** Considering Green ICT, only a fraction of the wireless signal is actually received by the user, so there is actually quite a lot of energy that is wasted. Because of this, finding a way to use energy well for the wireless parts of the network should have high priority within green ICT initiatives. I think this is one of the key points for the Wireless Research Center.

**Miyabe:** Earlier, the proportion of energy consumed by ICT was around 3%, but now it has risen a bit higher. If traffic continues to increase at the same rate, it will consume huge amounts of energy. Essentially, energy consumed will obviously increase as a result of increasing human activity, but it cannot continue in that way. The network itself will have to support sustainable societies. It will be the mission of the network infrastructure, as a core part of societal infrastructure, to provide an efficient network and to control energy consumption within the overall society.

**Harai:** Data communications traffic in Japan increases by about 40% every year, and is currently at about 1 tera bps overall. Continuing at this rate we will have 1000-times more, at about 1 peta bps, by around 2030. This means that for a sustainable society, we will need energy efficiency 1000-times better than today. One of the ways we will achieve this is by skillfully applying optical technology.

We will replace optical technologies where possible. Also, for items that need

not be split into data packets, we can reduce energy consumption in the core network by transmitting them as is.

**Murata:** It is going overboard to reduce energy consumption by simply reducing everything because energy is always required to create value. It is extremely important to consider the overall architecture of networks that are able to control energy consumption.

On the other hand, we also must consider the merits gained in creating value through the network. Thus it will be important to create a network architecture able to balance these issues well. Also, to reduce energy consumption by a factor of 1000, we will need to consider new communications principles and new devices over a slightly longer time span.

**Miyabe:** I agree we will need to consider balance. Even with present optical technology, we are approaching limits. We are already seeing problems with fiber melting when transmission power exceeds a certain level. Two different approaches to the issue of increasing efficiency will be needed.

**Hosokawa:** It is always better if we are able to limit energy consumption, but we are already limiting energy consumption because of serious environmental problems, so there is a question of whether simply reducing will be enough.

Through science and technology, humans have quickly become able to control their own environment, but that is not happening now. For example, we cannot say that just because nuclear power technology has advanced, that we can synthesize elements, and there is no technology able to eliminate the excess carbon-dioxide in the atmosphere in one stroke. Is this really technology that humans need to have? If we decide that we need it, we will need to promote knowledge creation more. I think there is room for networks to be involved in these areas as well.

It is difficult to know whether to defend or attack, but considering historical human curiosity and potential, I think that rather than suppressing energy consumption with preventative technologies, we should use more proactive technologies to create knowledge that will protect the environment.

**Murata:** I am doing research on bio-inspired network architectures and network control together with researchers from one of the departments at Kobe Research Laboratories. There, we are working on a network control implementation that thoroughly decentralizes control and builds self-organizing networks. From an energy efficiency perspective, we are hoping to be able to reduce consumption by a factor of 1000. Through self-organizing decentralization, we will not only reduce energy consumption, but will also be able to create networks that are resistant to disaster and failure at the same time.

**Miyabe:** There are various other initiatives, but without instituting the innovations of "Hikari", meaning optical technology, it will be difficult to achieve increases in speed and capacity. I would like these things to be introduced as well.

**Hosokawa:** In optical technologies, we have Photonic networks, and groups studying devices related to light waves, terahertz and milliwaves, and at the extremes, we have a group researching quantum information processing. We are gradually seeing these become integrated to produce new technologies.

Optical modulator technology has become particularly relevant to ultra-high-speed transmission. We are working on producing technologies able to transmit without losing accuracy by exploring the best ways to integrate wired and wireless technologies and creating reference frequencies with accuracy increasing from 10-15 to 10-17. With these types of technology, gradually a variety of things that have not been possible till now should start to become possible, and we need to nurture these seeds carefully.



Mizuhiko Hosokawa

### International strategy of cooperation and competition, examining Japan's strengths and weaknesses

—It seems that the New Generation Network R&D Strategic Headquarters is looking at the overall picture, rather than just individual technologies. The Strategic Headquarters was inaugurated by President Miyahara, as its director, on October 1, 2007. Executive Researcher Murata and Director Miyabe are Vice-President Members of the board of directors, and Tomonori Aoyama is the program coordinator. Can you tell us about policies and other activities of the Strategic Headquarters in the two years since its inception?

**Murata:** Firstly, important tasks for the Strategic Headquarters have been to create a vision for New Generation Networks, to think carefully about what sort of network will need to be implemented 20 and 30 years in the future, to create a technology strategy and roadmap based on that vision, and at the same time, to discuss standardization strategies and strategies for research funding in collaboration with international bodies.

