# Hitachi's Involvement in Networking for Cloud Computing

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*OVERVIEW: The adoption of cloud computing in IT systems is driving even greater diversity in network services. The requirements for the networks that support IT systems going cloud include ensuring the level of reliability required to make services available via the network, keeping data as secure as if it were stored in-house even when the siting of data centers has become borderless, and improving the energy efficiency of equipment including that used in data centers and networking facilities. Hitachi is working on the construction of networks that support the use of cloud computing for services that feature a high level of security and reliability and are capable of delivering responsive performance efficiently and with high availability.*

## INTRODUCTION

THE spread of the Internet based on IP (Internet protocol) technology has led to an expansion in the use of networks. The wider adoption of mobile broadband is also prompting the emergence of new needs and helping make our day-to-day lives more convenient. Communication providers are expanding their investment in NGNs (next-generation networks) that integrate existing networks based on IP technology. It is anticipated that the future spread of NGNs will accelerate the growing diversity of network services including the convergence of fixed and mobile communications and of communications and broadcasting.

Another factor that is seen as accelerating this greater diversity of network services is the shift toward cloud computing. Although a range of different definitions exist for the cloud, in essence it can be thought of as an approach to computing in which IT (information technology) functions are provided via a network as services and in a way that allows a high degree of scalability. The market is being led by global vendors in this shift toward cloud computing, but it has also been noted that issues remain including concerns about security and reliability and in relation to services that require fast response times. This article describes what Hitachi is doing in the field of networking to support the use of cloud computing to provide services with high levels of security, reliability, utilization, efficiency, and real-time performance.

## BASIC REQUIREMENTS FOR CLOUD NETWORKS AND HITACHI'S RESPONSE

Core user requirements driving the adoption of cloud computing for business systems typically include cost reductions achieved by shifting IT resources off the balance sheet and improvements in operational reliability. In the public sector, the centralization of servers and other IT resources at government departments, local governments, universities, and other agencies is also being accompanied by increased use of cloud computing and SaaS (software as a service) for front-office and other non-core applications. In finance and other areas of the private sector, although the tendency to keep core applications that handle confidential information in-house remains strong, there is growing demand for cloud computing and SaaS for non-core applications. As these examples demonstrate, use of cloud computing for non-core applications with low reliability requirements is already common, but it is also anticipated that it will increasingly be used in the future for core applications that require a high level of reliability.

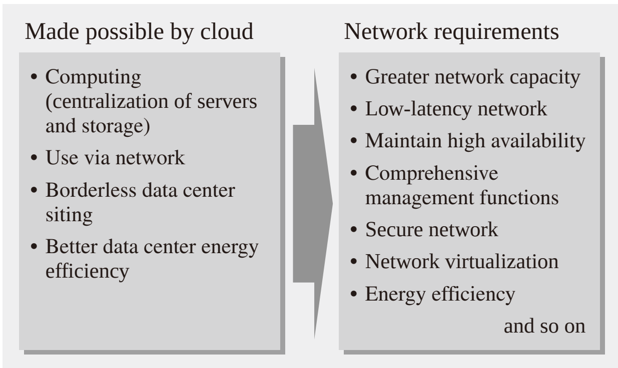



*Fig. 1—Requirements that Cloud Computing Places on Networks.*
*As advances are made in cloud computing, there is a need for higher speed, greater capacity, better reliability, and more advanced functions.*

Considering these user requirements, the following list itemizes the requirements for cloud computing itself as well as the core requirements for the networks used to support the cloud (see Fig. 1).

(1) Higher speed and greater capacity achieved by centralizing computing

Improve efficiency and reduce operating costs by physically centralizing servers, storage, and other IT equipment at data centers. As a result of this increased centralization of IT equipment at data centers, internal data center communication networks operating 10 Gbit/s are already common and there is demand for even higher speeds and capacity.

(2) Higher reliability and greater functionality achieved through use via network

Although it depends on the level of service quality required, use of services delivered over networks typically requires a level of reliability equivalent to a leased line connection (network with low latency and high availability). There is also demand for comprehensive management functions including improvements in the OAM (operation, administration, and maintenance) functions that support high reliability (performance monitoring, fault detection, route switching, etc.).

