Accelerating the Demonstration and Adoption of NetroSphere

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Abstract

The NTT Group aims to accelerate the transformation to a business-to-business-to-X (B2B2X) business model in response to changes in the telecommunication market. NetroSphere is the concept of a flexible and robust network that can cope with diverse and uncertain demand in the B2B2X model. The Feature Articles in this issue introduce the development of the network architecture and network systems technology that advance the materialization of the NetroSphere concept. It also touches on NetroSpherePIT and the global rollout to carriers and vendors as a collaborative program for accelerating the implementation of this concept.

Keywords: NetroSphere, network architecture, global collaboration

1. Introduction

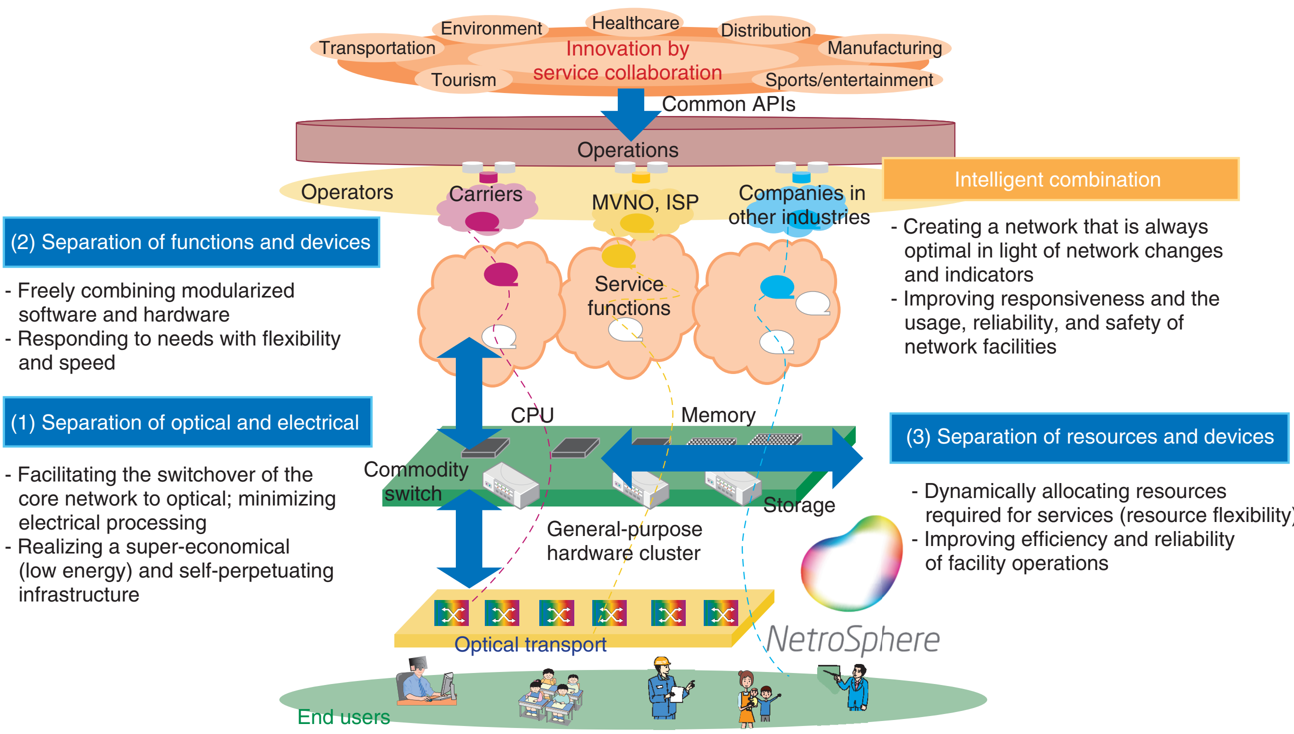
The telecommunication market is rapidly changing into an environment that surpasses the traditional value of connectivity and produces new value revolving around mobile and cloud services geared to OTT (over-the-top) players. In light of this environmental change, the NTT Group announced *Towards the Next Stage 2.0* as a medium-term management strategy and is now aiming to accelerate the evolution towards a form of business such as the Hikari Collaboration Model (wholesaling of fiber access service) by NTT EAST and NTT WEST. We are also working to achieve business in which networks are bundled with services such as MVNO (mobile virtual network operator) services, and the transformation to a business-to-business-to-X (B2B2X) business model through collaboration with partners in diverse fields. In addition, we are in a transformative period that involves the development of the Internet of Things (IoT) and machine-to-machine (M2M) services that are moving from traditional services focused on people to sensors and connected cars, while network requirements and the surrounding environment are undergoing major innovations.