A particularly important aspect has been to consider cooperation and competition; which aspects of New Generation Networking we should collaborate with other countries on, and which we should compete with them on. We compete in areas where we are strong, and collaborate where we are weaker. In order to do that, we needed to analyze our own strengths and weaknesses, and based on that analysis, we intend to enter an R&D phase, starting in the next fiscal year.

**Miyabe:** Having an international strategy is very important with the huge wave of globalization, so we have to carefully consider collaboration and competition with respect to technology R&D.

We are involved in a variety of cooperative efforts with the European Union (EU) and the National Science Foundation (NSF) in the USA. With the EU, studies with the Framework Programme 7 (FP7) continue to the end of 2013, and then FP8 will begin. We need to consider what direction we should take in

these types of programs. We have had joint meetings with EU organizations since last year, and we are currently starting activities with joint working groups formed with US organizations.

On another front, in Asia, we have also held meetings with China on two occasions. Korea is also active on New Generation Networks, and we have begun forward-looking initiatives with them. This includes the "Future Network 2020 Forum," starting in December, which is an organization similar to the "New Generation Network Promotion Forum" promoted by NICT and the Ministry of Internal Affairs and Communications (MIC), with planning from various ICT-related industries including IP-providers, content creators and game developers. We will have to collaborate and compete skillfully with all of these countries in the future. To do this, we will need to further develop what Executive Researcher Murata has been promoting at the Strategic Headquarters.

—Please tell us more about the Strategic Working Group at Strategic Headquarters.

**Harai:** The Strategic Headquarters has created the Strategic Working Group, composed of members sent from industry and researchers from NICT, and this group holds regular meetings. Since remaining just within the group has a tendency to narrow our perspective, we feel very strongly the need to go beyond the boundaries of New Generation Networks and NICT and to have a strong awareness of industry and academia in looking into the future and considering these Networking Strategies.

Systematically promoting a vision for human-resource development.

—Can you tell us more concretely about your approach for this?

**Miyabe:** As is commonly mentioned, it is getting more difficult to attract excellent students, as people are distancing themselves from science and technology. If we do not address this problem and develop human resources, Japan will not have the people needed to support the



Naoto Kadowaki

networks of the future.

Within NICT, mainly in the Strategic Headquarters, work is advancing on human resources development. We have established the New Generation Network Promotion Forum within Japan, but that alone is not enough. We need to prioritize initiatives, such as stemming the flight from science and technology, from the elementary and junior-high school levels to nurture the entire industrial infrastructure for ICT. For high-school education, we are also collaborating in the form of a Summer Science Camp, but these sorts of initiatives require more time and effort. We need to promote awareness of this need.

It is important that we nurture children's general interest in science in whatever way possible. We need to bring it into education in a form that is interesting to the students. Right now, the focus is on the latter half of high school and the beginning of university, but that is too late. We, ourselves must personally proclaim to them from an even earlier age, that this interesting world is out there.

**Murata:** I certainly agree with that. But in fact, we have no opportunity to do it. To get into our universities, students must first take entrance exams, and the fact that we have not been able to communicate our own dreams is significant.

Under these conditions, we are setting the current Internet aside for a moment and considering New Generation Networks, starting from a clean slate. This is a good opportunity to communicate our dreams.

Approach to technical innovation for building New Generation Networks

**Murata:** With technologies like networking, new innovations such as Ethernet, LAN, and the Internet come out in cycles of about ten years. When asked why it takes 10 years for these new technologies to appear quite some time ago, the chairman of the New Generation Network Promotion Forum, Tadao Saito, said "In ten years, even researchers start to lose interest!" (smiles). Of course, that is not the only factor; the cycle of research, development, and commercialization is another reason, and the chance for researchers to start from a clean slate is very important for coming up with new ideas. And it seems to me that if we do not do this, technological reform will not be possible. I believe this is closely connected to innovation.

**Harai:** In the "AKARI" project, we have created a conceptual design document for New Generation Networks and are updating it each year. In recent discussion, there has been a problem with an increase in the routing table size in the current Internet. This is due to problems with the structure of current networks, so we are talking about rebuilding the network structure from a clean slate. If we can limit the routing table size to several thousand, rather than the current 250 to 300 thousand entries, we should be able to reduce the scale of memory, and thus power consumption as well. For the architecture, it may not be good to consider optical technologies right away, but when we reduce the requirement to several thousand entries, we should be able to build a working optical router, so we are working on optical routers to replace the electronic routers.

