New-Generation Network R&D Project

新世代ネットワーク戦略プロジェクト

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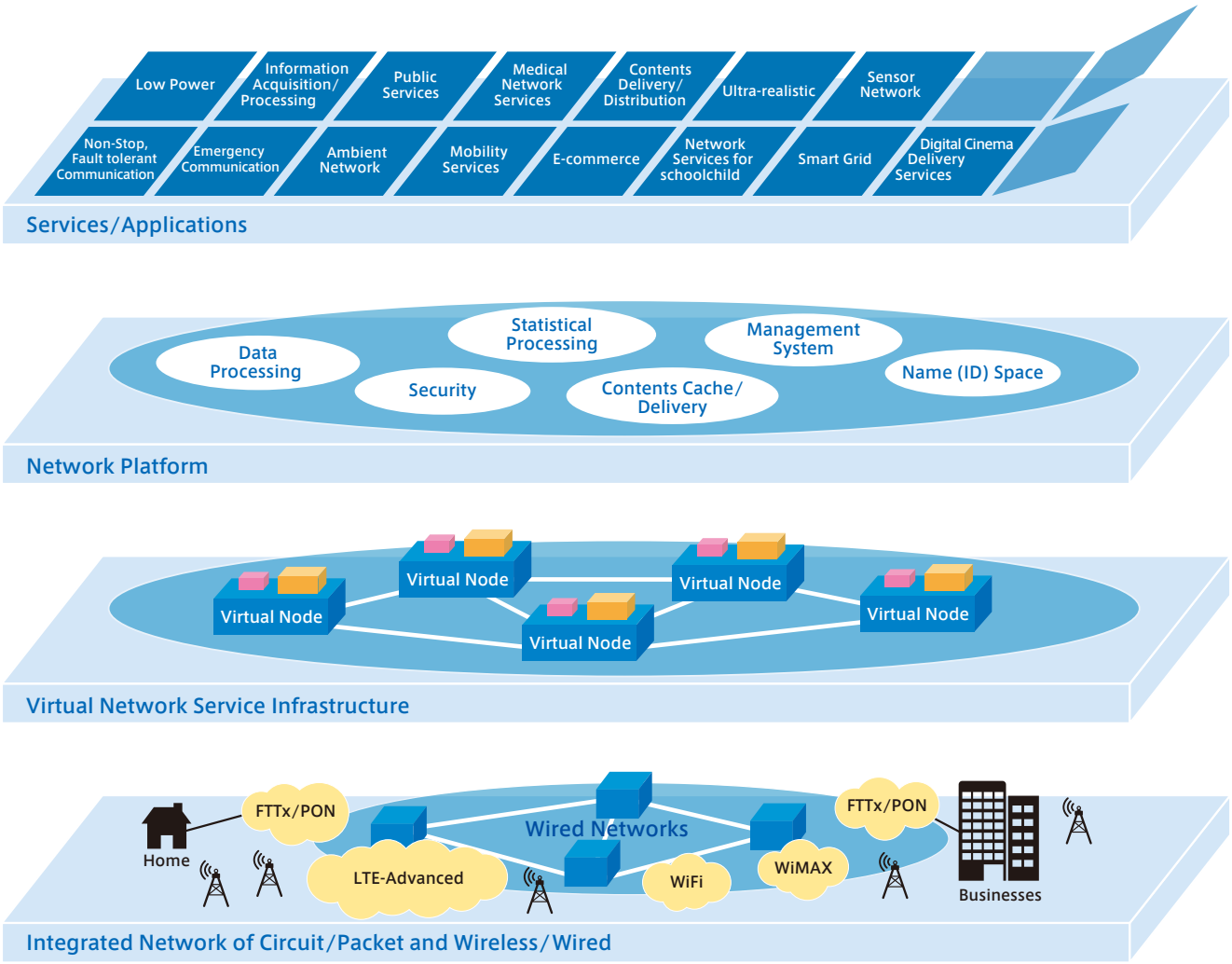
Looking Beyond the Next Generation Network

As a result of the prevalence and enhancement of computer networks, our social community has dramatically changed and improved so we can hardly do anything without the Internet now. The network keeps growing, and its traffic volume is predicted to go beyond 10,000 times more than today's network by 2025. Accordingly, power consumption by ICT is expected to increase as well so it may restrict users to use the Internet in the near future. In addition, security monitoring is required to prevent spam mails or any malicious activities, such as DOS attacks, which are caused by large amount of illegal traffic. Thus, the Internet needs security breakthrough to cope with such threats that become smarter and more complex. Moreover, the Internet has several structural problems, such as redundant functions or compatibility issues due to the accommodation of additional features introduce to the network. If those problems on security or structure remain unsolved, the network eventually will lose its function as a social infrastructure.

