Automated Network Control Technologies

● Kazuyuki Miura ● Takeshi Miyagawa ● Hirotaka Morita ● Akio Iwata

As cloud and mobile services continue to grow significantly, networks need to be more agile, flexible, and optimized than ever before. Today, many pieces of equipment deployed in both mobile wireless and transport networks are configured manually, and are not necessarily meeting the agility and flexibility required. Also, there is a limit to how instantaneously infrastructure can be updated to support rapidly increasing network demand, and network optimization is needed. Under these circumstances, automated network control and optimization technology is becoming more important to support continuously changing cloud and mobile services. This paper introduces automated network control and optimization technology as well as its potential for IT interworking.

1. Introduction

To keep up with the evolution of cloud and mobile services, network operators are required to construct more agile and flexible networks. There is also an urgent need to update infrastructure to meet the rapidly growing service demand but there is a limit to how much the current demand increase can be supported by infrastructure updates alone. Accordingly, network optimization (reallocation) is another important issue.

However, most network elements used in mobile wireless and transport networks that currently support the cloud and mobile services are configured manually and are not necessarily meeting such needs in terms of agility and flexibility.

This paper describes the effectiveness of automated control technology for networks and optimization technology for network resources that meet the needs at the right times.

2. Mobile network and control technologies

Figure 1 shows an image of networks that support cloud and mobile services.

At present, communication carriers are taking various approaches to meeting the increasing demand for mobile services, including the use of multiple frequency bands, development of technology for efficient utilization of frequency bands (from 2G to 3G to 4G) and increase of the station density (from macrocells to picocells to femtocells). They are attempting to support the demand increase by combining them but these measures are making radio access networks (RANs) increasingly complicated (heterogeneous networks [HetNets])[1] so that manual configuration and maintenance of the individual network elements is becoming unrealistic.

To address these issues, a standardization project for studying and establishing standards of 3G and subsequent mobile communication systems is being implemented. It is called the 3rd Generation Partnership Project (3GPP), and it is now specifying various types of automated control (such as automated configuration, handover, load distribution, and resource optimization technology) that covers RAN portions by means of self-organizing network (SON) technologies.[2]

3. Transport network and control technologies

Recently, the International Telecommunication Union – Telecommunication Standardization Sector

