New-Generation Network R&D Project

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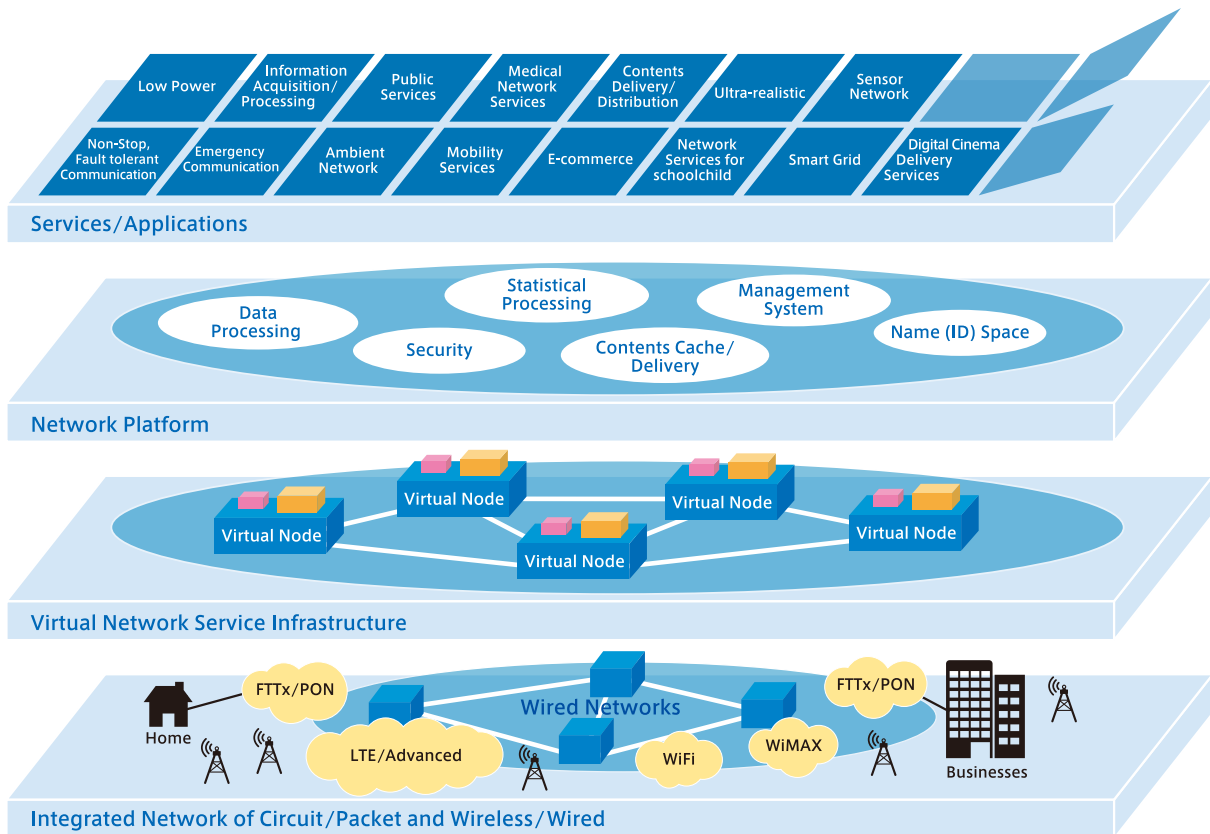Fax: +81-42-327-7587
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Looking Beyond the Next Generation Network

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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.

