NEC Cloud Computing System

Empowering users with the capability to utilize IT services via networks whenever they desire, cloud computing represents a paradigm shift in computing that is transforming how information systems are used. In this article, we would like to provide the reader with a general introduction to NEC's cloud service business, cloud environment building business and major related product technologies under development for the Enterprise, Carrier and Social target markets. In addition, we would like to share some of our thoughts on how cloud computing systems will develop in the future and provide a glimpse of the next-generation cloud computing system which will comprehensively integrate ICT technologies from computing and networking to storage and terminals.

Senior Vice President
KUNIO Takemitsu

1 NEC's Approach to Cloud Computing

1.1 Cloud Computing: The 4th Wave

Growing attention is focused on cloud computing and how it empowers users with on-demand usage of hardware, software, data, application development environments, and other IT services via networks. Looking back on the evolution of information systems, we can broadly divide their development into 3 phases: 1) centralized processing by a mainframe that vertically integrated all hardware and software in a proprietary and specialist environment; 2) distributed processing by "downsized" client-server systems made possible by the advent of low-priced mini-computers and PCs; and 3) wide-area distributed processing and system integration enabled by the explosive widespread adoption of PCs and the Internet. In this evolution of information systems, the new trend of cloud computing represents the "4th Wave" (see **Fig. 1**).

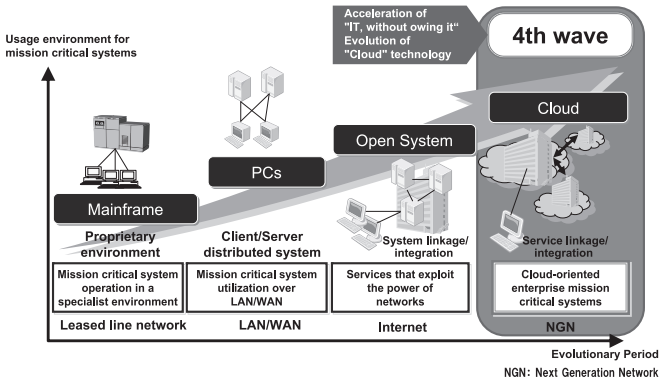


Fig. 1 Evolution of the usage environment in mission critical systems.

1.2 Application of Cloud Computing in Business and Social Infrastructure

Cloud computing is a work in progress. While "public cloud" utilization by consumers is already making advances, enterprise usage is just beginning. In order to expand the application of cloud computing in enterprise systems, NEC will incorporate the merits of cloud computing shown in **Fig. 2** while supporting corporate business activities that can take advantage of cloud computing by providing cloud-oriented service platform solutions that satisfy enterprise needs.

Exploiting our business process reform expertise, in-depth know-how of diverse industries, IT/network technologies, open mission-critical system (OMCS) technology [*1] , operational

technology and other strengths of NEC, our Cloud-oriented Service Platform Solutions will play an especially important role in transforming enterprise systems, contributing to not only to cost reductions but also agile deployment of services, expanded flexibility, greater convenience and improved productivity. By realizing application of cloud computing at a level that will satisfy enterprise needs, NEC aims to support enterprise system re-engineering that will promote our customers' shift to benefits of "IT, without owing it".

Fig. 3 shows the relationship between NEC's envisaged cloud computing markets, NEC's core businesses and the technologies that make cloud computing possible. Tailoring the four core technology themes that comprise our core competencies according to the attributes of the three target markets of "Enterprise", "Carrier" and "Social", NEC will move forward with our cloud service business and cloud environment building business.

1) Enterprise

Support for corporate activities that can exploit cloud computing and for business re-engineering.

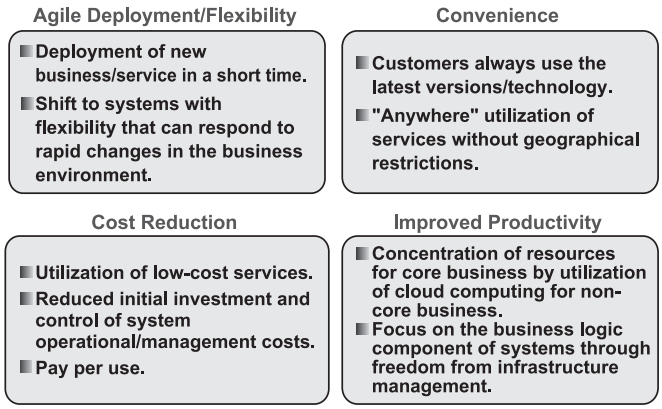


Fig. 2 Cloud computing advantages.