(3) Borderless data center siting

The siting of data centers is becoming borderless as network services become more global, with centers being located wherever is most convenient. In addition to requiring that the data center provide an equivalent level of security to in-house data storage, this also requires mechanisms for keeping data belonging to different companies separate.

(4) Energy efficiency

For environmental reasons, there is a need to improve energy efficiency across the cloud including both data center and network facilities.

The following sections describe what Hitachi is doing to satisfy these core requirements that cloud computing places on networks (see Fig. 2).

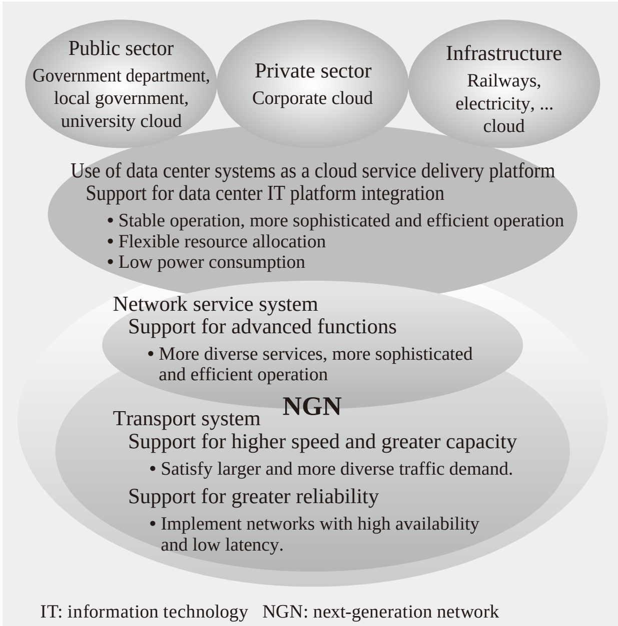



*Fig. 2—Network Support for Cloud.*
*Hitachi is working on enhancing the transport systems and network service systems that make up a network system platform and support use of data center systems as a cloud service delivery platform.*

## Support for Carrier Networks

(1) Higher speeds and capacities

As greater use is made of cloud computing, it is anticipated that network traffic in and out of data centers will expand creating a need for carriers' transport systems to find ways of coping with demands for more diverse traffic and even greater capacity. In response, Hitachi supplies high-speed, long-distance transmission systems with capacities of 40 or 100 Gbit/s. Hitachi has successfully developed and obtained interconnection certification for 100-Gbit Ethernet* transmission systems that provide Ethernet-based routing and transmission in both carrier transport systems and internal data center systems.

(2) Higher reliability

Hitachi is strengthening its involvement with transport systems that feature a high level of availability, low latency, high efficiency, and high reliability by incorporating network virtualization functions into carrier transport systems to resolve the issues listed below. One example is a packet transport system based on MPLS-TP (multiprotocol label switching—transport profile), a technology that is currently in the process of being standardized. The aims of this system are:

(a) To provide a highly reliable network service through improved OAM functions and central control of transmission paths. This is in contrast to current IP networks that work on the best-effort principle and in which transmission paths are intrinsically autonomous and distributed due to the use of IP routing.

(b) Significantly reduce operating costs and provide highly efficient network services by integrating the separate transport networks that have been

* Ethernet is a registered trademark of Xerox Corporation.

*Fig. 3—Service Module Card for Mounting in Router and Switch Units.*
*The service module cards provide a high level of added value for routers and switches.*

established for different services in the past.

(3) More sophisticated functionality

The requirements for more sophisticated functions in future network services include:

(a) Scalability (number of hardware units installed, bandwidth, etc.)

(b) Generational change (support for next-generation standards)

(c) Miniaturization, higher density, energy efficiency

(d) Functional extensibility to adapt flexibly to these needs

In any case, it will be essential to help improve operations by providing functions with high added value that can be flexibly customized. For its routers and switches for IP networks, Hitachi is moving toward greater use of service module cards that permit a high degree of customization and can be installed inside other equipment as autonomous devices (see Fig. 3). For example, already in use are the service module cards that perform large-scale and highly efficient IPv4 (IP version 4) address conversion inside the operating routers in the carrier network in response to the IPv4 address exhaustion. In future, they are expected to be widely adopted for improving operational functions through their use as sophisticated processing engines able to support wire rates in the 10-Gbit/s range, such as performing high-precision monitoring of traffic on high-speed lines.

