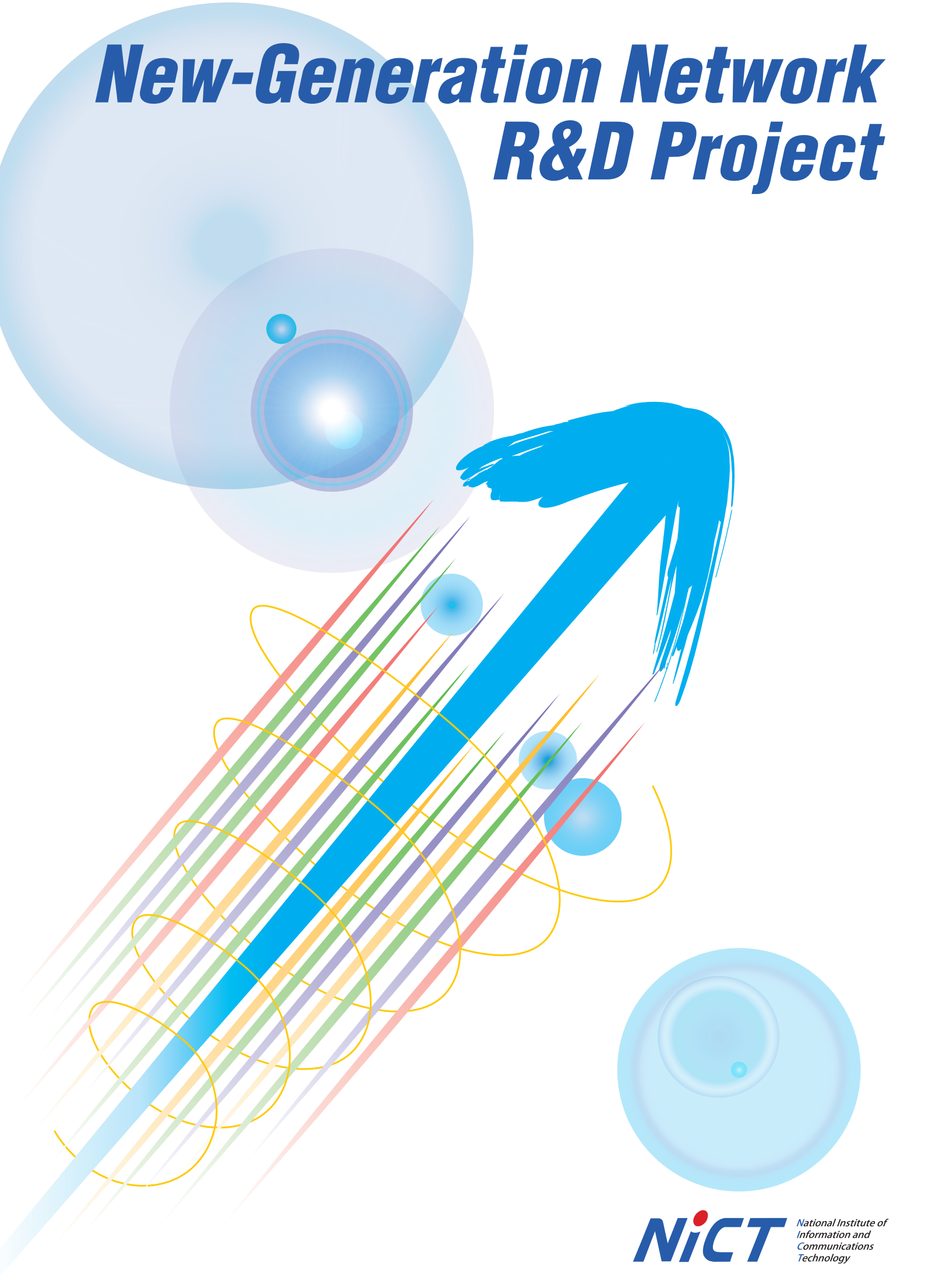
New-Generation Network R&D Project



NiCT National Institute of Information and Communications Technology

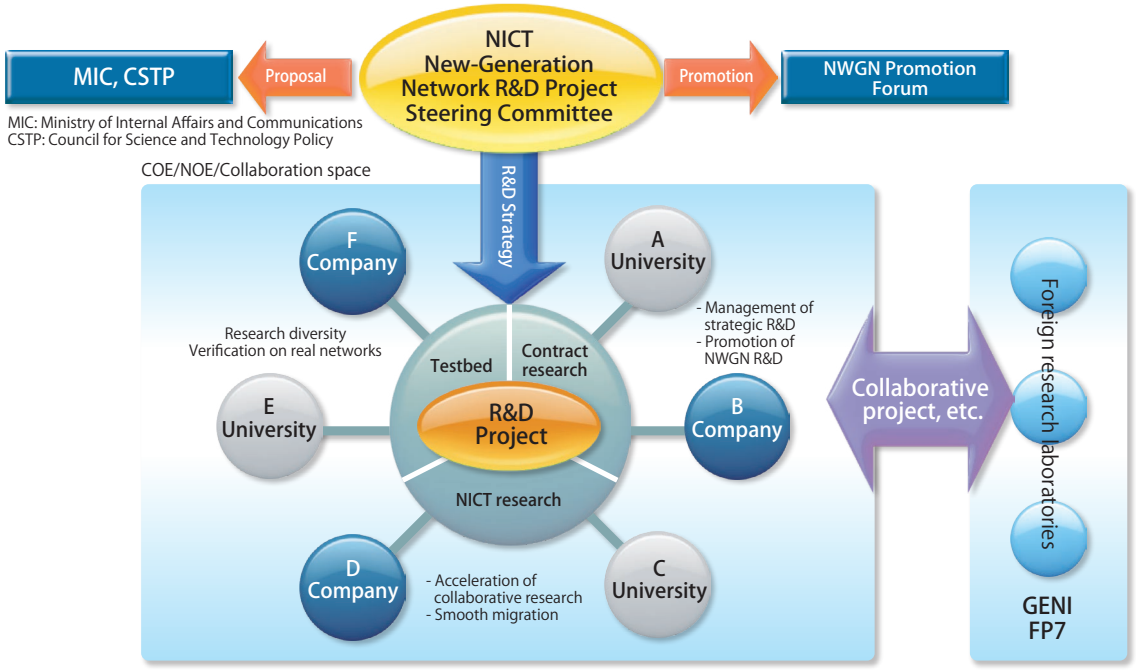
NiCT

New-Generation Network R&D Project

Outline

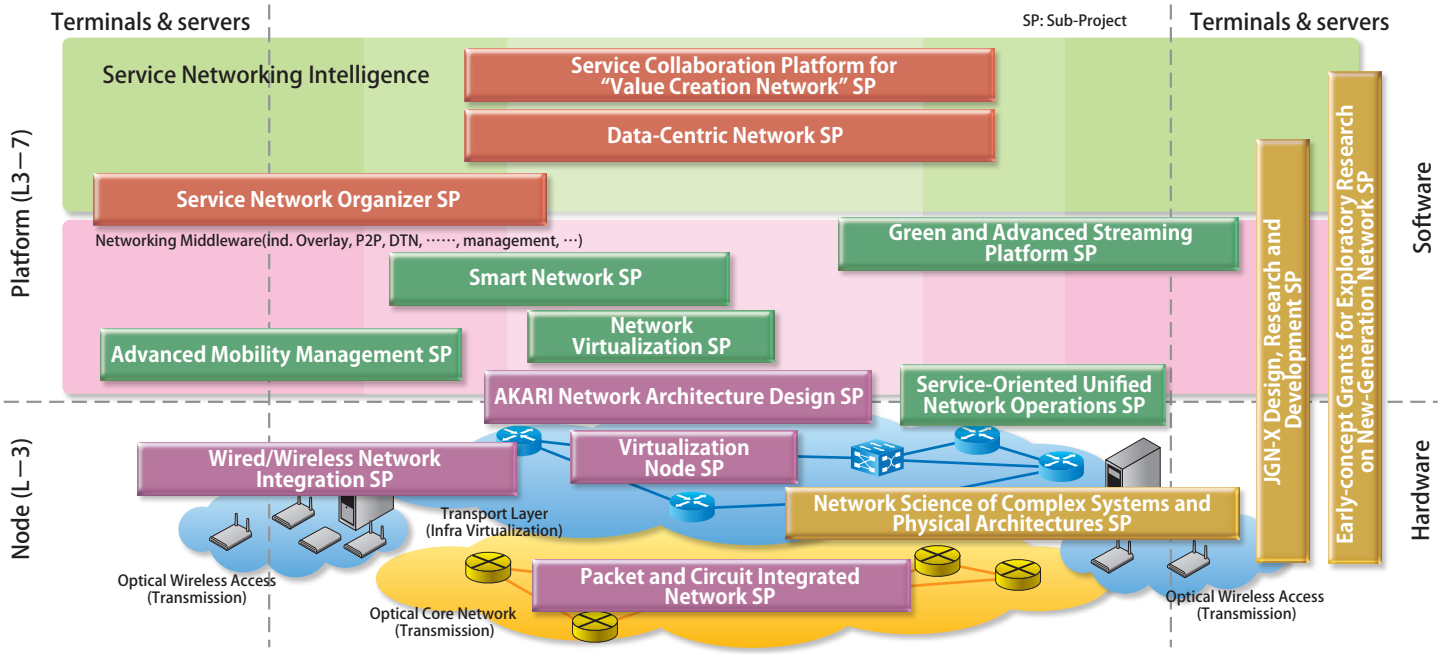
The new-generation network is such a newly designed network that can provide service applications to meet high-level needs from its users with a variety of large-scale networks and mult-function terminals. By introducing the new-generation network, it is expected to solve social issues such as serious energy problems and to create new values. Aiming at achievement of the new-generation network, the New-Generation Network R&D Project started in the year of 2010 by assembling the researchers inside and outside of NICT under the organized collaboration among industry, academia, and government.

In the New-Generation Network R&D Project, NICT will progress R&D activities, utilizing the state-of-the-art core technologies developed by NICT and taking advantage of NICT's various research schemes which involve collaborations among industry, academia, and government. Also, a testbed will be set up to feedback experimental results to future researches, so that R&D activities will be able to be steered towards more competent ones. Furthermore, NICT will carry on R&D activities, allying itself with overseas researchers both to collaborate and to compete with world's major players.