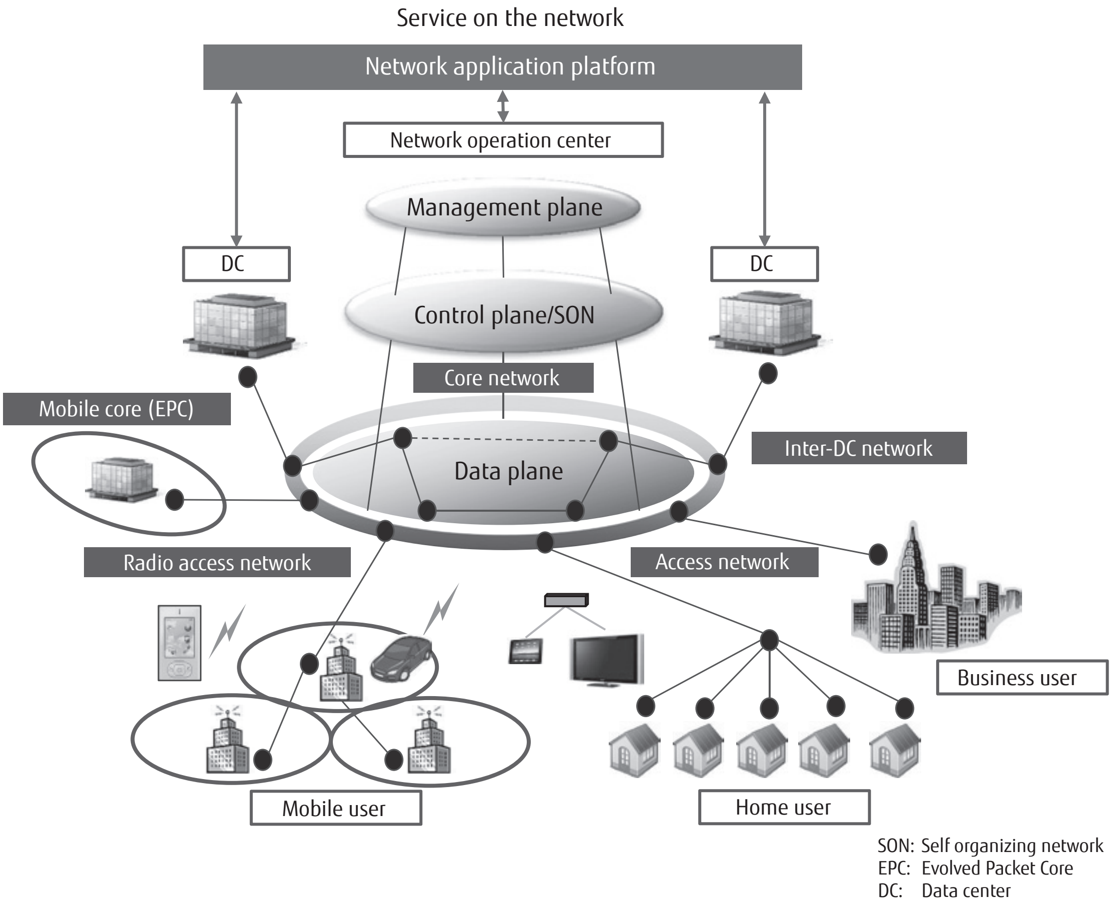

Figure 1
Image of networks supporting cloud and mobile services.

(ITU-T) has been specifying Optical Transport Network (OTN) transport technology to efficiently map both SONET/SDH and packet signals over the same OTN framing structure. Among networks that use OTN technology, mesh topologies are expected to become the mainstream. In a mesh network, there is more than one route to the destination in routing. For that reason, when determining and preparing a protected route upon a failure, the protected route can be designed to avoid the network elements and fibers used for the active route (Shared Risk Link Group [SRLG]), which allows risks to be mitigated in the event of network element failure. In addition, operators can run the network efficiently by sharing the protected route with multiple active routes.

In this way, mesh networks have various benefits but involve complicated operations. Accordingly, flexible network operation by automated control that makes use of software is called for. In OTN-based networks, it is important to have automation of path configuration, autonomous alternative path calculation in the event of failure, path switching, and network optimization technology by IETF-specified Generalized Multi-Protocol Label Switching (GMPLS) control plane. At present, Fujitsu is incorporating GMPLS in its FLASHWAVE series of products.

The development of hardware technology for increasing speed at the optical level from 40 to 100, 400 Gb/s is under way to meet the increase in transport network demand. At the same time, network flexibility and network resource optimization on the optical layer must also be achieved as traffic demand fluctuates. At present, the Wavelength Switched Optical Network (WSON) is being specified by the ITU-T within the Automatically Switched Optical Network (ASON)[3] context, and combining this next-generation reconfigurable optical add/drop multiplexer (ROADM) with the colorless, directionless, contentionless and gridless features (CDCG), allows flexile and efficient operation (network design and change) of a transport network on the optical layer. **Figure 2** shows control planes for the respective layers.

In the future, transport networks are expected to be applied in various ways not only by assuming the role of a large-capacity, high-reliability infrastructure as they have been, but also by flexibly allocating resources including network bandwidths as end users request high-speed and optimum paths on a demand basis. Network resources as a result of abstraction and pooling of functions of the respective layers are shown in **Figure 3**.

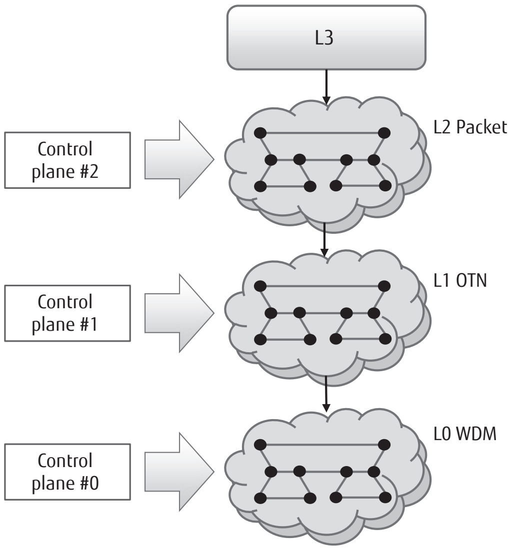

Figure 2
Control planes for respective layers.