**Kadowaki:** Right now, it is mainly people connecting to networks, but we are entering a time when all kinds of devices we are not aware of will be connecting; and this applies to the wireless domain as well. In sensing and monitoring particularly, all kinds of information is being gathered around us, usually without our awareness. For example, use of wireless nodes for smart grids\* is expected to increase.

First, sensing will become networked, including wireless, then there is cloud computing and how this data will be processed, and this will reflect back on our lifestyle. Next, actuators near the users

\* Smart Grid: An electrical power network able to optimize the supply of power automatically, without human intervention.

will be controlled, finally creating two-way network, with wireless also being an important factor.

Humans live their lives on the surface of the Earth, but when sensing becomes involved, we will clearly also be able to see in the air or in space. Sensors and actuators operating in 3D as well as in 2D are becoming more common. I believe that we are on the brink of an age when we will create a 3D networked cloud, encompassing things like satellites as well.

**Miyabe:** A huge number of sensors are being spread out on the networks, connecting by both wired and wireless, and we are just now seeing the beginning of breakdown from attempting this by simply extending conventional protocols. What sorts of approaches are being taken to address this type of problem?

**Kadowaki:** This is an extremely difficult problem, but I think the cognitive wireless technology that we are working on is one concrete example of a key technology in this area. Being able to use wireless extremely flexibly is important, and by eliminating various limitations, people and objects will be able to remain connected, even as they move around. I believe we will need to continue development on this sort of technology.

Sensors are being connected in a variety of places by wired and wireless. With current networking technology, they are connecting through address translations, in a sense like a gateway, and we need a way to connect without translation. There are also technologies that lie between free-space optical transmission and fiber optics which are nearing practical implementation, and these are able to connect instantly without using any special device. A key



Hiroaki Harai

point will be to move in the direction of highly transparent networks with good connectivity, whether wired or wireless.

### Expansion of the much anticipated "AKARI" and integration of various domains

**Miyabe:** "AKARI" has also begun to attract notice in Korea. We are getting inquiries for an English version of the AKARI Conceptual Plan document, and prominent professors in the networking world are citing it, so it is getting quite well known.

**Harai:** Fortunately, products are gradually beginning to appear, and this year we hope to begin actively promoting it externally. More than just the concept, we want to demonstrate the benefits of AKARI. Last year we gave mainly overview presentations on AKARI in various countries in Europe and America, but this year, we hope to have various researchers talk more about the detailed content.

**Kadowaki:** Where I work, basically we are researching two areas related to integration of wired and wireless networks. The first is building a test environment for connecting with wired/wireless integration. For the second, we are planning a demonstration of a cognitive wireless network allowing integrated connection to the Hotaru Open IMS Project, which operates on JGN2plus. In these ways, we are hoping to achieve good integration of wireless and networking technologies.

**Hosokawa:** At the New Generation Network Research Center, AKARI has begun to attract international recognition, and the New Generation Networks Strategy Working Group has given us a good vision, so our direction has taken form for the most part. In optical technologies, we are strengthening relationships in various areas, including between the Photonic Network Group and optical wave devices and terahertz and millimeter wave technologies, between quantum and photonic networks, between quantum and frequency standards, and between frequency standards and photonic networks. Personally, I support this sort of exchange in a more open way, and value exchange between the various technology areas. I think continuing this

in a constructive manner is extremely important.

**Murata:** We also mentioned fundamentals. Till now, fundamental theory in the networking field has centered on transport and traffic theory, but recently these have received less attention. What we need to establish now is a science of network design--a networking science. One way to realize this would be by merging with other fields of science and technology. It will be important to incorporate other scientific fields, like physics or, in my case, biology, and build a foundation for the networking domain based on these other fields.

—Thank you all for taking time out of your schedules to speak with us today.

#### Round-table Participant Profiles

##### Hiroshi Miyabe

Vice President, Member of the Board of Directors  
Deputy Director, New Generation Network R&D Strategic Headquarters

Completed Doctorate at Tohoku University. Joined Nippon Telegraph and Telephone Public Corporation (NTT) in 1980. Held positions at NTT since April, 2008, including General Manager of the Service Integration Laboratories, and of the Cyber Communications Laboratory Group. Doctor of Engineering.

##### Masayuki Murata

Executive Researcher  
Vice President, New Generation Network R&D Strategic Headquarters  
Professor, Graduate School of Information Science and Technology, Osaka University.