NTT formulated and announced the NetroSphere concept in February 2015 as a new network research and development (R&D) concept in order to address various future changes such as the full-scale implementation of the B2B2X model and IoT/M2M services, as well as the introduction of fifth-generation (5G) mobile communication technology. NetroSphere fulfills a variety of customer requirements through the free combination of modularized network functions, and its ubiquitous presence protects against risks and the changing environment [1] (**Fig. 1**).

Since announcing the NetroSphere concept, NTT has been striving to advance the penetration of this concept. To do this, we held dialogs with global carriers and vendors and pursued active interoperation and use of cloud technologies such as OpenStack. This enabled NTT to develop plans for a future network that will lead the world and to promote the R&D of elemental technologies that will constitute this network (**Fig. 2**).

2. Materialization of the NetroSphere concept

The initial work on the NetroSphere concept focused on facilitating the development of a new architecture centered on a core network and server systems, including a new network architecture called Multi-Service Fabric (MSF) [2]; a new server



API: application programming interface
CPU: central processing unit
ISP: Internet service provider

Fig. 1. Concept for implementing NetroSphere.

architecture called MAGONIA; and a management and orchestration operation system (MOOS), which exercises flexible control over MSF and MAGONIA. In technology development, we are pursuing open and global sharing of the concept and are actively promoting collaborative development with approved vendors. Announcements of the intent to cooperate in developing technology for the NetroSphere concept have come from multiple global vendors [3], while productization by individual companies in line with the NetroSphere concept is gaining momentum [4].

We investigated applications of MAGONIA not only to communication systems, but also to non-stop traffic congestion prediction and signal control systems by leveraging the benefits of a highly reliable, real-time distributed processing base technology, and we verified the effectiveness of these applications through demonstration tests [5, 6]. These examples show the application potential of NetroSphere architecture for a broad range of information and communication technology (ICT) systems. In addition, we are collaborating with Intel Corporation to develop SPP (Soft Patch Panel) technology that achieves ultra-high-speed interconnection over a diversity of services [7].

In February 2016, we expanded the NetroSphere concept to the access system domain and proposed Flexible Access System Architecture (FASA) as a new architecture for access systems [8]. FASA can be flexibly and economically constructed in response to service requirements by thoroughly modularizing the functions that constitute access device and freely combining these components. This conceptual proposal concerning device modularization that ventures into the field of access device implementation is a world first. Now, as we approach the era of 5G and IoT, we consider FASA to be an architecture that enables low cost and flexible combination of wired and wireless devices as well as flexible response even when computing resources must be deployed near the user, such as edge computing and ultra-low latency services.

After the concept was announced in February, NTT began recruiting global partners for the widespread