Overview of sub-projects

Fifteen sub-projects have been organized to carry out the full-fledged research and development activities aimed at the realization of the new-generation network.



NiCT

Service Collaboration Platform for "Value Creation Network" Sub-project

From the network for connectivity, to the network as a platform for innovation

Motivation

Today, interdisciplinary and inter-organizational problem solving, such as for climate change problems and environmental protection problems, is emerging. By the same token, the network, as a part of our social infrastructure, is also required to transform from a vertical structure reflecting an organizational hierarchy, to a horizontal structure facilitating inter-organizational partnerships based on service collaboration. As service computing is becoming the dominant computing paradigm, the technologies for modeling our social system as a service ecosystem and implementing it in the ICT system are expected.

Goal

This sub-project conducts research and development on fundamentals for a service collaboration network platform. It aims to coordinate a network of ICT systems developed and maintained by individual domains or organizations. Conventionally, there have been problems in the interconnection of those ICT systems across the boundaries at the network level. We try to overcome the problems by interconnecting the systems at the level of services they provide. Our service platform enables the creation of manifold services through collaboration among the ICT systems, while preserving their autonomy.

Research Overview

◆The development of technology that enables the seamless collaboration of services by hiding the heterogeneity of underlying networks. By expanding the concept of conventional service computing, all ICT resources (servers, storage, the network, terminals, software, communication methods, manual operation, etc.) are abstracted into a form of "service."

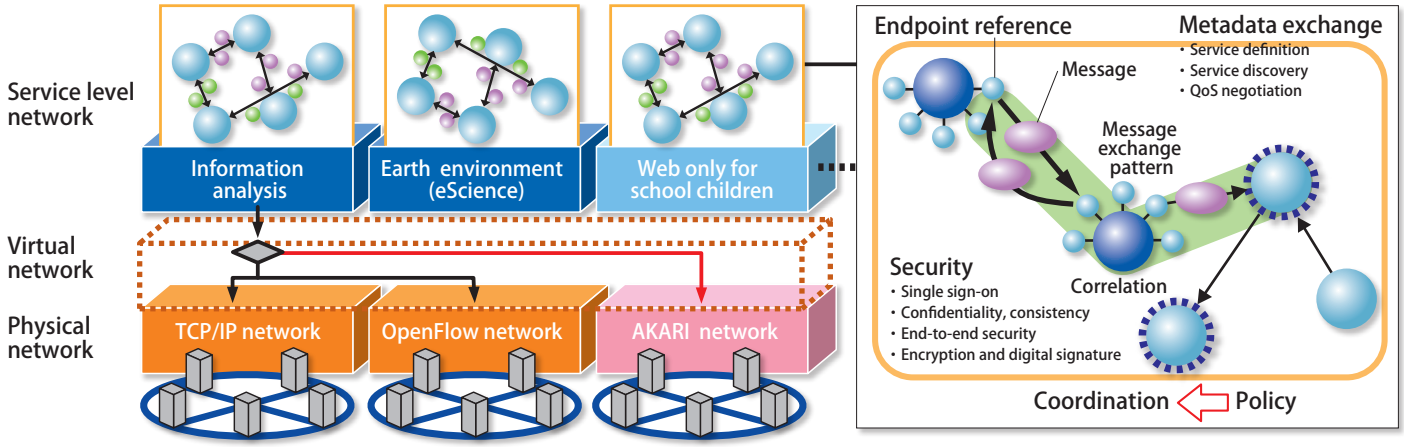
◆The development of a high-performance, scalable platform that enables horizontal collaboration among services, as well as vertical collaboration between services and ICT resources. This requires the direct implementation of the elemental technology constituting service networking (service addressing, messaging, service discovery, and coordinated control) on top of the physical network infrastructure.

◆Development of the technology for realizing both openness and safety, flexibility and sustainability of the service collaboration platform at a higher-level. This involves the isolation and interconnection of the service collaboration networks, the formation of virtual organizations (VOs), and clopen (closed-open) access.

◆Construction of testbed facilitating third-party development and the verification of various service collaboration networks, especially those designed for use in joint industry-university research. It also includes the development of the technologies required for network operation, such as SLA considering end-to-end QoS, and the mechanisms for coordinating and charging for the use of services owned by multiple providers.

Social Impacts

The service-level networking technology promotes collaboration across organizations and industrial boundaries more efficiently, which drives an upgrade of the social system as a whole. It also promotes an accumulation and sharing of knowledge and information throughout the "service ecosystem" that involves variety of participants, including the service users, service providers, national and local governments, and foreign countries. Moreover, it is expected to enhance the domestic quality of life and to trigger new economic growth centered on ICT.



NiCT

Data-Centric Network

Sub-project

Transformation of the network from terminal connectivity to contents connectivity

Motivation

The role of the network has been changing from the Internet that connects terminals to the network providing connectivity, to one that connects services (applications and contents) on the terminals. The data-centric network aims to foster a higher level of connectivity than the present-day networks, and, with the research and development of data-centric networking technology and accompanying applications, is geared toward bringing about a new network paradigm.

Goal

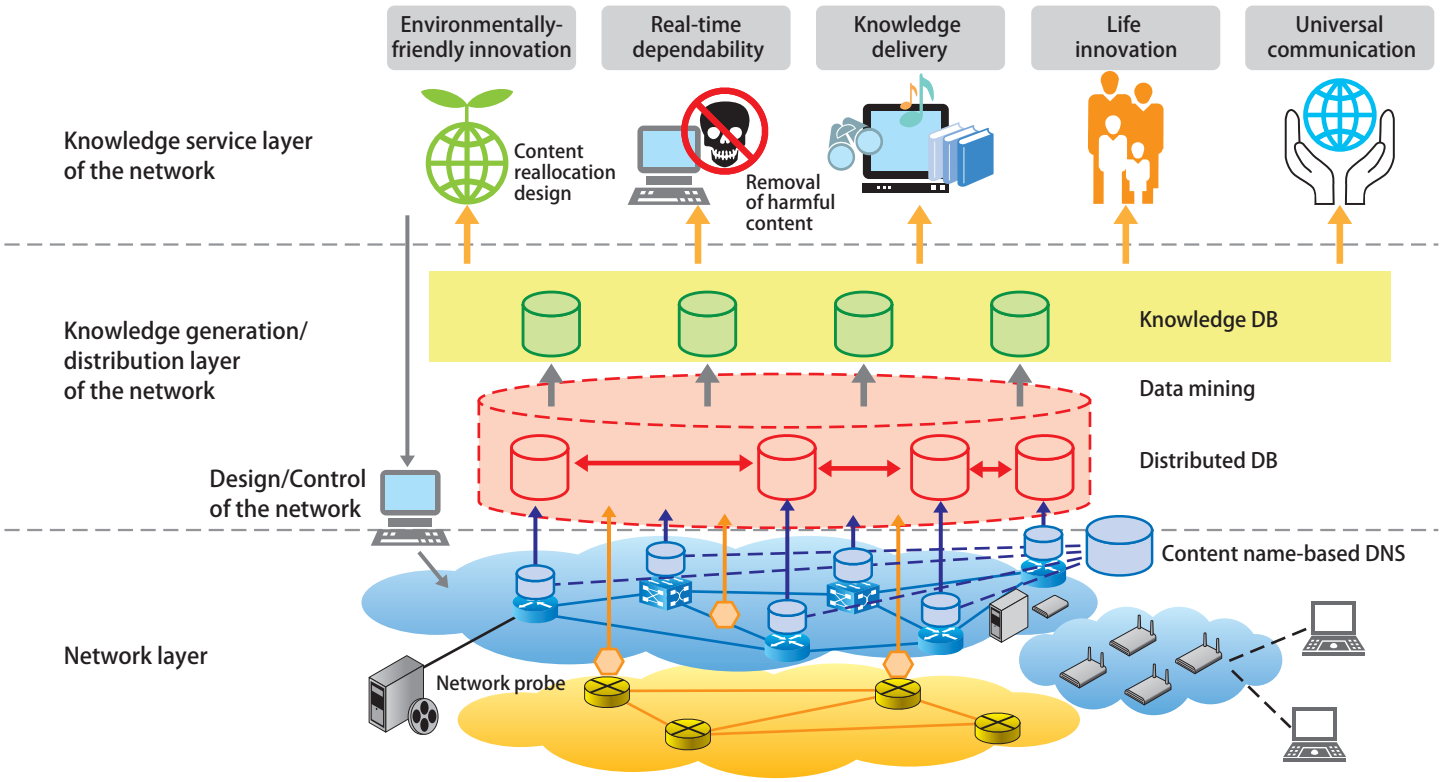
The data-centric network creates a new architecture, in which the end point of the network is shifted from the terminal to the application/contents that the user requires, aiming at a minimization of network service response time and optimization of contents distribution. Also, the data-centric network improves manageability of information (e.g. personal information contained in the network) by isolating data from applications. Moreover, the data-centric network constructs a network service platform that allows the accumulation and the utilization of data flowing through the network, enabling the user to create new values by mining the data.

Research Overview

- ◆Examination of the design of contents-oriented network architectures
- ◆Service platform technology that helps create innovative services based on accumulated knowledge
- ◆Construction technology for a knowledge database that enables the user to search/analyze/accumulate the desired data from the flood of contents data
- ◆High-speed packet-capturing technology that can visualize the contents flowing through the network

Social Impacts

The data-centric network enables the network operator to grasp the contents and applications that are flowing through the network, thus paving the way to the practical realization of such beneficial functions as the network-oriented user recommendation service, the optimization of contents reallocation design, and network operation at a higher level of security.



NiCT

Service Network Organizer

Sub-project

Towards service creative network by organizing distributed ICT-components

Motivation

The role of the ICT infrastructures is changing from providing quantity (performance and bandwidth) to providing quality (reliability and smart capabilities). The Service Network Organizer --a set of integration technologies that enable network services featuring excellent availability, security, and applicability-- offers novel capabilities to network customers. The aim of this sub-project is to establish these technologies and to build a common network service platform.