Graduated from the Information Engineering program at the Osaka University Graduate School of School of Engineering Science in 1982. Completed the preliminary course work for a doctoral program at the same university in 1984. Joined IBM Japan the same year. Worked at IBM Research Tokyo before moving to Osaka University in 1987. Became a professor in the Osaka University School of Engineering Science in 1999 and in the CyberMedia Center in 2000. Took his current position in 2004. Doctor of Engineering. Joined NICT as an Executive Researcher in 2007, and became Vice President of the New Generation Network R&D Strategic Headquarters.

##### Mizuhiko Hosokawa

Executive Director, New Generation Network Research Center

After completing a doctorate in the Department of Physics, Tohoku University, joined the Communications Research Laboratories (currently NICT) in April, 1990. After engaging in research on space-time measurements and atomic standards in the standard measurements department, was group leader for the Space-Time Standards Group and in the Strategic Planning Department before taking his current position in April 2009. Doctor of Physics.

##### Naoto Kadowaki

Director, New Generation Wireless Research Center  
After completing a Masters Program at Tohoku University, worked at Mitsubishi Electric Corp. before joining CRL (currently NICT) in 1986. Engaged in research on mobile satellite communications, high-speed satellite networks and other topics.

##### Hiroaki Harai

Group Leader, Network Architecture Group, New Generation Network Research Center

After completing a doctorate at Osaka University, joined CRL (currently NICT) in 1998. Engaged in research on optical network control, optical packet switch design, New Generation Network design and other topics. Doctor of Engineering.



# New Generation Network Targets "Trustable Network"



## Masashi Eto

Senior Researcher  
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### High-level Stability and Reliability of Networks

"Trustable Networks", one of the New Generation Networks technical strategy points, defines the technical objective of ensuring the safety of the network itself (stability), and its reliability (trustability). One of objectives of trustable networks is to implement stable networks that can maintain continuity even under the assumption of vulnerabilities. It is based on consideration of what sort of network failures could occur due to cyber attack or human error even though many elemental technologies will have advanced in networks 15 years in the future. The other objective from the user perspective is to implement a network user environment that ensures both usability and safety, maintaining aspects like privacy.

### Two technical priorities for trustable networks

The following two technical priorities are raised in order to achieve these objectives for trustable networks.

The first point, "Trustable Network Infrastructure", aims to establish a consistent, high-reliability technology from user devices through to network infrastructure and online services, with the goal of providing safer network functionality. The aim is to implement technology which will provide resistance and the ability to recover quickly from any damage caused by, for example, attacks from malicious users or human error in operation of the network. This applies to all parts of the network from terminals

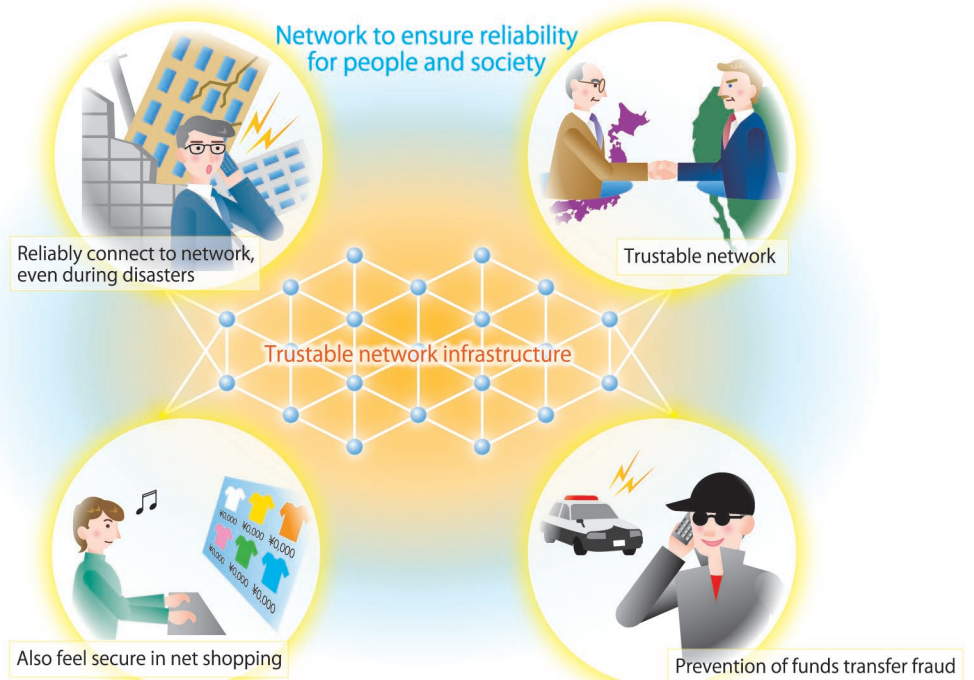
through infrastructure, realizing a data communications network able to support people and society.