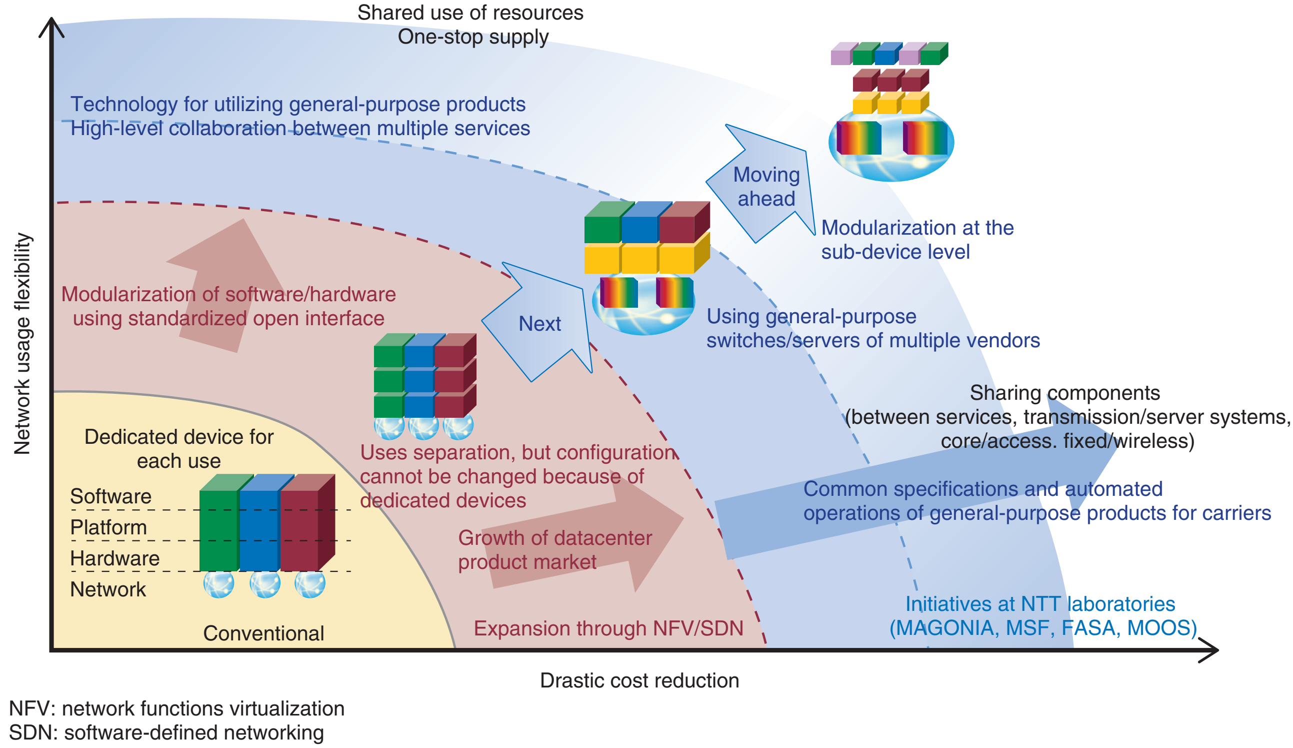


Fig. 2. Efforts underway to realize NetroSphere.

adoption of the FASA concept. In May, NTT released a FASA white paper, which is a detailed description of the FASA concept, together with a draft of the inter-component interface (API: application programming interface). Radical changes are taking place in the way access devices are handled, and such devices are undergoing a conversion to general-purpose and more economical ones. In addition, initiatives are increasing towards new uses of access systems for a wide range of partners [9].

While NTT laboratories are advancing the development of elemental technologies that realize the NetroSphere concept, they have also started building and operating a NetroSphere demonstration test environment that materializes the NetroSphere concept. This environment, named NetroSpherePIT, is not only used for visualizing the concept, and for establishing and verifying its technology; it is also used for developing concrete examples of ideas in real, physical form together with NTT operating companies and various partners to create new usage scenarios, services, and functions [10, 11].

Through these initiatives, the phase of permeating the NetroSphere concept has been completed, and we have entered the demonstration phase with an eye on commercialization, while the development of technology and products by various worldwide vendors is moving forward.

3. Future network architecture and NetroSphere technology usage sought by NTT R&D

In this section, we describe what we want to achieve in the future with NetroSphere.