Goal

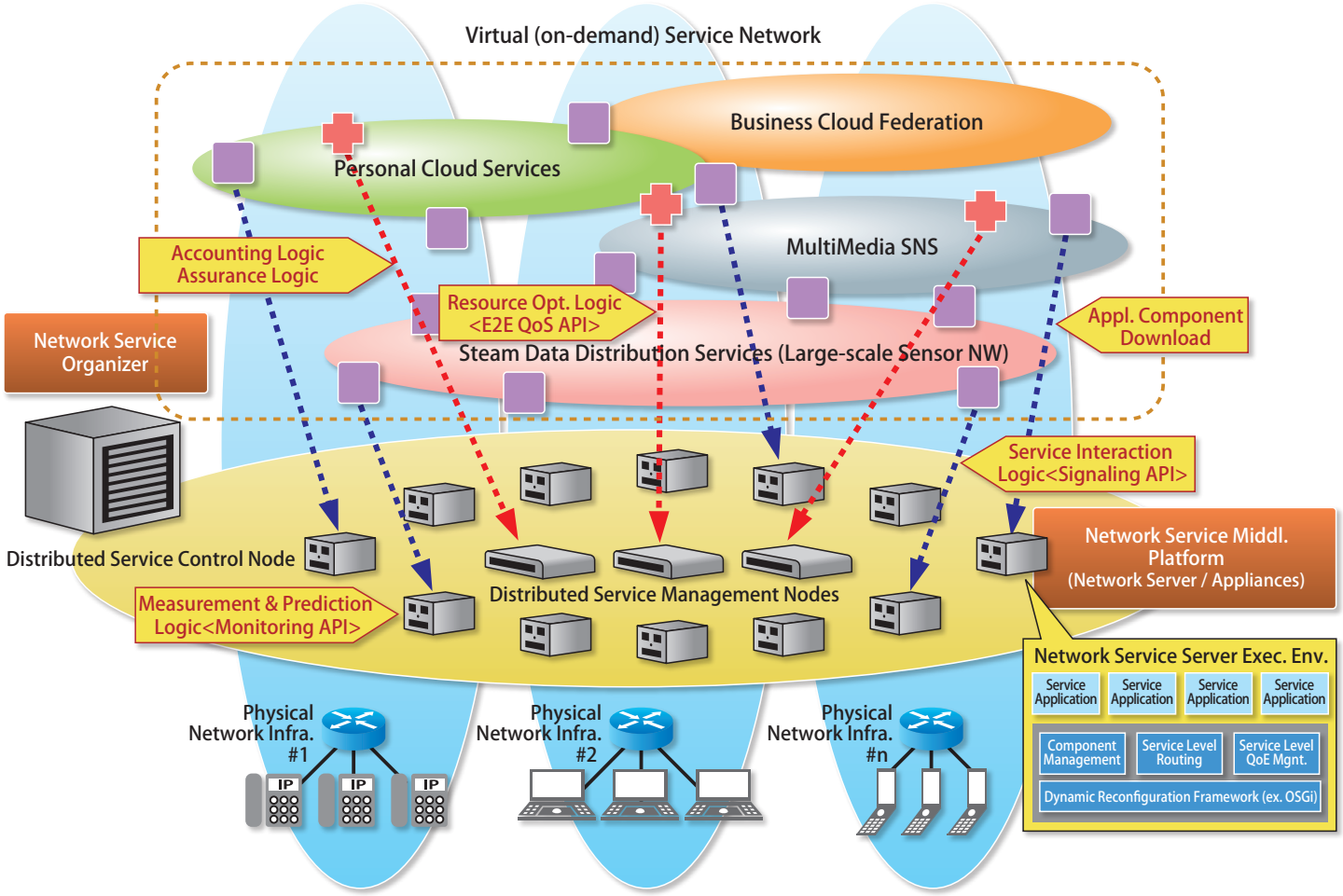
The deliverables of this sub-project are specifications and implementations of Trustable Network Service Middleware Platform. JGN-X deployment and technology validation works are also planned. The platform makes it possible to deal dynamically with Servers/Terminals Mobility, QoS and Traffic fluctuations, Real-time Adaptation, and Reliability/Safety Protections.

Research Overview

◆Dynamic Service Network Configuration: Traffic Prediction, Real-time Optimization of System Conf.
◆Service Mobility Control: Service Continuity, Service level Multi-path Routing, Service Caching
◆Scalable Trust Control: Autonomous Decentralized Algorithms, Assurance Control Algorithms

Social Impacts

◆Accelerate the creations of various Green and Life Innovation with dynamic infrastructure control
◆Provide secure network services of high quality with trustable service capabilities



NiCT

Green and Advanced Streaming Platform

Sub-project

Realization of a stable, low-energy video delivery network

Motivation

The new-generation network is geared toward the low-energy network capable of sustainable development into the future. Video delivery through the network – such as shared video sites on the Internet and IP retransmission of TV programs – has become a familiar part of our life nowadays, and the network has been firmly establishing its place as an indispensable infrastructure. A substantial portion of network traffic is now occupied by video data, and the portion is expected to increase continuously in the future. Given this situation, the development of low-energy video delivery technology capable of delivering stable, high-quality video data, with a high level of user friendliness, is an urgent task in new-generation network projects.

Goal

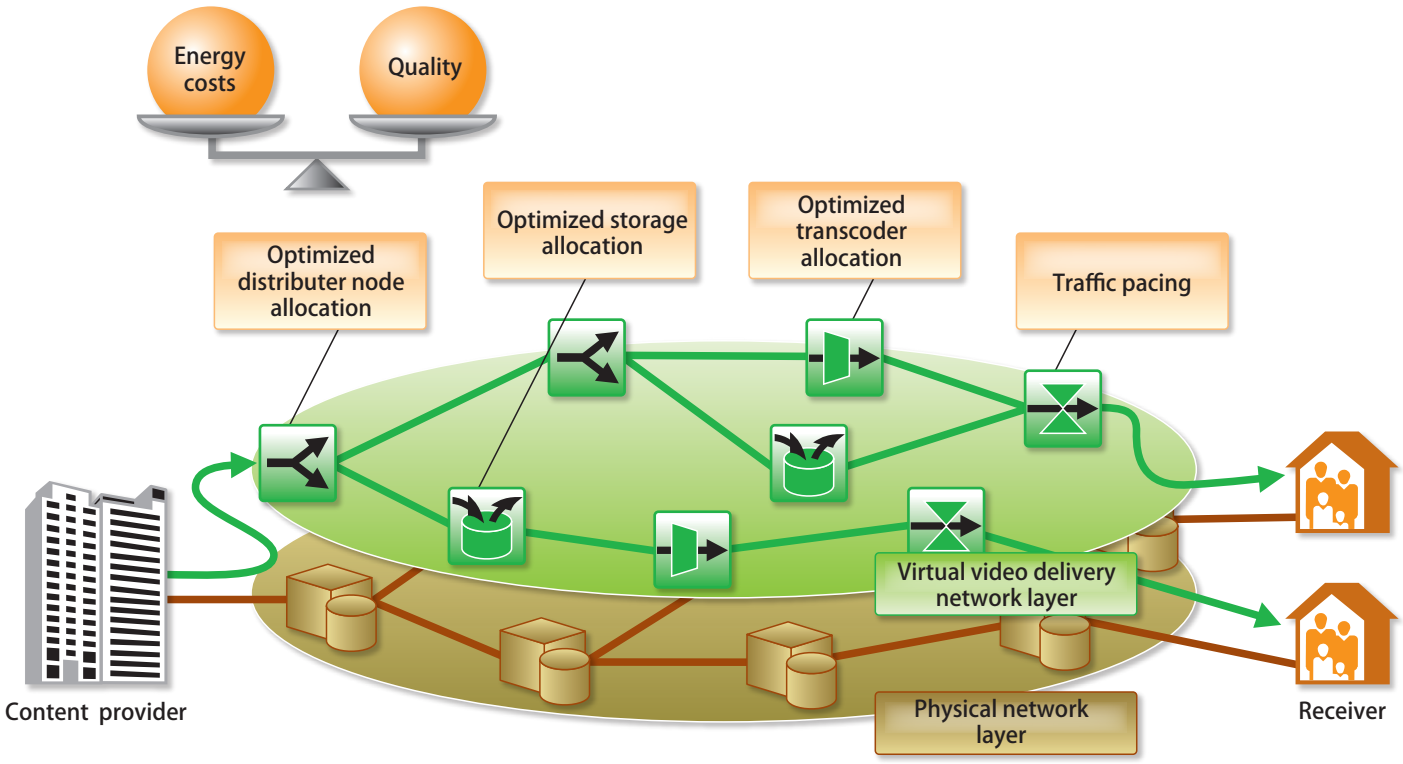
Establishment of video delivery network technology that meets the following requirements: (a) minimize energy consumed by network equipment and servers, (b) applicability to manifold user terminals, and (c) stable and superior video quality.

Research Overview

- ◆Establishment of a model to evaluate power consumption in the video delivery network, and a method to visualize energy usage in it.
- ◆Technology that enables the optimization of delivery tree topology and cache transcoder allocation in a video delivery network, while taking energy costs into account.
- ◆Pacing technology capable of suppressing instantaneous traffic fluctuation, thus mitigating stress to the network and receiver terminals.

Social Impacts

- ◆Realization of a high-quality and low-energy video distribution network will promote the transition to a low-carbon society.
- ◆Widespread network-connected video terminals will trigger the further growth of new ICT services.



NiCT

Smart Network Sub-project

Toward an agile, high-reliability network: application of layer structure and locator reorganization, automation

Motivation

The present day network has many problems on its plate, namely: 1) a bloated route table that necessitates a larger processing load to cut down search time, and increased power consumption due to the large-scale memory involved; 2) increases in operational costs due to the simultaneous management and operation of L2 and L3 networks (an overlapping network management load); and 3) reduced availability due mainly to the errors in addresses and name resolution that occur during manual setting.