### Using Data Center Systems as a Service Delivery Platform

Whereas in the past the IT equipment used in data centers (servers, storage, networks, and so on) tended to be optimized and operated individually, there is a growing need for integrated operation to improve ease-of-operation and efficiency. To meet these market needs, Hitachi is working on vertically integrated data center solutions that seek to achieve broad improvements in data center operation by strengthening IT equipment virtualization, centralized management, and functions for integration with application systems.

This article focuses on what Hitachi is doing in the field of network system platforms that provide transport and network services for carriers, and its involvement in using networks for data center systems as service delivery platforms.

## PACKET TRANSPORT SYSTEM FOR CARRIER NETWORKS

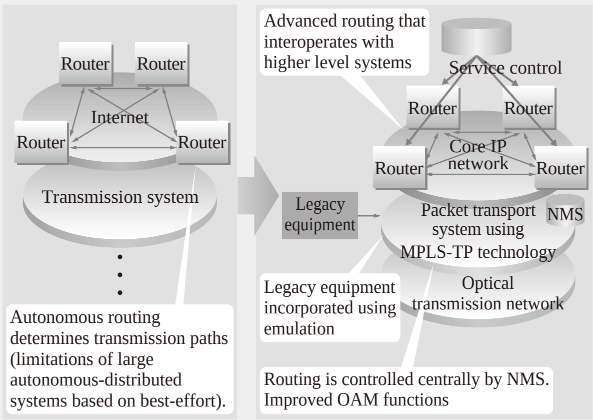
The transport layer and the IP network services that run on it face the following issues:

(1) Because each network service including the Internet and public telephone network has equipment for each network layer, the number of different types of equipment being used is increasing and its operation is becoming more complex.

(2) There is a limit to the level of service quality that can be guaranteed on IP networks which work on the best-effort principle and are intrinsically autonomous and distributed with transmission paths routed autonomously.

To resolve these issues, an important factor is separating the service and transport layers so that services can become more diverse and operation more sophisticated and efficient. The keys to success are to embed functions that straddle different service layers in routers and switches to allow for a greater diversity of services and to implement service nodes that provide flexibility in service configuration. Hitachi is working on developing service module cards that can be mounted in routers and switches and, in addition to the IPv4 address conversion described above, is progressively adding functions such as technology for communications with low power consumption, virtual node technology, and security.

One protocol that can help achieve more sophisticated and efficient operation in the transport layer is MPLS-TP (see Fig. 4). MPLS-TP is in the process of being standardized by The Internet Engineering Task Force (IETF) and Telecommunication Standardization Sector of the International Telecommunication Union (ITU-T) and uses an architecture in which route control (the function that manages and maintains communication routes in a packet network) operates separately from the packet transmission function. The aim is




IP: Internet protocol
MPLS-TP: multi-protocol label switching—transport profile
NMS: network management system
OAM: operation, administration, and maintenance

*Fig. 4—Role of Packet Transport System Based on MPLS-TP Technology.*
*The system can improve the level of end-to-end service quality compared to conventional IP networks.*

to guarantee end-to-end service quality by allowing control and management to be performed over the entire network. Using an NMS (network management system) able to perform centralized management of routes, bandwidth, and other resources over the entire network facilitates service quality guarantees and isolation of fault locations.

Hitachi is working on the development of an MPLS-TP-based packet transport system aimed at use on the metropolitan and core networks operated by telecommunication companies and the core system is already in use at a telecom company in Japan.

The system has the following features:

(1) Construction of highly reliable networks

High reliability is achieved through the adoption of MPLS-TP combined with comprehensive use of OAM functions (including functions for checking communication route connections and high-speed switching).

(2) Easy migration from existing networks

The provision of interfaces for existing protocols such as TDM (time-division multiplexing) and ATM (asynchronous transfer mode) facilitates migration from existing networks as they become obsolete.

(3) Able to expand in a scalable way depending on demand

A configuration consisting of general-purpose shelves for mounting the various different interfaces together with the associated monitoring and control allows hardware to be implemented with the minimum investment needed to meet demand.