Services/Applications: Low Power, Information Acquisition/Processing, Public Services, Medical Network Services, Contents Delivery/Distribution, Ultra-realistic, Sensor Network, Non-Stop, Fault tolerant Communication, Emergency Communication, Ambient Network, Mobility Services, E-commerce, Network Services for schoolchild, Smart Grid, Digital Cinema Delivery Services

Network Platform: Data Processing, Statistical Processing, Management System, Name (ID) Space, Security, Contents Cache/Delivery

Virtual Network Service Infrastructure: Virtual Node

Integrated Network of Circuit/Packet and Wireless/Wired: Home, FTTx/PON, LTE/Advanced, Wired Networks, WiFi, WiMAX, FTTx/PON, Businesses

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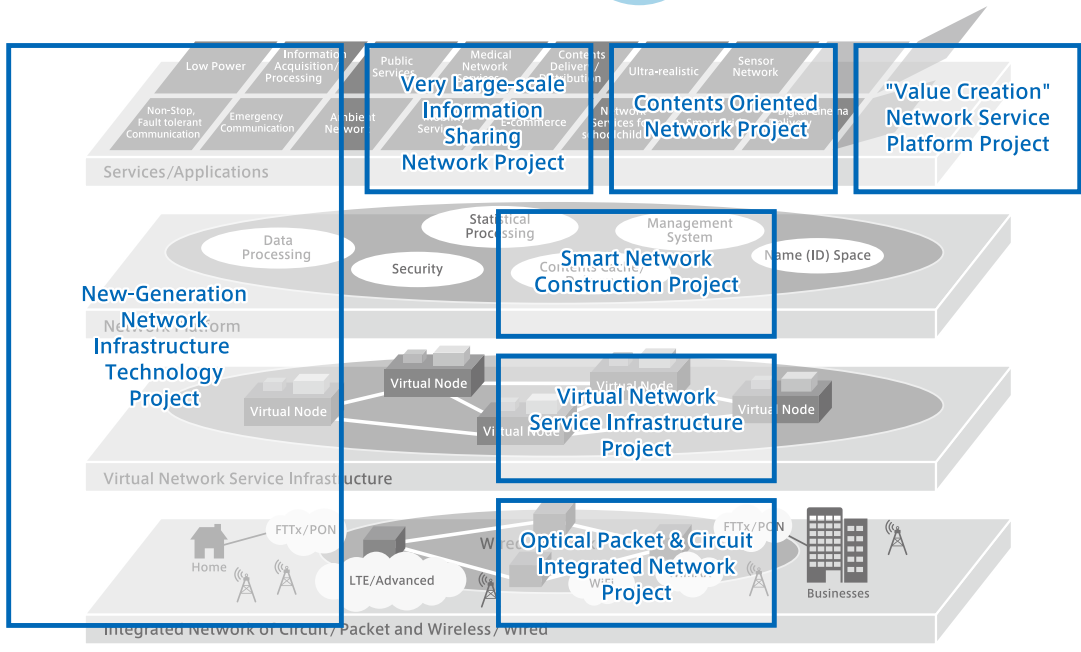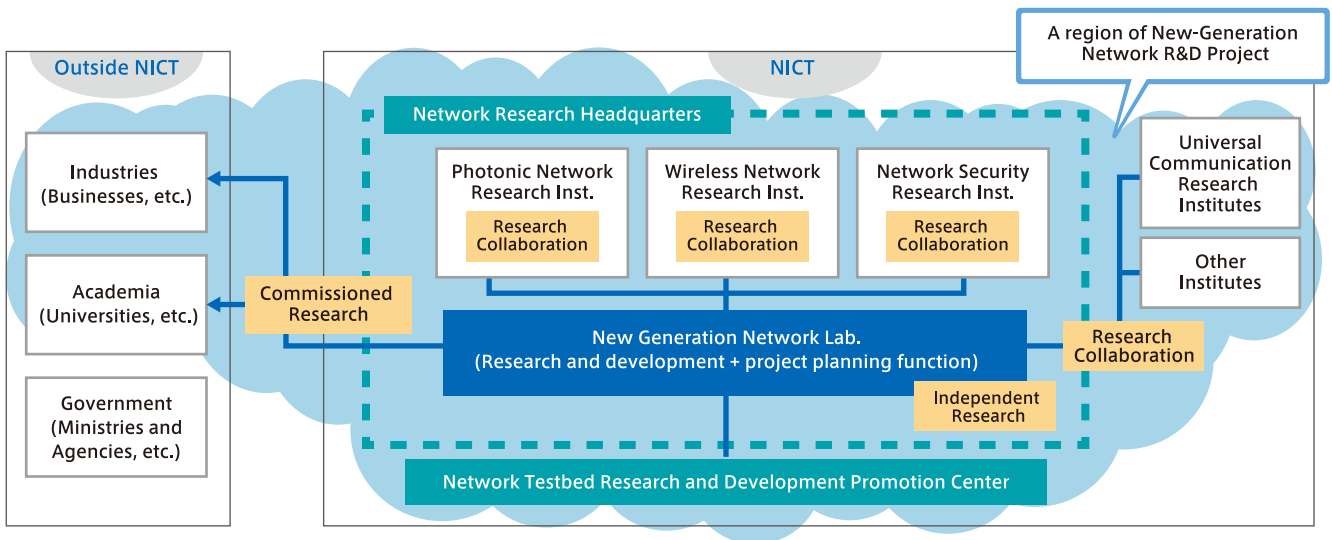**Shuji Yamaguchi**

