Diversity & Inclusion - Networking the Future

New-Generation Network Technology Strategy (Ver. 1.0)

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From New-generation Network Vision to Target

In the New-Generation Network Vision (issued September 2008, revised in March 2009), the Strategy Headquarters of New Generation Network Research and Development analyzed and proposed 20 technology requirements demanded for the New-generation network to solve social issues and create new value in future society.

This time, the Headquarters proceeded further with this investigation, deriving functional requirements which cannot be achieved by extending the existing Internet and Next Generation Network. We closely studied over 100 technology requirements, and grouped them into representative technology categories. In this grouping task, we carefully and deeply reviewed the vision; connections between the network and the world’s “things” and people, relationship with the world and sustainable society, trusting and supportive relationships between people and the network society, etc. From this investigation, we summarized the characteristics which the future network should possess. The five network targets shown in the diagram below form a specific image of the New-generation network to achieve in 10 to 15 years.

The technology development items shown in the five network targets are linked to multiple technology requirements which contribute to social issue solutions and the future society outlook. It is also considered important to perform integrated R&D straddling technology fields, towards achieving each target. It is also thought necessary to promote research on network science fields for sustainable network fundamentals common to the five network targets, advanced device development, etc., from the perspective of stronger fundamental research.

These will be discussed in the New Generation Network Promotion Forum, and we will proceed to closely examine and revise network targets, roadmaps and issues concerning R&D on network fundamentals, thereby forming a promotion and implementation strategy to maximize the competitiveness of the New-generation network R&D results.

Network targets derived from social requirement conditions
Value Creation Network

| Background of Targets |

Aim to bring about new services innovation in the network, going beyond services which simply provide connections. Issues are creating new value chains in order to provide services from the user standpoint, and connect to new users and sharing of service functions. It is also thought that a future network infrastructure must be achieved which services information flowing through the network, and integrates knowledge of businesses and people generating previously unseen new services.

| Network goals |

Network which induces service creation and media creation, creating new value
Network which creates value through the change from an information society to a knowledge society
Network which creates and supports new industries which put ideas into practice

| Technology goals |

Service creation network technology
In order to construct infrastructure which creates new value, technology to research and distribute knowledge information, and technology to analyze services situation and significances, knowledge databases which supports them

Media creation network technology
Network platform technology enabling anyone to transmit huge amounts of information, while enabling people to simply obtain information created which is useful corresponding to their situation

| Major R&D Promotion Strategy |

Promotion of services research
and its application technology development
- Subject research with social economics, human behavior sciences, etc.
- Foster talented software human resources and idea generation
- Build up know-how concerning services innovation infrastructure
- Strengthen support for service market businesses

| Effects |

Create new industries which put ideas into practice
- Global market of 140 billion yen in year 2020
- Knowledge distribution industries, knowledge processing service businesses
- Anyone able to create services, building new value chains and improving service productively
- Define services integration technology from Japan to the world

Priority Technology 1: Services creation network
- Technology to modularize network services and make them into platforms
  - For network services: Shared module technology, module protection technology, and general purpose platform technology
- Technology to achieve large scale knowledge delivery and distribution
  - Knowledge collection technology, knowledge delivery technology, knowledge data analysis technology, and knowledge data mining technology
- Large scale distributed services knowledge database construction technology, network build-in type service process visualization technology
  - Technology to build extremely large scale databases to store knowledge, support of visualization functions for the network to provide services, and provision of its test group

Priority Technology 2: Media creation network
- Micro media distribution platform technology
  - For new information transmission from each individual, video and wireless integrated networking technology and compatible terminal technology, enabling access to mobile transmission information anytime, anywhere, and development of the information distribution environment
- Information reliability evaluation technology
  - Information analysis technology and database construction technology, to choose accurate and significant information among large amounts of information
- User adapting new media generation technology
  - To provide information with new value impossible on previous media technology which understands the user’s situation and generates information satisfying user needs

With a handy idea at the last minute getting new ideas

Value Creation Network
Trustable Network

Background of Targets

Information and communication networks are essential in all social activities of individuals and organizations. Stability and trustability of the network itself are important for maintaining continual network functioning. It is thus thought necessary to achieve guaranteed service with advanced failure resilience, fast recovery from failure, and stable operation even when human errors and cyber attacks occur. This new trustable network infrastructure on the scale of the entire society should also achieve a network usage environment with stability and trust secured.