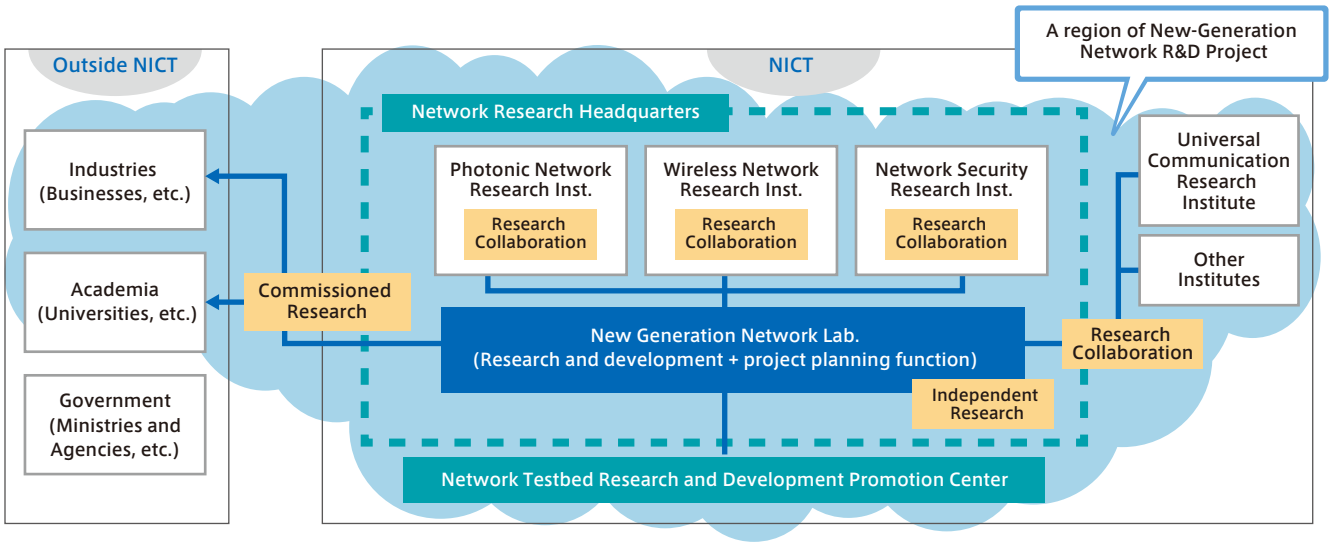
We have been researching and developing the New-Generation Network based on the principle of "clean-slate" rather than that of "patching the Internet". We aim to create a network that serves as a new social infrastructure with a life span of 50 to 100 years, free from the problems that today Internet has.

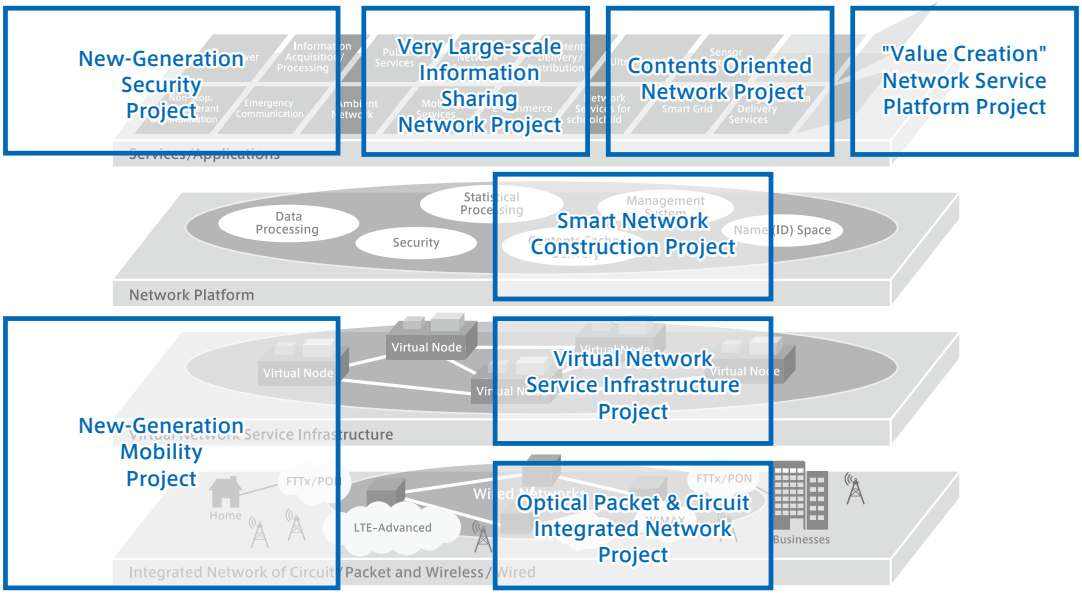


New-Generation Network R&D Project

Creating R&D cooperation: industry, academia and government

The project for the New-Generation Network R&D started in FY 2010 for the realization of the New-Generation Network.
It involves a wide-range of research on networks; from wired to wireless, from physical to contents, or from cutting-edge technologies to applications. For this reason, various researchers who have different experience and background should carry out comprehensive cooperation. For the success of such a broad R&D cooperation, a nation-wide research and development system or framework is necessary. In addition, unique ideas born in academy must be introduced to boost the project. Furthermore, research outcomes from the project must be handed-over to industry smoothly so they can use the ideas to evolve the current Internet architecture.
We, on the basis of contracted or joint research frameworks between academia and industry, perform R&D activities ranging from transport to service, for the realization of the New-Generation Network.





New-Generation Mobility Project

BYON (Bring Your Own Network): To realize a new generation mobile network infrastructure that can always locally configure a service-specific network

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Background — Increased demands not only for 'network connectivity' but also for 'service- or application-specific connectivity'