3.1 Approach and direction of future network architecture

Our objective is to achieve the appropriate and timely provision of a network in response to uncertain future demands from service providers (partners in the B2B2X model), and therefore, we will construct a network that freely combines various functions and components according to requirements. This will be achieved by adopting a network architecture utilizing virtualization technologies (network functions virtualization: NFV, and software-defined networking: SDN) and employing the three-separation

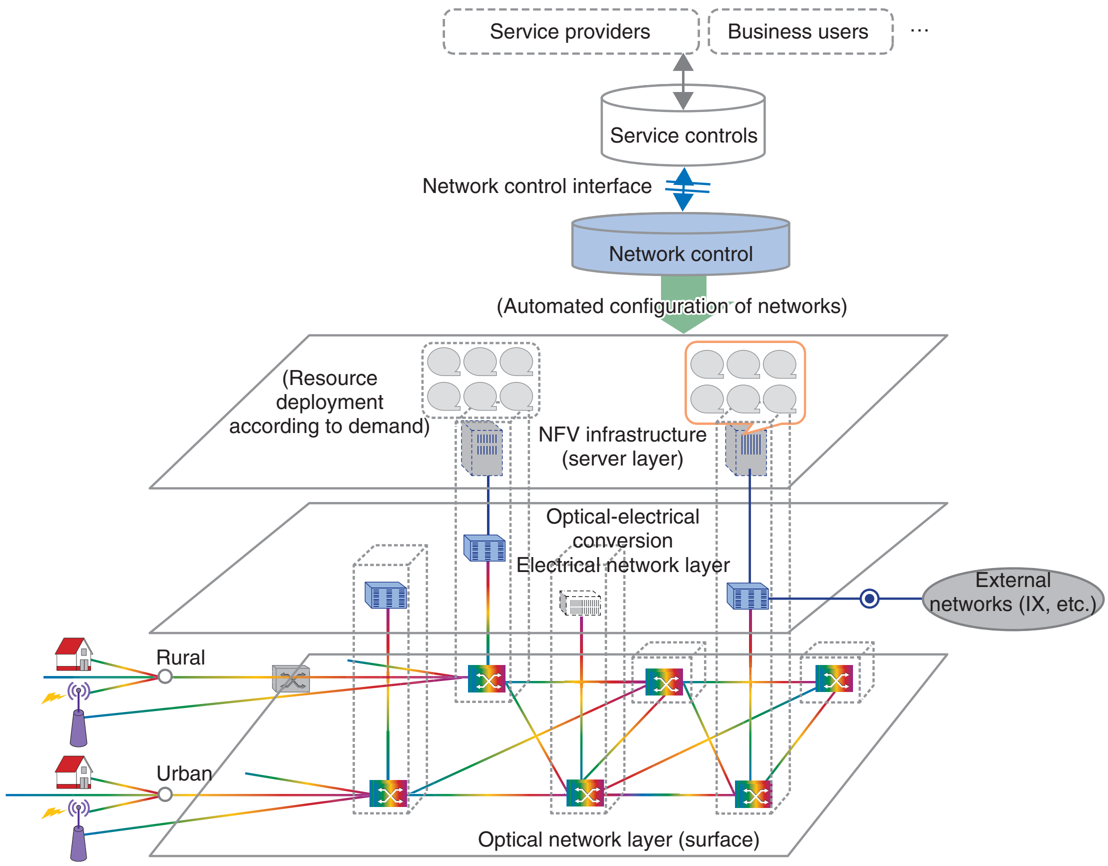


Fig. 3. Future network architecture based on the NetroSphere concept.

approach (optical vs. electrical, function vs. device, and resource vs. device) in the NetroSphere concept.

In the future, network functions designed under the assumption of frequent short-term changes will be implemented with software, and software additions and revisions will be implemented and allocated appropriately within the network (on server equipment). Together with this, rapid provision of network functions through reconfiguration of software and the network (controlled by SDN) will become possible.

In contrast, for networks that must be expanded over a wide area, the goal is to achieve long-term economical operations that are free from the effects of service-dependent changes. This will be accomplished by using a simple network architecture consisting of general-purpose devices, where optical transmission is performed as much as possible, and functions that depend on individual services are implemented in software and separated (**Fig. 3**).

3.2 Transport network architecture

The major changes in transport networks are presumed to be increased traffic volume and the introduction of new technology. To deal with the increased traffic volume, the plan is to expand network capacity by raising transmission speeds and expanding the electrical conversion interfaces at optical nodes. Also, maintaining an optical-electrical separation will minimize the effects on optical transmission that undergoes surface expansion over a wide area.