Hitachi intends to utilize the track record and experience it has built up over its many years as a network vendor by actively participating in and promoting the formulation of standards by the International Telecommunication Union—Telecommunication Standardization Sector (ITU-T), The Internet Engineering Task Force (IETF), and other bodies, and in the future to strengthen its involvement in the construction of highly reliable high-speed networks that support social infrastructure by anticipating the requirements of global markets.

## USE OF DATA CENTER SYSTEMS AS CLOUD SERVICE DELIVERY PLATFORM

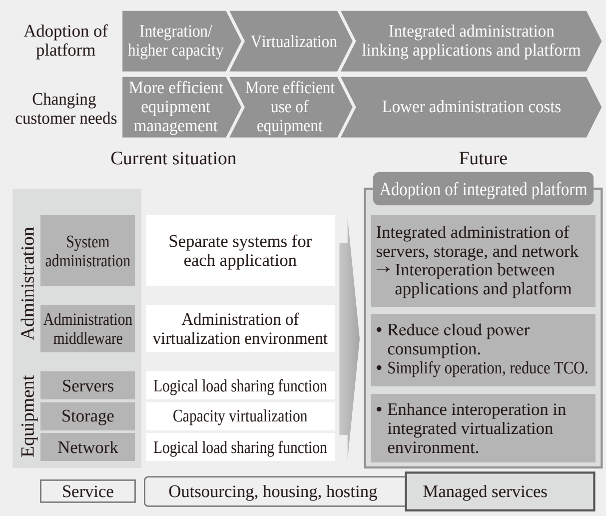
The requirements and challenges facing users (management and information systems departments) wishing to take advantage of the cloud include the following:

(1) Expectations for installation cost, installation speed, and system flexibility (values they wish to improve)

(2) Reliability, availability, compliance, security assurance, continuity (values that must not be compromised)

Consideration of changing user needs relating to the use of data centers as cloud service delivery platforms along with the process by which they are evolving prompts the following conclusions (see Fig. 5).

User needs are shifting away from improvements in the administration and operational efficiency of the servers, storage, networks, and other hardware




TCO: total cost of ownership

*Fig. 5—Adoption of Integrated Platform for Data Center Service Delivery Infrastructure.*
*The platform reduces operation and management costs through virtualization and integration.*

platforms used in data centers toward reducing the TCO (total cost of ownership), including of this equipment. With this shift in user needs, it is thought that data center systems too will expand and diversify away from the integration and virtualization of hardware platforms toward interoperation between application systems and hardware platforms as well as integrated operation and management.

In response to these changing requirements for data center systems, Hitachi is working toward an integrated platform that incorporates operation and management systems as well as hardware platforms such as servers, storage, and networks. The following section describes what Hitachi is doing in the area of platform virtualization and integrated operation and management from a network perspective.

### Platform Virtualization

Although use of server virtualization has become widespread as a way of reducing server hardware costs and facilitating backups and other administration, there is also a need to improve communication between virtual servers (virtual switch function) to reduce server load and improve the ability to perform maintenance on servers and networks (such as the migration of virtual servers). To meet this need, progress is being made on standardizing mechanisms for shifting the virtual switch function to hardware rather than implementing it in software on the virtual server's hypervisor.

Progress is also being made on standardizing CEE (Convergence Enhanced Ethernet) which runs the LAN (local area network) and SAN (storage area network) over the same cable using low-latency, lossless Ethernet communications to improve ease of maintenance and operation by reducing the number of servers, storage units, and cables.

Hitachi is currently evaluating the practicality of these techniques for interoperation between different data center hardware platforms and the virtualization mechanisms used for their implementation from various perspectives including ease of migration from existing systems and the extent to which they improve ease of maintenance and operation.