Network goals

Highly reliable network
- Sustainable and stable network, even considering natural disasters and failures
- Network for continued use of good usability with safety including privacy protection

Technology goals

Trustable network infrastructure
- Technology providing local operation reliability, including the network, device and user
- Network to ensure reliability for people and society
- Network technology with simple settings to obtain strong privacy protection and reliability of people and society

Major R&D Promotion Strategy

More advanced network operations and security countermeasures technology and creation of new industries
- Advances in and applications of network operation technology which has been built up in networks until today
- Strengthens activities for countermeasures of security countermeasures
- Creates new industry by supporting services related to network operation technology and security countermeasures technology
- Implement industry/academic/government cooperation, by inter-disciplinary work

Effects

Achieve safe and secure ICT infrastructure
- Resolve various of hazardous security threats concerning ICT
- Achieve social infrastructure which also functions during emergencies and disasters
- Minimize basis of private and social information

Priority Technology 1: Trustable network infrastructure

- Trustable terminals and infrastructure service applications
- Trustability technology at each level, from devices connected to the network through to infrastructure services
- Trustable application development and verification platform
- (Deployment) technology to detect and remove vulnerabilities, from the testing application development stage
- Trustable network management and operation technology
- Development of data transmission means which have advanced autonomy, and support mechanisms to minimize operations tasks of managers
- Survivable network
- Communications technology to ensure survivability of network users themselves during emergencies such as natural disasters

Priority Technology 2: Network to ensure reliability for people and society

- Network device authentication platform technology
- Authentication/communication technology which recognizes peer-to-peer (P2P) type communications, authentication technology incorporated in the operating system (lower layer), and technology for their easy authentication settings
- Network user authentication platform technology
- Technology to clearly manage the identities of communications counterparties, and also objectively evaluate their reliability
- Advanced information management technology
- Technology for the primary creator to precisely manage private information of individuals and social information of organizations
Ambient/Ubiquitous Network

| Background of Targets |

Environmental problems, food problems, aging problems, etc., can be raised as social problems closely related to the social life of humanity that are foreseen in the time of the new-generation network. In such an environment, to achieve a life supporting society in which humans can live decent lives and achieve high quality of life, support is needed from ICT for utilizing situations. There has been internationalization of distribution and progress in international cooperation, especially for environmental problems and food problems. Thus, it is believed that cross-border food distribution management, environmental monitoring, traffic accident prevention using networks, remote healthcare for senior citizens, support for humans by network robots, etc., can be achieved if it becomes possible to perceive, pursue, and necessary collect and process sensor information generated by humans, things, and living environments on a broad global scale, or drive actuators. It is thought necessary to develop the new-generation network technologies towards solving the social issues mentioned above.

Network goals

Network of sensors and actuators which support human daily life in all situations

- Large-scale sensor and actuator infrastructure which consists of each other and provides integrated management of the vast number of sensors and actuators in living environments, and using that to form a global-scale sensor network which can dynamically process diverse real-time sensor data.

Technology goals

Global sensor and actuator cloud

- Integrated management and control technology which turns the vast number of sensors and actuators in living environments into a cloud
- Technology for real-time processing for the vast amount of sensor data in a sensing service which stores distribution of 10 billion devices per year and the body monitoring of 10 million users, and interaction with the real world

Major R&D Promotion Strategy

Develop sensor and actuator nodes utilizing the strengths of electronic device technology, and form into open toolbed

- Promote R&D focusing on wireless sensor and actuator node technology
- Construct an open sensor toolbox to expand globally to verify node technology and accelerate services development
- Establish the IoT actuator API (Application Programming Interface), and foster a service development community

Effects

Achieve ICT support in all living situations

- Achieve safety and security by food resource distribution management and traffic accident prevention
- Achieve environmental conservation by environmental monitoring
- Achieve aging society with good quality of life, by remote healthcare and living assistance robots
- Achieve large-scale cloud infrastructure, including embedded devices

Priority Technology 1: Network to handle the quantitative explosion

- Sensor and actuator node technology (energy conservation, implementation)
  - Hardware design technology for sensor and actuator nodes under extreme conditions, such as extreme energy conservation, extreme precision, and extremely light weight

- Sensor and actuator cloud management and control technology
  - Technology to form a sensor and actuator cloud from diverse nodes, from the level of micro machines in the body, to nodes in the world and extending to extreme distribution in outer space

- Cloud self-organizing technology
  - Cloud self-organizing technology which autonomously detects and connects connectable networks and adjusting sensors and actuators

