ICT R&D Programs for the Ubiquitous Network Society

~UNS Strategic Programs~

(Outline)

-- Universal Communications, New Generation Networks, Security and Safety --

-for-

-- the Ubiquitous Network Society –

(Tentative)

The Telecommunications Council

Ministry of Internal Affairs and Communications

July 2005

Summary

- The Telecommunications Council organized the R&D Strategic Committee under the Information and Communications Technology Sub-Council to deliberate on Inquiry No. 9 (July 28, 2004), “ICT R&D Programs for the Ubiquitous Network Society”. Deliberations started in August 2004, and a report was submitted at the 14th meeting of the Telecommunications Council (July 29, 2005).

- Japan has set up one of the world’s most advanced broadband environments as a result of concentrated efforts on ICT promoted through e-Japan Strategy I / II and as one of four priority areas of the Second-Term Science and Technology Basic Plan. To keep up the most advanced environments, Japan is now in the process of launching the u-Japan Policy, which is an effort to establish the ubiquitous network society.
  Many other countries have also positioned ICT as an important technology for their economic development and are making national commitments to promote its research and development under a clear vision. The development and standardization of the Next-Generation Network (NGN), which is aimed at restructuring the communications infrastructure using IP technology, are about to begin in full swing.

- Against this backdrop, this report analyzes social trends toward the ubiquitous network society and clarifies priority areas on which to focus ICT research and development based on trends in other countries.
  Furthermore, specific programs have been set up as UNS Strategic Programs to promote research and development in these priority areas.

- UNS Strategic Programs include
  (1) Strategic programs for “New Generation Networks Technologies” aimed at enabling Japan to play a leading role in ICT in the international community
  (2) Strategic programs for ICT “Security and Safety Technologies” aimed at establishing a secure and safe society
  (3) Strategic programs for “Universal Communications Technologies” aimed at promoting intellectual creativity
  These programs comprise 10 R&D projects. Industry, academic, government, and users will form partnerships to make committed efforts in carrying out these projects.

- This report also includes the government’s role in promoting the three strategic areas as well as the organization structure and environment required in conducting research and development.

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1.1 Trends in Japan

Japan is now experiencing dramatic changes in every aspect of the country. At the same time, there is a sense of stagnation in society, the economy, and various other areas where people feel that they cannot find solutions to many issues. To break free from this sense of stagnation and achieve further progress under these circumstances, it is essential that Japan departs from the traditional development model of trying to catch up with the rest of the world. Instead, it should play a leading role in the international community by becoming the first to create new values (value creation).

Maintain / strengthen international competitiveness

As Japan's society and economy become more globalized and Asian countries experience rapid growth, Japan must make efforts to maintain / strengthen international competitiveness to ensure further growth in the future. These efforts include working to become one of the first to produce a new shift in paradigms through the use of the most advanced technology; establishing Japan's position as a country strong in science, technology, and intellectual property; becoming the first to develop new 21st century models of social systems and business models by taking on the unprecedented challenge of building an ubiquitous network society; and contributing to the development of the international community as a country with an established presence.

Ensure security and safety in society and people's daily lives

As more natural disasters and crime threaten people's daily lives and more concerns are raised on the safety of food and medical services, Japan strive to ensure security and safety in society and people's lives so that its people can lead their everyday lives without worrying about their safety. Even in times of disaster / emergency, damage can be minimized. In addition, environmental problems, such as global warming, have become worldwide issues that cannot be avoided if mankind is to progress in the future. It is essential that Japan searches for solutions by taking advantage of new knowledge and by promoting joint efforts with various domestic / overseas entities.

Promote personal dynamism

As personal lifestyles and values become increasingly diversified, Japan must endeavor to promote personal dynamism, including shifting from a uniform society to a more pluralistic and diversified society that meets a broad range of needs of various people so that each individual can enjoy the true richness of life and exert one's full power in society, and take advantage of the individual's power to maintain social and economic strength amidst an aging society with a declining birthrate.

Based on the above trends, Japan is now promoting a u-Japan Policy, which is an effort to realize the ubiquitous network society where there is a network connection anytime and anywhere to anything and anyone.

1.2 ICT Establishing Itself as a Social Infrastructure

In the past, ICT used in people's daily lives was mostly in the form of telephones and televisions. However, with the rapid spread of Internet connections and mobile phones that started around 1995, ICT advanced dramatically.
This leap in technology has made the role of ICT today increasingly more important in people's lives, society, and the economy. ICT is now establishing itself as an indispensable social infrastructure, spanning a wide range of areas, including daily lives, industries, academic research, arts, and culture.

Infrastructure for socioeconomic activities that support prosperity

ICT has become an indispensable infrastructure for socioeconomic activities that enable today's prosperous lifestyle. For example, ICT is used in creating new business models, such as e-commerce, and in managing customer information. This enabled corporate / government operations to speed up while reducing cost and has led to better customer / user satisfaction.

Infrastructure for ensuring security and safety in people's daily lives

ICT has become an indispensable infrastructure for ensuring security and safety in people's daily lives. For example, ICT is used to confirm the processing history of food, improve the quality of medical and welfare services, and provide a means to confirm the safety of others in times of disaster, thus helping to ease the feeling of distrust and anxiety that is spreading among the people.

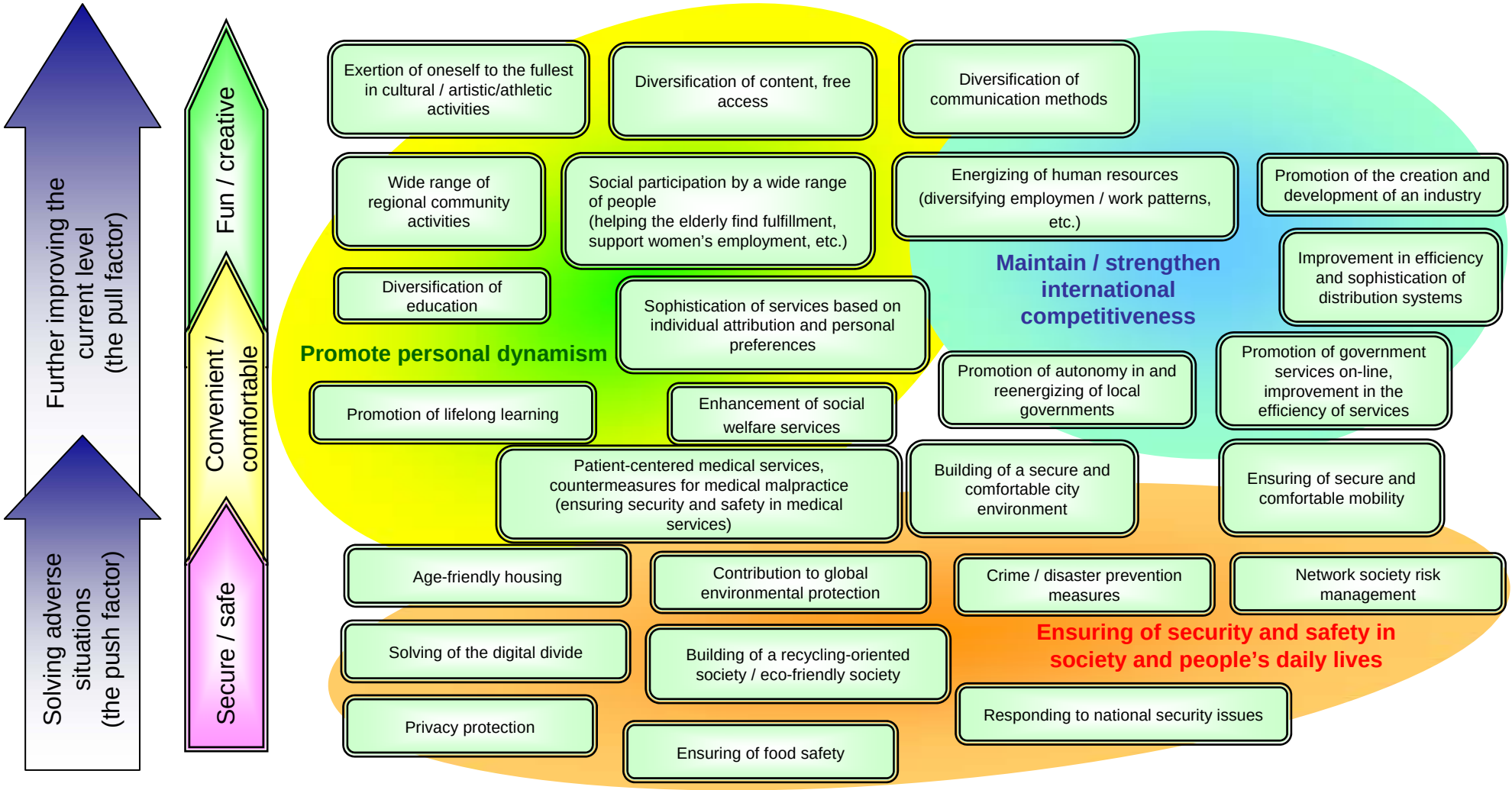
Infrastructure for science and technology that enable the creation of new knowledge

ICT has become an indispensable infrastructure for science and technology that enable the creation of new knowledge. For example, global climate predictions and bioinformatics, which were formerly thought to be impossible, became possible through ICT's ability to perform the sophisticated processing of vast amounts of data in a very short time.

ICT is a strategically important technological / industrial field, and its importance is growing further as a social infrastructure in the ubiquitous network society.

1.3 Society's Need for ICT

The ubiquitous network society is expected to take advantage of its strength in providing a network connection anytime and anywhere to anything and anyone in order to devise ways to maintain / strengthen international competitiveness, promote personal dynamism, and ensure security and safety in society and people's daily lives. The individual challenges within these three main areas of endeavor can be divided into challenges to solve adverse situations and challenges to further improve the current level. ICT is expected to be useful in responding to both types of challenges.



1.4 Challenges in Deploying ICT as a Social Infrastructure

(1) Insufficient Network Dependability

Countermeasures (defense) against attack from inside and outside the network system are still not enough. Such problems as personal information leaking due to vulnerabilities in the system security still persist. In addition, because information systems have greatly expanded in size, network failures caused by attacks or disasters can result in massive damage.

* Dependability: being able to be relied upon
Here, “dependability” means that ICT as a social infrastructure is highly functional and easy to use with a high level of reliability (the system is stable and secure) and that it is highly repairable, traceable, predictable, and durable in the event of a failure so that users can feel safe in using ICT.

(2) Digital Divide Due to Physical Capacity and Information Literacy

Information appliances are becoming increasingly more sophisticated, and elderly people and other people in general have a difficult time using them. There is also a gap in ICT use caused by the difference in physical capacity and information literacy. The situation is such that it may actually affect people’s daily lives.