### Operation and Management of Virtualization Systems

The operation of a data center includes tasks such as analyzing information relating to the allocation of resources and the administration of their operating status at the planning, implementation, and operational

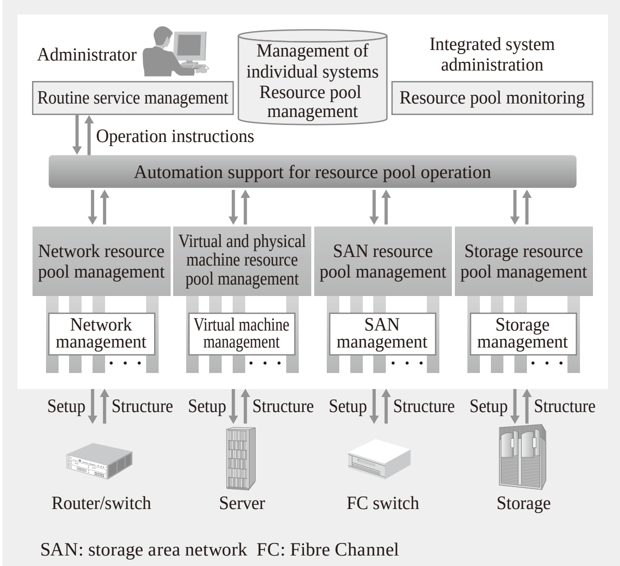



*Fig. 6—Architecture for Integrated Operation and Management of Virtualization Systems.*
*The architecture seeks to optimize IT investment including data center administration by strengthening integrated operation and management in a virtualization environment.*

phases respectively and optimizing systems based on the results. Hitachi is working on providing integrated operation and management in the forms described below to support the series of tasks that make up this resource administration lifecycle (see Fig. 6).

(1) Support for automated operation of virtualized resources: Administer server, storage, and network hardware platforms as virtual resource pools and optimize the allocation, setup, and reconfiguration of these resources in response to requirements.

(2) Implement integrated resource administration functions that can work in a multi-vendor platform environment.

Hitachi is enhancing functions for networking of virtual systems that enable improvements in portability, scalability, and ease of operation and maintenance in a virtual system environment made up of virtual servers and storage. Strengthening the integrated operation and management of this virtual environment simplifies the administration of large data centers while also allowing the overall investment in IT to be optimized.

## FUTURE INITIATIVES

### Broadcast and Broadgather

In the future, further development of the cloud will allow its use to collect huge volumes of real-world data via networks. Further, it will become possible to reproduce highly valuable information by taking the sophisticated knowledge obtained by accumulating

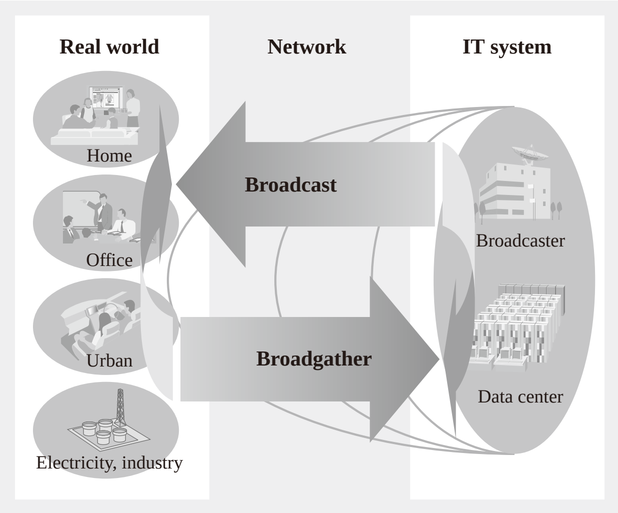



*Fig. 7—Future Information and Communication Platform.*
*Reproduction of high-level information value is made possible by a cycle of collecting information via the cloud (broadgathering) and distributing information back to the real world (broadcasting).*

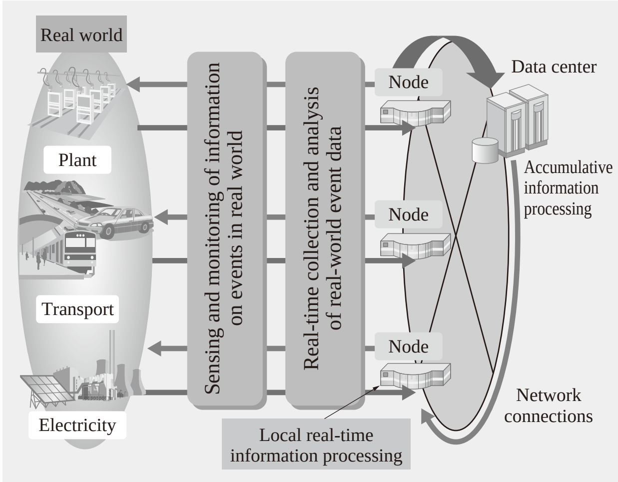



*Fig. 8—WAN (wide area network)-centric Computing.*
*Sharing cloud information processing with local information processing on the network instead of centralizing all functions at the data center reduces the load on the network and improves the responsiveness of information processing.*