Priority Technology 2: Life-supporting network

- Environment adaptive sensing technology
  - Technology to automatically learn the environment and individual user profiles and context from results of analysis of primary sensor data collected, and based on these, automatically configure sensors and actuators

- In-network processing technology
  - Technology for real-time and highly reliable data aggregation at intermediate nodes expediting data service network

- Wireless network virtualization technology
  - Technology to dynamically create on-demand, secure, and highly customizable wireless virtual networks satisfying individual application requirements and user control

Ambient/Ubiquitous Network

- Real-time surveys of live water quality
- Network processing
- Security & actuator
- Real-time environment sensing
- Sensor network
- Global sensor & actuator cloud
- Constant, inexpensive tracking of health status of elders
- Vegetable & fruit distribution, locally grown crops
- Real-time large-scale information distribution
Self-* Network

Background of Targets

In recent years, networks are being used for data transfer like Web and email and also to transfer sensor data and streaming data like voice and video. There is also rapid progress in diversification of services, such as offering applications and platforms through the network, called PASI (Platform as a Service). On the other hand, though the accompanying conditions required for services are also diversifying, until now it has been difficult to completely provide networks which are customized for each service between sender and receiver, and dramatic problems are foreseen. Thus it is thought necessary to achieve a network that anyone can use without stress, which can respond flexibly to conditions requesting services, etc.

Network goals
Pleasani network which can be used without feeling network restrictions
- Network which accommodate diversity, able to simultaneously operate different networks matching conditions required
- Used in heterogeneous networks, unified network which can provide consistent and shared services
- "OMOTENASHI" (hospitality) network which can provide services matching user literacy

Technology goals
Network technology which can handle diverse requirements
- Operation of multiple networks with different specifications, according to each service, etc.
- Optimal transmission under both in a unified network
- Use of network services without stress, not requiring complex settings

Major R&D Promotion Strategy
Use tested and accelerate R&D promotion
- Strengthens development based on competitive optical/wireless technology
- Construct unified network testbed service
- Strengthens federation tested and integration technology
- Developing of operation management using tested

Effects
Provide network customized for the individual
- Make extremely simple for network operation managers
- Automatic network configuration to administer user stress
- Faster migration, to achieve scalable network
- Provide infrastructure which solves social problems and advances the future society

Priority Technology 1: Diversity network
- Virtualization of nodes and network resources
  - Provide virtual networks in multiple layers, technology for virtualization of nodes and network resources including processing functions, in multiple layers
- Virtual networks on physical networks
  - Technology for network construction, operation and management, in order to map virtual network resources to heterogeneous physical network resources, and built multiple virtual networks
- Adaptive custom network
  - Technology to launch dynamic functions using appropriate resources, to enable handling of dynamic changes in network composition and traffic, handling of dynamic addition of new functions, etc.

Priority Technology 2: Network unification
- Data transmission in unified path/packet network
  - Network architecture which unifies packet/packet network, and technology to achieve data transmission by route and transmission method according to the flow's characteristics
- Data transmission in wired/wireless unified network
  - Network architecture which unifies transmissions in rough and precise wireless networks and optical/other networks, and technology to achieve data transmission by route and transmission method according to the flow's characteristics
- Network which unifies multiple aspects: optical/electronic/wireless and path/packet
  - Technology for operation, management and data transmission in unified network which integrates wired/air, optical/electronic and path/packet network

Priority Technology 3: "OMOTENASHI" (hospitality) network
- Automatic network configuration
  - Ease of use technology to enable understanding use of unified network which integrates wired/air, optical/electronic and path/packet
- Network status visualization and autonomous networks
  - Technology for visualizing network status and various network problems, and for autonomous networks which optimally maintains the network while providing problem solutions corresponding to user intentions

User data control network
- Architecture which finds and manages network user's data, and technology which enables control of user data in the network, according to user desires

Try on clothing with 3D videos
- Self-* Network
- Self-* Network architecture
- Self-* Network application
- Self-* Network user
Sustainable Network

Background of Targets

Information and communications societies have been achieved through synergistic effects of innovative technologies, especially broadband communication technology using applied lifter, Internet technology, mobile telecommunication technology, computer technology, etc. On the other hand, with the rapid innovation and spread of services, this field is now facing many problems that can be called limits of the earth’s capacity, and these problems are becoming the constraints for further development of network systems and services.

Among these, today’s most important issues are “energy problems” and “frequency resource problems”. Efforts have been made on these issues, but considering current forecasts of growth in users, diversification of sensors and other appliances, and traffic growth, there are thought difficult to solve by existing methods.