(3) Internet Architecture Still Not a Fully Matured Technology to Be Used for the Next-Generation Infrastructure

Concerns remain as to whether current Internet architecture can fully meet the high demands of the next-generation infrastructure. In addition, traffic congestion and security problems are difficult to predict and tend to manifest after the system is running, often causing countermeasures to lag behind.

(4) Difficulty in Judging the Reliability of Information as Advances in Broadband Communications Bring an Explosive Growth in Information

It is becoming increasingly difficult to obtain necessary information from the mass of mixed information that flows through networks. One of the reasons is that because networks are now able to handle an almost infinite amount of information, they send out all types of information in the same manner, regardless of its reliability and possible social impact.

2 Overseas Trends in ICT Research and Development Policies

2.1 Overseas Trends in ICT Research and Development Policies

Many other countries position ICT as an important technology for their economic development and are making national commitments to promote its research and development under a clear vision. It is important that Japan also strengthen its efforts in ICT research and development.

United States

Vision: ICT research and development with technological innovation at the core

Networking and Information Technology R&D (NITRD) Program used in solving national priority issues

Outline: Identifies 14 ICT research and development themes that contribute to solving national priority issues

Long-term efforts are made to achieve challenging goals in order to realize innovative breakthroughs. R&D budget for ICT surpasses that for other areas.

Europe

Vision: Strengthening industrial competitiveness and employment creation through the construction of a European network of knowledge Framework Programme (FP) for the realization of an e-Europe (FP6: 2002–2006, FP7: 2007–2013)

Outline: Bolsters R&D budget to enhance knowledge-intensive economy

Budget is heavily allocated to R&D in the ICT area, with an eye to strengthening industrial competitiveness through knowledge

China / South Korea

Vision: Vitalizing and nurturing various ICT industries simultaneously through a positive chain reaction

Outline: Plans to ignite economic development by strategic ICT deployment based on the 10th 5-Year Plan (China) and the IT839 Strategy to realize a u-Korea (South Korea)

Efforts are made to enhance ICT in a broad, comprehensive manner and as an industrial area that will drive the nation's growth

2.2 Trends in International Standardization: (1) Activities in ITU

The ITU Telecommunications Standardization Sector (ITU-T) decided to actively promote standardization in NGN, home information appliances, and security in their sessions during the four-year period starting from 2005. The ITU Radiocommunication Sector (ITU-R) made a recommendation concerning the framework for the fourth-generation mobile communications system. New research themes were also set for the broadband wireless access (BWA) system, which is expected to be the new broadband communications method. In response to these movements, carriers and vendors in the world's major countries are now stepping up efforts towards standardization, and Japan needs to actively respond to this trend as well.

Next-Generation Network (NGN)

→NGN unanimously given highest priority; organizational structure to study standardization established

Service requirements and implementation scenarios are now being studied for the construction of the next-generation all-packet network, as traditional circuit-switched-based networks are shifting to packet-based networks. Studies on the standardization of NGN are being lead by Europe (ETSI). It is important for Japan to conduct high-level studies on strategies in cooperation with Europe and the United States as well as to respond to the movements of China and South Korea. ITU-T and IETF are considering further cooperation in standardization efforts, and it is important for Japan to promote such activities for efficient and effective NGN standardization.

Home Network (Information appliances)

→Full-scale standardization activities begin

Studies on standardization, including those regarding the interconnection of information appliances, home gateways, and multimedia application services, are expected to lead to highly convenient home information appliance applications for users.

Security

→ Identification of more detailed and specific standardization issues agreed upon; relative study groups to enhance cooperation

The standardization of next-generation security architecture, biometrics, and mobile security is being studied amidst the growing importance of security in telecommunications.

Fourth-generation mobile communications system

→More detailed standardization activities based on the standardization framework now underway

Studies are being conducted on such technical conditions as frequency arrangement, wireless interface, and software-defined radio. Service requirements and market reports are also being studied.

Broadband wireless access (BWA) system

→ Studies on the development of a recommendation based on new research themes are underway

The development of a recommendation regarding requirements for the operation of fixed-line systems is being studied. Studies on how to handle standards expanded for application to a mobile environment have also started.

2.2 Trends in International Standardization: (2) Activities in Major Standardization Forum

IETF

Mobile Ad-hoc Networks

→The goal is to create a proposed standard (PS) by 2006.

This working group studies an independent network system that consists of mobile terminals connected by wireless links. This network system requires a different routing method than that used by the Internet, which does not take mobile terminals into consideration.

Security (IPsec and PKI)

→A number of draft standards are scheduled to be created in 2005.

Basic standards for IPsec and PKI have been established, but their implementation has been thus far limited. This working group will identify their issues and conduct studies to realize secure communication through the Internet.

IEEE

Wireless LAN

→Now working to further improve throughput

IEEE 802.11n is being studied as a wireless LAN standard that will further improve throughput compared with IEEE 802.11a/b/g.

Broadband wireless access (BWA) system

→ Now working to expand the system's application to include a mobile environment

IEEE 802.16-2004 was issued in October 2004 as a standard for broadband wireless access. Currently, IEEE 802.16e (commonly known as WiMAX) is being developed to expand its application to a mobile environment. Mobile broadband wireless access is also being studied under IEEE 802.20, and for IEEE 802.15, ultra wideband (UWB) technology is being studied for short-range (approximately 10 meters), high-speed data transmission between personal computers and audio-visual equipment.

3 Priority areas in ICT Research and Development

3.1 Direction of ICT Research and Development

Based on trends in Japan, society's need for ICT, the challenges in deploying ICT as a social infrastructure, and overseas trends in ICT research and development policies, the key direction (target area) for Japan's research and development are "international competitiveness", "security and safety", and "knowledge".

Maintain / strengthen international competitiveness

International competitiveness in ICT: Maintain and strengthen international competitiveness in ICT, in which Japan has a leading role; contribute to the world by playing a leading role in international standardization; create new technology that will generate a paradigm shift to lead the world in new ways.

International competitiveness through ICT: Enhance Japan's international competitiveness through the advanced use of ICT; develop the world's first next-generation social system based on ubiquitous network technology.

Establish a secure and safe society

ICT security / safety: Ensure the dependability of ICT as a social infrastructure as well as its security / safety so that ICT can be used effectively by all people.

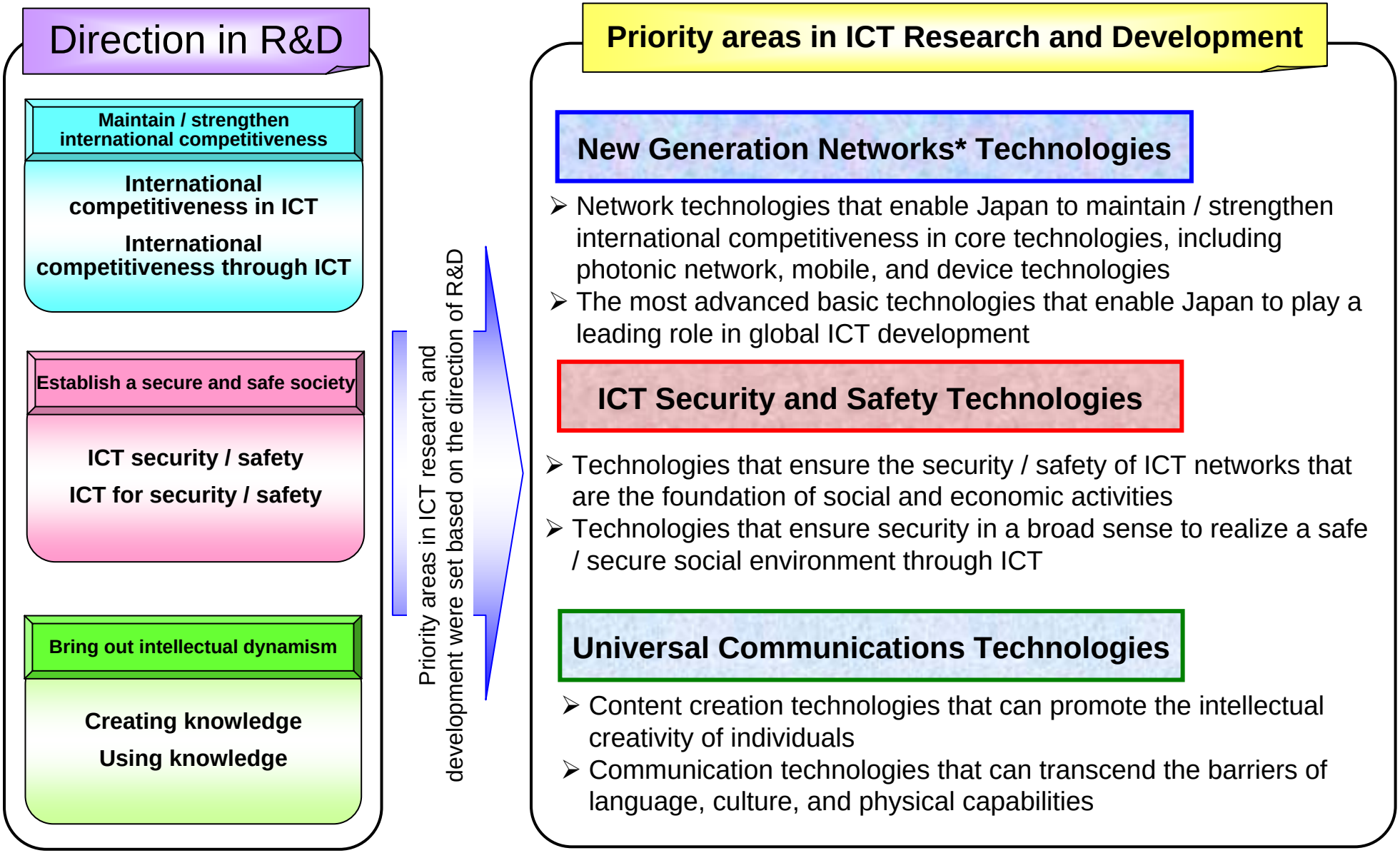
ICT for security / safety: Utilize ICT to solve issues in various fields, including healthcare, welfare, food, agriculture, crime prevention, disaster reduction, and the urban / natural environment, so that a secure / safe society can be realized.

Bring out intellectual dynamism

Creating knowledge: Bring out the potential of each individual and promote the creation of value through the synergy of various areas of knowledge.

Using knowledge: Make knowledge and value available to be used effectively so that various issues in society can be solved and advanced, easy-to-use services as well as people-friendly communication can be realized.

3.2 Priority Areas in ICT Research and Development



*** Here, "New Generation Networks" refers to both the Next Generation Network (NGN) and subsequent future networks.**

3.3 Challenges Concerning ICT Research and Development in Japan

In promoting ICT research and development in priority areas, it is essential that its challenges are taken into consideration.

