# Research and Development Activities toward Smart and Flexible Future Network: NetroSphere Concept

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**Abstract**

The NTT laboratories announced the NetroSphere concept in March 2015 with the aim of creating future networks that support the Hikari Collaboration Model (business model to wholesale fiber access). This article introduces our recent efforts concerning NetroSphere and explains the importance of creating future smart and flexible networks based on the NetroSphere concept in order to accommodate the digitization of various industries and the rapid growth of multiple Internet of Things services. These Feature Articles are based on lectures given during workshops at the Tsukuba Forum 2016 held on October 26, 2016.


*Keywords: NetroSphere, future network, smart and flexible*

## 1. Introduction

The progress made in information and communication technology (ICT) in recent years has led a multitude of industries that had not previously embraced ICT to incorporate ICT into their businesses and reform their operations through digitization. At the same time, the Internet of Things (IoT)—which connects various devices through wireless transmissions—has been rapidly expanding. Moreover, devices such as smartphones are improving in performance and functionality, and video services are improving in image resolution, and as a result, the amount of communication traffic is steadily increasing.

A diverse range of industries utilizes communication networks, and consequently, there are diverse requirements for different communication networks. To handle these requirements and the continuing increase in communication traffic, it is necessary to not only create future networks economically but also to make them flexible so they can handle additions and changes to requirements.

From a historical standpoint, services provided by communication networks have long been centered on telephony. However, the introduction of Internet connection services, video delivery services, and other recent changes has resulted in the triple play of Internet access, telephone, and video distribution becoming available in the era of next-generation networks (NGNs).

In addition, with the progress of digitization and the IoT, it is necessary to understand that communication networks no longer provide all services, but rather, they support some of the diverse end-to-end services provided by service providers in various industries. It is thus considered difficult to sufficiently handle these circumstances by utilizing demand-forecasting techniques and network-design techniques that have been fostered on public switched telephone networks and NGNs.

With these circumstances in mind, we consider that future networks will have the features outlined below.

- An architecture that can flexibly handle changes resulting from fluctuations in demand and differing requirements

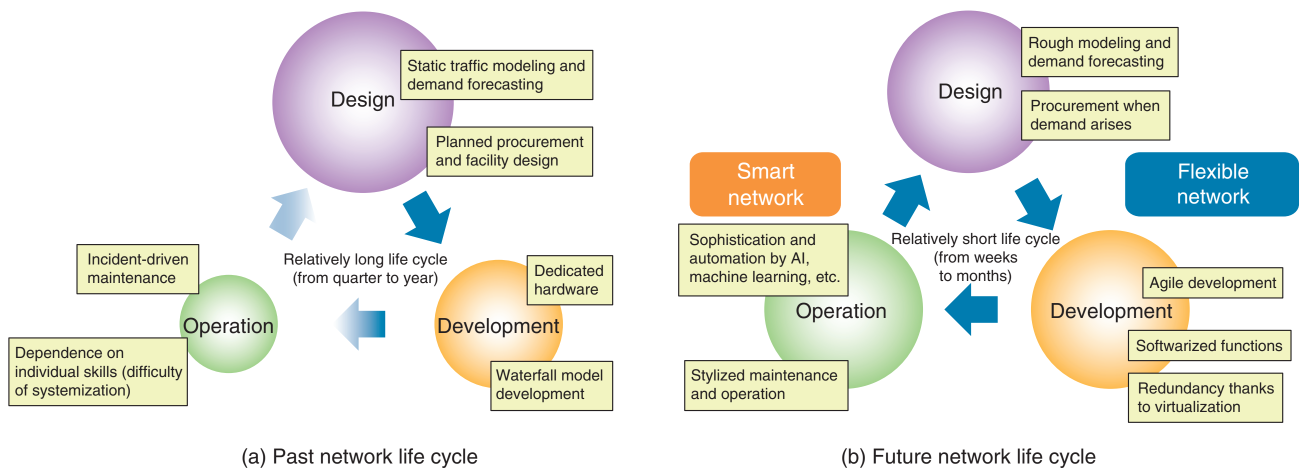



Fig. 1. Network life cycle.