![NICT]

New-Generation Network R&D Project

Creating R&D cooperation: industry, academia and government

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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.

Outside NICT

- Industries (Businesses, etc.)
- Academia (Universities, etc.)
- Government (Ministries and Agencies, etc.)

Commissioned Research

NICT

A region of New-Generation Network R&D Project

Network Research Headquarters

Photonic Network Research Inst.	Wireless Network Research Inst.	Network Security Research Inst.
Research Collaboration	Research Collaboration	Research Collaboration

New Generation Network Lab.
(Research and development + project planning function)

Independent Research

- Universal Communication Research Institutes
- Other Institutes

Research Collaboration

Network Testbed Research and Development Promotion Center

Very Large-scale Information Sharing Network Project

Contents Oriented Network Project

"Value Creation" Network Service Platform Project

New-Generation Network Infrastructure Technology Project

Smart Network Construction Project

Virtual Network Service Infrastructure Project

Optical Packet & Circuit Integrated Network Project

New Generation Network Laboratory

Director	Managing Director	Plannning Manager	Expert	Research Expert
Nozomu Nishinaga	Masahiro Kiyokawa	Yozo Shoji	Haruo Saito	Hiroaki Yano

New-Generation Network Infrastructure Technology Project

Realizing a common infrastructure easy to use and safe for everyone

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Background — The Internet, working as the social infrastructure today, is built on wired and wireless networks. Because each of such networks consists of systems based on different technical requirements, the Internet as a whole has complex and complicated structures. Especially, the structure of the IP network has become complicated and will become even more so as a result of the accumulation of repeated revisions of the technical requirements. In addition to that, in the near future, it would be difficult for the Internet to be the service infrastructure, which could solve environmental issues, such as requirements for saving energy, and provide a safe service infrastructure for ordinary people to use.

Objectives — Network requirements depend on service types and environments. We aim to build a network infrastructure that autonomously satisfies security or quality under universal control covering wired/wireless and ensures service delivery without users needing to worry about which network, wired or wireless, mobile or not, is available. We also aim to build a widely available and low-carbon-footprint infrastructure that supports data flow generated by over one trillion terminals.

Theme —
1. Virtual wireless network construction technologies enabling flexible configuration of networks adaptive to service types, by universal administration and use of wired or wireless resources.

2. echnologies for breaking through the limitations of today's Internet and building sustainable network architecture.

3. Security technologies providing the optimum level of security without worry on the user side, by systematically integrating existing or future technologies.

Utilization of network resources or frequencies will be realized. New-types of network services or applications, universally accessible from any type of computer system, will be provided through the new network.