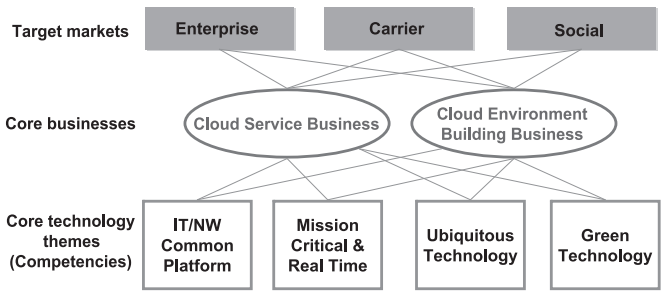


Fig. 3 Target markets and core businesses.

2) Carrier

Creation of new cloud computing-based carrier services.

3) Social

Promotion of more intelligent infrastructure for a safer, more secure and "greener" society.

2 Introduction to NEC Cloud Solutions and Technology

In this section, we would like to provide an overview of the NEC cloud-oriented solutions and product technologies that will described in this special issue.

2.1 Cloud–oriented Service Platform Solutions

(1) Features

In order for enterprises to achieve sustainable growth in the continuing economic recession, the acceleration of the twin engines that power the rapid launch of new business: more efficient "leaner" management and the creation of new value - is urgently needed. By providing our customers with the Cloud-oriented Service Platform Solutions described in Chapter 1 of this special issue, NEC will support this transformation. In addition to NEC's proven products and platform technologies, these solutions feature a comprehensive approach to customer needs from consulting to system integration and operation. As shown in **Fig. 4** , NEC's Cloud-oriented Service Platform Solutions support customers with consulting services that lead to effective business process re-engineering as well as services that realize system provision/operation from the perspective of life cycle management.

In order to respond to the diverse needs of enterprise customers, NEC's solutions offer three models to provide the services that will realize system provision and operation.

1) SaaS model

Providing numerous enterprises with standardized service, the SaaS (Software as a Service) model assures a defined service level at a low cost.

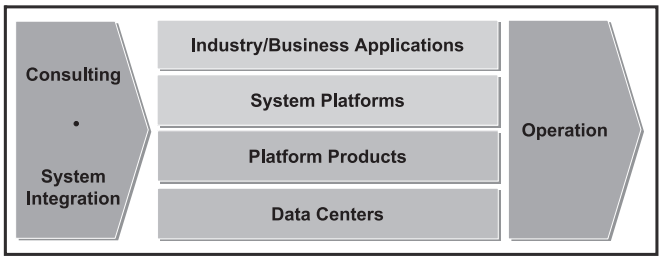
2) Consortium center model

Multiple enterprises sharing a common objective form a consortium to utilize business applications available at "joint center", enabling access to industry-standard services at a low cost.

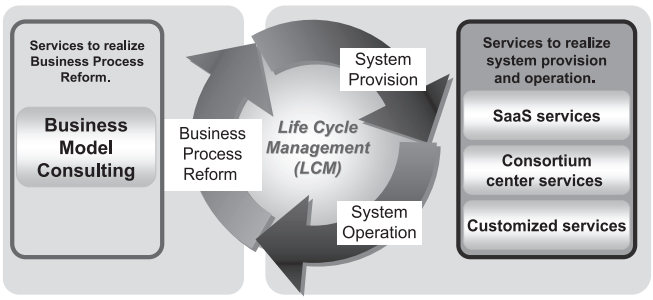
3) Customized model

Providing maximum flexibility for making resources available to individual enterprises and facilitating their phased reconstruction of the customer's existing system, the customized model limits access to users within an individual enterprise by building a custom "cloud" for each

*1 OMCS (Open Mission Critical System): Technology for building robust, flexible enterprise information systems.



Structural Elements of "Cloud-oriented Service Platform Solutions"



NEC Cloud-oriented Service Platform Solutions from the Perspective of Life Cycle Management

Fig. 4 Cloud-oriented Service Platform Solutions.

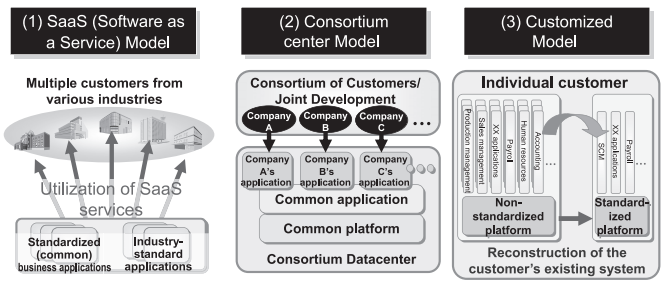


Fig. 5 Selection of 3 service provision models.

enterprise.