4. Enhancement of user experience

Because mobile traffic depends heavily on the movement of people, the traffic load geographically varies with time. In order to provide uniform mobile services, it is important to effectively design the RAN portion of the network.

To deal with mobile traffic that varies every moment geographically, the SON technology can be applied for promptly adapting RAN design, which allows the network to be constantly optimized and enables uniform mobile services.

Organic operation for optimization of the RAN would result in a load fluctuation to the underlying mobile backhaul (MBH) infrastructure that supports an entire mobile network. Although dependent on the magnitude of load fluctuation, in future, data volume increase is expected to result in a significant enough load affecting MBH that it may be required to be linked to RAN operation.

This is where interworking between the control plane and SON technologies takes on significance. The

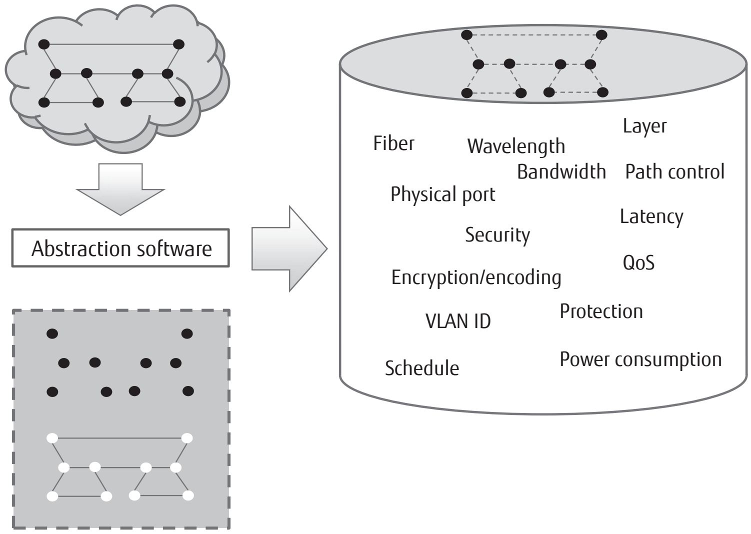

Figure 3
Network resources abstracted and pooled.

RAN optimized by the SON technology can be interworked with the MBH optimized by the control plane technology to optimize the entire network (**Figure 4**), which allows uniform services to be provided in a way that is stress free to users.

5. Interworking with services

A network can be service content aware and connect between IT resources only for the required time, bandwidth, optimal layer topology, and/or even flexibly tune the bandwidth and paths according to the application requirements. In this way, close interworking between IT services and networks can help create high value-added services.

The following describes a mechanism of interworking between IT services and a network. The configuration of the services is shown in **Figure 5**.