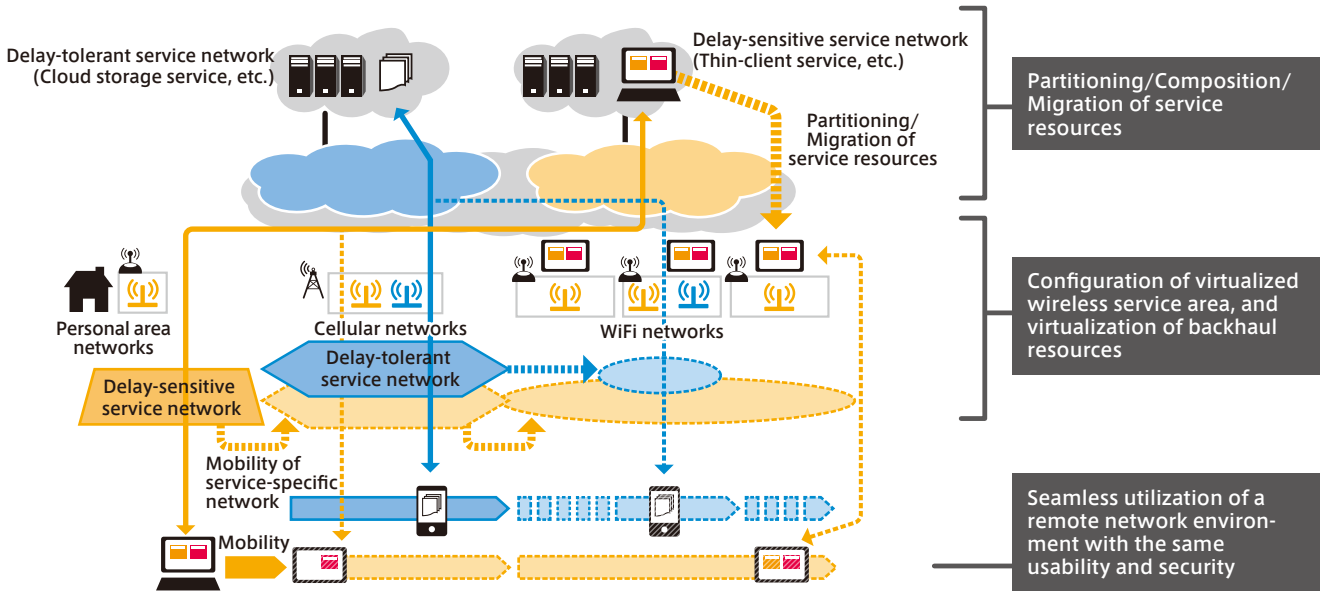
With the rapid advances of mobile network technology, it has been an era that one can enjoy the network services such as voice call, e-mail, WEB surfing, and SNS (Social Networking Service), even on a high-speed train or traveling abroad. Moreover, there is a high demand from mobile devices of accessing remote office networks and various kinds of cloud services. However, a large amount of traffic of delay- and losstolerant services tends to disturb the connectivity of some delay-sensitive or emergent services in the case of dense mobile devices and wireless sensors situation. As a result, there is a trend to hope a technology that enables a remote user to use the ordinary office/home network with the usual usage and security, but without any complicated pre-configuration or exclusive networks.

Objective — Enable BYON (Bring Your Own Network): a new generation mobile network infrastructure that can dynamically configure a service-specific network nearby the users without making the users conscious of the location or environmental changes.

The requirements for security, latency and communication qualities differ from different types of mobile services and applications. One of our goals is to develop a technology to differentiate a target service's traffic from the other's and dynamically configure a service-specific network, which should solve the problem that delay-sensitive services' traffic are disturbed by other traffic as described above. Another goal is to develop a technology which enables a remote or travelling user to utilize the ordinary office/home network with the same usability and security.

Themes — R&D of mobile network virtualization and service mobility to enable BYON (Bring Your Own Network)

1. R&D to dynamically configure a virtualized wireless service area upon service's or application's request adapted for the geographical distribution of mobile devices and the access frequency
2. R&D to manage backhaul resources in coordination with the virtualized wireless service area
3. R&D to partition/composite/migrate service resources aiming for a new generation thin client service
4. R&D to seamlessly utilize a remote network environment with the usual usage and security



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Very Large-scale Information Sharing Network Project

Realizing a network treating over a trillion objects

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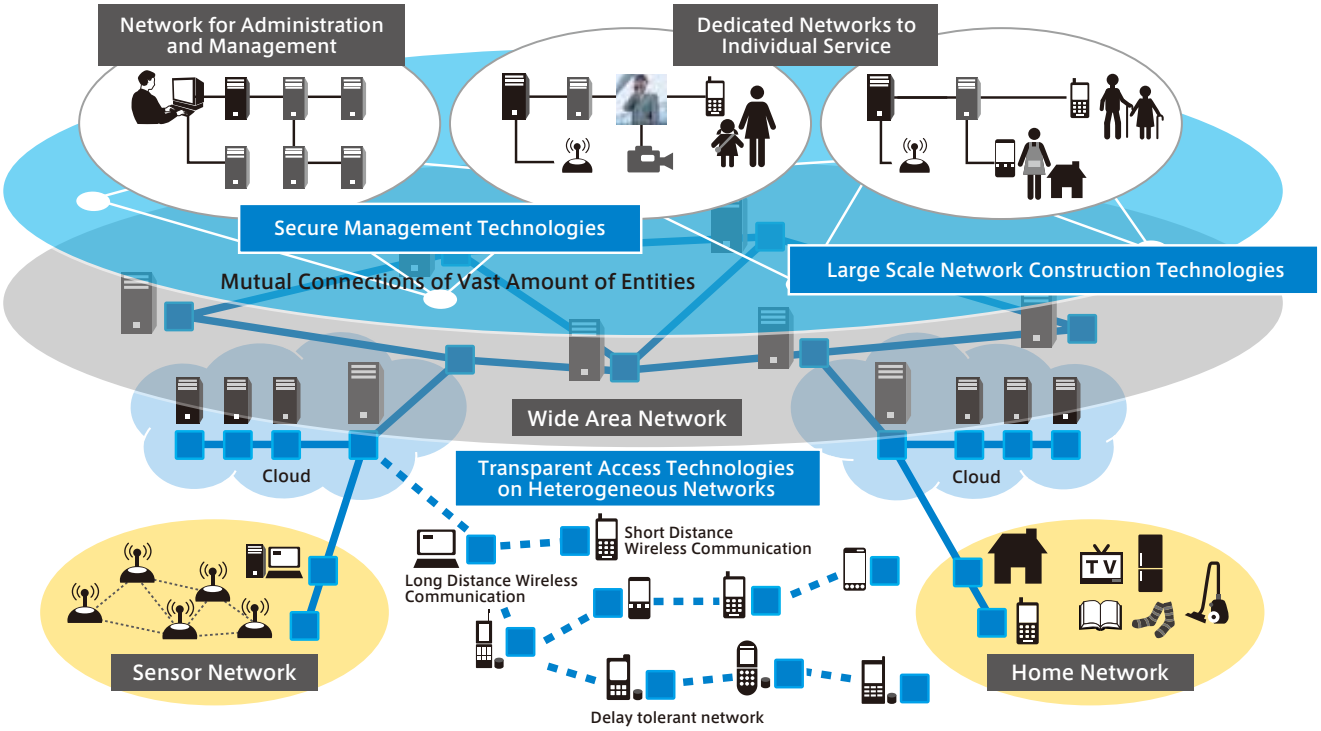
Background — Recently, it is increasingly expected that 'objects' which currently lack enough communication functions, i.e. physical entities like daily necessities, sensors or devices embedded in the environment will be connected to the network and utilized in the same way as users and contents in the current information systems. Such network can improve the overall utilization and convenience of social infrastructure. However, current Internet has no capacity to treat a huge number of objects, over one trillion by some estimations, distributed in the real world.