The second point, "Network to ensure reliability for people and society", has the objective to establish an environment allowing network users to use the various online services safely.

A large variety of online services and network applications are currently available on the Internet, but many people hesitate to use them due to concerns regarding possible leakage of personal information and criminal activity on the network. To eliminate this sort of insecurity, New Generation Networks will

establish technology that properly certifies "who I am currently communicating (transacting) with" for not only devices (servers, etc.) on the network, but the users themselves behind the devices. Against the problem of privacy information leakages in recent years, NGN will implement mechanisms allowing the primary creator of data to manage that data in any circumstances, through high-level data management technology.

The objective of Trustable Networks is to realize New Generation Networks that can be used more safely and securely through the two technology goals above.



## Trustable Network



# New Generation Network Targets "Ambient/Ubiquitous Network"



## Kiyohide Nakauchi

Planning Manager  
Strategic Promotion Office for  
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### Sensor-Actuator Networks

The objective of "Ambient/Ubiquitous Networks" is to resolve some of the problems foreseen in the New Generation Network age, and particularly those closely related to life in society such as the environment such as food shortages and aging population. This will help realize a society with high Quality of Life (QOL) and allow people to live a more "human" life. To achieve this, high-level lifestyle support through ICT is needed in all scenarios of daily life. Examples include managing of cross-border circulation of foodstuffs, wide-area environmental monitoring, networked prevention of traffic accidents, and services for the aged

such as remote health care guidance and networked robotic assistance. To achieve these services, a network is needed that is able to track circulation of roughly 10 trillion items per year, monitor the lives of several billion users in real time, and perform sensing, tracking, data collection and processing, and operation of actuators with the degree of real-time, accuracy and reliability desired by each user. We call this sort of large-scale, multi-purpose sensor-actuator network\*1 the Global sensor/actuator cloud.

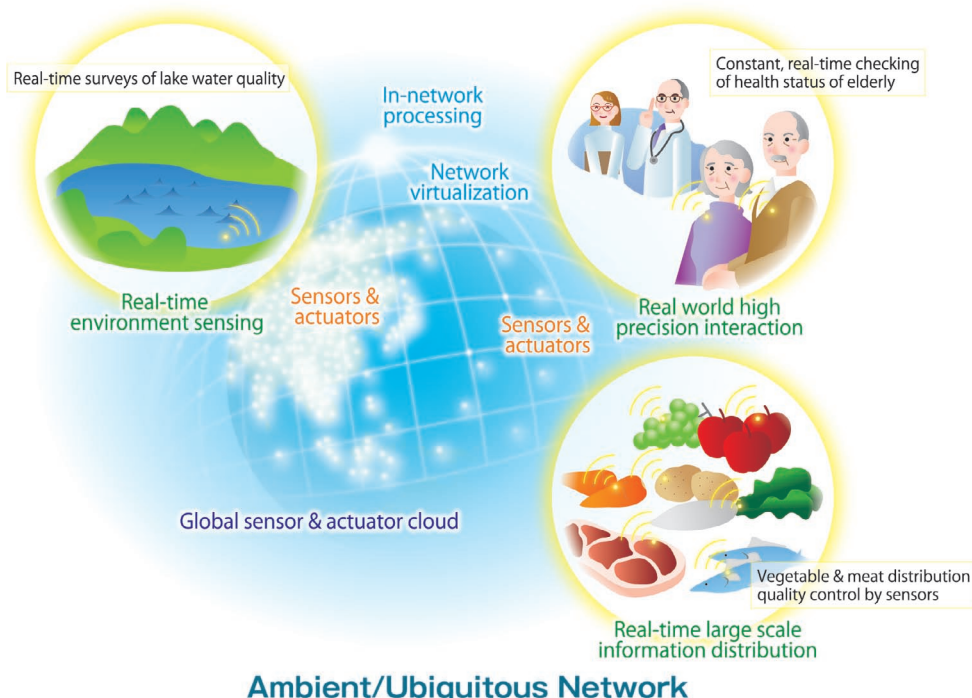
### Two Technical Objectives

Two of the technical objectives for New Generation Networks contribute to realizing this "Ambient/Ubiquitous

Network". The first technology is able to build, control and manage a global sensor-actuator grid capable of sensing, tracking and driving all of the data generated by all people and items in our living environment. The second is a sensor-actuator middleware infrastructure technology applied to the environment, and able to recognize and track changes in state flexibly, handle the various requests, and perform data collection, data processing, data recovery, and actuator driving tasks as necessary.