Goal

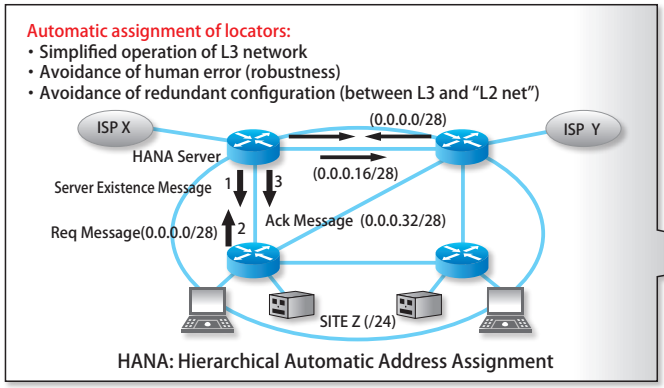
The sub-project is making progress toward the construction of a new layer-structured network in which IDs and locators are split, and in which smart network technology – centered on the hierarchically-structured locators, and automatic setting of the locators and name resolution servers – is implemented. For the network administrator, it represents an energy-efficient, high-speed network with ease of operation and management; for the user, it represents a highly reliable network allowing automatic network selection depending on the situation such as congestion, failure, and mobility.

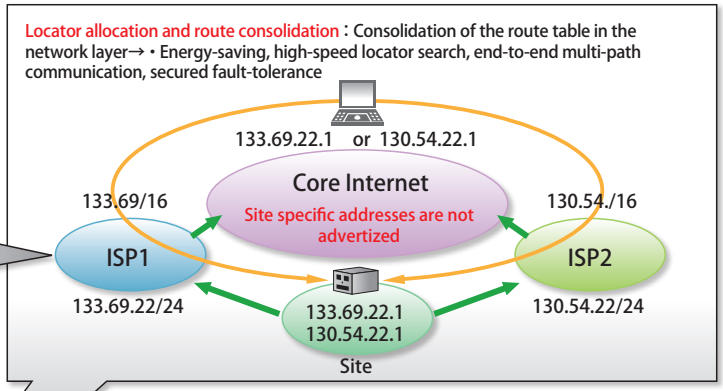
Research Overview

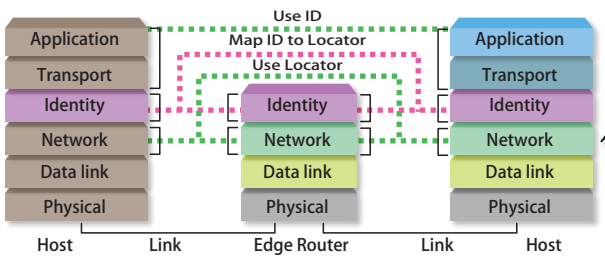
(1) Technology to prevent an excessive growth of the routing table, even in the case of an increase in the number of network providers and instruments. This technology involves a hierarchical locator configuration.
(2) Technology to automate the determination and setting of the locators and registration to a name server, which has the effect of relieving a cumbersome load from the network administrator.
(3) Overall design - including the separation of IDs and locators and transport layer control – and its implementation

Social Impacts

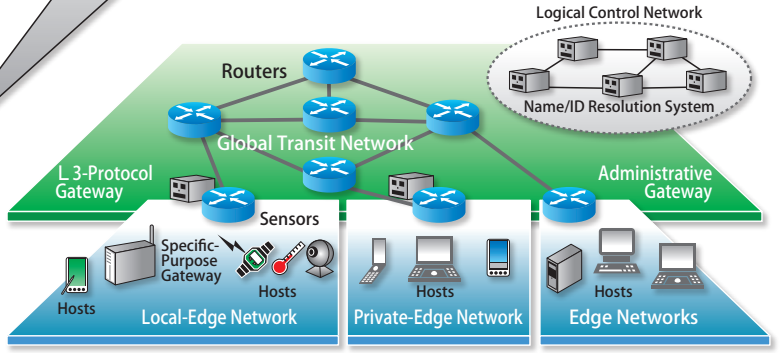
The promotion of network automation – a simple and smart network structure – has the effect of reducing human error, which results in the provision of stable and high-speed network services that all of us can use with a sense of security.







Separation of ID from locator: Removal of locational restrictions facilitates mobile communication, multihoming and route aggregation, and connections among heterogeneous networks.



NiCT

Advanced Mobility Management

Sub-project

Seamless mobility among multiple virtual networks which provide various services

Motivation

As network virtualization advances, it is expected that the service providers (e.g., MVNO) construct the networks that provide different levels of QoS and applications on individual virtual networks including the wired and wireless access network within a shared physical infrastructure at low costs. This environment enables users to select the virtual network to which they will be attached based on the required level of QoS, communication fees, etc. In this environment, users may change the virtual network during their communications (an action we term "virtual network mobility"). However, there are no procedures that sustain their communications without disrupting their communications when users move from one virtual network to another. Seamless mobility protocol among multiple virtual networks is not presently considered.

Goal

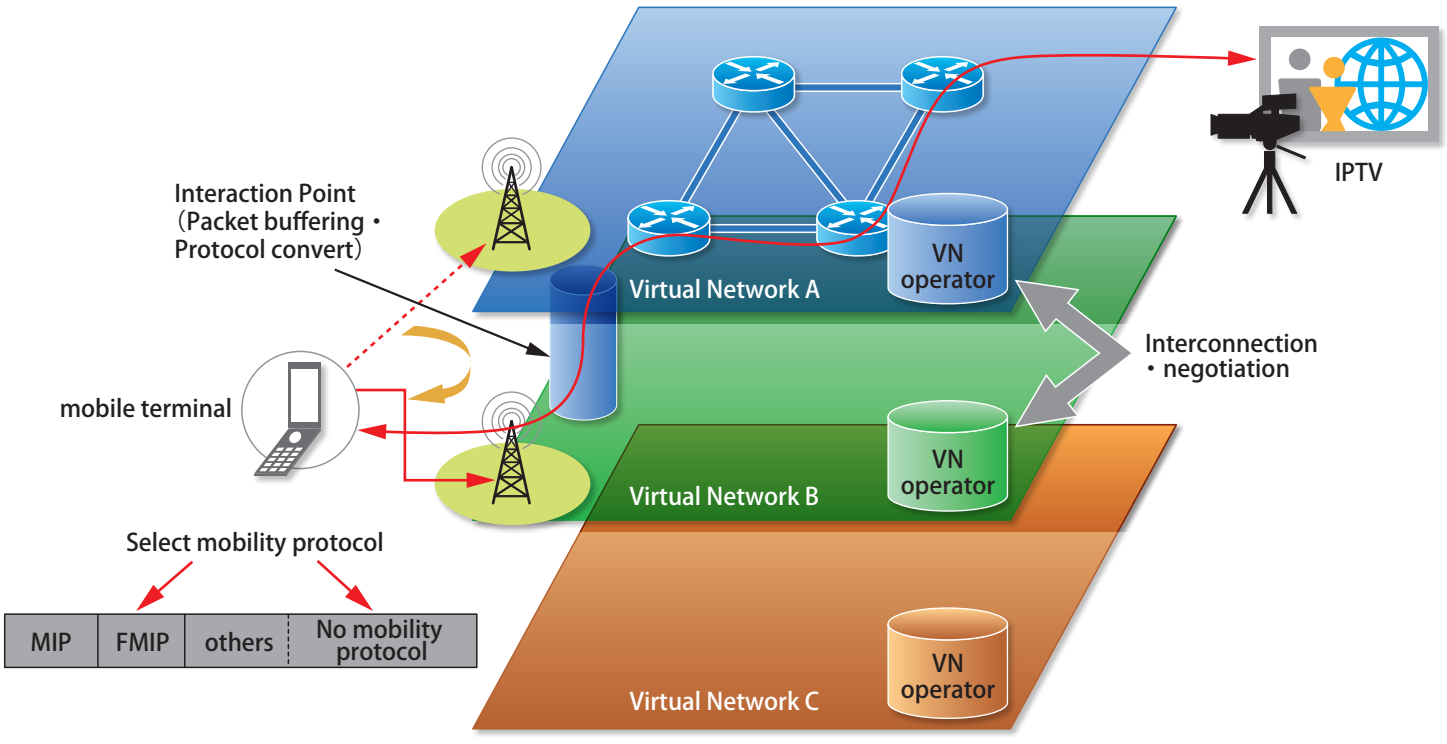
In consideration of the characteristics of the virtual networks which are constructed in a shared physical infrastructure, we define virtual network mobility procedures where users can move freely among multiple virtual networks without disrupting their communications.

Research Overview

◆Packet buffering technology taking into account L4 and wireless resources to avoid packet dropping
◆Virtual Network Mobility framework among multiple virtual networks
◆Mobile terminal that selects suitable architecture and protocols based on the virtual networks

Social Impacts

The users can move seamlessly among the virtual networks without any interruptions to their communications. As a result, the users can continue to use the services moving among the virtual networks without limitations associated with the wireless access and the networks which the service providers provide.



NiCT

Network Virtualization Sub-project

Network virtualization technology gearing toward meta-architecture

Motivation

The Internet of today suffers from a multitude of problems, such as security vulnerability, sub-optimal availability and robustness, lack of seamless evolve-ability, etc. that could not be resolved through the conventional approaches.

Recently, various research projects have been launched all over the world to design the proper networks "*on a clean slate*", i.e., from scratch, and to propose, implement, and verify various novel communication methods to realize the visions.

Network Virtualization technology has gained its popularity as a viable vehicle for enabling an environment that isolates resources of the entire communication infrastructure into *slices* of logical networks through virtualization technologies, while each slice allows us to invent innovative network functionalities on it.