In areas and facilities where the traffic volume is smaller than interface capacity, improving usage efficiency through traffic layering by electrical operations (such as a layer-2 switch) is thought to be an option. However, in consideration of changes in traffic volume and characteristics over the long term, a method with cost-effective operation and resource allocation, for example, of wavelength, will be selected. In addition, the optical-electrical separation makes it possible to implement a network in which the respective advances in optical and electrical technology can be independently accepted.

3.3 Server network architecture

The major changes in server networks are presumed to be the introduction of new services such as the IoT and M2M. IoT/M2M traffic has various characteristics. Like a telemeter, it has no movement and very little traffic; like a connected car, it has a broad range of movement and a small amount of traffic; and like a drive recorder, it has a lot of movement and a lot of traffic. For existing silo-type facilities* optimized for individual services, efficient accommodation of IoT and M2M terminals, for which vast numbers are anticipated, will be difficult. This is because the signal processing capacity of the existing silo-type facilities will be insufficient even if there is spare capacity in transmission, and facility expansion will be necessary due to the lack of certain network resources. By maintaining a resource-device separation in order to have flexible allocation of required resources for signal processing and packet transmission functions, optimal network provisioning can be implemented efficiently through an appropriate balance suited not just to IoT and M2M but also to individual traffic characteristics.

3.4 Network control architecture

The major changes resulting from the adoption of the B2B2X model are presumed to be a short-term reconfiguration of the optical transmission/transport network and the server network by service providers who supply services for end users. To achieve these short-term changes by service providers, a network control interface will be set up, and automatic network configuration will be provided. Prompt and economical network provisioning can be achieved by automatically conducting network settings and operations in order to satisfy the diverse requirements from service providers (from broad network requirements to more detailed ones) [12].

4. Global expansion of the NetroSphere concept

Since the announcement of the NetroSphere concept in February 2015, in order to facilitate specific implementations of the concept, the NTT laboratories have moved forward with the global expansion of the concept with the goal of achieving widespread adoption of technologies and products based on this concept.

Until now, we have been delivering our vision of future networks through international conferences and other events, while also examining use cases and the applicability of new technologies towards concrete collaboration with global carriers and vendors. As discussed above, the NetroSphere concept will bring about substantial innovation in the network architecture of telecommunication carriers. We have been gaining the approval of many global carriers and vendors and have been starting collaboration with partners outside Japan.

One of the base technologies of NetroSphere is virtualization. Since its introduction, virtualization has been advancing as server technology for datacenters, and the technology has been developed and adopted through open solutions centered on software implementation. Both NFV and SDN apply virtualization technology to telecommunication carriers' infrastructure. Major innovation in infrastructure technology development and standardization is considered necessary so that carriers can use these technologies. Therefore, it is necessary to facilitate technology development and expanded adoption by using open source software and the like, based not only on existing de jure standardization but also on open collaboration. Consequently, to implement this type of effective approach in the development of NetroSphere, NTT has opened the door to associated global carrier and vendor partners, and is proceeding with technology development and expanded adoption of the technology through combined use of diverse methods that go beyond existing frameworks.

In its collaboration with global carriers, NTT is studying the use cases and applicability of technology through joint efforts with Asia-Pacific (APAC) carriers, in addition to its existing activities with European and American carriers through standardization organizations. In the APAC region, the growth potential of telecommunication markets is comparatively high, and investment in the new technologies and services of the telecommunication infrastructure is expected. The region is composed of countries with diverse local characteristics. Therefore, new services based on diverse customer requirements can be expected to be introduced in the telecommunication market and ICT industry.

We believe that the network flexibility resulting from NetroSphere will be adopted not only in the Japanese market but also in the markets of the APAC region with their great diversity. NTT thus aims to

* Silo-type facilities: Telecommunication facilities that are optimally configured for signal processing and packet transmission capacity using dedicated systems for designated services.

bring innovation to the entire global sector to contribute to the expansion of these markets.