- *Intelligent* operation that can handle events that are difficult to forecast
- A structure that efficiently achieves the above-stated features without incurring high costs

## 2. Life cycle of future networks

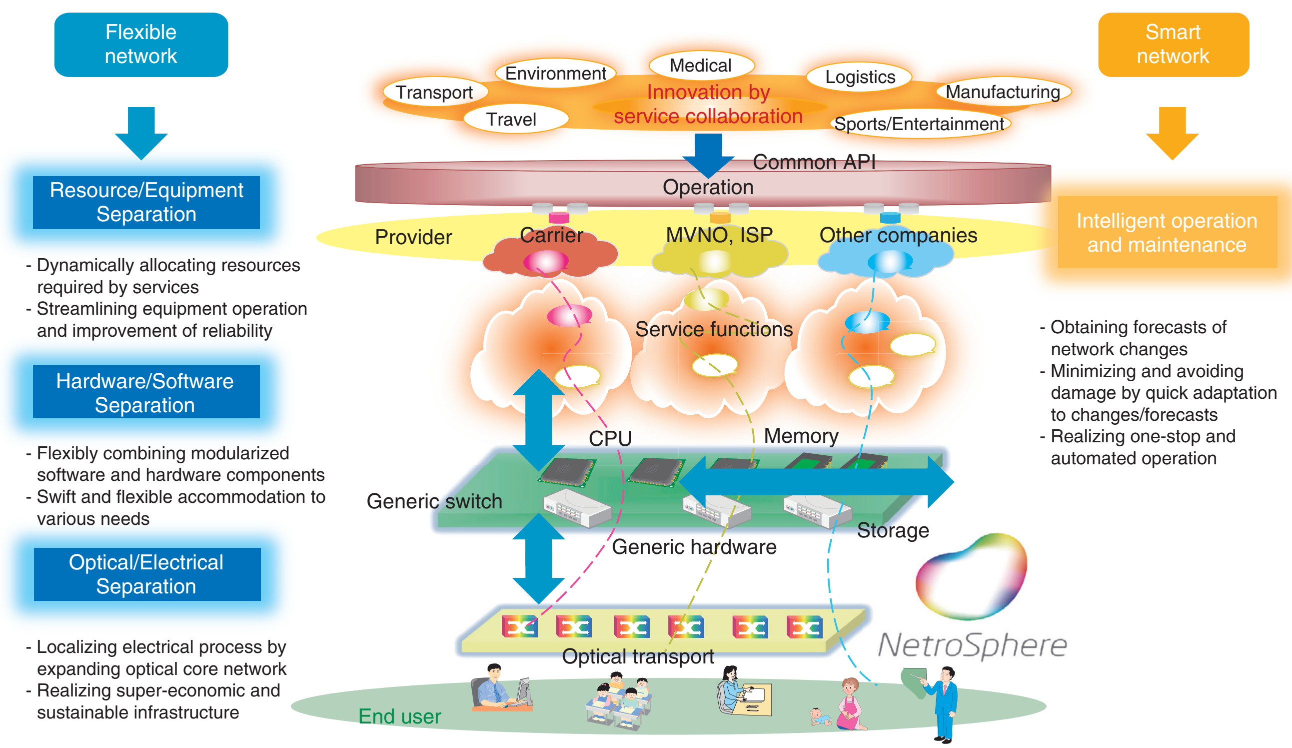
The life cycle of networks can be split into three phases: design, construction, and operation. That is, a communication network is designed in accordance with given requirements and demands, constructed on the basis of that design, and then operated. The knowledge gained during operation is fed back to the design phase as required. However, with the progress of digitization and the expansion of IoT, it has become necessary to change the way this life cycle is understood.

When services are directly provided by a communications carrier in the manner of conventional telephone networks and NGNs, the upstream of the life cycle has tended to receive the most attention. In other words, the approach taken has been to firmly forecast demand in the design phase, optimize the network design on the basis of the forecast demand, and procure hardware according to plan. In the development phase, requirements are specified, and the network is developed in an orderly manner according to the waterfall model. By doing so, operations are optimized in the operation phase (**Fig. 1(a)**).