Goal

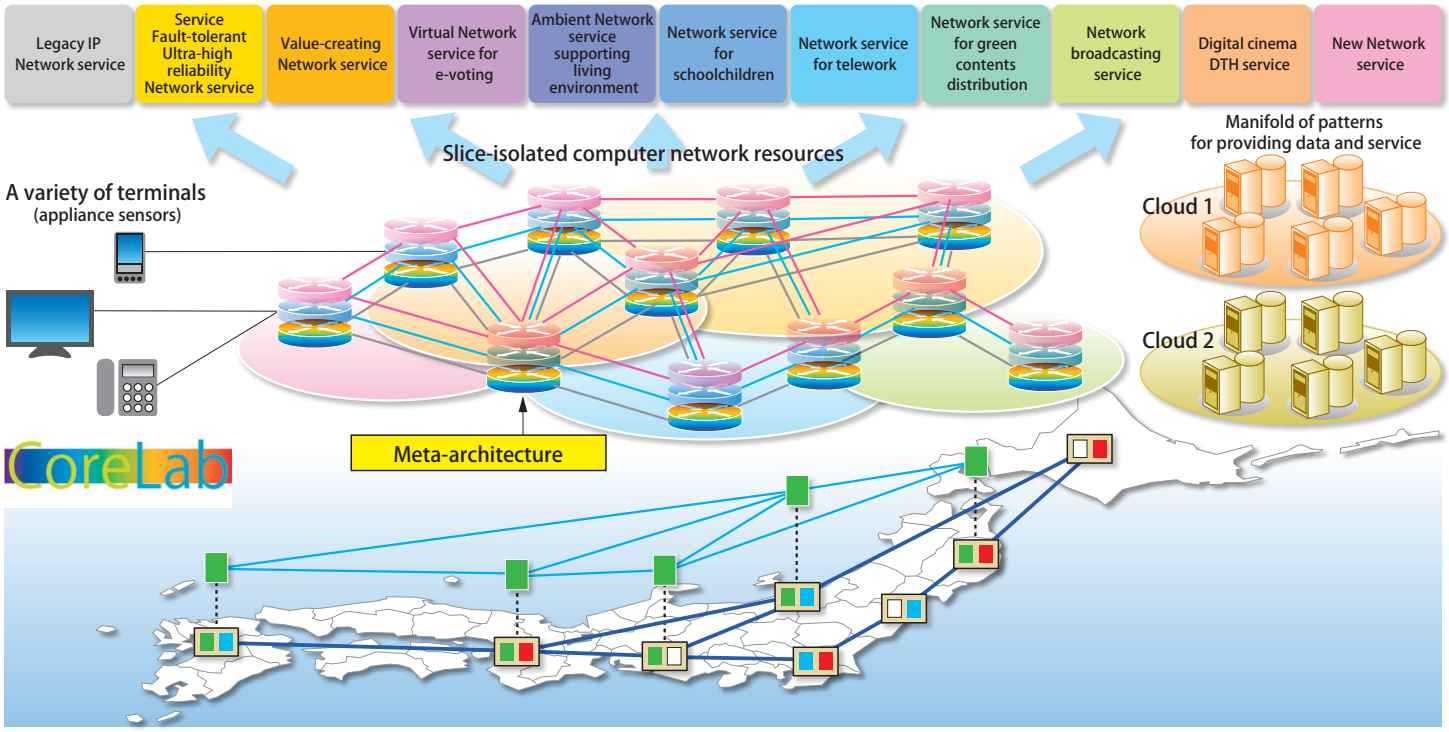
We put forth research and development on *meta-architecture* that simultaneously accommodates multiple network architectures and services corresponding to heterogeneous requirements. For instance, our R&D focuses on isolation of computational resources and network resources by means of virtualization technology, thus providing multiple application-specific and programmable independent networks.

Research Overview

◆R&D of meta-architecture based on network virtualization technology
◆R&D of advanced network virtualization technology – the fundamental technology for testbed construction.
◆Design and implementation of CoreLab, i.e., the environment for experimenting with network virtualization, and its expansion throughout Asia, Europe, and the United States.
◆R&D of diverse network services that take advantage of network virtualization
(e.g. in conjunction with cloud computing, cache-oriented/data-oriented network architecture, etc.)

Social Impacts

◆Promoting the invention of diverse network service architectures
◆Accelerating practical realization of various kinds of network technologies backed up by our new meta-architecture with seamless evolution.
◆Achieving life innovation through the business model that isolates communication services from communication infrastructure



NiCT

Service-Oriented Unified Network Operations

Sub-project

Creating diverse customized networks

Motivation

Network infrastructure for information and communication is becoming indispensable to modern lifestyles. However, the provision of network services customized according to application and service features is not enough. This sub-project aims at providing a flexible network service environment tailored to service features.

Goal

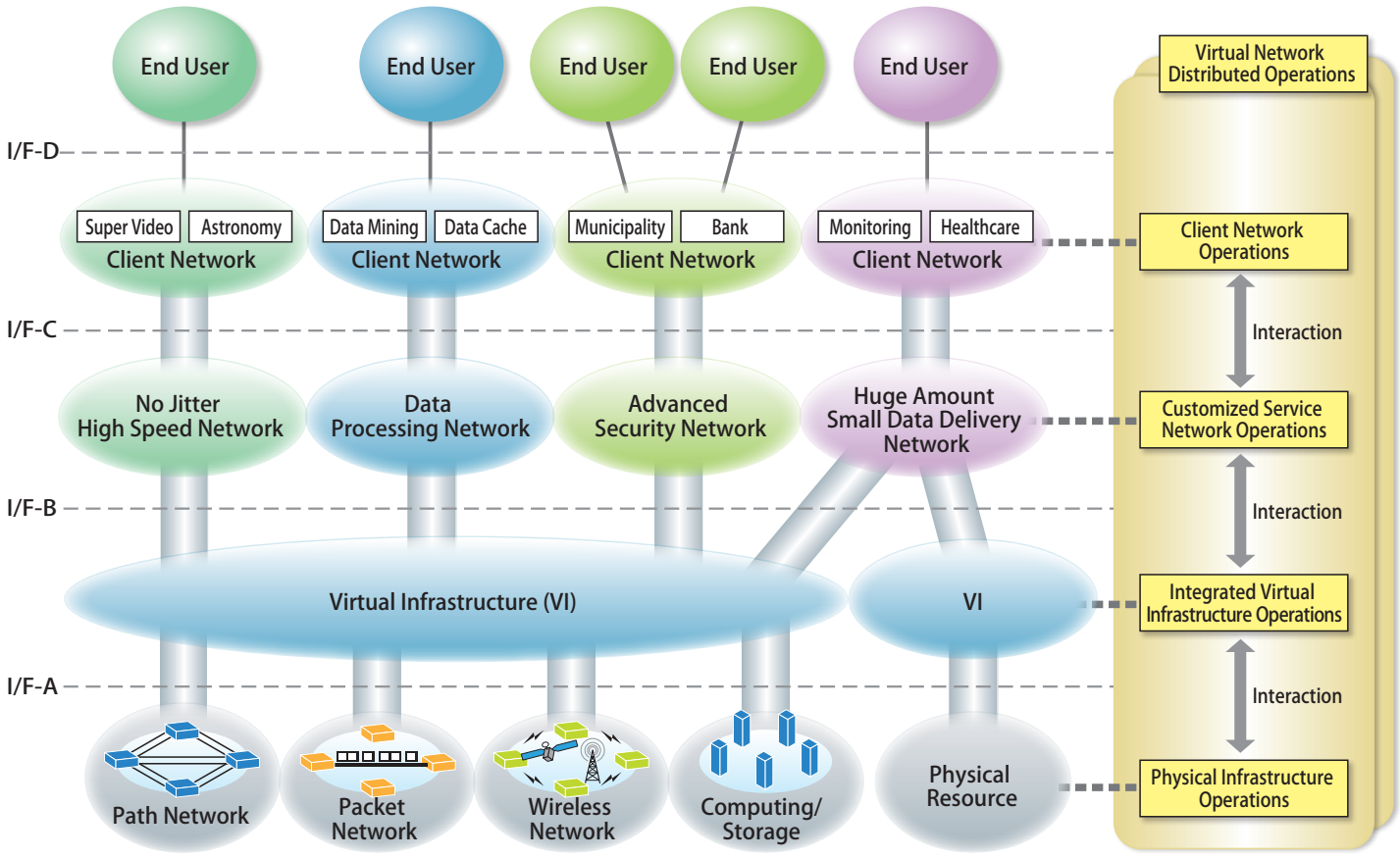
Create the operating and management technologies for integrated multi-layer and heterogeneous networks, and efficiently deploying simultaneous customizable networks.

Research Overview

- ◆Client Network Operations: Resource specification model, resource fulfillment, and operations
- ◆Customized Service Network Operations: In-network processing component distribution, service composition and management
- ◆Integrated Virtual Infrastructure Operations: Virtualized resource modeling, aggregation and isolation framework, logical and physical resource adaptation
- ◆Physical Infrastructure Operations: Monitoring and management for each virtualized network
- ◆Virtual Network Distributed Operations: Distributed management framework, dynamic installation of management components

Social Impacts

Deploy customizable multiple networks using network virtualization and provide customized network services according to individual user preferences.



NiCT

AKARI Network Architecture Design

Sub-project

The network design that underpins future society

Motivation

As diverse functions such as high-speed, reliability, mobility and security are involved, the Internet has become full of patches and joints, making further evolution hardly feasible. Intent upon dramatic performance enhancements – availability, ease of operation, as well as transfer capacity and a reduction in delays –there has been a global move afoot, since around 2005, to design and build a new breed of network aiming at the realization of an ideal network. Infrastructures that provide a platform for experimental verification have also gradually been put in place: GENI and FIRE in the United States and Europe, and the Virtual Node Project in Japan. NICT has been conducting a research endeavor, the AKARI architecture design project, to create a new generation network design from clean slate.

Goal

The objective of this sub-project is to design an ideal network that allows a breakthrough performance upgrade much more rapidly than the current technological extension pace, and to map out transition scenarios toward the network's realization from the present. The research involves forecasting the technologies that will become available in the future, and engaging in the actual development of these technologies as the need arises.