Challenge 1: Long-term research and development / Basic research

Although ICT is a technological field characterized by fast-paced innovation, key technologies in ICT, such as the Internet and photonic fiber, required 20 to 30 years to advance from basic research to practical use. As can be seen from this, developing basic research into something that can be put to practical use requires a long period of time. However, long-term research and development / basic research is now experiencing a decline.
It is important to establish an environment and organizational structure that end the decline in long-term research and development / basic research that needs to be developed in the future.

Challenge 2: Systems and Architecture

In the ubiquitous network society, various kinds of equipment are used in a mixed environment, where peripheral devices and high- and low-grade systems are interconnected. The network as a whole must work as a system, but Japan has not made sufficient commitment to realize well-coordinated network systems.
It is important to promote research and development that place greater importance on the architecture of the entire system as a whole.

Challenge 3: Efforts to improve social acceptance

Basic research, application, and practical use are not the only phases that ICT research and development go through. In order to be deployed widely in society, ICT requires social acceptance. However, efforts for its smooth introduction to society have been lacking.
It is important that social acceptance is taken into consideration in the R&D process.

Challenge 4: Talent to carry out ICT research and development

ICT is being deployed in various areas as a socioeconomic infrastructure and ICT researchers are sought after from an increasingly wider range of areas. To play a leading role in long-term basic research and take the lead in developing architecture, it is essential to develop, both in quantity and quality, able researchers to take the lead in the future and leaders to promote R&D projects. However, there are concerns over a shortage of talent in ICT research and development.
It is important to develop human resources in order to take the lead in the future.

4 Ubiquitous Priority R&D Strategy

4.1 Ubiquitous Priority R&D Projects
4.2 Aspects that should be Considered in Ubiquitous Priority R&D Projects
4.3 Ubiquitous Priority R&D Strategy
〜 UNS Strategic Programs 〜

4.1 Ubiquitous Priority R&D Projects

○ Why these projects are necessary

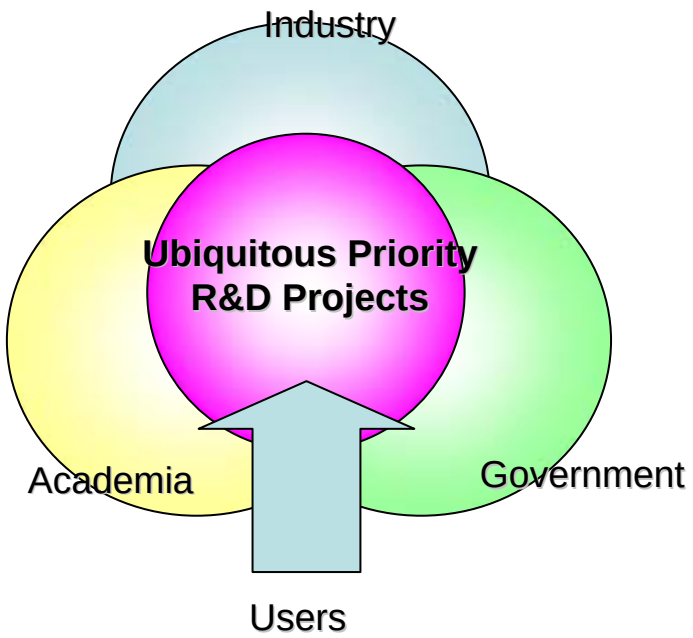
- For Japan to continue its growth despite having an aging society with a declining birthrate, it must focus on effectively using its limited resources (human resources/budget).
- Because ICT is characterized by its rapid pace of technical progress and fierce international competition, other countries have organized state-sponsored projects in their concentrated efforts to promote ICT research and development.

○ Ubiquitous Priority R&D Projects

- Japan is vigorously promoting these national policy R&D projects through the joint efforts of industry, academia, and government to achieve greater technological advancement and establish a comprehensive R&D infrastructure.

○ Project structure

- Ubiquitous Priority R&D Projects will be carried out through the joint efforts of users, industry, academia, and government.
- The specific roles of the participants will differ by project (or project goals), for example, projects that need to pay special attention to the budget, projects that require a frequent exchange of information among researchers, and projects that need to be organized. Each project will be considered individually to determine the optimum role of each participant.
- The projects do not consist of a single scheme but several schemes. However, the schemes will be coordinated towards a single goal.



In building the ubiquitous network society, it is essential to utilize technologies that meet the user's needs. For this reason, research and development should include the participation of users for their point of view, not only in the final evaluation after the project is completed but also from the early stages of planning and research.

4.2 Aspects That Should Be Considered in Ubiquitous Priority R&D Projects

Promoting Innovation and Breakthroughs
Projects must take the future into consideration with a long-term perspective and should include basic research in unexplored fields and new technologies, thus promoting innovation and breakthroughs that will enable the country's position in the most advanced technology to be maintained.

Creating New Businesses
ICT can contribute to revitalizing society and the economy by serving as a social infrastructure. ICT should not be limited to research and development but used to expand applications to other areas based on the results of research and development. ICT can thus contribute to creating new businesses and even new industries.

Playing a Leading Role in Developing System Architecture
In the ubiquitous network society, various kinds of equipment are used in a mixed environment that requires devices to be interconnected and applications to be coordinated. In order to become a "top runner" in the ubiquitous network society, Japan must play a leading role in creating its system architecture.

Strategic Leading in International Cooperation / Competition
Because ICT is often deployed globally, Japan should take a strategic lead in international cooperation and competition by cooperating with Europe and the United States, promoting joint research and a human resource exchange with a central focus on Asia, and playing a leading role in standardization through its advanced technology.

Open Demonstration Tests with an Eye to Providing an Actual Use for the Technology
To ensure the smooth social acceptance of research and development results, the projects must be reviewed from various perspectives, including architecture, business model, and user acceptance. Open demonstration tests with an eye to providing an actual use for the technology must be promoted.

Solving Social Issues
The ubiquitous network society is a society in which ICT is used to deal with various social issues and in which ICT affects society as a whole. It is important for the national projects to produce solutions to social issues in Japan and other countries to bring about tangible benefits to the people.

Developing Human Resources for the Future
The projects should have the well-balanced participation of not only researchers, coordinators, and older members but also young members in order to develop young researchers on an ongoing basis to maintain continued progress and also develop project managers, coordinators, and producers.

Inspiring Hope
ICT is an important component of social infrastructure. However, being a part of that infrastructure is also the very reason why it is difficult to recognize ICT's importance. Projects must convey the significance and fascinating aspects of ICT, contribute to enriching the future, and inspire hope.

4.3 Ubiquitous Priority R&D Strategy

Priority areas in ICT R&D

It is important to promote R&D with a focus on the entire system architecture.

New Generation Networks Technologies

- Network technology that enables Japan to maintain / strengthen international competitiveness in core technologies, including photonic network, mobile, and device technologies
- The most advanced basic technologies that enable Japan to play a leading role in global ICT development

ICT Security and Safety Technologies

- Technology that ensures security / safety of ICT networks that are the foundation of social and economic activities
- Technology that ensures security in a broad sense to realize a safe / secure social environment through ICT

Universal Communications Technologies

- Content creation technology that can promote the intellectual creativity of individuals
- Communication technology that can transcend the barriers of language, culture, and physical capabilities

Understanding technological trends in the three priority areas

Aspects that should be considered in Ubiquitous Priority R&D Projects

- Promoting innovation and breakthroughs
- Playing a leading role in developing system architecture
- Open demonstration tests with an eye to providing an actual use for the technology
- Developing human resources for the future
- Creating new businesses
- Strategic leading in international cooperation / competition
- Solving social issues
- Inspiring hope

UNS Strategic Programs

< Intellectual Creativity Program >

Universal Communications

< International Leadership Program >

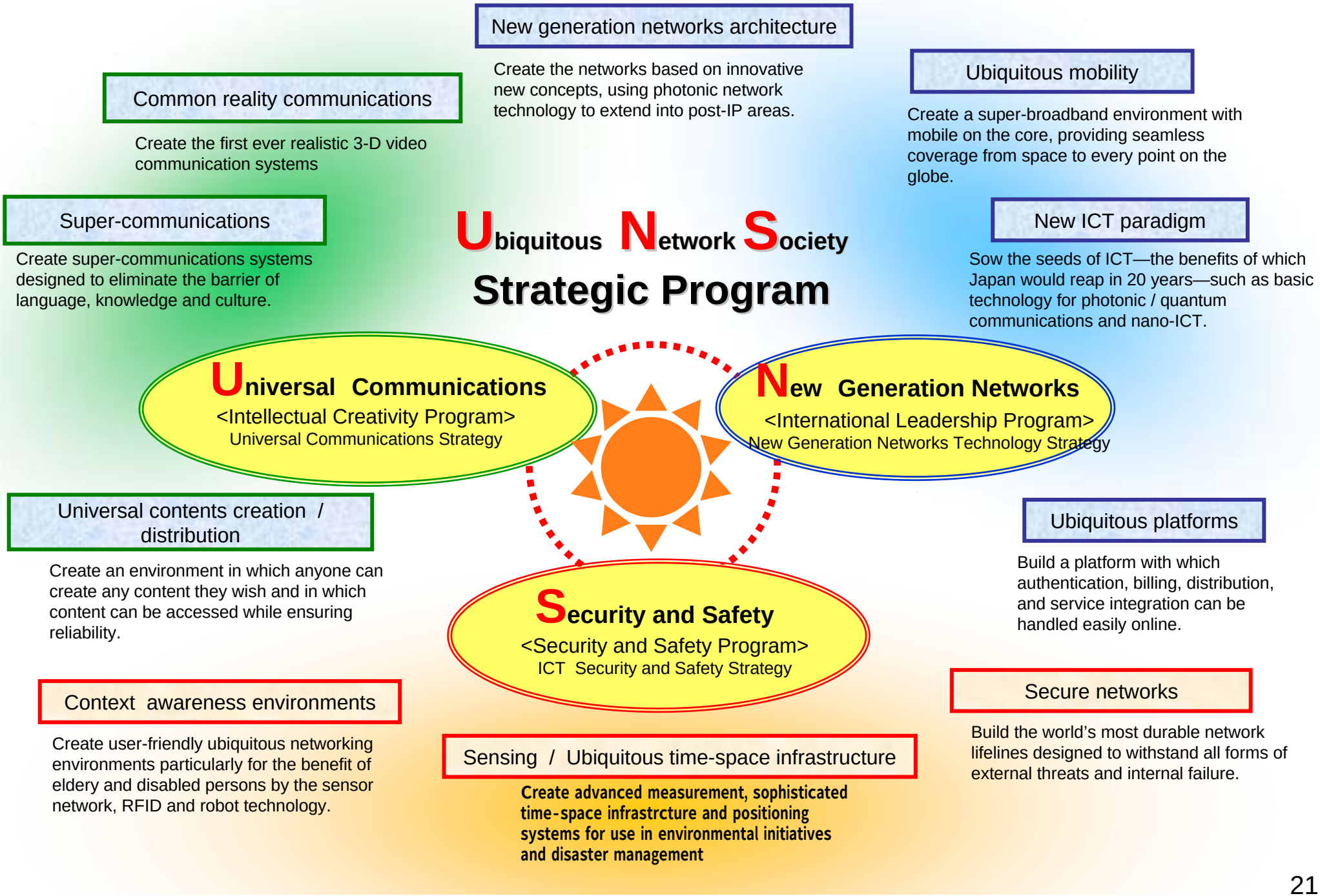
New Generation Networks

< Security and Safety Program >

Security and Safety

10 R&D projects

- New generation networks architecture
- Ubiquitous mobility
- New ICT paradigm
- Ubiquitous platform
- Secure networks
- Sensing / Ubiquitous time-space infrastructure
- Context awareness environments
- Universal contents creation / distribution
- Super-communications
- Common reality communications