Objectives — The objective of the research includes developing basic technologies for large-scale information sharing network platform that can treat a huge number of contents, users and objects as interoperable open resources. Specifically, the objective of the research is to design transparent access method of different kind of objects and network construction method to enable safe and efficient information sharing that can treat discoveries or distributions of objects.

Theme

1. 'Large Scale Network Construction Technologies', that treats the discoveries of objects or facts and information distributions to the users or services thereon in a large-scale and wide-area environment.
2. 'Transparent Access Technologies on Heterogeneous Networks', for the transparent treatment of heterogeneous types of entities in the network.
3. 'Secure Management Technologies', for both protections from network abuses and safe and secure management/use of information services.

We test and prove our research outcomes on a wide-area network test-bed 'JGN-X'.
The new type of applications and services of the Future Internet or the New-Generation Network will be available; the social system will become smarter and our life circumstances will become safer, more secure, more creative, and friendly to humans and environments. Furthermore, economic impacts are expected by expansion of domestic demands through consolidation of industries and emergence of new industries.



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Optical Packet & Circuit Integrated Network Project

Toward the low-energy network to support diversifying network services

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Background — People today easily communicate with others thanks to the prevalence of the Internet. Now, people's demands are growing for high-quality network services, such as entertainment, medical, or other quality-of-life oriented services, in addition to demands for data-communication services at 40 Gbps maximum at present with higher speed and higher stability. In addition, an energy-saving society based on ICT technologies is a common target worldwide.

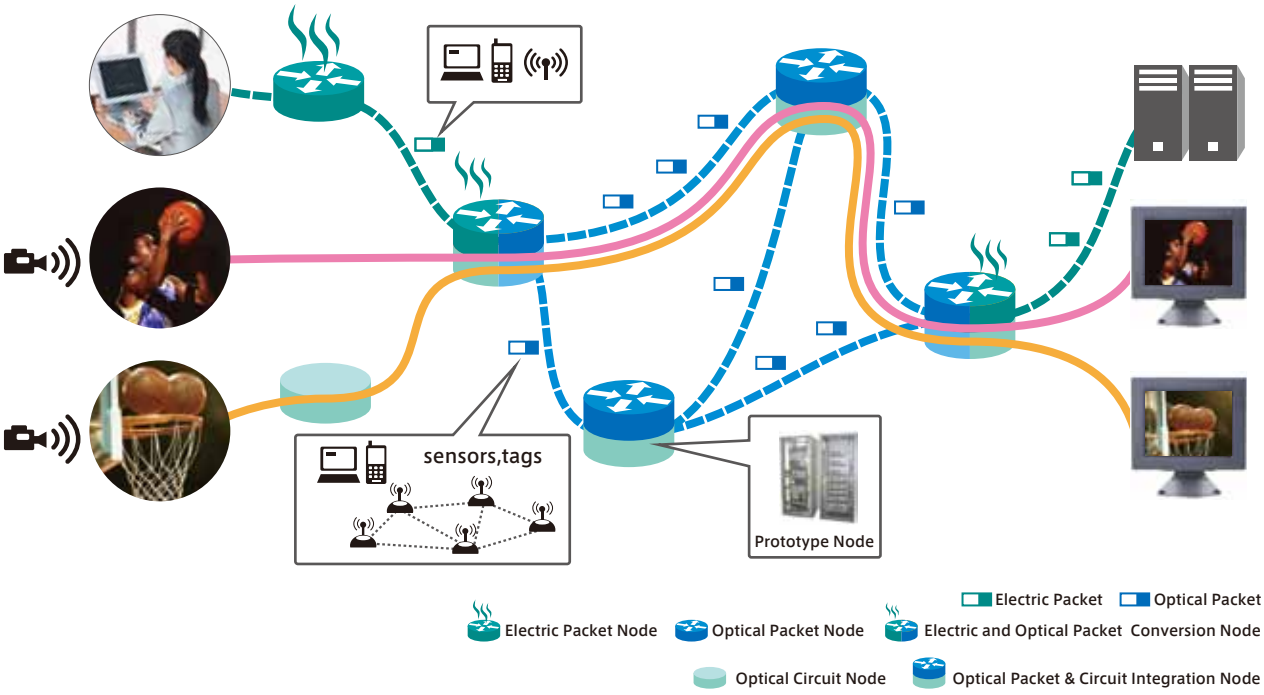
Objectives — We aim to, through the Optical Packet & Circuits Integrated Network technologies, benefit both network users and network providers. We provide users with higher-speed more cost-effective network services, and short-delay low data-loss high quality services, through both a packet-switching service and an end-to-end path service enabled by our technologies. We enable network providers to consolidate their networks separately built for the Internet and leased-line networks, into a united and low-power-consumption network.

Theme

1. We build networks satisfying the following:
   - High-speed: handling growing traffic and improving user-service quality;
   - Diversity: satisfying a wide range of user demands;
   - Low power: application of optical packet & circuit switching and adaptive power-control.