Research Overview

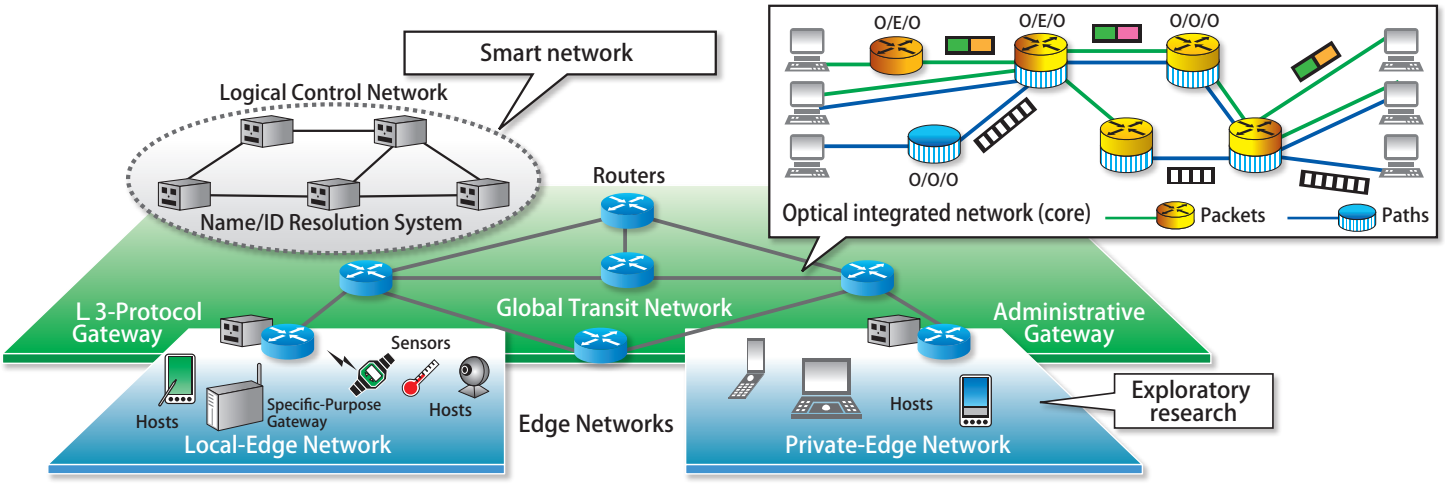
◆Preparation of a blueprint of the new generation network

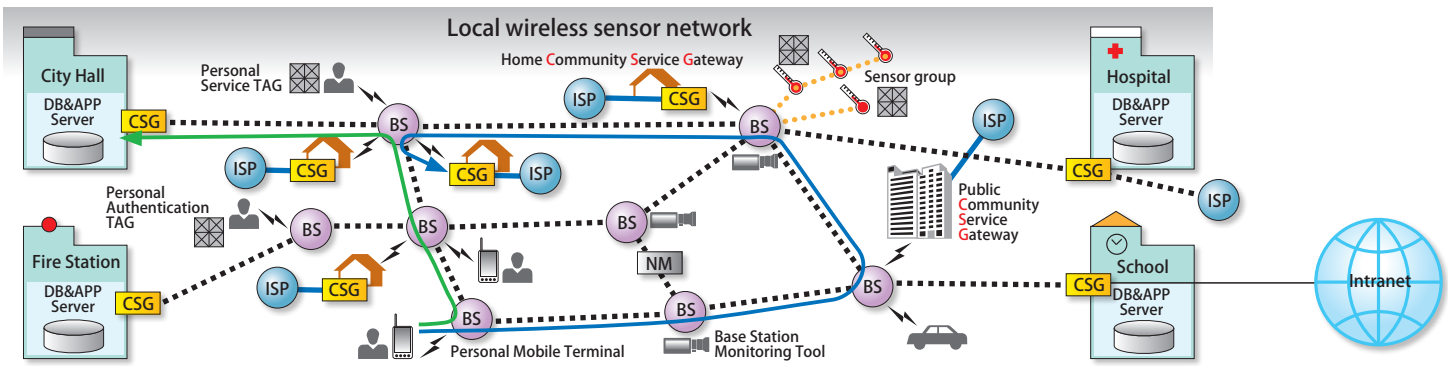
◆Incorporation of each SP's development and verification results into the grand design. Preparation of a technological overhead view indicating new generation technologies, whereby coordination and adjustment may be required to avoid interference and contradiction (an inability of simultaneous utilization) among the technical developments carried out by each SP (element technologies other than those proposed in the AKARI project may be included). The testbed for each elemental technology will be implemented by the SP concerned.

◆Research into the uncharted domain, e.g. wired/wireless integration

Social Impacts

By presenting a blueprint of a network capable of sustainable evolution, with no redundancy in legacy configurations, the results of this research will contribute, from a long-term perspective, to the construction of a cost-effective network.





NiCT

Wired/Wireless Network Integration

Sub-project

Toward the realization of wired/wireless integration in the new-generation network

Motivation

To cope with the increasingly diversifying services and QoS, network virtualization technology is required to enable the concurrent deployment of multiple network technologies on a shared network infrastructure with the capabilities of resource isolation and re-configurability. When the concept of network virtualization is extended to the wireless domain, especially in heterogeneous wireless access environments with multi-mode wireless terminals, cognitive radio technology is quite an effective approach because it facilitates re-configurations of the wireless network and enhanced radio frequency usage efficiency. Integration of these technologies imparts both diversity accommodation and sustainability (effective utilization of frequency), which are the key elements for the new generation network, and also enables the provision of a variety of service-specific virtual networks optimized for each mobile service.

Goal

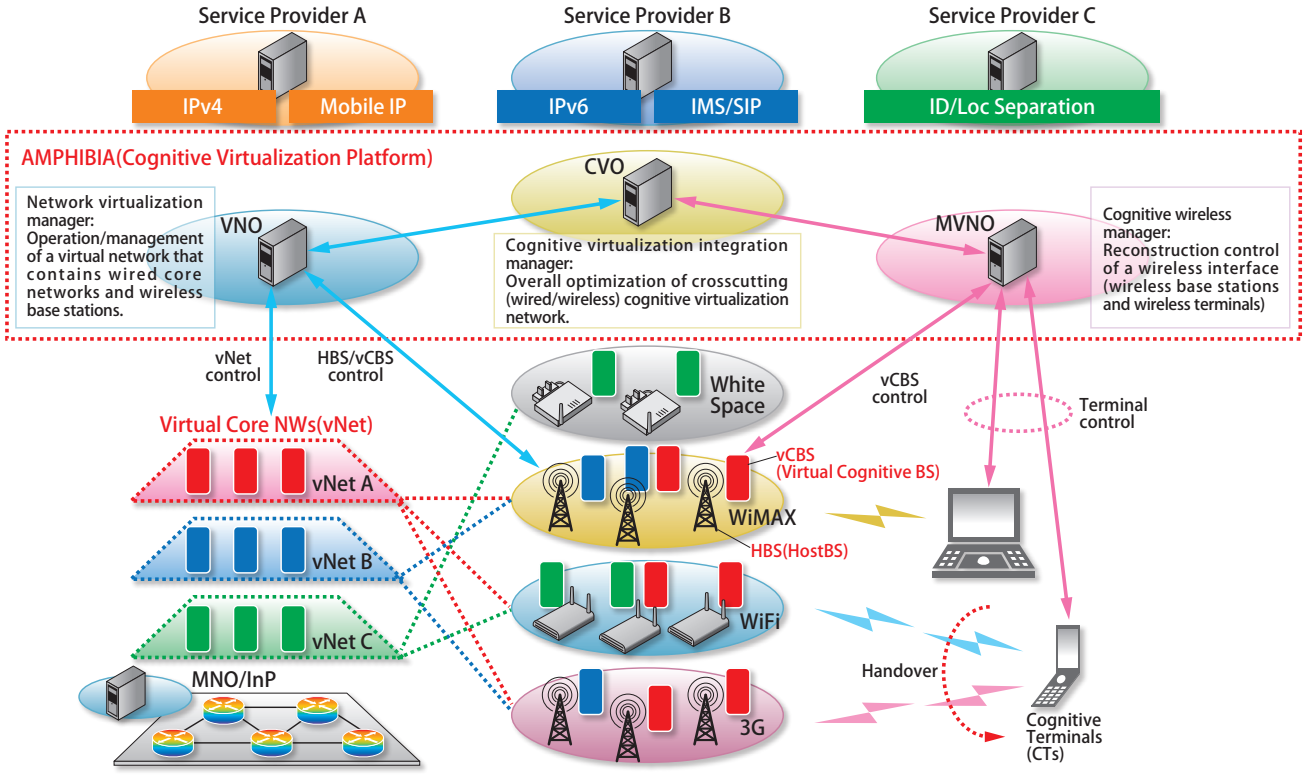
The goals of this sub-project is to establish the technology for construction, management, and optimization of an wired/wireless integrated virtual network, and identify the service models and its effects. Specifically, this sub-project is aimed to develop the key technology that enables dynamic network configuration, dynamic protocol configuration, and dynamic resource allocation over heterogeneous networks, including wireless access networks and wired core networks. This sub-project is also aimed at the construction and provision of the demonstrative experimental environment (open wireless testbed) required to accelerate R&D of key technologies of the new-generation network, including network virtualization, cognitive radio, large-scale sensor networking, and the integrated resource control for heterogeneous networks.

Research Overview

- ◆Technology for cooperation between network virtualization and cognitive radio systems (system architecture, interface, protocol)
- ◆Technology to virtualize a cognitive radio base station
- ◆Resource management technology for wired/wireless integration

Social Impacts

Integration of wired/wireless networks enables the on-demand provision of optimized networks across wired and wireless networks. It also has the potential of significantly improving the utilization efficiency of network resources (e.g. radio frequency utilization).



NiCT

Virtualization Node (VNode)

Sub-project

Establishing fundamental technology for network virtualization

Background

Research and development of the fundamental technology for network virtualization is underway in various countries. A global virtualization environment has been discussed and constructed around the world, such as PlanetLab and GENI in the United States and OneLab2 and FEDERICA in Europe. However, such systems are constructed through developing software on COTS (commercial-off-the-shelf) hardware and often referred to as so-called toy systems initiated by academia. There are few cases where fundamental technologies for network virtualization have been developed with a view toward commercial adoption.

Goal

The short term goal of the R&D is to build foundation for research on constructing network test-bed facilities that enable experimenting with new network architectures and services. The long term objective is to define a new meta-architecture for enabling various heterogeneous network architectures and services concurrently. We aim to define the network virtualization infrastructure that can simultaneously accommodate multiple independent new network functionalities and services and to build a prototype of the infrastructure. According to the demand from users and applications, we elect to construct a national "*critical information and communication infrastructure*" that could facilitate innovative end-to-end communications from scratch.