New generation networks architecture
Create the networks based on innovative new concepts, using photonic network technology to extend into post-IP areas.
Common reality communications
Create the first ever realistic 3-D video communication systems
Ubiquitous mobility
Create a super-broadband environment with mobile on the core, providing seamless coverage from space to every point on the globe.
Super-communications
Create super-communications systems designed to eliminate the barrier of language, knowledge and culture.
Ubiquitous Network Society
Strategic Program
New ICT paradigm
Sow the seeds of ICT—the benefits of which Japan would reap in 20 years—such as basic technology for photonic / quantum communications and nano-ICT.
Universal Communications
<Intellectual Creativity Program>
Universal Communications Strategy
New Generation Networks
<International Leadership Program>
New Generation Networks Technology Strategy
Universal contents creation / distribution
Create an environment in which anyone can create any content they wish and in which content can be accessed while ensuring reliability.
Ubiquitous platforms
Build a platform with which authentication, billing, distribution, and service integration can be handled easily online.
Security and Safety
<Security and Safety Program>
ICT Security and Safety Strategy
Context awareness environments
Create user-friendly ubiquitous networking environments particularly for the benefit of eldery and disabled persons by the sensor network, RFID and robot technology.
Secure networks
Build the world's most durable network lifelines designed to withstand all forms of external threats and internal failure.
Sensing / Ubiquitous time-space infrastructure
Create advanced measurement, sophisticated time-space infrastrcture and positioning systems for use in environmental initiatives and disaster management

<New Generation Networks Architecture>

Create the networks based on innovative new concepts, using optical technology to extend into post-IP areas.

- Outline
  - Create network integration architecture with a long-term perspective into the future, including photonic networks, ubiquitous networks, and next-generation backbone networks. This architecture should be independent of current Internet architecture.

- Project goals
  - Develop core technology that stimulates innovation in the ubiquitous network society.
  - Enable Japan's world-leading broadband communications environment to support rapidly growing traffic and contribute to the world by playing a leading role in architecture development, to which Japan has not made much contribution thus far.
  - Develop an international cooperation / competition strategy so that the developed architecture will become a global de facto or de jure standard.
  - Maintain Japan's current, strong leading position in devices. International competition for routers is intensifying; therefore, Japan should also play a leading role in new-generation nodes, such as optical routers.

- The national government's role
  - Provide funds for R&D / tests of optical routers and optical RAMs. Produce project managers, coordinators, and producers.
  - Build the Beyond-JGNII network as well as a network interconnectivity / interoperation testing center. Manage open laboratory and support standardization activities.
  - Accumulate and effectively use experience gained from Beyond-JGNII demonstration tests conducted as a step towards practical use.

By 2010, develop next-generation network architecture that encompasses networks from IP-based NGN to future post-IP as well as all-optical photonic network technology and create a network for demonstration tests and R&D. Furthermore, based on the achievements of the aforementioned, develop a concept for subsequent new-generation network architecture for the future in order to conduct exploratory research toward the implementation of network architecture.

Road map outline

2010 — 2015

Enable the network to respond to a rapid increase in traffic / the concentration of traffic. At the same time, establish network architecture that allows autonomous connection for the selection of optimum network access and interconnection as well as greater freedom in allocating network resources, which can result in higher quality than a "best-effort" network.
Realize a 100-Tbps optical router that supports multidomain / multilayer networks and can provide wavelength paths on a gigabit scale according to user demand.

Establish address, routing, and signaling technologies for greater sophistication and enhanced functionality as well as "survival" network functions that can provide reliability as an infrastructure.
Develop an all-optic network, aiming to achieve a high-speed / maximum-speed broadband through such technologies as all-optic signal processing and ultrahigh-speed optical communications.
Conduct demonstration tests for new-generation network architecture.

Technologies of “New Generation Networks Architecture”

Establish one of the world’s first network architecture that goes beyond IP to build ubiquitous networks and next-generation backbones. The networks will be based on photonic technology that enables users to easily hold the initiative in using various applications and can support the high and fluctuating traffic volumes of ubiquitous networks.

	Around 2010	Around 2015
Network architecture	• Networks that integrate fixed and mobile communications as well as networks with speeds up to 100-Tbps are autonomously configured to establish network architecture that enables the selection/interconnection of the optimum network and quality control. • Establish traffic control logic for transmissions that include various priorities and characteristics. Develop the concept of new-generation network architecture based on this logic and conduct exploratory research on the establishment of such a network.	• Achieve greater sophistication and enhanced functionality in address, routing, and signaling technologies. Establish “survival” network functions that can be used in highly reliable infrastructures. • Develop autonomous / distributed operation and control technology, such as RFID tags and sensors, that can be applied to the ubiquitous network environment and conduct demonstration tests. • Conduct demonstration tests on new-generation network architecture.
Flexible management/control technology that can meet needs	• Establish multiformat node technology that supports various data of different types and granularity and allows different types of networks to be connected. • Establish technology that allows access at the 10-Gbps level and accelerate the implementation of ultrahigh-speed communications at the end-user’s site.	• Establish transmission processing capacity at the petabit level, technology that enables fine-tuning and flexibility in optical path bandwidth control, and integrated route control technology for multilayer / multidomain networks. • Develop interserver transmissions at the terabit level, ultrahigh-speed storage access, and ultrahigh-speed optical data distribution.
The most advanced photonic node technology	• Develop network control technology that can handle the combination of optical and IP networks and 100-Tbps optical routers to resolve bottlenecks at the core system. • Establish basic optical RAM technology that can be applied to optical packet routers that are able to process several hundred optical labels. • Develop optical communications systems with low standby power / high efficiency (above 2 bps/Hz).	• Develop integrated routers that support all-optical packet processing through all-optical ultrahigh-speed signal processing using optical RAM. • Develop the maximum speed possible in optical communications within the Shannon limit.

<Ubiquitous Mobility>

Create a super-broadband environment with mobile on the core, providing seamless coverage from space to every point on the globe.

- Outline
  - Realize the ubiquitous mobility environment where mobile networks, satellite networks, and fixed networks are seamlessly connected while working to expand spectrum resources. Users can use secure, user-friendly, high-performance terminals (high-performance appliances) to consistently access any content as necessary in a wide range of applications, including ITS, anywhere and anytime, under optimum conditions.

- Project goals
  - Build a social infrastructure that provides convenience and comfort based on Japan's leading mobile ICT through the development of system architecture and by providing an open site for demonstration tests.
  - Strategically achieve the world's standard through international cooperation and competition, keeping in mind that mobile technology will be used everywhere on the globe.
  - Conduct demonstration tests to develop technology that can be used in real-world situations. Provide an open environment to facilitate participation from various fields so that the technology can offer multiple uses.
  - Using satellite mobile networks in addition to terrestrial mobile networks, set up robust and flexible networks that can offer reliable connections anytime and anywhere for communication in times of disaster / emergency and a universal communications service to contribute to building a secure and safe society.
  - Promote efficient socioeconomic activities through various technologies, including ITS, and reduce the environmental burden of society.

- The national government's role
  - Play a leading role in efforts to develop seamless QoS and superhigh efficiency technology for spectrum usage. Build a test bed to develop and interconnect various mobile communications systems for practical use. Conduct technical demonstration tests in space using satellites. Conduct standardization activities. Produce project managers, coordinators, and producers.

Recognize light / high frequencies as new network resources to realize a seamless, strong ubiquitous mobility environment that covers all areas, from the earth to space, from wideband to low power, by 2015.

Road map outline

Realize an environment with seamless and scalable connections by setting up various IP-based mobile networks and fixed-mobile convergence (FMC) while working to expand spectrum resources.
Develop a mechanism that allows the coordination of quality of service (QoS) control / management in heterogeneous networks and advanced network management, such as traffic engineering and profile management, so that users can transparently access a wide variety of services.

Set up a scalable and strong ubiquitous mobile communications infrastructure within an environment that includes various types of networks and that can accommodate more than a few tens of millions of appliances, allowing users to select the optimum resource for their terminals or applications in accessing a wide range of services simultaneously / consistently.
The status of, and other information on, a large number of appliances with different capacities in various situations can flow freely throughout the network to autonomously and efficiently provide a seamlessly integrated communications environment that can spontaneously respond to even high-level services.

Technologies of “Ubiquitous Mobility”

Recognize light / high frequencies as new network resources to realize a seamless, strong ubiquitous mobility environment that covers all areas, from the earth to space, from wideband to low power, by 2015.

	Around 2010	Around 2015
Super-broadband / scalable mobile network technology	- Establish broadband communications technology at the gigabit level in office environments (nomadic) and above 100 Mbps when traveling at high speed. - Use the above technology to create the ubiquitous mobility test bed where demonstration tests can be jointly conducted by industry, academia, and government in an open environment.	- Establish super-broadband communications technology at the tens-of-gigabit level in office environments (nomadic) and at a gigabit level when traveling at high speed so that users can have ready access to broadband content. - Establish scalable and robust ubiquitous mobility network technology that can accommodate tens of million to hundreds of million appliances.
Technology for the seamless connection of heterogeneous networks	- Realize an environment with seamless connections by setting up various IP-based mobile networks and fixed-mobile convergence (FMC). - Establish technology that can realize QoS control / management and traffic engineering management among heterogeneous networks.	- Develop seamless handover technology that ensures QoS and services between heterogeneous networks, which include mobile networks, satellite networks, and fixed networks, from wideband to low power. This will allow users to access any content necessary in various situations under optimum conditions through a single high-performance appliance.
Spectrum resource development technology	- Establish technology for advanced methods of sharing radio spectrum usage, such as cognitive radio transmissions that autonomously adapt to the surrounding radio frequency spectrum usage. - Establish technology that promotes migration to radio frequencies, such as high microwave bands (6 to 30 GHz) and milliwave bands.	- Develop technology that enables the effective and transparent use of spectrum resources by having networks and appliances autonomously select the optimum wireless resource according to the situation / needs or by having them simultaneously use multiple channels. - Establish technology that enables wireless devices and RF circuits for high microwave and milliwave bands to be manufactured at a low cost, enabling the production of super-broadband smart appliances.
Ultra-high speed, highly reliable new-generation satellite communications system technology	- Enable the practical use of gigabit-class fixed satellite communications. - Establish satellite mobile communications technology with the same transmission speed level as third-generation (3G) mobile phones, which are dependable enough for use in times of disaster / emergency.	- Establish basic satellite communications technology that offers transmission speed at the 100-gigabit level as well as satellite mobile communications technology with the same transmission speed level as fourth-generation mobile communications systems. - Set up robust and flexible satellite communications networks that do not disconnect in times of disaster, emergency, or congestion. - Enable users to safely use the same appliance for both terrestrial and satellite networks without being aware of the difference.