   For these purposes, we develop network nodes capable of optical-packet switching with high-speed header processing, optical burst-signal stabilization, and optical buffering and optical-circuit.
2. Also, we develop optimum packet and path resource boundary control, QoS routing, and quality assurance of mobile communications.
3. We execute proof-of-concept/operation experiments on different test beds (optical test beds, subscriber fibers, or virtual networks), assuming that services start in 2020.

High quality, telemedicine and high-precision video communication not feasible today will be available at low-cost, and energy-efficient power. It will contribute to the realization of a high quality-of-life and low-energy society.



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Virtual Network Service Infrastructure Project

Base of the New-Generation Network Infrastructure for ICT innovation

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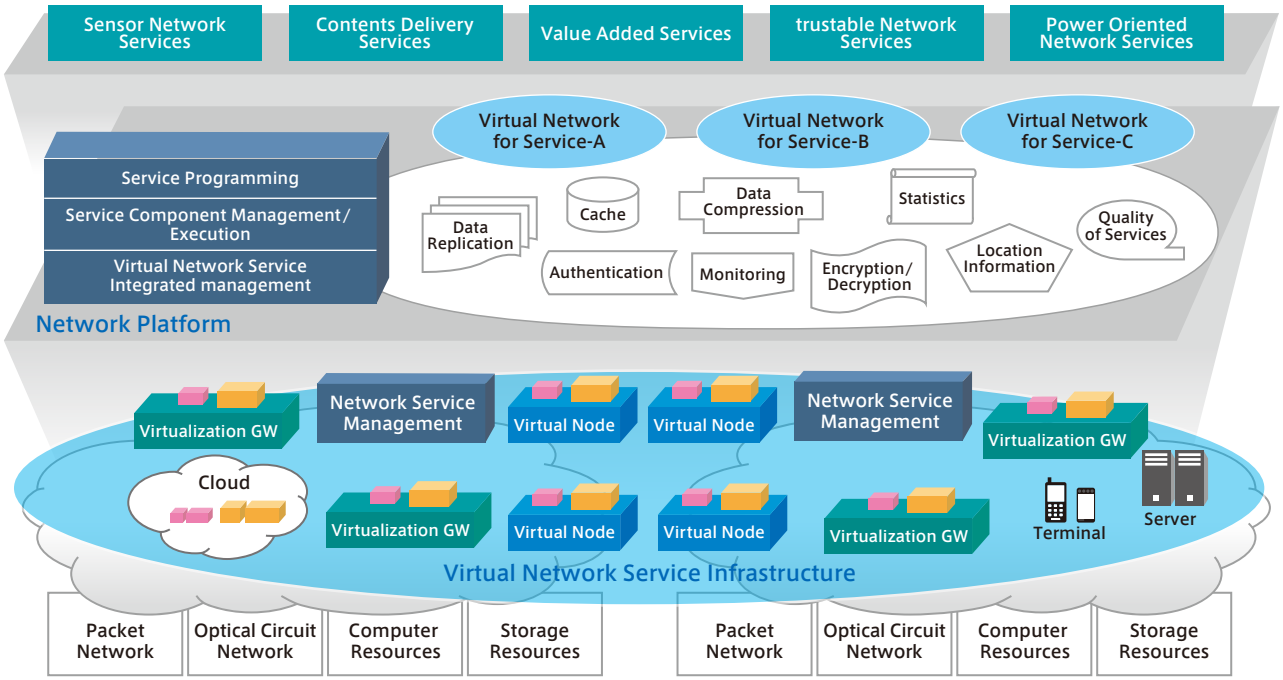
Background — The Internet, with its IP-centered architecture, has been realized as a worldwide network infrastructure to enable information exchanged from any place to any place. However, it has no frameworks to solve recently emerging problems and has suffered from the integration of patches that have been created with a shortsighted policy. Now, we need a revolutionary breakthrough to move to the next age.

Objectives — To develop the Virtual Network Service platform as a framework for introducing new functionalities to the new era. The infrastructure virtually serves as a platform where a network operates through its resource isolation (Isolation) and programming (Programmability) features. It also intends to provide developers with easy-to-use platforms where proof-of-concept or experimental validation is required to verify innovative networks.

Theme —

1. A virtual network using wavelength paths besides the conventional packets, for strictly separating networks; and
2. A platform allowing component packaging of target network architectures or services, and creating a new network service on the virtualized network by integration of those packages.

We expect that Virtual Network Infrastructure will create an innovative network with a life span of over 50 years that are long enough to accept new functions based on user demands. We hope that service-innovations emerge due to the new features introduced to the network, and ICT enriching human life come into the world.



Commissioned Research ア(A) "Architecture Design and Implementation of Advanced Network Virtualization Infrastructure : ANV"
: **NTT※, Tokyo University, Hitachi, NEC, FUJITSU**

Commissioned Research イ(I) "Network Platform for Flexibly-Programmable Advanced Service Composition over Virtualization Network : FPASC"
: **KDDI R&D LABS※, Tokyo University, NEC, Hitachi,**

Commissioned Research ヴ(U)1 "Application for Content Distribution in New Generation Networks with In-Network Guide: In-Network Guide"
: **Kansai University※, Osaka Prefecture University, Kobe University, NEC**

Commissioned Research ヴ(U)3 "Relational Metrics for New-generation Network Applications: Relational Metric"
: **Kyoto University※, The University of Electro-Communications, Kobe Digital Labo**

Commissioned Research ヴ(U)4 "Energy Efficient, Enhanced-type Data-Centric Network: E3-DCN"
: **Keio University※, Hitachi**

Commissioned Research ヴ(U)8 "Robust data transmission over multi-sliced virtual networks: ROMSNET"
: **NTT※, Keio University**

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Smart Network Construction Project

Toward networks with high availability and agility through layer re-configuration and automation