If the requirements concerning a communication network are simple, and if fluctuations in demand are comparatively easy to forecast, the above-described approach is sufficient. However, the situation must be reviewed if the communication network has numerous requirements or if the fluctuations in demand for future networks are expected to vary considerably. That is, since requirements and demand are indeterminable beforehand, the network design will proceed in a rough manner, and hardware must be procured according to each demand.

We aim to implement agile development in order to flexibly accommodate changes in requirements. To handle events that are difficult to predict, new technologies such as artificial intelligence (AI) are being applied in the operation phase to improve functionality and performance. To efficiently create such a future network, we are simultaneously *softwarizing* network functions by utilizing software instead of hardware in the conventional manner, establishing network flexibility and redundancy (reliability) through virtualization of resources, and reducing operational costs through automation and *stylization* of maintenance (i.e., establishing a certain form for network maintenance and making it routine) (**Fig. 1(b)**). In creating a future network, we consider it important to establish a flexible network via the upstream processes (design and construction) and a smart network via the downstream process (operation).

Our approach for the NetroSphere concept announced in 2015 [1] involves efficiently creating a flexible network based on separation of resources and equipment, separation of functions and equipment, and separation of optical and electrical components, and a smart network for intelligent operation and maintenance (**Fig. 2**).




API: application programming interface
CPU: central processing unit
ISP: Internet service provider
MVNO: mobile virtual network operator

Fig. 2. Key elements of NetroSphere concept.

## 3. Activities aimed at realizing the NetroSphere concept

At NTT laboratories, we are developing technology in five areas in order to realize the NetroSphere concept (**Fig. 3**): (1) high-speed and highly reliable server architecture technology for speeding up application development (MAGONIA), (2) transport network configuration technology for achieving both scalability and economy (Multi-Service Fabric: MSF), (3) network equipment modularization technology for enabling flexible and low-cost access networks (Flexible Access System Architecture: FASA), (4) enhancement of operational technology by applying AI, and (5) verification of the NetroSphere concept (NetroSpherePIT). The current status of these activities are explained below.

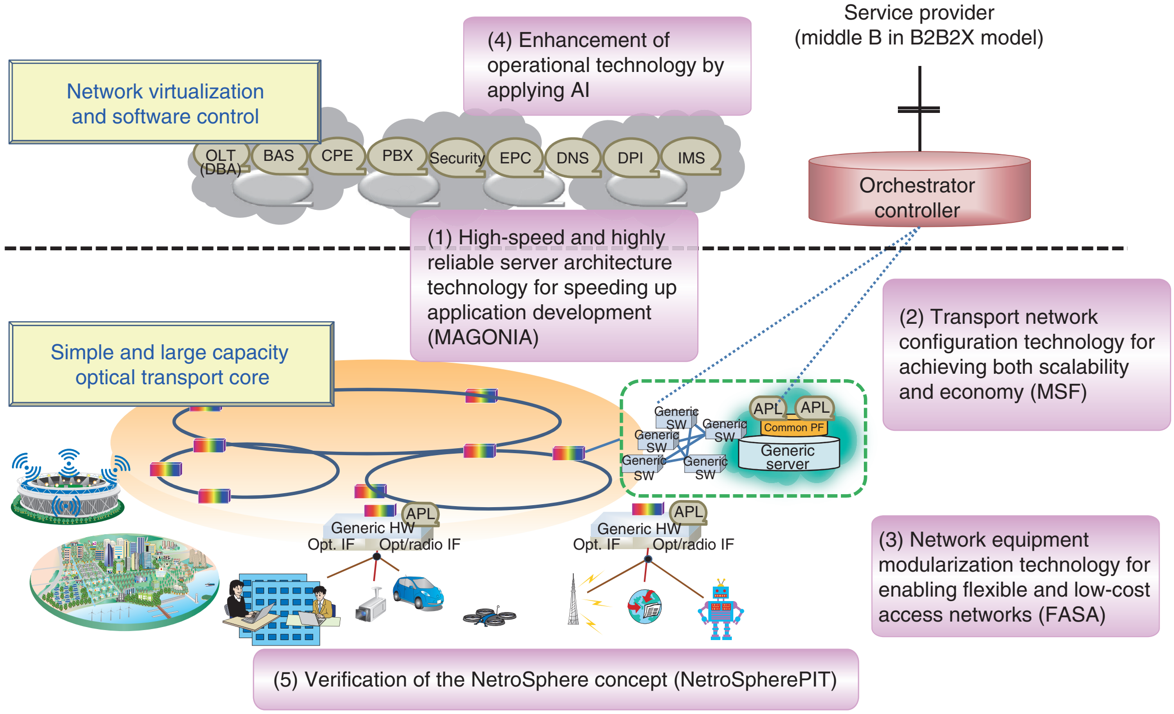
(1) High-speed and highly reliable server architecture technology for speeding up application development (MAGONIA)