New-Generation Network Infrastructure

- Contents/Application
- Architecture of New-Generation Network
- Wired Network Resources
- Security Technologies
- WiFi
- Broadcasting
- 4G Mobile Network
- Near Field Communication
- Wired & Wireless Virtualization Tehnologies
- Wireless Network Resources
- WiMAX
- Wireless Home Network
- White Space
- Wireless Sensor Network
- Wireless Network Resources

Project Member

Yozo Shoji※   Hiroshi Harada   Kiyohide Nakauchi   Takeshi Usui   Hiroaki Harai   Kenji Fujikawa   Takaya Miyazawa   Daisuke Inoue   Shinichiro Matsuo

※：Principal Investigator

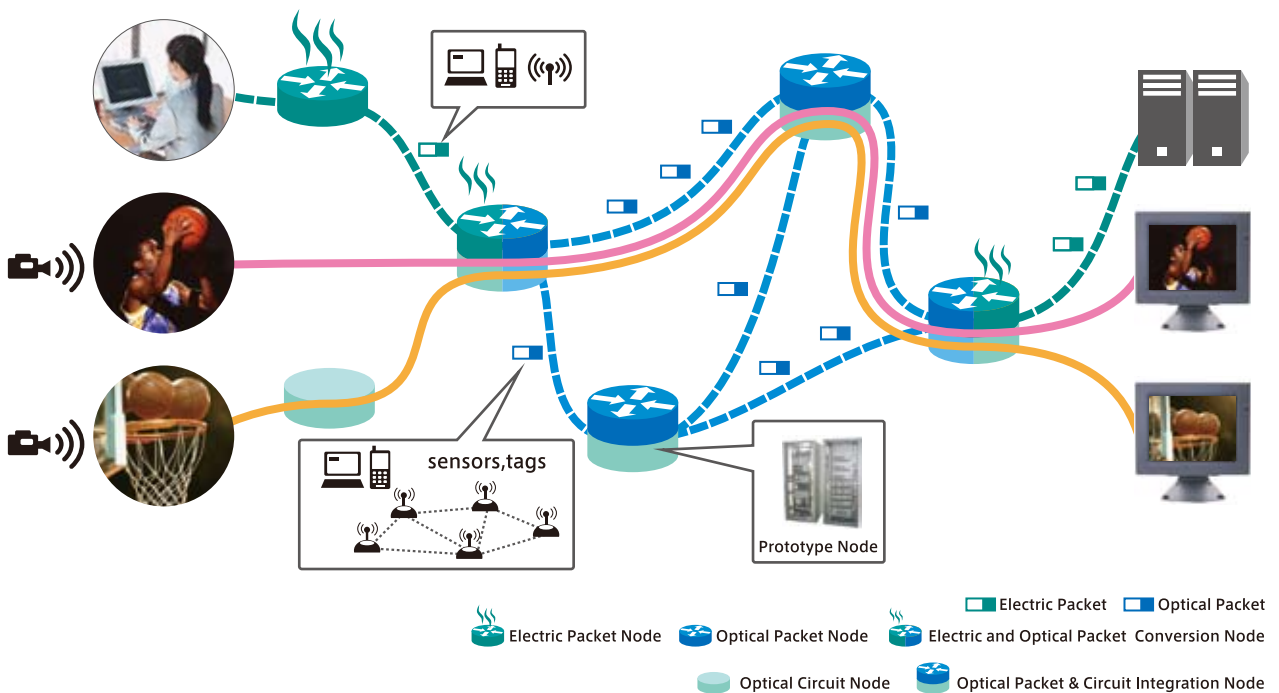# Optical Packet & Circuit Integrated Network Project

Toward the low-energy network to support diversifying network services

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.

sensors,tags

Prototype Node

Electric Packet | Optical Packet
Electric Packet Node | Optical Packet Node | Electric and Optical Packet Conversion Node
Optical Circuit Node | Optical Packet & Circuit Integration Node