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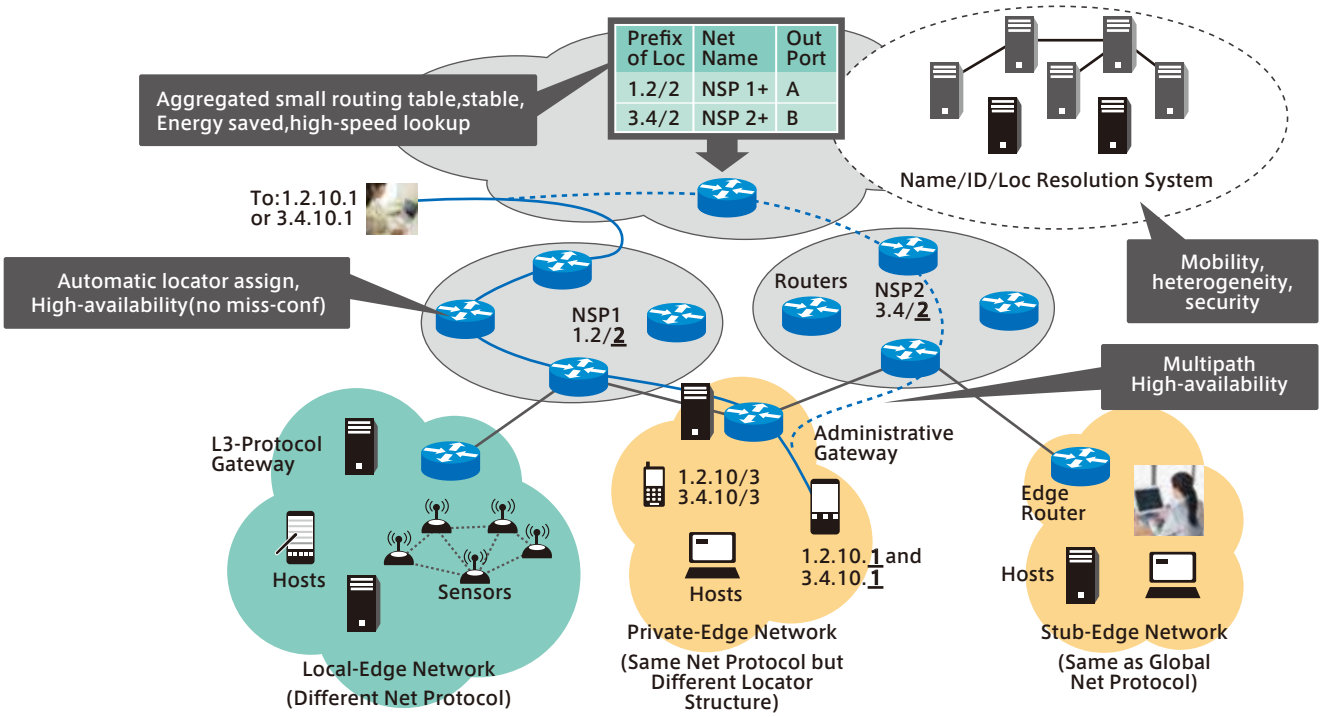
Background — The present networks have the following problems: (1) growth of circuit-scale, and process time for prompt address-search, and route-convergence time, caused by bloated routing tables; (2) increase of administration cost due to simultaneous management of more than one network layer; (3) degradation of availability caused by human error during manual operations in address configuration and name resolutaion; and (4) increase of delays in mobile communications and inaccessibility between heterogeneous network protocols.

Objectives — We aim to develop networks with an innovative layered-structure where ID's, as information identifiers, and locators, as location identifiers, are separated. The network facilitates mobility of terminals and sensor devices and communication between heterogeneous network protocols. We provide network administrators with high-speed, highly reliable, and easy-to-manage networks, enabled by smart network technologies by using hierarchically structured locators and automatic locator setting for hosts and registration to name resolution servers. We also provide users with highly convenient and highly reliable networks enabled by automatic and adaptive-to-situation selection of optimum networks with a stable speed and routes.

Theme

1. Development of technologies that use hierarchical locator structure and ID/locator split architecture to prevent route-table-bloating when a new provider or computer is added to the network.
2. Development of technologies that ensure security through automated locator selection/setting and registration to name servers, in order to eliminate administrators' complicated operation-work.
3. Total design and implementation, including ID/locator separation and transport layer control.
4. Large-scale proof-of-concept experiments on StarBED3 and wide deployment through the implementation on JGN-X.

A simple/smart structure and the management of networks will support the automation of network operation and lead to less human error. Safe, secure, stable, and easy-to-use high-speed networks will be provided to ordinary users.



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New-Generation Network Security Project

To achieve authentication, privacy and security technologies for over ten trillion entities

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Background — According to the growing of the network, it becomes too complicated to realize secure network. It makes unaware security risks.

In the NWGN, we suppose ten trillion network devices are connected; that is one thousand devices for one person, and there are ten billion persons in the world. Existing authentication schemes and privacy enhancing techniques cannot meet this situation. We must deal with not only PCs but also smartphones and RFID tags, which has less computation power. We must protect authenticity and privacy for such kind of devices with different computation power.

Objective — Ensure security efficiently for large-scale and multimodal network.