1) Network Hypervisor

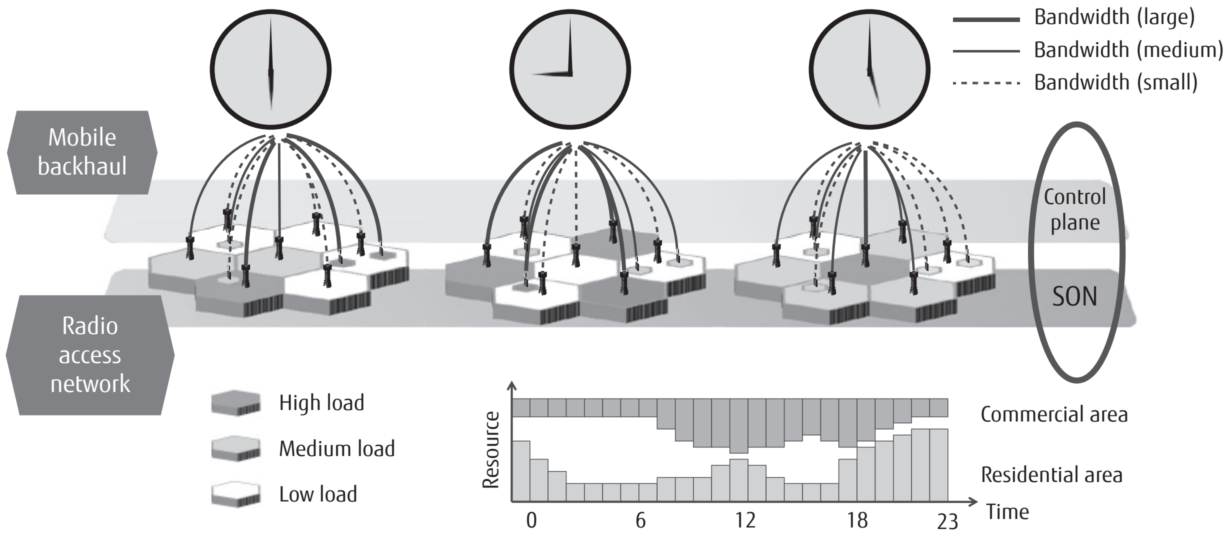

Figure 4
Integration of SON and control plane.

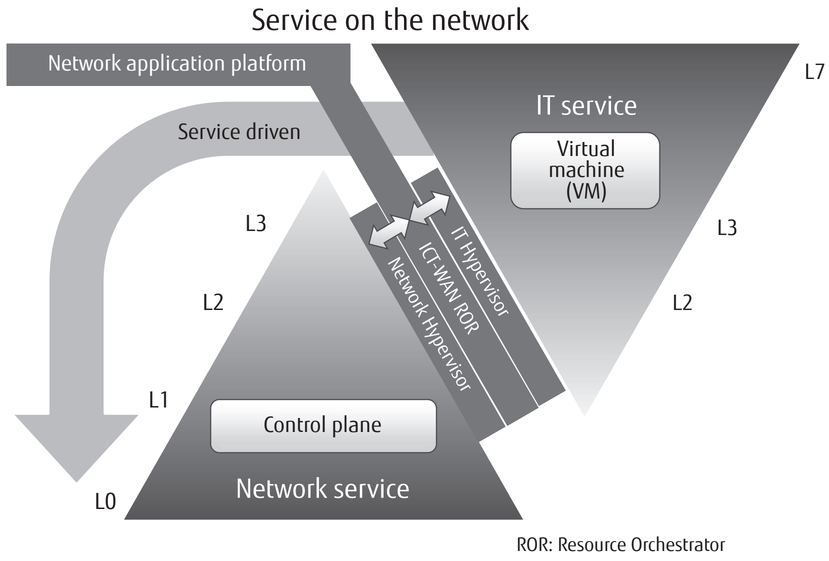

Figure 5
Configuration of services.

This software is intended to abstract the network functions of a network service for sharing in the same way as the IT service OS virtualizes resources for sharing. The control plane takes charge of the management of the cable, wavelength and channel resources as well as estimation of the bandwidth, path, delay, power, and such like, and the optimum network environment is provided according to the request from the application.

2) Network Application Platform

This management system dynamically links and controls IT and network services according to the service requirements. The Network Application Platform is interworked with both IT and network resources, secures the resources and schedule required by them respectively and offers the optimum network application to the services. In addition to the ICT-WAN ROR (Resource Orchestrator) function, this Network Application Platform is equipped with a function to adapt the network policy configuration and billing system according to the service offered. In this way, interworking between IT and network services leads to the creation of new mechanisms and services that make use of the existing network facilities.

Functional interworking between IT and network services in a cloud service is presented here as an example of the Network Application Platform. **Figure 6** shows a use case of a bandwidth service.

To deal with a seasonal peak E-commerce period, one possible measure is to temporarily extend business applications, which are normally operated on the local server on the premises of an enterprise, to a remote server in a cloud only during the peak. At that time, the management system on the IT side requests the remote server to add virtual machines (VMs), along with which the Network Application Platform requests the Network Hypervisor to add bandwidth resources and automatically requests the network between the enterprise and the data center to acquire the same QoS configuration as that of the network in the data center for a service launch in a short time. In this way, added value can be offered to on-demand services in the cloud.