Project Member

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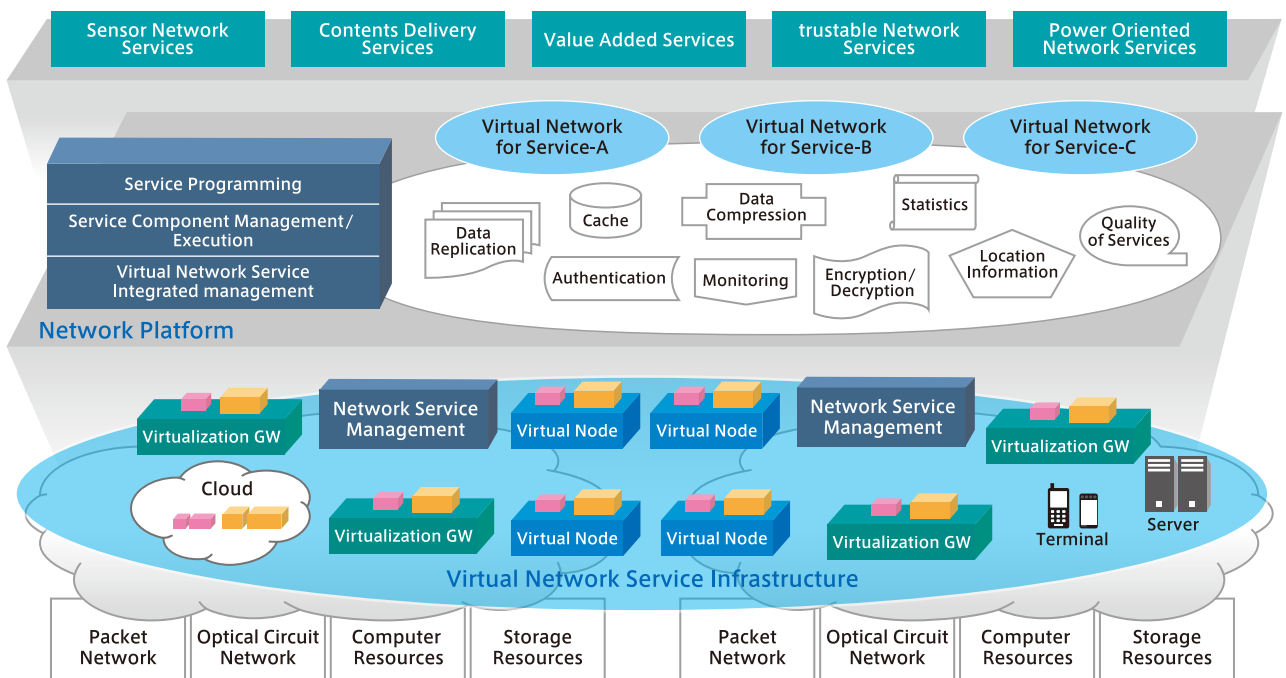
Virtual Network Service Infrastructure Project

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.

Sensor Network Services | Contents Delivery Services | Value Added Services | trustable Network Services | Power Oriented Network Services

Virtual Network for Service-A | Virtual Network for Service-B | Virtual Network for Service-C

Service Programming
Service Component Management / Execution
Virtual Network Service Integrated management

Data Replication — Cache — Data Compression — Statistics — Quality of Services — Authentication — Monitoring — Encryption/Decryption — Location Information

Network Platform

Virtualization GW | Network Service Management | Virtual Node | Virtual Node | Network Service Management | Virtualization GW

Cloud — Virtualization GW | Virtual Node | Virtual Node | Virtualization GW | Terminal | Server

Virtual Network Service Infrastructure

Packet Network | Optical Circuit Network | Computer Resources | Storage Resources | Packet Network | Optical Circuit Network | Computer Resources | Storage Resources

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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 (layers 2 and 3); (3) degradation of availability caused by human error during manual operations in resolving addresses/names; and (4) increase of delays and process time in mobile communications.

Objectives — We aim to develop networks with an innovative layered-structure where ID's, as information identifiers, and locators, as location identifiers, are separated. 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 automatically configuring 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-structures 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.