These three models for providing cloud computing services enable selection of the optimum provision model according to system characteristics and requirements (**Fig. 5**).

(2) Platform Technologies for NEC's Cloud-oriented Service Platform Solutions

In October 2009, NEC announced its vision for the development of "REAL IT PLATFORM Generation2", the next-generation IT platform for cloud-oriented service platform solutions. Evolving beyond the original REAL IT PLATFORM concept of "flexibility, security and simplicity (ease of use)", Generation2 sets the stage for a large-scale cloud-oriented datacenter, strengthening each of the 3 key domains (infrastructure, service execution platform and operational management) and comprehensively supporting datacenter operation (See **Fig. 6**).

Priority on reinforcement of the three domains comprising cloud-oriented data centers (infrastructure/services/operational management)

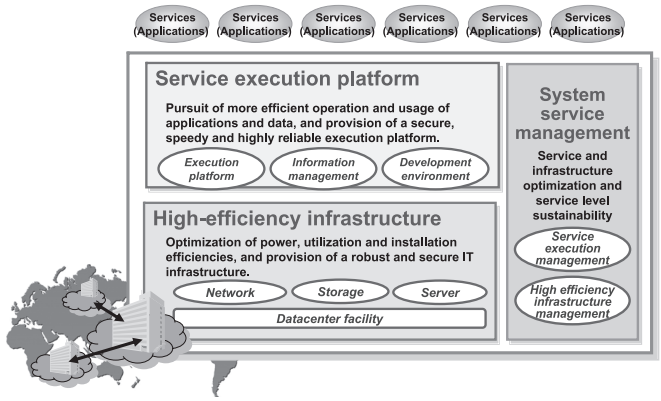


Fig. 6 NEC's Cloud-oriented Datacenter Platform.

1) High-efficiency Infrastructure

In addition to providing customers with even higher reliability/lower power consumption server and storage products and energy-saving facility technology, NEC's platform infrastructure contributes to significant management cost reductions through centralized management of network devices. Plans call for the provision of Programmable Flow Switch/Controller products based on OpenFlow [*2] technology by end of fiscal year 2010.

2) Service Execution Platform

While delivering the high reliability and high availability demanded by core business needs, the platform features improved service capabilities including multitenant service for secure provision of a single service to multiple users and mashup services for accelerated development speed by combining multiple cloud computing services.

3) System Service Management

System service management responds with automated optimized allocation and restriction of IT resources depending on the demanded service level.

2.2 Platform for Telecom Carrier Cloud Computing Services

In the telecommunications carrier market which has witnessed the explosive growth in communications traffic, carriers are entering a new stage and transitioning to a new business model. Against this background, NEC is endeavoring to help

[*2] New network device control interface that is under consideration as a network standard with development and support hosted at Stanford University.

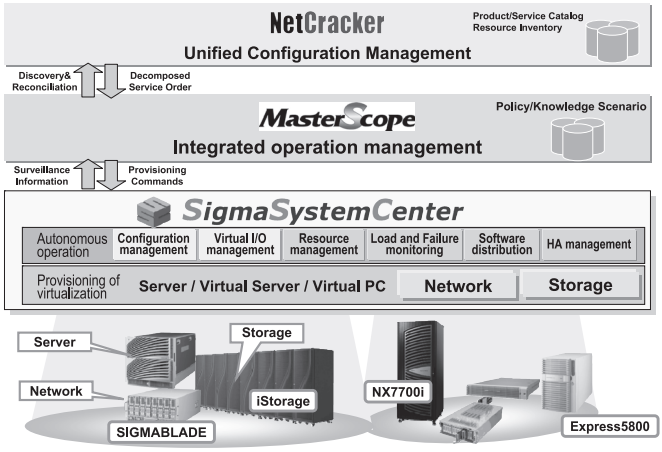


Fig. 7 System service management.

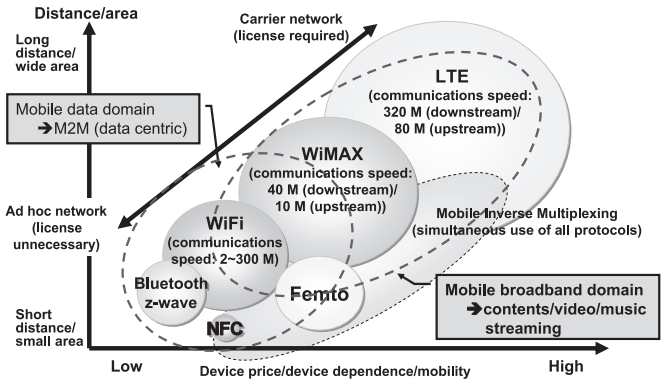


Fig. 8 Wireless broadband technology to support the cloud computing business of telecom carriers.

telecom carriers to hone their service edge by 1) assuring telecommunications quality - the foundation on which services are delivered, 2) developing robust security technology to protect the privacy of communications, 3) providing a high-reliability management platform, 4) improving price competitiveness by curbing telecommunications costs, and 5) tackling the provision of an integrated "cloud" IT and network infrastructure for telecom carriers.