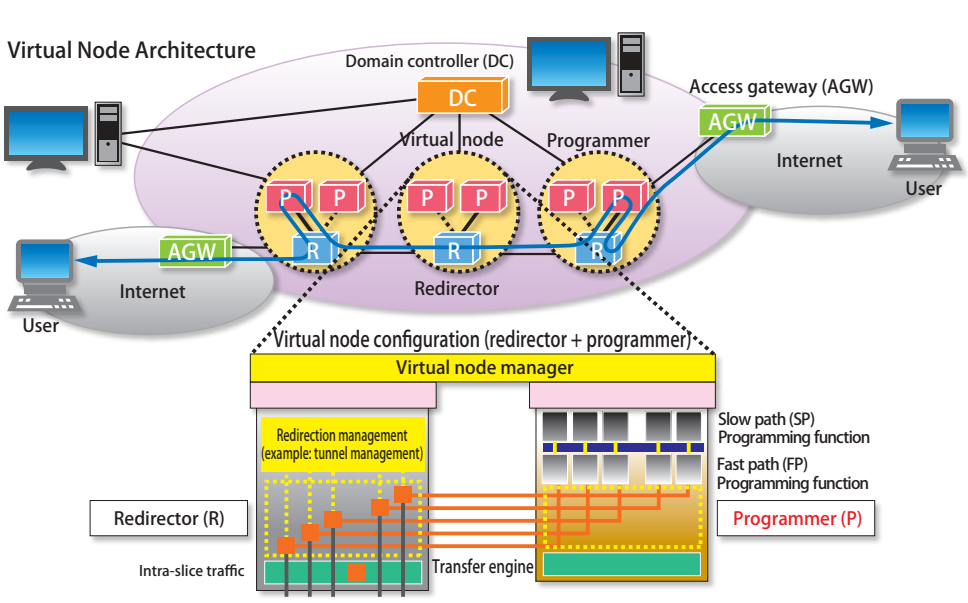
Research Overview

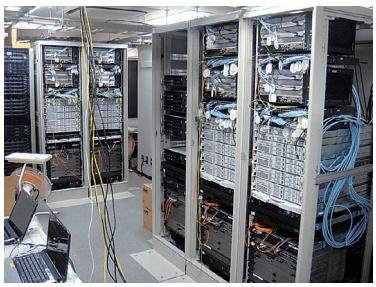
The project promotes an industry-academia-government collaboration combining the state-of-the-art development expertise of industrial sectors and the cutting-edge knowledge from Tokyo University and NICT. This is the world's first attempt to develop a network virtualization platform in the sense that it is an industry-academia-government collaboration, involving major enterprises and a top-level university in Japan. Together with major Japanese companies known for their strong engineering capabilities, accomplishing the rapid establishment and activation of a virtual network infrastructure is a challenge of great importance.

- ◆Realizing unconventional end-to-end data communication (non-IP/new generation network communication).
- ◆Proposing an integrated architecture that accommodates various communication technologies as well as programmability and processing capabilities.
- ◆Promoting the concept of access gateway for user opt-in

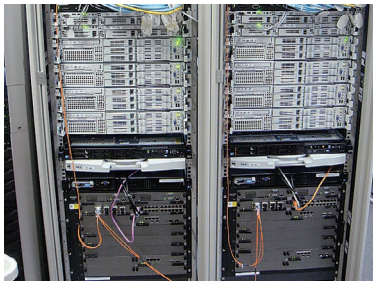
Social Impacts

- ◆Promoting the creation of various network service architectures, and boosting commercialization through pilot operations.
- ◆Industrialization of virtual platform technology and expanded market scale for the new network infrastructure technology.





Virtual node prototype (four sets) (Hakusan hub)



NiCT

Packet & Circuit Integrated Network

Sub-project

An earth-friendly network that responds to diversified service needs

Motivation

Widespread prevalence of the Internet has enabled us to communicate very conveniently. Still, the need for high quality communication is ever-increasing, for the purposes of entertainment, medicine, and a higher quality of life. Additionally, the effort toward the realization of a power-saving society through the effective application of ICT has become a shared demand across the world.

Goal

The sub-project is making progress toward the construction of an optical switch-based network, which utilizes optical packet and circuit integrated network technology to provide the user with packet switching service and end-to-end path service. The network provides the network administrator with a power-saving integrated network – the Internet and private line network have previously been constructed and operated independently of each other. It provides the user high-speed inexpensive services and low-delay, low data-loss high-quality communication services.

Research Overview

◆High-speed (increase the average service quality to the user)
◆Diversity (provides service quality required by the user)
◆Power-saving (introduce lightpaths and optical packet-switching, appropriate power management)

In this sub-project, research and development will be carried out on the following themes to attain the above-listed objectives.

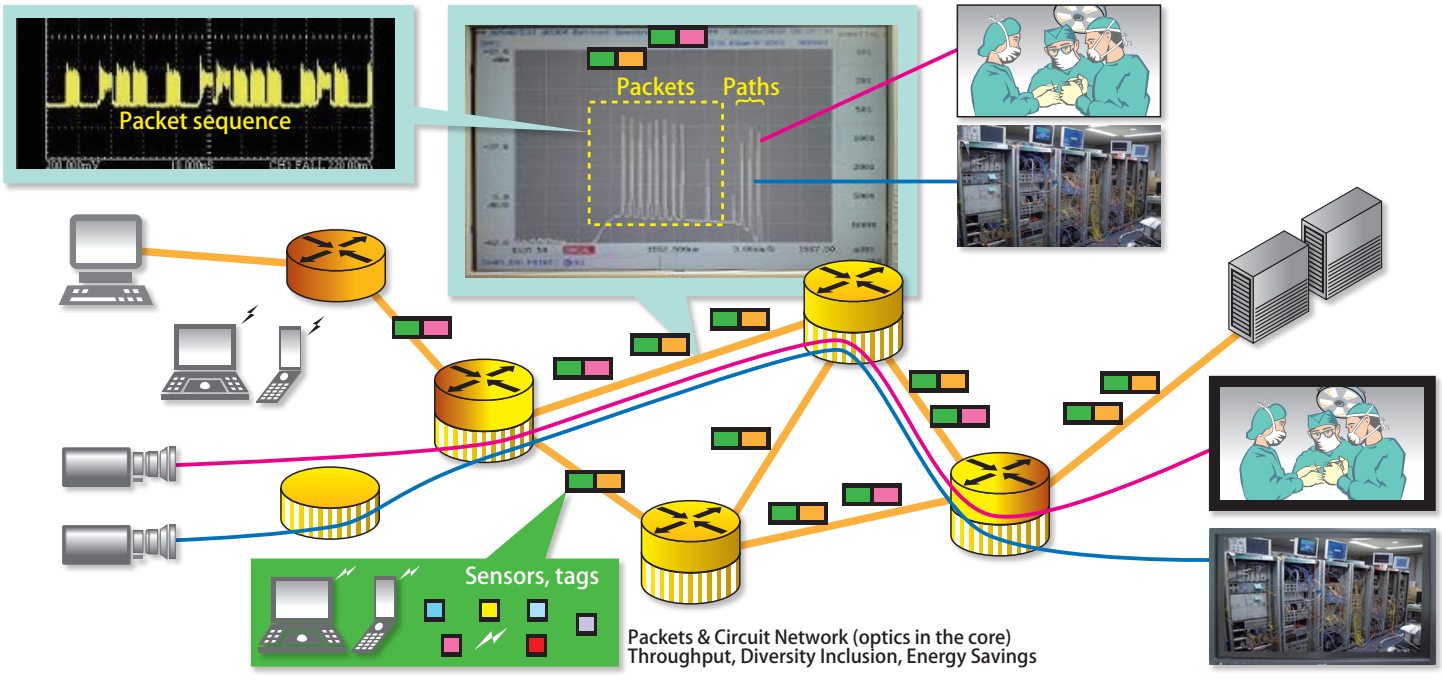
(1) Construction of optical integrated node: requires the development of a node that provides optical packet switching and optical circuit switching functions, which in turn provide high-speed header processing of optical packets, stabilization of optical burst signals, and optical buffering.

(2) Network control: development of optimized boundary control of packet and circuit resources, QoS routing, and quality assurance of mobile communication – these R&D will be carried out in cooperation with the smart network SP.

The results of the research and development will be examined by verification tests and pilot operation using a variety of testbeds (e.g. optical testbed, municipal optical fiber network, and network virtualization). Practical operation of the services is slated for 2020.

Social Impacts

The results of this sub-project contribute to the enhancement of quality of life, and the realization of a low-energy society.



NiCT

Network Science of Complex Systems and Physical Architectures

Sub-project

Toward constructing theoretical foundations for large-scale, complex networks

Background

The most significant attributes in the era of the new-generation of network include the vast scale and complexity of networks. However, it is difficult for traditional network theories to solve quantitative challenges such as the scale and complexity, and to resolve the qualitatively new requirements posed in networks. Also, network should be harmonized with innovations in cutting-edge physical and device science and technology so that, for example, ultimate energy saving is accomplished.

Goal

This sub-project aims at the construction of new fundamentals for new-generation networks that break through the limitations of conventional ones to deal with increasingly larger and more complex networks by multidisciplinary disciplines, including system sciences, physical sciences, biology, etc. and by industry-academia-government collaborations.