<New ICT Paradigm>

Sow the seeds of ICT—the benefits of which Japan would reap in 20 years—such as basic technology for photonic / quantum communications and nano-ICT.

• Outline
- Establish photonic / quantum communications technology that enables the maximum reliability and transmission speed currently conceivable.
- Create a new ICT paradigm through the convergence of various fields, such as understanding and modeling the activities of the brain and peripheral nerves, applying nanotechnology / biotechnology to ICT, etc.

• Project goals
- Create new businesses by bringing about communications that go far beyond the traditional limitations of reliability and bandwidth by promoting basic research from a short-term perspective to medium- and long-term perspectives that target various quantum technologies, from the early implementation of quantum cryptography to the deployment of full-scale quantum communications networks.
- Promote basic research from a long-term perspective on the convergence of various fields in order to bring out the potential of individual fields as well as stimulate the birth of new technology and innovation through the synergy of various areas of knowledge, thus further strengthening Japan's lead in international competitiveness in ICT and triggering a paradigm shift that can lead global trends in the future.
- Achieve ultralow power consumption through nano-ICT to reduce the environmental burden caused by ICT.

• The national government's role
- Invest risk money in lightwave communications technology research projects, which include quantum relays and terahertz technology, and the convergence of nanotechnology, molecular technology, and biotechnology. Support exploratory research by supplying competitive funding. Build research centers for photonic / quantum communications research and nanotechnology / molecular technology / biotechnology research. Produce project managers, coordinators, and producers. Develop evaluation standards for quantum cryptography.

Work towards becoming one of the first to achieve / test component technology on which post-2020 technologies would develop, such as basic technology for photonic / quantum communications that enable maximum speed and reliability, as well as nano / molecular / bio-ICT that would form the basis for ICT's return to human elements.

Road map outline

2010 — 2015

Establish basic technology for a future optical system using lightwave and nano-ICT.
Set up an unconditionally safe city network using quantum cryptography key distribution and establish basic technology for quantum relays and quantum signal processing.
Create "brain communication" technology, which can read sensory perception. Model nerve activity involved in perception through the five senses and in movement.
Develop basic technology for the Next-Generation Network (NGN) using photonic / nano-ICT and untapped superhigh frequencies, basic technology for highly advanced networks that can repair itself based on biomodels, and molecular communications technology that has self-organizing functions.

Set up an ultrahigh-speed, high-reliability, high-adaptability photonic network based on the ultimate lightwave technology basics.
Quantum relays enable quantum cryptography to be deployed in backbone networks. Create new paradigms in photonic networks, such as quantum distribution networks and quantum communications, that go beyond the Shannon limit.
Develop a five-sense communication interface. Establish basic technology for the creation of a new ICT paradigm through the convergence of biotechnology and molecular technology.

Technologies of “New ICT Paradigm”

Work to establish photonic / quantum communications technology that enables the maximum reliability and transmission speed currently conceivable and create a new ICT paradigm based on the convergence of various fields, such as understanding and modeling the activities of the brain and peripheral nerves, applying nanotechnology / biotechnology to ICT, etc.

	Around 2010	Around 2015
Photonic / quantum communications technology	• Establish component technology for the ultimate lightwave technology. • Achieve a key distribution system for 1-Mbps transmissions within a 100-km radius and short-range wireless quantum encryption to deploy quantum cryptography in city networks. • Realize a small-scale / high-performance single photon source, photon detector, and entangled photon source in the communication bandwidth. • Establish basic technologies for quantum relays and quantum signal processing.	• Realize innovative optical systems, such as ultracompact optical nodes and large-scale integrated optical circuits. • Establish basic technology for large-volume quantum communications that surpasses the Shannon limit. • Realize long-range (over 100 km) quantum encryption through quantum relays. • Establish basic technology for authentication / payment using quantum technology, such as multifunctional security systems between multiple parties. • Establish practical technology for quantum information processing and basic interface technology.
Nano / molecular / bio-ICT network technology	• Realize optical regenerative repeaters and optical delayed OADM in order to achieve a compact / low-power network using nanotechnology. • Realize a high Q value and optical confinement through photonic crystal technology. • Establish technology for quantum dot formation in the 1.55-μm wavelength range. • Establish basic technology for nanophotonics using near-field optics. • Establish advanced self-repairing network technology based on biomodels. • Establish component technology for the coding, selection, and transmission of information using molecules as part of molecular communications technology.	• Realize ultracompact optical nodes, universal connections, and large-scale integrated optical circuits. • Realize nanogate / carbon nanotube FET. • Realize advanced nanophotonic signal processing circuits based on near-field optics. • Establish new information communications foundation technology through the convergence of biotechnology and molecular technology. • Develop molecular logic elements. • Develop prototypes for RFID tags and wearable information communications devices.
Basic technology for using untapped superhigh frequencies (terahertz technology)	• Realize a quantum cascade laser that can maintain continuous oscillations at room temperature for applications in hazardous substance detection and biometrics. • Create a terahertz spectral database. • Establish basic technology for high-end routers that operate at 160 GHz, which will enable ultralarge volume communication.	• Realize compact spectral imaging devices that can perform real-time measurements. • Integrate spectral databases in various areas. • Realize sensors / wireless LAN integrated networks in the terahertz bandwidth.
Basic biotechnology that returns to human elements	• Model nerve activity involved in perception through the five senses. Model nerve activity involved in movement. • Decode brain activity and develop basic technology that applies the knowledge obtained.	• Realize a five-sense communication interface. • Establish a foundation system, such as the decoding analysis of simple brain activity for “brain communication.”

<Ubiquitous Platform>

Build a platform with which authentication, billing, distribution, and service integration can be handled easily online.

- Outline
  - Achieve a service integration platform that enables users to select / coordinate reliable services as necessary from a vast number of services offered in the ubiquitous network society where various appliances—including information appliances and mobile terminals—and networks are interconnected.

- Project goals
  - Realize architecture for the autonomous formation of communities and the integration of services.
  - Conduct demonstration tests to make full use of communities and examine technology for the interoperation of services, thus creating new businesses through a collaboration of businesses that was formerly impossible due to differences in industry or the scope of services (national / local).
  - Commit to international cooperation necessary for the standardization of platform technology and play a leading role based on Japan's strength in information appliances and mobile terminals.

- The national government's role
  - Provide funds for R&D / demonstration tests for ubiquitous platform technologies that can support the dynamic formation of communities. Produce project managers, coordinators, and producers. Build an open test bed.

By 2010, realize a highly flexible common platform technology that promotes the use of ICT in service integration, authentication, billing, and copyright management.

Road map outline

2010 — 2015

Create a service platform on top of high-speed wireless / wired networks to serve as the ubiquitous common platform that allows the effective interoperation of personal information space, social systems, and services. Establish common technology that seamlessly integrates terminal technology, including mobile phones and information appliances, with server technology.

Establish community technology that dynamically forms and manages the connection (community) between users and services formed according to the user's current situation on a service platform.

Technologies of “Ubiquitous Platform”

Establish common platform technology with high security and interoperability to promote the use of ICT in service integration, authentication, billing, and copyright management.

	Around 2010	Around 2015
Ubiquitous service platform technology	• Create a service platform that serves as a common ubiquitous infrastructure on top of high-speed wireless / wired networks to establish cooperative architecture that allows the effective interoperation of personal information space, social systems, and services.	• Enable connection (community) between services and users as well as among services to be formed and managed dynamically according to the user’s current situation. • Build an integrated platform that enables a higher level of efficiency and safety in performing authentication, billing, and copyright management.
Basic technology for personal authentication/billing systems using ubiquitous network appliances	• Ensure high-speed interconnectivity between ubiquitous network appliances, such as IC cards, RFID tags, and information appliances, as well as high reliability in their mutual authentication / interoperability.	• Build an authentication / billing system that fundamentally improves security features to enable the formation of communities by connecting users to services according to the user’s needs. • Enable the selection of highly secure communications and service information on an appliance network.
Basic technology for digital rights management (DRM)	• Establish the foundation for digital rights management that can flexibly support various copyright management methods according to content type and value and that enables any device to meet the terms of use and provide the appropriate protection of rights.	• Establish a new system for generic copyright management that will allow a smoother flow of information.
Ubiquitous platform integration technology	• Build a test center for ubiquitous platform interoperability to widely test the interoperability of various devices and services.	• Build and manage a test bed that would become the foundation in developing new systems, testing the interoperability of those systems based on the new architecture, and contributing to playing a leading role in international testing.

<Secure Networks>

Build the world's most durable network lifelines designed to withstand all forms of external threats and internal failure.

- Outline
  - Develop an information communications network with autonomous recovery / repair functions that can respond to emergencies and failures, functions to prevent illegal access and attacks by computer viruses, functions to authenticate the other party during communication, and functions to prevent failure, accidents, and network deterioration.

- Project goals
  - Overcome vulnerability to failures caused by natural disasters, errors in routing information, and operation errors as well as vulnerabilities to malicious attacks like those found in traditional network infrastructures to ensure the dependability of ICT as a social infrastructure so that ICT use can be safe, secure, and effective.
  - Realize system architecture that meets the demands of the ubiquitous network society and that will contribute to improving security technology throughout ICT.
  - Conduct open demonstration tests that takes into consideration the real-world Internet environment to develop system managers to protect the network and that contributes to reviews from not only technical aspects but also operational aspects, such as ICT governance.

- The national government's role
  - Provide funds for development / demonstration tests of component technology that blocks malicious communication. Produce project managers, coordinators, and producers. Build an open laboratory. Build a test bed that simulates peering into the real-world Internet and can be shared by all R&D. Build a test center for the evaluation of security. Build a large-scale security exercise network simulator.

Deploy one of the world's most robust network lifeline technologies by 2010. This network will enable the safe / secure exchange of information anytime between anyone and have functions that automatically repair, respond, prevent, and protect against failure to ensure anyone the full-time availability of communications, including during such times of emergency as cyber-terrorist attacks and natural disasters.