With respect to global vendors, NTT intends to share the concept for future networks and move ahead with the joint implementation of technology discussions and examination of specifications. We are carrying out joint examination of use cases, network configuration methods, and technology specifications employing the primary technologies of NetroSphere—MSF, MAGONIA, FASA, and MOOS—with several vendors who are active worldwide. Furthermore, preparations are being made for jointly conducting PoC (proof of concept) demonstrations to verify the feasibility of new technology.

As a specific example in server technology, starting in February 2014, a joint study project was initiated by Nokia Corporation (formerly Alcatel-Lucent), Fujitsu Limited, and NTT towards the establishment of distributed server technology as the basic functional section of the communication network together with a new server architecture [13]. In February 2016, Ericsson and NTT began collaborating on technology concerning a next generation cloud server [3]. Technology for separating server hardware, and management and control technology are positioned as important elemental technologies that need to be established to achieve the NetroSphere concept that will provide new services in a shorter time. NTT is facilitating open collaboration with these global partners to achieve the NetroSphere concept in the future.

5. Future development

NetroSphere has gone beyond the concept stage and is entering the verification phase with an eye on commercialization. Towards full-scale implementation of IoT and 5G, we aim to develop NetroSphere as a network infrastructure that supports the B2B2X collaboration business of the NTT Group as we look ahead beyond the year 2020. With the NetroSphere architecture, it is also possible to have a small start that responds flexibly to service requirements in the form of add-ons to the existing network. We aim for concrete application in the global market in time for the big event in 2020, so we are taking the initiative to achieve the rapid commercialization of the technology.

Furthermore, we will make maximum use of the benefits of the NetroSphere architecture by combining it with *Network-AI*, NTT's artificial intelligence (AI) technology, that enables dramatic improvements in network security and diverse network log information usage (big data analysis), and will thereby improve the value of networks that are easy for partners (service providers) to use with safety and security.

References

[1] Press release issued by NTT on February 19, 2015.
http://www.ntt.co.jp/news2015/1502e/150219a.html

[2] K. Takahashi, H. Yoshioka, K. Ono, and T. Iwai, "Promoting the MSF Architecture for Flexible Networks," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa6.html

[3] Press release issued by Ericsson on February 18, 2016.
https://www.ericsson.com/news/1986917

[4] H. Shina, A. Masuda, and A. Kawabata, "Initiatives for Realizing NetroSphere—Promotion of Global Expansion and NetroSphere Demonstration Tests," BUSINESS COMMUNICATION, Vol. 52, No. 12, pp. 8–9, 2015 (in Japanese).

[5] Press release issued by NTT on April 12, 2016.
http://www.ntt.co.jp/news2016/1604e/160412a.html

[6] H. Kobayashi, T. Kitano, M. Okamoto, and T. Fukumoto, "MAGONIA (DPB: Distributed Processing Base) Applied to a Traffic Congestion Prediction and Signal Control System," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa7.html

[7] T. Nakamura, Y. Ogawa, N. Takada, and H. Nakamura, "MAGONIA (Soft Patch Panel): High-speed Inter-function Technique," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa8.html

[8] Press release issued by NTT on February 8, 2016.
http://www.ntt.co.jp/news2016/1602e/160208a.html

[9] M. Yoshino, H. Ujikawa, T. Harada, R. Yasunaga, T. Mochida, K. Asaka, J. Kani, and K. Suzuki, "New Access System Architecture (FASA)—Enabling Provision of Services Flexibly and Promptly," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa3.html

[10] T. Okutani, A. Kawabata, T. Kotani, T. Yamada, and M. Maruyama, "NetroSpherePIT: Demonstrations to Accelerate the Adoption of NetroSphere," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa2.html

[11] Y. Soejima, M. Nakajima, and K. Takahashi, "One-stop Operation Technology," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa5.html

[12] K. Kawakami, M. Kobayashi, K. Yogo, K. Okuda, M. Sekiguchi, T. Kurahashi, S. Arai, T. Tsuchiya, and N. Shirai, "Network Control Technology to Realize the NetroSphere Concept," NTT Technical Review, Vol. 14, No. 10, 2016.
https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201610fa4.html

[13] Press release issued by NTT on February 7, 2014.
http://www.ntt.co.jp/news2014/1402e/140207a.html

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