6. Conclusion

This paper has described how the present networks are required to be agile, flexible, and optimal, and presented control and optimization technologies

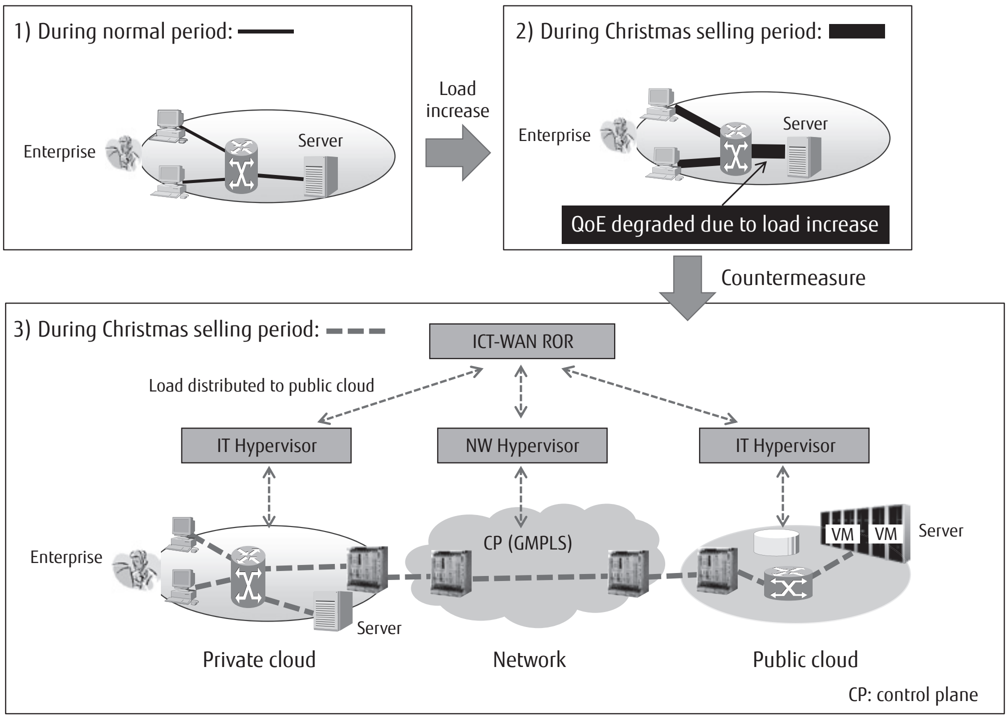

Figure 6
Use case of bandwidth service.

such as control plane and SON.

Cloud and mobile services will continue to evolve in the future and more advanced network services than ever will be called for. As Fujitsu, which has communication technologies including mobile and transport technologies together with IT, we are committed to promptly providing a system that integrates these technologies.

References

1) 4G Americas: Mobile Broadband Explosion: 3GPP Broadband Evolution to IMT-Advanced, Sep 2011.
http://www.4gamericas.org/index.cfm?fuseaction=page&sectionid=334
2) 4G Americas: Self-Optimizing Networks: The Benefits of SON in LTE, Jul 2011.
http://www.4gamericas.org/index.cfm?fuseaction=page&sectionid=334
3) Khurram Kazi (Editor): Optical Networking Standards: A Comprehensive Guide for Professionals. Springer-Verlag, 2006.
http://www.springer.com/engineering/signals/book/978-0-387-24062-6

Kazuyuki Miura
Fujitsu Ltd.
Mr. Miura is currently engaged in business planning of control plane for network products.

Hirotaka Morita
Fujitsu Ltd.
Mr. Morita is currently engaged in business planning of control plane for network products.

Takeshi Miyagawa
Fujitsu Ltd.
Mr. Miyagawa is currently engaged in business planning of control plane for network products.

Akio Iwata
Fujitsu Ltd.
Mr. Iwata is currently engaged in system development of network products.