Road map outline

2010 — 2015

- Establish basic technology for stability, durability, predictability, traceability, restorability, and safety to build an infrastructure that can be protected against communications breakdown in times of disaster, failure caused by routing information error or operation error, and malicious attacks, including information leaks as well as attempts to damage communications facilities via the network.
- Based on above, develop network architecture that is robust enough to resist failures and malicious attacks.
- Build a large-scale failure simulation network for systems administrator training.

Establish a new-generation network that offers safety, reliability, assurance, security, durability, and restorability as an information communications infrastructure.

Technologies of “Secure Network”

Develop an information communications network with autonomous recovery / repair functions that can respond to emergencies and failures, functions to prevent illegal access and attacks by computer viruses, functions to authenticate the other party during communication, and functions to prevent failure, accidents, and network deterioration.

	Around 2010	Around 2015
Network building technology	• Establish network autoconfiguration technology, easy-to-manage addressing technology that assigns addresses according to network configuration, and technology that secures alternative routes so that networks can autonomously recover if communications routes are cut off by accident / natural disasters.	• Set up new-generation networks that are highly durable / restorable by developing autonomous network formation technology. • Implement ICT that remains robust in times of emergency or failure.
Network management technology	• Make operation management technologies that are already established for existing telephone networks also available for the Internet, including technology used to understand the overall structure of the Internet network; wide-area monitoring technology that monitors overall traffic status; technology that maintains / secures sessions; traceback technology; technologies that detects, recovers, and prevents communications failure caused by routing information errors; and technology that detects and controls traffic anomalies.	• In new-generation networks, implement automatic traffic control that manages congestion and priority based on automatic traffic monitoring. • Set up networks based on the above technology to realize stable and reliable networks that are highly dependable and do not inconvenience users even when a large of volume data or high-priority data are being transmitted over the network.
Technology that blocks malicious communication	• Establish technology that automatically collects information on the types of malicious attacks, technology that supports the development of prevention measures according to the types of attacks, and low-latency filtering that cuts off attacks without delay. At the same time, improve resistance against attacks on communication devices. • Establish operation technology that enables cooperative prevention against attacks and the remote monitoring of terminals.	• For new-generation networks, develop technology that detects and cuts off attacks. • Cooperate internationally to prevent the large-scale spread of malicious communication in new-generation networks.
Technology that prevents wiretapping / spoofing	• Establish technology that embeds an authentication system within the network as well as VPN technology that offers very easy user setup. • Make the operation of highly reliable technologies possible, such as encryption / digital signature technology that protects data from wiretapping and tampering as well as re-encryption technology that can be used in case the encryption is breached. • Establish technology to save logs in forms that can be used later as evidence.	• Establish and put into practical use VPN technology, authentication technology, and encryption technology in the new-generation network. • Establish the reliability of a communication source, including the identification of that source, in the new-generation network by monitoring traffic and managing logs.

<Sensing / ubiquitous space-time infrastructure >

Create advanced measurement, sophisticated time-space infrastructure and positioning systems for use in environmental initiatives and disaster management.

- Outline
  - Set up a network that recognizes the real-world environment by integrating networks from short-range / urban sensor systems to a global terrestrial / satellite integrated observation network and detects disasters and provides disaster relief support for the protection of people's lives and property.
  - Develop basic technology that serves as a common platform for using ICT to provide social security, including technology to use untapped frequency bands for the maintenance and development of a source platform for the high-precision time-space information and frequency standard, frequency standard and sensor technology, and EMC.

- Project goals
  - Trigger innovation through the effective use of information, such as the location, status, and movement of people / objects by capturing real-world information in cyberspace.
  - The interaction of real-world and cyberspace is expected to promote new ways of utilizing the ubiquitous network, such as using ICT to reduce environmental burden. For this reason, it is important to develop human resources that are familiar with dealing with real-world situations.
  - Actively capture real-world information in cyberspace to work towards creating new businesses that offer new network services based on real-world environments.
  - Contribute to solving various social problems, including environmental problems and disasters, by using a terrestria / satellite integrated observation network.

- The national government's role
  - Provide funds for developing component technology / demonstration tests for space monitoring technology. Build an infrastructure. Build a center for space / earth environmental information. Build a center for time-space information / standard applications. Build a center for electromagnetic environment evaluations.

By 2015, develop the following technologies that use satellite positioning systems and sensors to recognize time, location, environmental status in real time so that ICT can contribute to a securer and safer society: measurement / sensor technology with the highest quality of precision, real-time distribution technology of satellite data, real-time simulation / visualization technology, and ICT platform technology with the highest precision and reliability.

Road map outline

Set up a global terrestrial / satellite integrated observation network that includes short-range / urban sensor systems, i.e., information system / service for ionospheric storms and magnetic storms.

Implement multisensing systems for environmental information—which includes accident / disaster information from urban areas to global / space—as well as a data distribution system and an information system that can produce real-time forecasts concerning such things as the sun / space and the earth's environment.

Technologies of “Sensing / ubiquitous space-time infrastructure”

Establish measurement / sensor technology and space technology with the highest precision that comprehensively covers environmental information from the atomic / molecular level to outer space, a high-precision time-space / frequency standard that will be the foundation for all ICT, and an infrastructure for the electromagnetic environment.

	Around 2010	Around 2015
Measurement / sensor technology and space technology with the world highest precision that comprehensively covers environmental information from the atomic / molecular level to outer space	- Implement a short-range / urban sensor system as well as global environment observation system and an observation system for ionospheric storms and magnetic storms in space that can cause GPS errors. - Establish basic technology for using untapped frequency bands for sensors, such as the terahertz bandwidth.	- Implement multisensing systems for environmental information—which includes accident / disaster information from urban areas to global / space. - Establish technology for using untapped frequency bands for sensors, such as the terahertz bandwidth.
Technologies for real-time simulation using information from sensors that collect disaster / environmental change-related information, creating digital images, information broadcasting, and system development	- Set up a global terrestrial / satellite integrated observation network that includes the above sensor system and information systems / services that capitalizes on the observation system. - Establish technology that creates real-time digital images from sensor data on the order of one million. - Establish basic technology that leads to deploying a disaster warning system / barrier-free system on the order of several meters. - Establish basic technology that distributes large-volumes of satellite data at several Gbps in real time.	- Implement an information system that can produce real-time forecasts concerning such things as the sun / space and the earth’s environment. - Establish technology that creates real-time digital images from sensor data on the order of one hundred million. - Establish basic technology that leads to deploying a disaster warning system / barrier-free system on the order of several centimeters. - Implement a system that distributes large-volumes of satellite data at several Gbps in real-time.
Maintenance / development of a source platform for a high-precision time-space / frequency standard	- Establish technology that generates / provides reliable time-space / frequency information anytime, anywhere.	- Establish technology that generates / provides the world’s leading real-time, high-precision time / location information.
Foundation for a comprehensive electromagnetic environment in which anyone can exchange information safely / securely	- Establish comprehensive wideband electromagnetic environment technology that covers bands to the microwave level.	- Establish a comprehensive ultraf-wideband electromagnetic environment technology that covers bands to the milliwave level.

< Context awareness environments >

Create user-friendly ubiquitous networking environments particularly for the benefit of older and disabled persons by the sensor network and robot technology.

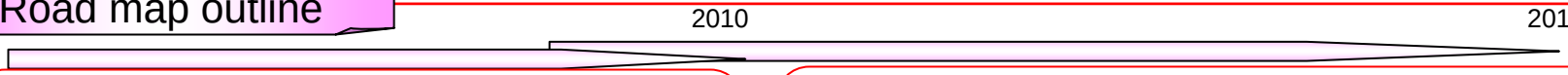
- Outline
  - Create an environment that supports the daily lives of each individual based on a comprehensive ubiquitous network system.
  - With an eye to developing user-friendly appliances, easily connected devices, and town facilities that detect danger in advance and guide people to safety, create monitoring technology that supports the elderly as well as technology that supports community activities while preserving traditions, outdoor activities, and lifelong learning, and combining these with content creation / distribution technology and communications technology to develop an integrated social infrastructure that connects ubiquitous networks, sensor networks, network robots, and home networks to form a secure large-scale ubiquitous environment that can meet the demands of an aging society.
  - Reduce energy consumption by improving the efficiency of transportation and production by using the ubiquitous network and realize an eco-friendly society through such efforts as promoting paperless operations.

- Project goals
  - Connect ubiquitous networks, sensor networks, and home robots to form architecture for sophisticated coordination, such as complementing functions and collaboration.
  - Conduct demonstration tests to clarify the kind of daily life support that can provide true benefit as well as what is necessary in a social infrastructure system.
  - Work towards passing on knowledge and skills to the next generation, creating opportunities for the elderly to find fulfillment in an aging society with a declining birthrate.
  - Realize the dream of ICT appliances supporting individuals in everyday life.
  - Realize the ubiquitous network environment that is grounded in the real world by considering operational matters, such as privacy and governance, in addition to technical matters.
  - Implement power control by having ICT recognize real-world status information in order to bring about a society that minimizes energy consumption, thus contributing to reducing the burden on the global environment.

- The national government's role
  - Build a test bed of the ubiquitous network town that simulates a user-friendly and eco-friendly ubiquitous network society environment that capitalizes on ICT. Provide funds for development / demonstration tests of component technology for networks, robots, sensors, and information appliances.

Develop ubiquitous network environment technology for the realization of a user-friendly and comfortable new-generation intelligent housing environment that uses networks, robots, sensors, and information appliances while keeping an eye on the arrival of a superaging society as well as the realization of an energy-efficient society. This environment is to be developed by 2010 with the private sector participating in the efforts.

Road map outline



Establish basic technology that enables the network to interact with the real world, for example, coordinating network robots and actuators. Establish basic technology that enables networks, such as short-range / urban sensor systems, to collect real-world information. Establish basic technology that enables networks to analyze real-world information, such as technology to build / use ontology and context analysis technology.

Integrate the technology that enables the network to interact with the real world, technology that collects real-world information, and technology that analyzes real-world information to establish monitoring technology that supports the elderly and the handicapped as well as technology that supports community activities while preserving traditions, outdoor activities, and lifelong learning. Conduct demonstration test / evaluations for coordinated use with content creation / distribution technology and communications technology.

Technologies of “Context awareness environments”

Establish technology that collects information on the user’s surrounding environment through the coordinated functions of systems, including network connections, and provides services accordingly.