Thus in the low-generation network, it is thought necessary to aim for further sustainable development of the information and communication society, by finding methods for essential solutions to global scale problems.

Network goals

Sustainable network

“Green network” enabling information distribution with very little energy

Highly efficient spectrum use wireless networks which shares limited spectrum among many users and diverse appliances

Technology goals

Green network technology

Information distribution with very little energy

Network enabling transfer of information at 5/100 of current energy levels (1000 times higher energy efficiency). Current technology has a bit of about 12 times higher energy efficiency.

Technology for advanced use of frequency resources

Achieve higher spectrum use efficiency, by distance frequency sharing technology, frequency use technology comprised of singular cells, and provisioning of secured sub-net oriented to wireless selectivity. Thence achieve 100 times higher wireless communication volume (traffic capacity).

Major R&D Promotion Strategy

Achieve goals by innovation in network architecture and wireless communication methods

New network architecture aiming for lower power consumption

International standardization to promote industry

Pioneer spectrum sharing technology verification

Provide development of technology for higher efficiency spectrum use and accelerate development of technology for its reduced fixed mobile communication (FMC) enabling end-to-end quality guarantees

Effects

Coexistence of lower global environmental burden and greater communication volume

Drive the information and communication market, utilizing strengths in energy reducing technology

Allow further communication traffic growth, user growths, and diverse appliances

International contributions utilizing energy conserving network technology

More portable telephones for all information home applications, to improve usability and develop new usage situations and business models

Priority Technology 1: Green network (Extremely low energy information transmission)

Low-power-oriented network architecture

Technology is to make and verify new network architecture with lower power consumption.

Information transfer as the primary objective

Power-minimization in ICT overall

Technology is to optimize mechanisms for allocation and transfer of distributed contents in the network

Low power consumption photonic network, optical access, wireless access

Technology for lower power consumption

Low power consumption technology for wireless communication devices which comprise a large share of power consumption today

Protocols for low power consumption networks

Communication protocol to handle lower communication bandwidth and temporary appliance disconnection from the network by such as short duration.

Real-time measurement and methods to calculate power use in network and appliances

Technology for methods to calculate power usage in network equipments and appliances, and realize measurement and information distribution to gain feedback

Priority Technology 2: Advanced efficient spectrum utilization

New spectrum usage technology

Technology to use unused frequency bands: millimeter-wave, sub-millimeter wave and terahertz wave

Cognitive wireless technology

Technology to sense spectrum utilization and share such information among systems and users, and to share the same spectrum between multiple systems

Technology for cooperation between systems, by heterogeneous networking

Technology for mobility protocols which consider aggregation and handover between different systems seamlessly

Highly efficient spectrum use wireless network

New efficient specturm utilization technology supporting communications traffic growth.

Green network (Extremely low energy network)

Network energy reduction technology

Sustainable Network
New-generation Network Fundamentals

Fundamentals to Support The Five Network Targets

The most significant attributes in the era of the new-generation network include the vast scale and complexity of networks. However, it is difficult for traditional network fundamentals to solve quantitative challenges such as the scale and complexity, and to resolve the qualitative requirements posed in the network. In addition, the network must work in the era of a knowledge-society. The network should also be harmonized with innovation in cutting-edge physical and device science and technology. That is, we need to develop the new-generation network fundamentals in order to break through the limitations of classical technologies, to handle diverse new requirements, and to create emergent value.

Network goals

Network fundamentals enabling continual values and solving quantitative and qualitative challenges
Fundamentals to handle the tough conditions posed in the new-generation network, such as extremely large-scale complexity and diversity, fundamentals to create new value and functions in the new-generation network.

Technology goals

Network fundamentals in the era of complexity and interdisciplinary research
Scientific and technological fundamentals to support extremely large and complex network systems
Network fundamentals incorporating complex behavior of networks, people, and society
Fundamental technology for value creation in a knowledge society
Creating value chains between networks and cutting-edge innovations in physical properties, materials, and devices

Major R&D Promotion Strategy

Strategic promotion of fundamental research
Under network architects
Interdisciplinary research promotion scheme
Strategic strengthening of fundamental areas

Effects

For future and emergent innovations in the network
Diverse impacts from fundamental technologies of the new-generation network
Developing fundamentals in the knowledge-society and value creation
Explicit Japan’s strengths in materials and devices for innovation in network systems