Prefix of Loc	Net Name	Out Port
1.2/2	NSP 1+	A
3.4/2	NSP 2+	B

Aggregated small routing table,stable, Energy saved,high-speed lookup

Name/ID/Loc Resolution System

To:1.2.10.1 or 3.4.10.1

Automatic locator assign, High-availability(no miss-conf)

Mobility, heterogeneity, security

Routers

NSP2 3.4/**2**

NSP1 1.2/**2**

Multipath High-availability

L3-Protocol Gateway

Administrative Gateway

Hosts   Sensors

1.2.10/3 3.4.10/3

1.2.10.**1** or 3.4.10.**1**

Edge Router

Hosts

Hosts

Local-Edge Network (Different Net Protocol)

Private-Edge Network (Same Net Protocol but Different Locator Structure)

Stub-Edge Network (Same as Global Net Protocol)

Project Member

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※:Principal Investigator

Very Large-scale Information Sharing Network Project

Realizing a network treating over a trillion objects
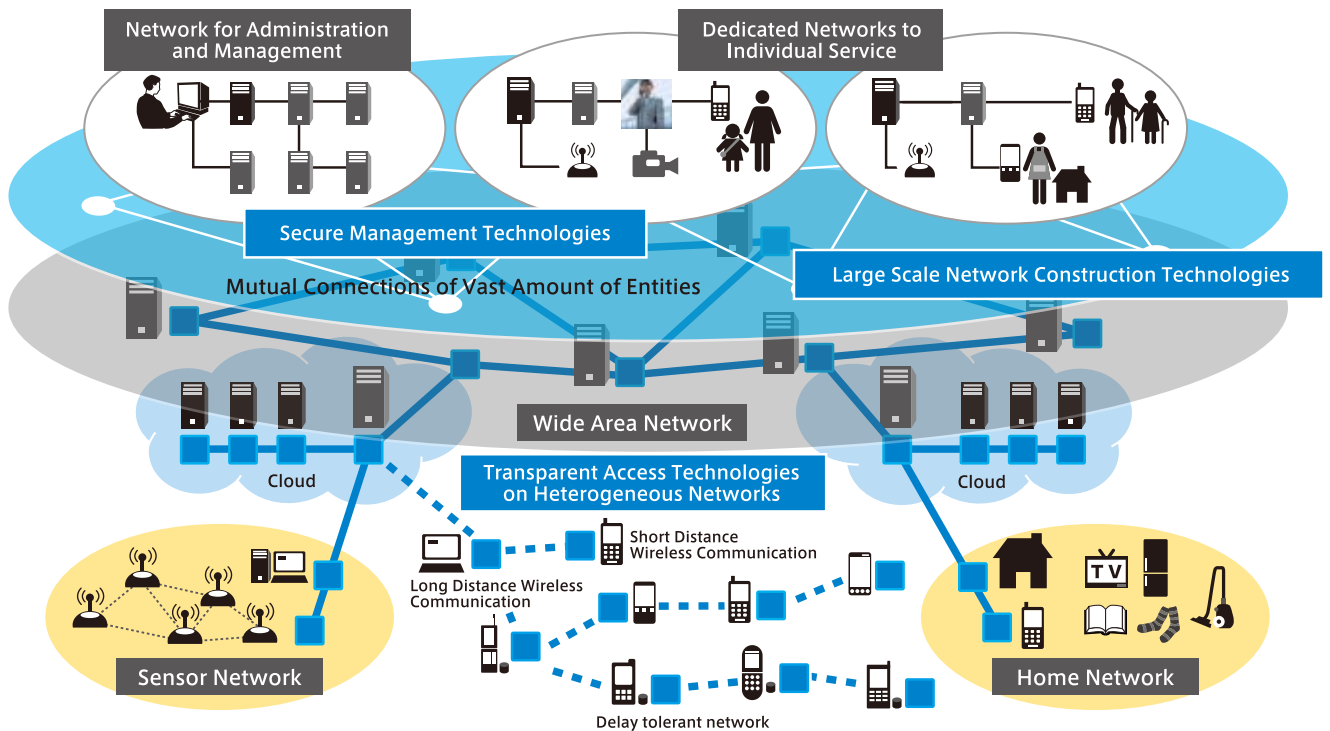
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Background — Recently, it is increasingly expected that 'objects' which currently lack enough communication functions, i.e. physical entities like daily necessities, sensors or devices embedded in the environment will be connected to the network and 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.