	Around 2010	Around 2015
RFID technology	• Establish flexible tag information management technology that exchanges information between various tag platforms.	• Use the action history provided by RFID tags together with background information on the user to autonomously determine the user’s status and purpose and apply the information to provide summary information and a context service. • Enable the coordinated use of a wide range of appliances.
Sensor network technology	• Establish real-time, large-volume data processing / management technology to appropriately pick out necessary data from the information sent from a vast number of sensors.	• Use information from a vast number of sensors and background information on the user to autonomously determine the user’s status and purpose and apply the information to provide summary information and a context service. • Enable the coordinated use of a wide range of appliances.
Network robots	• Establish robot communication technology that is dramatically improved compared to current technology in communicating with humans.	• Use the robot’s authentication / stored / history information and the user’s background information to autonomously determine the user’s status and purpose and apply the information to provide a life-support service. • Enable the coordinated use of a wide range of appliances.
Home network technology	• Establish technology that exchanges information within a home network even when devices use different communication standards.	• Establish technology that recognizes the user’s status from information flowing through a home network to provide healthcare services and useful information. • Enable the coordinated use of a wide range of appliances.
Environmental evaluation technology, environmental information distribution, and guidance based on the information	• Establish technology that can evaluate functions, environmental burden, and benefits in a social system in a comprehensive manner rather than individually.	• Establish technology that guides users to conduct activities in an environment-friendly way when shopping or moving from one place to another.

<Universal Contents Creation / Distribution>

Create an environment in which anyone can produce any content they wish and in which content can be accessed while ensuring reliability.

• Outline
- Enable functions to search for content as needed by the user and convert it into a form that is most accessible to the user according to the type of terminal, personal preference, and physical capability. At the same time, create an environment that enables anyone to capitalize on the content creation knowledge of experts through “smart” user interfaces to create sophisticated content using a wide variety of materials.
- Realize an environment in which various kinds of content can be created, distributed, and used safely by enabling the flow of content that would flexibly form a community and allowing users to select useful communities or knowledge according to their needs from a number of communities with different levels of reliability.
- Realize an environment in which knowledge learning / inference systems and reliability / credibility validation systems can be used in accessing information and services from networks that contain a vast number of wide-ranging information and services while maintaining credibility and appropriateness.

• Project goals
- Establish an environment that can bring out personal talent and promote value creation through the synergy of various areas of knowledge and effectively use existing knowledge together with newly produced knowledge / values to enable innovation to overcome various problems in society and implement sophisticated services.
- Efficiently concentrate users / data and conduct open demonstration tests across multiple operators to support various users and operators.
- ICT for content has international de facto or de jure standards that produce considerable economic advantage. The project will work to gain such advantage by developing and carrying out a strategy for international cooperation and competition.

• The national government’s role
- Create a global content archive. Create databases of know-how and knowledge. Provide funds for the development / demonstration tests of component technology for content that is perceived through all five senses. Obtain knowledge from the standpoint of human science. Provide project managers, coordinators, and producers. Implement a comprehensive content promotion policy through the joint efforts of government ministries and agencies (group of policies). Develop technology that recognizes / protects the copyright holder, software that checks for copyright infringement, financial support, and tax incentive measures for investment in content creation, research, and development.

By 2015, develop advanced technology to search, edit, and distribute content. This technology will enable an environment in which anyone can easily handle and use content in sophisticated ways, drawing from sources of information that encompass all types of knowledge, including videos, music, and dictionaries, that are made available to the public.

Road map outline

2010

Enable the development of knowledge bases for know-how and other knowledge concerning content creation, easy production of video content through tools, and safe distribution and easy search via the Internet.

2015

Develop technology that supports content creation and enables anyone to use the knowledge bases to produce professional content that can appeal to all five senses. Build systems to transmit / render content while adapting to various networks, terminals, and users. Enable the collection of reliable information to be available on the network.

Technologies of “Universal Contents Creation / Distribution”

By 2015, develop advanced technology that searches, edits, and distributes content. This technology will enable an environment in which anyone can easily handle and use content in sophisticated ways, drawing from sources of information that encompass all types of knowledge, including videos, music, and dictionaries, that are made available to the public.

	Around 2010	Around 2015
Capitalize on the content creation knowledge of experts	• Develop knowledge bases for know-how and other knowledge concerning content creation. • Systematize content description that enables sophisticated processing and editing.	• Establish technology that supports content creation and enables anyone to use knowledge bases to produce professional content that can appeal to all five senses. • Establish universal content production technology that uses knowledge bases.
Technology that produces / distributes / presents content according to needs	• Realize distributed collaborative content creation / editing technology on networks. • Realize technology that safely searches, analyzes, and edits necessary data via the Internet from organized and systematized archives, including such multimedia content as videos and knowledge information.	• Build systems that can autonomously select routes, security levels, and time-space levels that are suitable for the network, appliance, and / or user to distribute / present content. • Establish technology that converts and presents the most suitable content for the user’s access situation and knowledge as well as the supporting content description system and terminal / transmission / browser technology.
Knowledge learning / inference system Information reliability / credibility validation system	• Establish automatic example collection and corpus building technology. • Establish basic technology that obtains knowledge from natural language as well as basic inference logic.	• Build an asset of large-scale corpus that categorizes a wide range of information and knowledge for easy use. • Develop technology that selects / obtains reliable and credible information.
Technology for content that is perceived through all five senses	• Establish basic sensing and recognition technology that enables the user’s status to be tracked with a five-sense communication interface. • Establish basic technology for modeling users, including viewer psychology measurements.	• Establish technology that creates structured content that is perceived through all five senses as well as technology that processes copyrights. • Realize appliances for content that is perceived through all five senses. • Realize a production system for five-sense content based on viewer psychology models.

<Super-communications>

Create super-communications systems designed to eliminate the barrier of language, knowledge and culture.

- Outline
  - Realize communication for true mutual understanding that accurately conveys the message of the speaker, including gestures and other nonverbal* information in addition to the speech itself. This is carried out not only at the surface level of literal speech but takes into consideration the knowledge, culture, surrounding situation, and physical capacity behind the speech to transcend differences in language, culture, background information, age, and situation.

*Nonverbal: Nonlinguistic communication, such as gestures, facial expressions, and tone of voice.

- Project goals
  - Promote intellectual creativity as well as maintain and strengthen Japan's international competitiveness by solving the communication gap caused by differences in language and culture.
  - The project is targeted at Japanese, which is a language not used in any other country, to solve issues specific to Japan, including the Japanese language and culture.

- The national government's role
  - Provide funds for development / demonstration tests of component technology, such as natural language processing. Promote the creation of a database of background knowledge. Provide a test bed.

By 2015, develop supercommunication technology that dramatically improves human communication ability and enables everyone to exchange accurate communication between Japan, Europe, the United States, and the rest of Asia that transcends language, knowledge, and cultural barriers.

Road map outline

2010 — 2015

Create a corpus of about 100 million examples and their translations as well as a search protosystem. Realize the multilingual translation of major Asian and European languages at the everyday-speech level as well as media-integrated search.
Create a model of background culture and personal knowledge in the following steps: create dataset → model culture gap → utilize generation / dialogue evaluation technology → utilize technology that recognizes messages / feelings.

Establish technology that converts the sender's information according to the receiver's personal knowledge model. Create a knowledge database that supports multiple languages and includes nonverbal information in everyday speech. Use these to conduct demonstration tests aimed at the application of the technology to other Asian and Western languages, further development of the first target languages, and knowledge sharing.

Technologies of “Super-communications”

Establish technology that builds, automatically creates, and converts semantic structures, both verbal and nonverbal, and finds methods to express the message based on these, taking into consideration social conventions.

	Around 2010	Around 2015
Natural language processing technology	• Establish natural language syntax analysis technology. • Establish technology that automatically collects examples of natural languages and automatically creates a corpus. • Establish basic technology that obtains knowledge from natural languages. • Standardize the semantic structures of the Japanese language.	• Establish technology that automatically builds a correspondence between the languages of different cultures. • Translation technology between different languages • Create a large-scale corpus.
Nonverbal processing technology	• Categorize action and intention in nonverbal behavior.	• Establish nonverbal message analysis technology.
Communication enhancement technology	• Establish analysis technology for information through the five senses. • Develop equipment that presents content to each of the five senses. • Clarify the human recognition / understanding mechanism.	• Establish technology that encodes / communicates five-sense information.
Knowledge community technology	• Establish technology that analyzes / obtains knowledge and common perception in communities. • Technology that carves out communities from the flow of various areas of knowledge.	• Establish technology that estimates the social acceptability of a community. • Establish technology that obtains reliable information in a community.

<Common reality communications >

Create the first ever realistic 3-D video communication systems.

- Outline
  - Develop super-virtual reality video / sound systems that make the viewers feel as if they are really in the scene, three-dimensional arbitrary viewpoint video rendering systems, and super-virtual reality systems that capitalize on information obtained through various forms of perception, including the five senses, and gestures. For example, understanding and modeling the activities of the brain / peripheral nerves enable the transmission of sensory information that traditional human interfaces cannot detect / render. Furthermore, by enabling the smooth flow of information from these super-virtual reality systems on a network, face-to-face communication, where the difference between virtual reality and true reality is hardly noticeable even via the network, is possible.

- Project goals
  - Effectively use existing knowledge with newly produced knowledge / values to enable innovation and overcome various problems in society and implement sophisticated services.
  - Enable people to share culture, art, and sports experiences through audiovisual content and pass on those experiences to the next generation through archives, thus contributing to the creation of knowledge and effective use of that knowledge.

- The national government's role
  - Provide funds for the development / demonstration tests of component technology that obtains, transmits, stores, and plays large volumes of information. Produce project managers, coordinators, and producers. Build a test bed for super-virtual reality video.

Launch a super-virtual reality / three-dimensional communication / broadcast by 2020. This will use virtual reality technology, including three-dimensional video, in which the difference between virtual reality and true reality is hardly noticeable.

Road map outline

2010 — 2015

Develop a prototype for Super Hi-Vision or natural-vision technology that enables colors to be rendering true to life and create, display, and distribute three-dimensional video that has an image quality level that matches current television broadcasting. Establish modeling / interface technology that perceives information from all five senses, which goes beyond that from only the senses of sight and sound.

Establish a scalable super-virtual reality audiovisual rendering system that can meet wide-ranging purposes and create, display, and distribute high-resolution three-dimensional videos.
Through the combined use of super-virtual reality three-dimensional videos, RFID tags with a five-sense interface, and information obtained from sensors, including gesture information, realize a very real feel in communication as if everyone was at the same location. Also, develop a versatile multipurpose mobile appliance that supports five-sense communication.

Technologies of “Common reality communications”

Launch a super-virtual reality / three-dimensional communication / broadcast that uses virtual reality technology, including three-dimensional video, in which the difference between virtual reality and true reality is hardly noticeable.