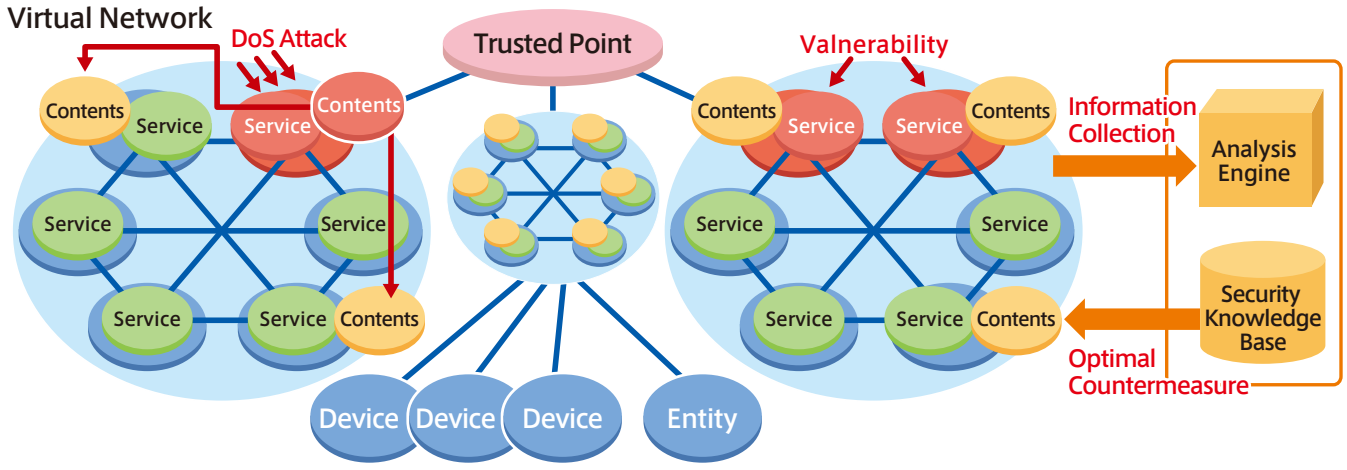
Existing authentication and privacy enhancing technologies are based on public key cryptography. Hence, key management is quire important. This key management operation is not feasible for one ten trillion network devices. Thus, reducing key management cost is quite important issue.
The more the network become complicated, the more it becomes difficult to find appropriate security technologies to cover security risks. Thus, the mechanism to find appropriate security technologies for such situation become so important.

Themes — Developing security technologies for huge number of network devices

1. We develop authentication scheme suitable for ten trillion network devices. Especially, we develop authentication schemes which reduce key management cost which affect operation cost and network efficiency and implement to many kinds of devices.
2. We develop technologies which can recognize network security risks and find appropriate security technologies and teach to devices and users for huge-scale network.

Optimal security configured infrastructure depending on network situation

To achieve optimal security measure depending on the New-Generation Network situation



Infrastructure of authentication/privacy protection for over ten trillion Entities

To achieve Device/Property authentication for vast amount of entities

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Content-Oriented Network Project

Network assisted architecture enables efficient information dissemination

Background – From server-centric communication to content-oriented networking

Traditional IP based one-to-one communication potentially degrades data transmission quality, especially when a server is located far from clients or a network is congested. Although CDN and cloud computing escape from some of the troubles, yet it is difficult to optimize the transmission quality and the network resource usage. On the other hand, many users tend to access to the same contents even in the recent Internet. According to these aspects, we study the content-oriented networking, which makes network itself cache popular contents and assist users in retrieving contents.

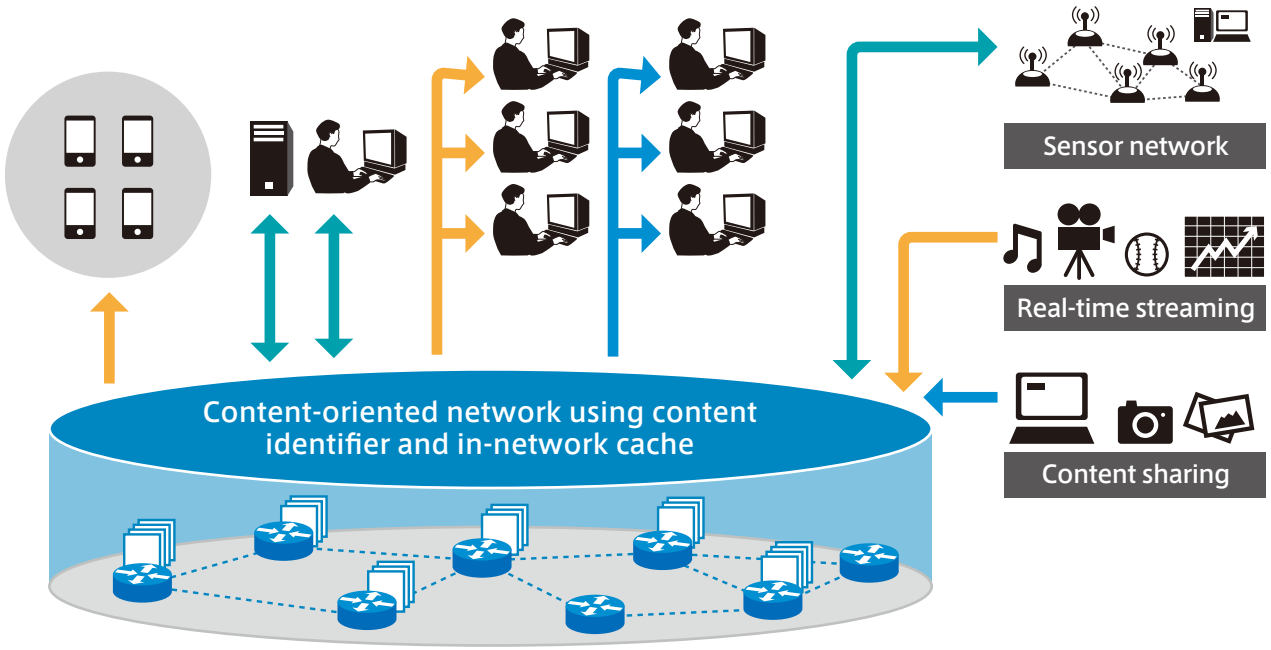
Objective — We aim at developing technologies of optimizing transmission quality and improving network resource usage

In the content-oriented networking, a user specifies a content name (or identifier) to retrieve data, not only from a publisher but also from in-network cache. This technology improves data transmission quality and provides effective network resource usage. It can be also applied for real-time communications. For example, it contributes to live streaming applications broadcasting contents to many users, or sensor applications collecting a huge amount of data from distributed sensors.