For the former, we envision a large-scale sensor-actuator network, covering from implantable micro-machine sensor networks, to those covering the wide areas of the earth and space. We are emphasizing technology able to manage and control the entire network in a scalable\*2 and reliable way, while concealing internal variation such as network form, node architecture, and node density.

For the latter, on the other hand, we are emphasizing technologies such as environment-adaptive sensing and internetwork processing technologies. Environment-adaptive sensing is able to learn automatically about the environment, context and profiles of individual users and based on these, automatically set the sensing accuracy and driving accuracy for sensors and actuators respectively. In-network processing involves technologies such as having the sensor network perform its own primary processing of sensor data, or giving networks self-organizing mechanisms.



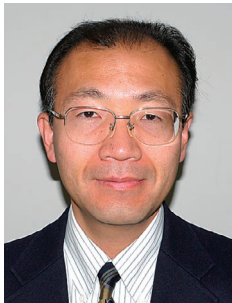
## Ambient/Ubiquitous Network

\*1 Sensor-actuator network: A communications network, including routing and addressing for constituent nodes, able to sense (sensing) and analyze (data processing) a variety of environmental or biological data, and physically manipulate (actuation) the environment or organism based on the results by performing this basic operating cycle periodically or on-demand. It may also indicate a cooperative system that includes such a network and a series of data processing systems.

\*2 Scalable: For network systems, the ability to increase the scale of the network (number of nodes or devices) while maintaining performance.



# New Generation Network Targets "Self-\* Network"



**Toshiaki Suzuki**

Senior Strategic Manager  
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## Networks suited to users and situations

One of the important objectives for the New Generation Network R&D has been called "Self-\* Network". A network satisfying this objective will be able to provide network environments customized to the variety of needs and situations of multiple users at the same time. For example, a network could be configured and provided with extremely low latency and jitter, as would be needed to perform surgery remotely. Or, to broadcast ultra-high-resolution 3D video over a wide area, an ultra-wideband broadcasting network adjusted for a large number of receivers could be provided.

## Key technology providing multiple simultaneous customized networks

In order to provide networks customized to each user or application, the following three key technologies need to be established.

The first is a "network unification technology" for providing network service through an end-to-end network in a lower layer and integrating and managing various types of network resources. This will be a multi-integrated network management technology for operating networks that integrate wired and wireless, packet-type and path-type, as well as optical and electronic networks.

The second is a "diversity network technology", which is a middle-layer technology for providing multiple customized networks and services

simultaneously in accordance with the conditions specified for the various network resources under unified management. This technology will operate multiple virtual networks on unified physical networks and be able to introduce new services in each virtual network on-demand.

The third is "OMOTENASHI (hospitable) network technology", which is an upper-layer technology that enables network services to be provided in a comfortable manner, regardless of user's network literacy. The network technology allows easy and safe connection to the network without complex configuration, visualizes real-time network conditions to help users

to understand the actual situations, and provides an interface for applying the desired processing to user data.

Our objective is to provide multiple simultaneous customized network environments through the cooperative operation of the lower to upper layers presented above. By realizing the network of our objectives, it will be possible to provide a variety of networks, customized for highly-advanced remote medicine, highly-realistic communications or distance education, or even to correct disparity in digital society or provide digital government that is easily accessible to anyone.



Expert Researcher, Network Architecture Group, New Generation Network Research Center

# Ved P. Kafle

●Profile  
 Graduated from Punjab Engineering College with a Bachelor of Engineering degree, received a Masters degree from Seoul National University in 2003 and Doctorate from the Graduate University for Advanced Studies in September, 2006. Joined NICT in October of the same year. Engaged in research on new generation network technologies, also involved in the AKARI Architecture Design Project. Doctor of Informatics.

## New generation network architecture designed from a clean-slate Toward standardization of an ID/locator split architecture for realizing networks of the future

### Activities as a staff member of the AKARI Architecture Design Project

The Network Architecture Group of the New Generation Network Research Center is working on the AKARI Architecture Design Project ("AKARI Project"), towards realization of the information-network society of 20 and 30 years in the future. Dr. Kafle, who has come from Nepal, is working on this project to develop a new generation network, an ideal network designed from a clean-slate. In other words, the envisioned new generation network will not be limited by the constraints of current networks. His recent research area is a new network architecture called ID/locator split architecture.