and analyzing this data in the cloud (data centers) and returning it back to people, objects, and services in the real world (searching by keyword is a familiar example). This use of networks to collect information in the cloud is called "broadgathering" and distributing the information widely across society is called "broadcasting" (see Fig. 7).

Broadgathering and broadcasting are not limited to keyword search, and Hitachi is working on their technical development in the belief that they will be key technologies in fields such as sustaining the global environment and ensuring safety and peace of mind through applications including smart grids (collecting information on solar power and other forms of generation and managing the stability of the electricity grid) and video surveillance.

## WAN-centric computing

To realize broadcasting and broadgathering and utilize the cloud in social infrastructure systems, the bandwidth, response time, and electrical efficiency of information processing in the cloud need to be improved further. In the conventional cloud architecture consisting of data centers that handle information processing and a network that carries this information, attempting to process huge volumes of real-world information results in problems such as inadequate bandwidth and poor responsiveness due to communication overheads because all the information is sent to the data center. In response, Hitachi is working on the development of WAN (wide area network)-centric computing in which the information processing functions of the cloud are split onto accumulative information processing functions and local information processing functions. As in the conventional architecture, accumulative information processing is located at the data center and handles functions that accumulate and process data such as database management and data mining. In the case of real-time processing required by real-world applications, on the other hand, instead of centralizing all processing at the data center, it is instead parceled out to local information processing functions (filtering, load sharing, etc.) located on the network to reduce the network load (increase effective bandwidth) and improve the responsiveness of the information processing[(1)](see Fig. 8).

## Energy-efficient Router Technology

As advances are made in cloud technology, the need to improve the energy efficiency of routers and other network equipment will become more urgent. However, IT systems are typically designed so that the amount of data transmitted across them is kept lower than what the system is actually capable of handling (surveys of corporate LANs have found cases that use only 1% of their data carrying capacity, for example). Accordingly, the key to future improvements in network energy efficiency lies in controlling the performance of networking equipment to save power by reducing wasteful processing on capacity that is

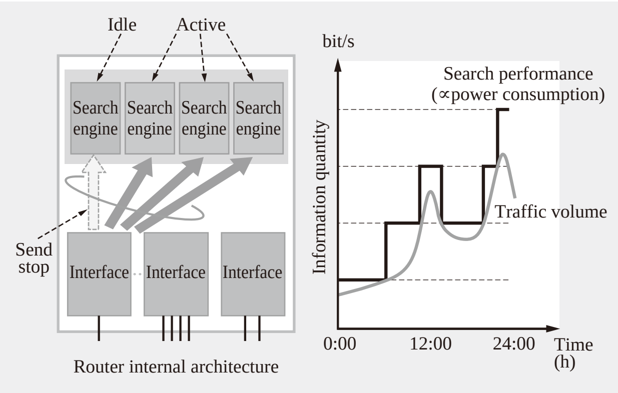



*Fig. 9—Energy-efficient Router Technology.*
*The technology improves power consumption by reducing unnecessary processing that is not normally used.*

not normally used. In response, Hitachi is working on the development of technology for energy-efficient routers. These routers are fitted with more than one multiple engines (internal cores) for packet processing (destination search) and Hitachi's power saving technology achieves a 20% to 30% reduction in power consumption by dynamically adjusting the number of operating engines based on the quantity of input data (see Fig. 9)[(2), (3)].

## CONCLUSIONS

It is anticipated that the range of applications for cloud computing will expand because of its potential to improve the efficiency of IT systems and create new business opportunities. Hitachi intends to continue working at a global level on networks that are part of the social infrastructure with the aim of implementing services with high levels of reliability, security, and efficiency, characteristics that are key elements of cloud computing.

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