Network for Administration and Management

Dedicated Networks to Individual Service

Secure Management Technologies

Mutual Connections of Vast Amount of Entities

Large Scale Network Construction Technologies

Wide Area Network

Cloud

Transparent Access Technologies on Heterogeneous Networks

Cloud

Short Distance Wireless Communication

Long Distance Wireless Communication

Sensor Network

Delay tolerant network

Home Network

Project Member

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※：Principal Investigator

Contents Oriented Network Project

High-quality, high-reliability, and low-energy delivery of large volume contents

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Background — According to the growth of broadband networking in the Internet, the delivery of large-volume contents, such as videos, has become familiar. The New-Generation Network, serving as a lifeline, is required to have higher performance and higher reliability in the large-volume contents delivery. In addition, since the energy problem due to the traffic increase becomes more serious, the New-Generation Network is also required to save the energy consumption.

Objectives — Focusing on video traffic that will occupy a large portion of future network traffic, our project aims to establish the technologies enabling the high-performance (wide bandwidth and small delay) contents delivery; the highly sustainable and reliable operations under severe conditions; and the technologies for visualization and reduction of the traffic and energy consumption.

Theme — On the New-Generation Network, the dynamic infrastructure utilization gets available with the virtualization technologies. The low energy consumption contents delivery network with high quality and strong fault tolerance will be developed by

1. Promoting the optimization of the contents delivery routing and placements using traffic measurement and analysis technologies,
2. The establishment of new contents centric network concept,
3. The study on the contents delivery service architecture and its business model.

Through promptly proving the feasibility of delivery services of large-volume contents such as videos, we will be able to take a global leading role in the development of New-Generation networks, and contribute to the creation of a secure, safe, and low-carbon society by ICT.
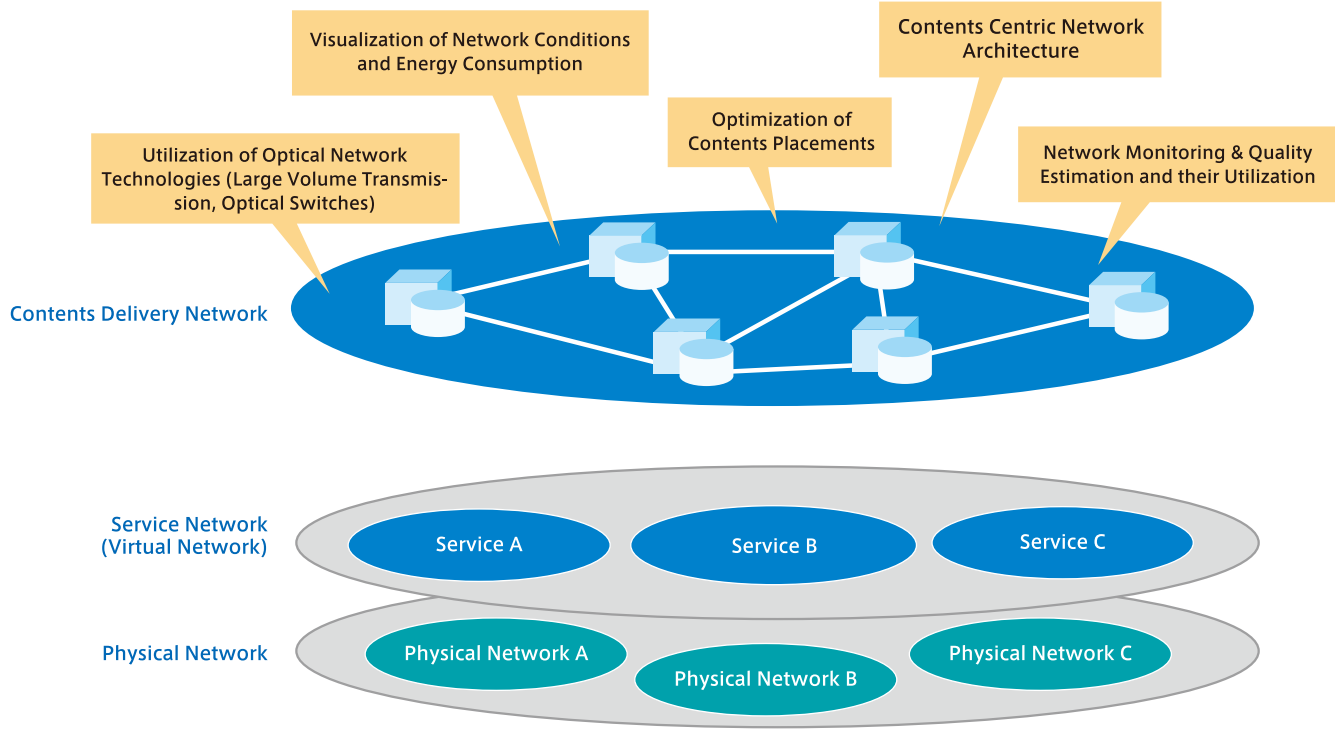
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"Value Creation" Network Service Platform Project