	Around 2010	Around 2015
Super-high resolution image capture / display technology (Super Hi-Vision)	• Develop full specifications for image capture / display equipment and a system with 4,000 scan lines to build a high-resolution video system (Super Hi-Vision).	• By effectively using image capture / display equipment for Super Hi-Vision, realize a super-high resolution video system that virtually offers 8,000 scan lines.
Super-parallel photonic / electronic technology	• Gain rough knowledge on the bioevaluation of the eye and brain regarding vision to develop prototypes for super-parallel optical systems for image display. Combining this with the above Super Hi-Vision technology, confirm the operation and performance of the resulting three-dimensional video rendering system.	• Organize knowledge on the stereoscopic mechanism of the human eye from psychological / physiological aspects, improve the performance of super-parallel optical systems and integrate them with the above system to form a three-dimensional video rendering system that can be applied for practical use. • Use the above to realize technology that effectively presents / communicates three-dimensional images in super virtual reality.
Compression / transmission / viewpoint rendering technology	• Develop an algorithm to efficiently compress Super Hi-Vision and three-dimensional images. • Pioneer an arbitrary viewpoint video rendering system that is in line with the above algorithm.	• Implement Super Hi-Vision and a compression algorithm for three-dimensional image rendering by hardware and establish transmission technology via 21-GHz satellites and broadband. • Develop equipment that can efficiently render the arbitrary viewpoint image from the compressed / transmitted data.
Audiovisual integration technology	• Select audio and other sensory information that is appropriate for the image and find the keys to understanding the acceptance characteristic of the senses when the image is combined with other sensory information as well as the activities of the brain / peripheral nerves involved in emotional information.	• By understanding and modeling the acceptance characteristics of the senses and the communication mechanism for emotional information, organically integrate image and other sensory information, including audio, to build a super-virtual reality system where the difference between virtual reality and true reality is hardly noticeable.

5 Policy in Promoting UNS Strategic Programs

Policy in Promoting UNS Strategic Programs -Role of government and associated background support-

Standardization

- Joint promotion of R&D and standardization
- Promoting openness by strengthening interconnectivity and interoperability tests
- A bigger role to be played by NICT※ and other organizations in promoting standardization
- Stronger efforts in the private sector to support the development of human resources for international standardization activities

Developing Human Resources

- Develop young researchers in the ICT field and secure personnel
- Work to improve the ability of project managers
- Expectations of NICT complementing the development of human resources for R&D at universities and companies

The Ideas-Based R&D

- Promote R&D that is creative and unique
- Promote regional R&D
- Support young researchers

Role of Government

☐ **Promotion Policy of the Three Strategic Programs**

> **International leadership ; Promote R&D to strengthen industrial competitiveness with an eye to providing an actual use for the technology**

> **Security and Safety; Promote stable and consistent R&D to support the security of Japan and its people**

> **Intellectual Creativity ; Research on the convergence of human / social sciences and the creation of large-scale databases**

☐ **Common Promotion Policy for All Three Programs**

> **Promote exploratory R&D to trigger a paradigm shift**

> **Establish / manage a large-scale, open R&D infrastructure**

Transfers of Technology Licenses

- Committing to R&D with an eye on society's needs
- Expectations of NICT as the bridge between industry, academia, and the government

Active Use of Research Evaluation

- Conduct research evaluations that bring about achievement
- Conduct multilateral evaluations according to the goals of the research
- Build an efficient evaluation system and evaluation structure

※ NICT：National Institute of Information and Communications Technology

5.1 The Government's Role in Promoting UNS Strategic Programs

<Promotion Policy of the Three Strategic Programs>

- **Promote R&D to strengthen industrial competitiveness with an eye to providing an actual use for the technology:** International Leadership Program
  - Focusing on a project R&D budget that capitalizes on technology with competitive strength
  - Commitment to R&D with an eye to providing an actual use for the technology in order to overcome the "Death Valley" of technology
  - Enhancing international cooperation with Asian and other overseas universities and public R&D institutions

- **Promote stable and consistent R&D to support the security of Japan and its people:** Security and Safety Program
  - R&D that requires neutrality and fairness in its achievements
  - R&D that is involved in the security of Japan and its people
  - Maintaining and developing standards to serve as a foundation for R&D

- **Research on the convergence of human / social sciences and the creation of large-scale databases:** Intellectual Creativity Program
  - Creating a large-scale database and archives
  - Promoting efforts toward the convergence of fields, such as human and social sciences
  - Commitment to R&D that is closely related to relations with other countries, national systems, cultures, and social systems

<Common Promotion Policy for All Three Programs>

- **Promote exploratory R&D to trigger a paradigm shift**
  - Commit to exploratory research and development, such as basic research and long-term research, in which the return on investment is difficult to determine.
  - Serve the role of an incubator that stimulates breakthroughs and innovations.
  - Support a wide range of areas to prepare for the future, such as areas that are currently receiving little attention.

- **Establish / manage a large-scale, open R&D infrastructure.**
  - Build large-scale test beds as well as accumulate experience in the operation technology of large-scale systems.
  - Support R&D in the validation phase at an open laboratory.
  - Serve as a core R&D center for ICT to act as a bridge between industry and academia as well as between different industries.

5.2 Associated Background Supports

- **Promoting Standardization**
  - Joint promotion of R&D and standardization
  - Promoting openness by strengthening interconnectivity tests
  - A bigger role to be played by NICT and other organizations in promoting standardization
  - Stronger efforts in the private sector to support the development of human resources for international standardization activities
- **Developing Human Resources**
  - Develop young researchers in the ICT field and secure personnel.
  - Work to improve the ability of project managers.
  - Expectations of NICT complementing the development of human resources for R&D at universities and companies
- **Promoting the Ideas-Based R&D**
  - Promote R&D that is creative and unique.
  - Promote regional R&D
  - Support young researchers
- **Active Use of Research Evaluation**
  - Conduct research evaluations that bring about achievement.
  - Conduct multilateral evaluations according to the goals of the research.
  - Build an efficient evaluation system and evaluation structure.
- **Promoting Transfers of Technology Licenses**
  - Committing to R&D with an eye on society’s needs
  - Expectations of NICT as the bridge between industry, academia, and the government
- **Establishing Other Environments**

5.2.1 Promoting Standardization

- **Joint promotion of R&D and standardization**
  - Clarify where standardization stands in the R&D project.
  - Evaluate the standardization in the R&D project.

- **Promoting openness by strengthening interconnectivity tests**

- **A bigger role to be played by NICT and other organizations in promoting standardization**
  - NICT to strengthen efforts to develop human resources for standardization and conduct standardization activities as well as interconnectivity tests
  - Strengthen standardization organization within Japan to strengthen upstream standardization activities

- **Stronger efforts in the private sector to support the development of human resources for international standardization activities**
  - Promote the exchange of views between CTOs in charge of R&D and standardization.
  - Secure personnel for standardization activities and properly evaluate said personnel.
  - Reduce the load for standardization activities and support the international standardization process.
  - Increase participation to international standardization activities.

5.2.2 Developing Human Resources

- **Develop young researchers in the ICT field and secure personnel.**
  - Develop and present an attractive vision of ICT that is full of possibilities as well as its career path.
  - Plan efforts to attract the interests of junior high school / high school students who may become future ICT researchers.
  - Provide R&D funds specifically to young researchers.
  - Develop researchers in a wide range of areas.
  - Promote an exchange of information between researchers both in Japan and overseas to enhance industrial competitiveness.

- **Work to improve the ability of project managers.**
  - Expectations towards NICT that can lead projects
  - The R&D management structure should include both young and older researchers

- **Expectations of NICT complementing the development of human resources for R&D at universities and companies**
  - Support the development of researchers who can quickly respond to newly emerging and converging areas.
  - Secure supporting engineers who can contribute their expertise in supporting the most advanced research.

5.2.3 Promoting the Ideas-Based R&D

- **Promote R&D that is creative and unique.**
  - To maintain consistent technical strength into the future, it is essential to stabilize the foundation for wide-ranging areas of emerging technologies. Focus resources on the Ubiquitous Priority R&D Project from the top down. At the same time, promote support for R&D from the bottom up, where each research that won in a competition can bring out its uniqueness and creativity.
  - Research in emerging fields has the potential to be future technology. These fields must be considered for exploratory research that could produce results for the next generation of Ubiquitous Network Priority R&D Projects.
  - Hold contests and invite entries in order to select the research that may develop in the future even if its direction is unclear and that complies with the standards set out by forums.
  - Also, support research that applies technology to practical use through joint efforts of industry, academia, and government. Promote the technological transfer of unique / creative technology in the R&D phase.

- **Promote regional R&D**
  - Hold competitions and accept entries from regional areas in order to develop R&D strength and support the promotion of R&D to solve local issues through ICT.

- **Support young researchers**
  - While R&D resources tend to focus on distinguished researchers, develop young researchers by making concentrated efforts to support and evaluate appropriately those who have won competitions with their unique and creative projects.

5.2.4 Active Use of Research Evaluation

- **Conduct research evaluations that bring about achievement.**
  - Conduct research evaluations that contribute to producing better results, such as those with the standpoint of encouraging researchers.
  - Conduct research evaluations that promote innovation.

- **Conduct multilateral evaluations according to the goals of the research.**
  - Evaluations must be made from the perspective of not only evaluating potential seeds but also addressing the needs from the people's standpoint.
  - Do not conduct evaluations in a uniform way but according to the system or purpose concerned.
  - Conduct evaluations that are not constrained by numeric evaluation indices.

- **Build an efficient evaluation system and evaluation structure.**
  - Build an efficient, high-quality evaluation system that eliminates waste and duplicate efforts.
  - Develop evaluation personnel, including young personnel, and support capacity-building to create a fair evaluation system.
  - Establish an evaluation system with world-class reliability.
  - Establish a management system that enables a sufficient level of regular communication between the entity or personnel performing the evaluation and the entity being evaluated.

5.2.5 Promoting Transfers of Technology Licenses

- **Committing to R&D with an eye on society's needs**
  - It is necessary to shift from seed-oriented R&D (a concept that says good technology will eventually blossom) to R&D with an eye on society's needs.
  - It is necessary to provide continuous follow-ups to determine whether the benefits reaped from R&D are returned to society.
  - It is necessary for industry, academia, and government to combine their knowledge in order to establish an environment that would promote smooth R&D activities that lead to the practical use of the technology.
  - It is necessary to provide support in raising start-up funds, such as government policy-based financing.

- **Expectations of NICT as the bridge between industry, academia, and the government**
  - Provide a place where industry, academia, and government can exchange ideas so that academia and government will have the opportunity to learn of market needs.
  - Create market needs through the joint efforts of industry, academia, and government.
  - Educate researchers, including those of NICT, on intellectual property and support intellectual property produced in the various stages of R&D.

5.2.6 Establishing Other Environments

- Build an environment to promote R&D that successfully incorporates the effectiveness of individual development capacity and open technology.
- Promote joint efforts by various government ministries and agencies as well as cross-organizational coordination and cooperation that involve different departments and companies.
- Establish an R&D promotion system that functions as a consistent effort based on the creation of a vision.
- Develop ICT governance.
- Provide tax breaks and policy-based financial support to promote R&D.