Research Overview

◆Network science of complex systems

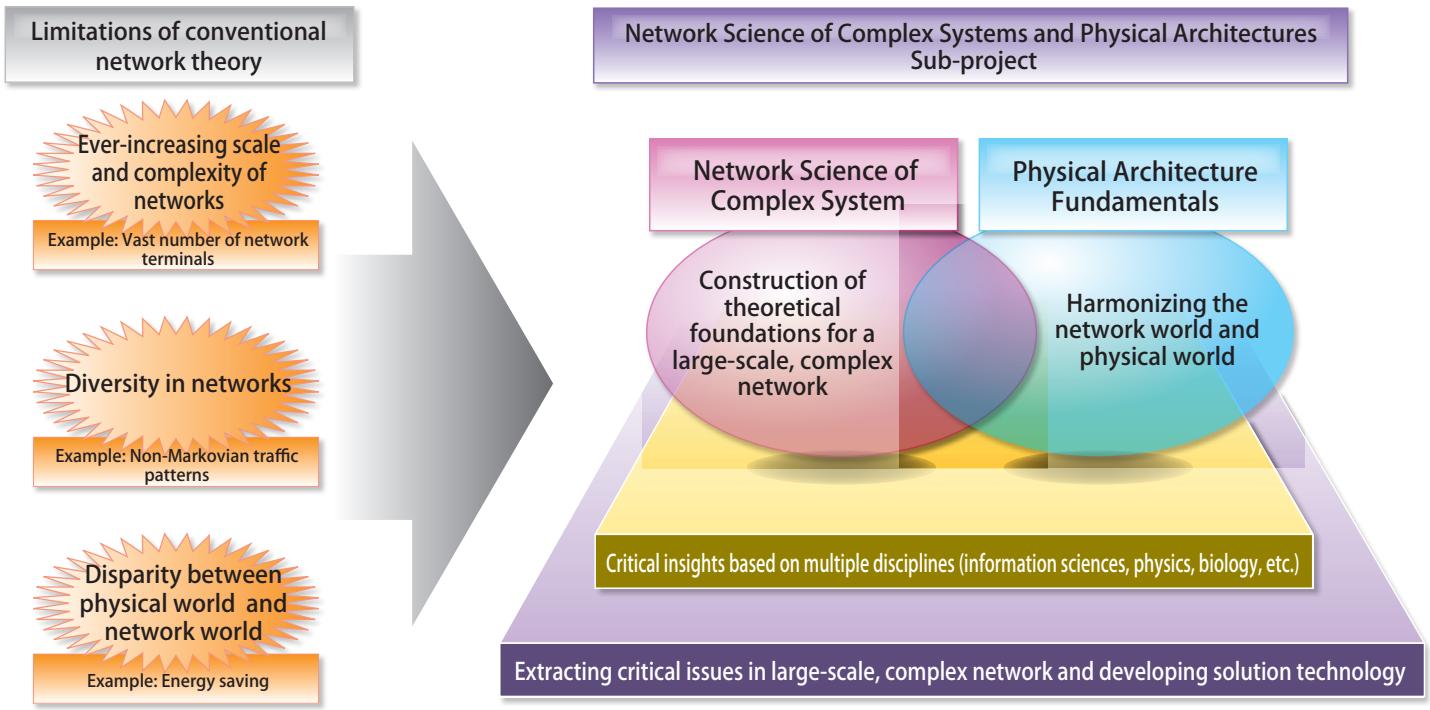
Extracting fundamental and structural challenges for large-scale, complex network systems. Constructing theoretical foundations for new-generation network addressing complex and large-scale nature by diverse insights including information system sciences, theoretical physics, biology, and other disciplines.

◆Physical Architecture Fundamentals

Construction of fundamental technologies so that network systems are harmonized with real physical world (e.g, energy efficiencies) and with cutting-edge physical and device science and technologies.

Social Impacts

By providing fundamental insights to cope with the ever-increasing scale and complexity of networks, this sub-project contributes to building theoretical foundations underlying information networks, which is one of the most important infrastructures for safe and diverse society and people's living.



NiCT

JGN-X Design, Research and Development Sub-project

From the establishment of technology to the verification of serviceability

Motivation

For Japan to evolve in the future, and make a contribution to the world, we have to develop a capacity for comprehensive problem-solving that applies ICT-related technology components to a variety of challenges in Japan and across the world. To attain this objective, it is important to apply the new-generation network technology in a field such as a testbed and to work to improve upon it, in preparation for global deployment in the future.

Goal

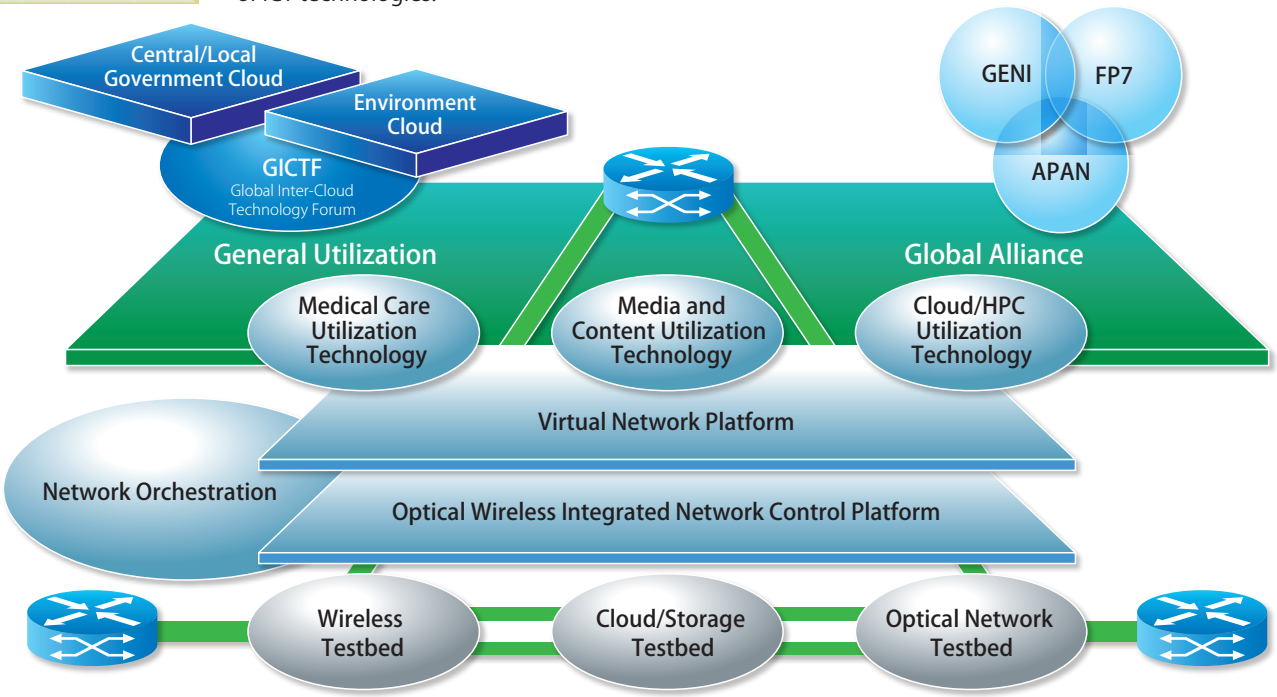
In addition to JGN2plus (a testbed NICT developed and has been operating), further components such as network virtualization node, StarBED, and a wireless testbed will be integrated to establish a large scale new-generation network testbed, JGN-X. Transition from the R&D level to an operational level will be realized by making use of and integrating technology components such as network virtualization node and optical technologies that NICT has been developing. Since we have been experiencing to apply new technologies into several use cases by many researchers in JGN, we strongly believe that making use of new technologies brings these technologies into reality. This transition will be a technological challenge and the results of it will contribute to establishing serviceable technology for the new-generation network. NICT is geared to lead the way to overcome the challenges ahead.

Research Overview

- ◆Virtualized network platform capable of accommodating multiple virtually configured networks
- ◆Control platform based on an optical wireless integrated network for total control of multilayered resources
- ◆Network orchestration mechanism that performs optimized resource allocation dynamically on the entire network
- ◆Network-aided medical services underlying the delivery of manifold medical care and health care services
- ◆Network-aided media services that underpins flexible sharing and the delivery of a variety of content
- ◆Utilization technology of Cloud/HPC (High-Performance Computing) to provide intelligent and flexible processing services

Social Impacts

The verification of various utilization technologies on a large-scale testbed helps to establish the reliability required for actual deployment. The results obtained will accelerate the broader utilization of ICT technologies.



NiCT

Early-concept Grants for Exploratory Research on New-Generation Network

Sub-project

Promotion of industry-academia-government joint projects

Motivation

It is necessary to forge the new-generation network in which innovation is generated by high novel fundamental/ exploratory research and development. Therefore industry-academia-government joint projects have to be promoted with their own excellent technologies and wisdom. Collaborations among dominant projects in FIND/FIA*1 program of NSF (National Science Foundation) in the US or FP7*2 ICT program of EC (European Committee) are also necessary for future international standardizations of the new-generation network. Hence, international cooperation is an important strategic promotion of the new-generation network. Furthermore we will also proactively develop the excellent technologies which will be leading the world on a large-scale. Therefore we have called for public subscription of innovative research to challenge cutting-edge technologies of information and communication as a first step for large project.

*1 FIND:Future Internet Design/FIA:Future Internet Architecture *2 FP7:Framework Programme 7

Goal

Research for the sub-project will move forward by taking advantage of creative ideas, submitted by outside researchers, that address the realization of the new-generation network which meets the expectations of users and future society at-large. With such technologies as one of our country's original powerful technology, and through the establishment of a partnership between the industrial sector, academia, and government, we will proactively develop the research on a large-scale.

Content

This sub-project is forging ahead with nine exploratory research projects, on a contractual basis, toward the practical realization of five new generation network targets (value creation, reliability, life environment support, restriction-transparency, and an Earth-friendly network) and one target in the fundamentals domain. Most of the research projects are being carried out in collaboration with overseas research organizations.

Exploratory Research (contracted research)

Flexible structure routing framework technology
◆Osaka City University

User-oriented network control technology in wired/wireless cognitive environment
◆Kobe University, Osaka University, Kyoto University, Asahi University, NEC

Self-organizing control technology
◆Osaka University

Distributed autonomous network technology based on local interaction
◆Tokyo Metropolitan University, KDDI R&D Labs, Hiroshima City University

Contents distribution platform technology by linkage between content ID and location ID
◆Kansai University, Osaka Prefecture University, Kobe University, NEC

Optical flow routing network technology
◆Nagoya University, National Institute of Informatics

Integrated architecture based on social metric
◆Kyoto University, The University of Electro-Commnications, Kobe Digital Labo, Inc.

Assurance network technology
◆Hiroshima City University, Tokyo Institute of Technology

Network technology based on service-oriented router
◆Keio University, University of Tsukuba, Hitachi Information & Communication Engineering, Ltd., National Institute of Informatics

NiCT

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