This technology utilizes virtualization technology to implement on a shared platform network functions that in the past were implemented on exclusive-use appliances with separate functional capabilities, and network functions that were created with high-performance hardware. We confirmed that when this technology is applied to traffic simulation in ITS (intelligent transport systems), it enables congestion forecasting and signal control with high availability and scalability [2].

(2) Transport network configuration technology for achieving both scalability and economy (MSF)

This is a technology for configuring clusters by flexibly and optimally combining and controlling general-purpose switches. Since no exclusive-use equipment is needed, installation and operation costs can be reduced, and various services can be provided in a prompt and flexible manner. We published the architecture of this technology in August 2016 [3], and we are continuing to collaborate with various partners.

(3) Network equipment modularization technology for enabling flexible and low-cost access networks (FASA)




APL: application
BAS: business application service
B2B2X: business-to-business-to-X
CPE: customer premises equipment
DBA: dynamic bandwidth allocation
DNS: domain name system
DPI: deep packet inspection
EPC: evolved packet core
HW: hardware
IF: interface
IMS: Internet protocol multimedia subsystem
OLT: optical line terminal
PBX: private branch exchange
PF: platform
SW: switch

Fig. 3. NTT research and development activities for the NetroSphere concept.

The modularization of access system functions and the use of softwarization technology (access equipment modularization) in FASA enable it to share equipment. They also simplify maintenance and operations and achieve flexible and prompt handling of services. In May 2016, we released a FASA white paper, including FASA APIs (application programming interfaces) (proposal), and we are presently seeking partners to participate in technical discussions concerning the development of technical specifications [4].

(4) Enhancement of operational technology by applying AI

We are working on enhancing operational technologies that utilize big data analysis, AI/machine learning, and other techniques to handle various kinds of large-capacity data (network equipment, server information, traffic information, etc.) acquired from communication networks and the cloud. We have recently been working on anomaly detection technology and workflow visualization technology using syslog (system-log analysis).

(5) Verification of the NetroSphere concept (NetroSpherePIT)

We have established a verification environment called NetroSpherePIT as a venue for specifying and sharing common thoughts with various partners regarding technology created based on the NetroSphere concept [5]. The name NetroSpherePIT is analogous to a pit at a racing circuit, namely, a place where experts from various fields (car bodies, engines, tires, etc.) come together and think as one as they assemble racing cars and discharge them onto the circuit. It is a venue for not only verifying technology but also promoting collaboration with our partners. Moreover, we think that by incorporating networks utilized for daily work at our labs in NetroSpherePIT, we can operate NetroSpherePIT as a venue for accumulating our own operational technologies.

## 4. Future development

At NTT laboratories, we are striving to create a smart and flexible future network that can handle the upcoming era of seismic change. By jointly creating a wealth of value through collaboration with various partners, we aim to promote research and development that is more open than ever.

## References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### ■ Author profile


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He received a B.E. and M.E. from Nagoya Institute of Technology, Aichi, in 1988 and 1990. He joined NTT in 1990 and engaged in research on traffic engineering and quality management in telecommunications networks. From 1999 to 2005, he developed systems for IP-based services at NTT EAST. He is currently working on developing the architecture of future telecommunications networks.