Information service-controlled network

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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.
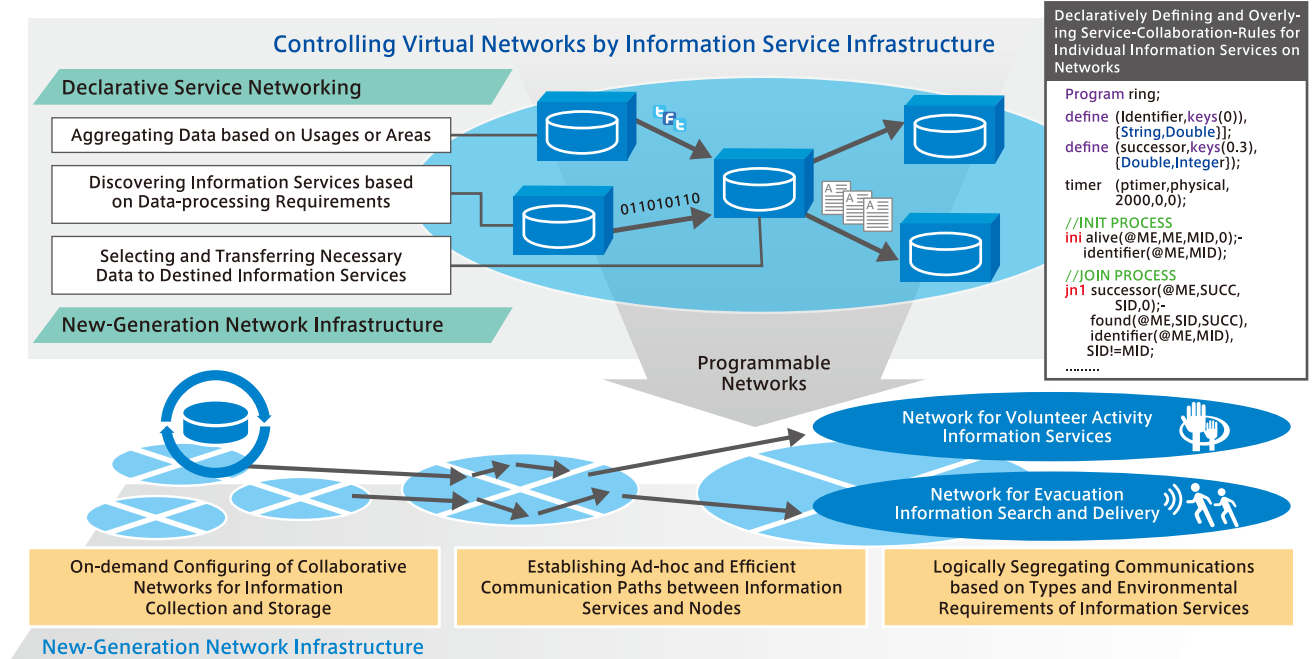
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