Themes — The content-oriented networking technology we apply will provide effective information sharing and dissemination and lead the great possibilities for the future Internet

- Distributing contents through optimized path(s) (instead of relying on shortest path)
- Developing distributed in-network cache algorithms
- Supporting real-time as well as delay tolerant communications

We will evaluate our research outcomes in a large scale testbed or the Internet, and work toward practical use of the future Internet technologies. The evaluated technologies will contribute to the safe and security social infrastructure in the future.



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"Value Creation" Network Service Platform Project

Information service-controlled network

Background — Networks, during flexible transport of data abruptly generated beyond expectations or analysis of enormous amount of data through trial and error, are required to re-configure themselves according to the level of urgency or the importance of required information services, so as to avoid an extraordinary increase of management or operation cost.

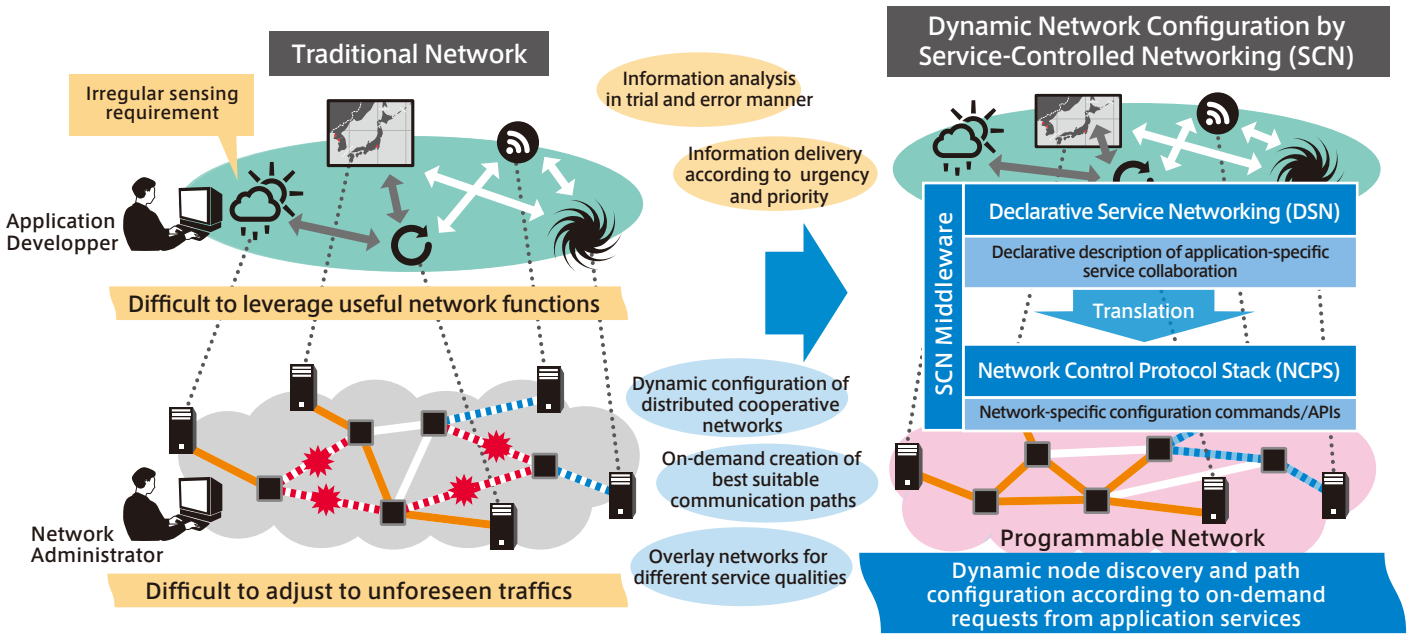
Objectives — We develop new technologies for precisely and promptly delivering information service requests to networks and dynamically adjusting network configurations in order to process an enormous amount of data distributed in networks and efficiently collaborate different information services, on the basis of the high processing power and scalability of the New-Generation Network Infrastructure.

Theme — Specifically, we aim at the following:

1. Proposing information service-controlled networking,
2. Building open test-beds for the collaborative development of applications with the composition of information services,
3. Integrating the research outcomes into the New-Generation Network Infrastructure.

In particular, the information service-controlled networking technology supports the functionalities of information service coordination embedded in networks and continuous service delivery. Our technology enables networks to handle unexpected, suddenly occurred information such as disaster mitigation information, analyze vast amounts of data by trial and error, and prioritize information delivery according to urgency or importance. In addition, it allows searching and providing alternative information services on the New-Generation Network Infrastructure.

We will contribute to the realization of the Future Networks(Recommendation ITU-T Y.3001)objectives, such as “Data-Oriented” or “Service-Oriented” , by implementing the information service-controlled networking. Networks will have capabilities to accept information service requests and to dynamically adjust their configuration in the New-Generation Network Infrastructure. Finally, we expect the future networks to be configured on demand for establishing ad-hoc and high-efficient communication paths between services and nodes, and logically segregating communication traffic according to service types or environments, even though certain situations happens such as natural disasters.



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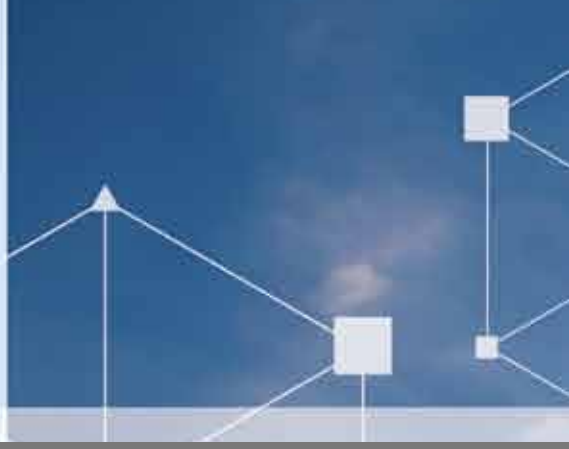

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