"In the current Internet, an IP address not only represents the location of a node, but also functions as the node identifier, or ID. When a node location changes, its IP address also changes. This means the identifier changes, and any established communication sessions are lost. To solve this problem with the current Internet, the ID and locator should be separated, so the ID can be used continuously, without loss of communication sessions, even if the locator changes due to node mobility."

The design principles for the current Internet were created over 40 years ago, with no strong security functionality, and no consideration of mobile communication environments such as

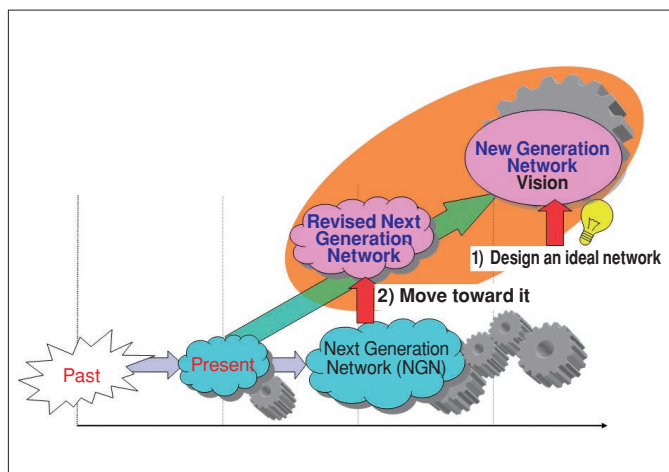
mobile phones. This is now becoming a problem. There are also problems with the routing architecture, which forwards data toward its destination. The AKARI Project is designing a clean-slate architecture, completely reexamining issues of security, mobility and routing.

### Two Prizes Awarded Last Year

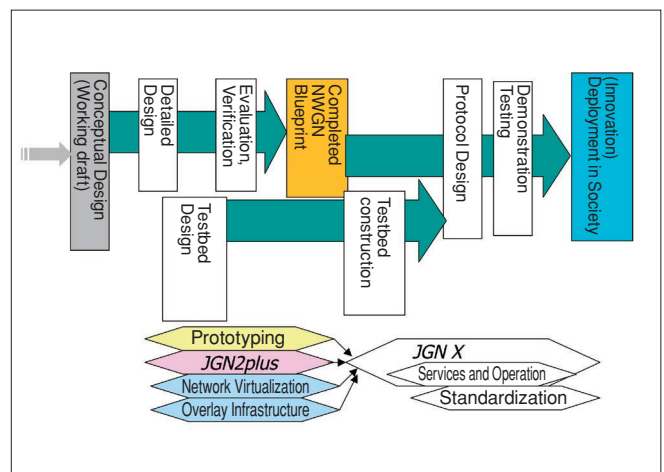
For his novel research on ID/locator split architectures and contributions to international standardization of the architectural components, Dr. Kafle received an award from the International Telecommunications Union (ITU) Association of Japan in May of last year, as well as the best paper award at the ITU-T Kaleidoscope Academic Conference held in September in Argentina.

"Standardization for new generation networks has started at the ITU, and I am also involved in that activity. The paper I presented at the ITU-T Kaleidoscope conference recommends this ID/Locator split architecture for standardization."

The AKARI Project aims to implement technology for building a new generation network by 2020, and after that, deploy it to serve society. Completion of the new architecture is anticipated to establish cyber-security and help solve various current societal issues through realization of services such as eGovernment and eDemocracy.



●New Generation Network Architecture for implementation by 2015



●R&D Verification Plan

"One issue for the implementation stage of the new architecture is to present the ways in which it is better than conventional networks to society. For this purpose, the new generation network should have the capability to provide several new services that would maximize human potential (education, health-care, awareness, etc.) and reduce the negative impact (energy consumption, global warming, disasters, etc.) on society or the environment. It should also be capable of accommodating unexpected new functions that people come to use and take for granted."

### Memorized up to 20x20 in elementary school

Dr. Kafle comes from a town in the south-east of Nepal, with a view of Mount Everest (in Nepali Sagarmāthā) to the north on a clear day. Like India, Nepal is enthusiastic about education, and elementary school textbooks are apparently heavy with even more content than those used in Japan.

"In elementary school, Japanese students learn multiplication tables up to 9x9, but we had to memorize up to 20x20 (in some schools up to 20x9). In Japan the goal is that everyone should be good at the same level, but in Nepal the competition is fierce right from elementary school. Parents want their children study very hard and achieve the best result. We are immersed in the idea that to get good jobs, you have to progress in school, and study is the most important thing for having a good life."

As his parents wished, Dr. Kafle passed high school exams with good grades and was able to go through a competitive process of getting a scholarship to study at the Punjab Engineering College (now renamed as PEC University of Technology) in India. This university is in Chandigarh, a new city formed in India after independence. The city was built based on plans by the celebrated French architect, Le Corbusier, and is known for its beauty.

"When India and Pakistan became independent in 1947, the Punjab region was partitioned into India and Pakistan regions, and all of the university (then known as Maclagan Engineering College) was in the city of Lahore that belonged to the Pakistan region. As such, the first Prime Minister of Independent India,



Jawaharlal Nehru, decided to build a new city and established the college, with the name of Punjab Engineering College, on the India side."

### Moved to Japan from Korea

After graduation, he returned home and worked for five years before continuing with a Master's degree, this time at Seoul National University in Korea. His chance to come to Japan came through Japanese professors who were visiting the University.

"I heard about the research system and environment in Japan from the Japanese professors, which got me interested in going to Japan, and then I applied. I came to Japan in October, 2003."

After completing a Doctorate at the Graduate University for Advanced Studies, he decided to apply to work at NICT.

"NICT has a wide range of work, from basic research to standardization, applying technology and introducing it into society. Personally, I prefer a wide variety of work, so working at NICT is attractive for me. Here, I have a lot of opportunities to meet and work on various topics with people from universities as well as ICT industry."

Apart from work, Dr. Kafle says he enjoys sports.

"I play badminton once or twice a week, and run about 10 km on the weekend. I like any kind of sport, but these two I can do easily."

He appears to be thoroughly used to life and the research environment in Japan.

# Recent Activities of the New Generation Network Promotion Forum

The New Generation Network Promotion Forum (<http://forum.nwgn.jp/>) is an all-Japan organization established in November 2007 to promote realization of the New Generation Network. The Chairman is Emeritus Professor Tadao Saito of Tokyo University, and it has a membership of 253 individual and corporate members (as of April 2009), so it attracts a high level of interest. Its four working groups (WGs), and there is also an advisory committee regarding international collaboration, consisting of academic researchers and others, the "New Generation Network Promotion Committee". NICT supports operation of the Forum, in the area of general affairs, with the Ministry of Internal Affairs and Communications. NICT also contributes proactively to the content of the Forum, for example by using results of studies by the NICT New Generation Network R&D Strategic WG.

We have entered the Forum's third year, and results are gradually starting to emerge. Within the R&D Strategy WG, four sub-working groups have been created to expand on the key technologies required to realize the five targets as outlined in the technology strategy proposed by NICT. The Assessment WG is summarizing its study of the initial three application fields (health/medicine/welfare, networked robotics, and lifestyle), while also discussing what fields to study next. The Testbed Network Promotion WG is planning to promote use of the testbed (JGN2plus) supported by NICT's Service Platform Architecture Research Center. It is also considering R&D on elemental technologies leading to the testbed, and discussing the role of the technology in realizing the New Generation Network. The Planning Promotion WG is improving the Forum web site, while also holding hearings on the future direction of the Forum with domestic and international related parties. The Promotion Committee has reported on the 2nd Japan-EU Symposium held in cooperation with the EU, the US-Japan Future Network Collaboration Workshop, held with the cooperation of the USA National Science Foundation, and the FutureNet II International Academic Conference which Japan contributed to holding. It is also discussing trends in the ITU-T Focus Group on Future Networks.

In November last year, the R&D Strategy WG and the Assessment WG planned a symposium, for the first time, to share results with each other and also with others who are not members of the Forum. The symposium was held on November 11 at the Mita Kyoyo Kaigijo (meeting facility), and in addition to reports of study in each of the WG, Chairman Saito gave a presentation summarizing the current state and issues for the future, and there were guest presentations on cloud computing. The event was a success, attracting over 150 attendees in spite of rain on the day.

As results take form, we look forward to gathering ideas from even more participants and creating even more-active discussion in the future.



R&D Strategy WG/Assessment WG Symposium

## Information for Readers

In the next issue we will feature research in biological EMC, related to the safety of electromagnetic waves.

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