In the cloud computing business, it will be necessary for telecom carriers to have not only IT technology that enables them to flexibly respond to the needs of end users, but also technology that enables the network infrastructure environment to flexibly adapt to service content. NEC provides the Cloud Platform Suite as a platform product that integrates IT and networks. In order to support customer service order service, system monitoring and other carrier-grade services, NEC also offers telecom carriers an impressive portfolio of software products to support cloud computing service operation including 1) SigmaSystemCenter which performs management, monitoring and optimized allocation of virtualized resources, automatic recovery from failures, and other support for virtualized environment management, 2) WebSAM (known outside of Japan as MasterScope) for total integrated operational management of IT systems, and 3) NetCracker for operations support systems including service provisioning (See **Fig. 7**). In addition, a high-speed wireless broadband access environment is increasingly vital to the convenient and comfortable usage of cloud computing services. NEC is responding to user demand an environment that can support this need by providing 4) WiMAX technology and LTE technology which can deliver a satisfactory access environment even outdoors, 5) FemtoCell technology for improved coverage and capacity especially indoors, and 6) Mobile Inverse Multiplexing technology which enables access, reaggregation and resynchronization of a data communicated over different multiple frequencies into a single circuit (**Fig. 8**).

2.3 "Personal Cloud"

In our approach to making our BIGLOBE strategic vision "Personal Cloud" a reality, we are moving forward with the development of the "Cloud Device" to provide both communications and services to terminals, "Application & Contents Market" offering a diverse selection of services over the Internet, and other innovations. The service platform that will support all these will be able to flexibly respond to huge access demand with a "scalable" architecture using open source software.

2.4 NEC Research and Development Supports the Future of Cloud Platform Technology

In this section, we look at NEC's approach to research and development of service execution platform, IT/Network convergence and system operation/management technologies which will provide the foundation for the future of cloud computing.

In the case of SaaS-type services, tenant capacity-density ratio in cloud computing has a large impact on the cost of providing service. In order to achieve efficient multitenancy utilization of existing applications, NEC is undertaking research and development of application flow control technology to increase the ratio by using a shared-schema model to share the application among tenants while ensuring tenant isolation by individual processing units.

Our R&D efforts in IT/Network convergence technology that will pave the way for the next-generation cloud computing sys-

tem are focused on advancing our OpenFlow technology. OpenFlow technology realizes the virtualization and integration IT and networks, providing flexibility to diverse multitenant environments and enabling more efficient operation while also providing both scalability and expanded functionality with firewall protection and load balancing for the front-end system.

Future operational management of cloud computing will also benefit from our research and development of a authorization management platform for virtualized servers in an integrated environment and autonomous operational control platform technology. Because our authorization management platform technology provides integrated management of access in a multi-platform/multilayer environment, it can perform modeling of resource/access control data from the VM layer to the application layer, generate access control policy based on the model and provide the functionality of converting and distributing policy in a format in conformance with each software of the virtualized server. This approach is on its way to adoption as an industry standard by DMTF [*3] (Distributed Management Task Force), an industry organization that establishes standards for multi-vendor system operation and management. Our R&D in autonomous operational control platform technology focuses on linking new managed information networks, methods for downsizing system operational data and virtualized device state estimation technology with the aim of shrinking data transmission latency, reducing data volume, improving availability of virtualized devices and other innovations that contribute to the stable operation of cloud computing systems.

3 Evolving Toward a New ICT Infrastructure

NEC views the rising tide of cloud computing as more than simply a replacement of conventional IT technology. We believe that it is a revolution that will sweep through the entire ICT infrastructure and lead to its expansion as a wide-area social infrastructure, more advanced enterprise systems and the creation of new services and business models.

The diagram in **Fig. 9** shows the next-generation cloud computing system as envisaged by NEC. Utilization of the current generation of cloud computing is mainly focused on consumer-oriented services and business services that enhance efficiency of enterprise systems. However, the cloud computing system of tomorrow will be demanded to transcend the application

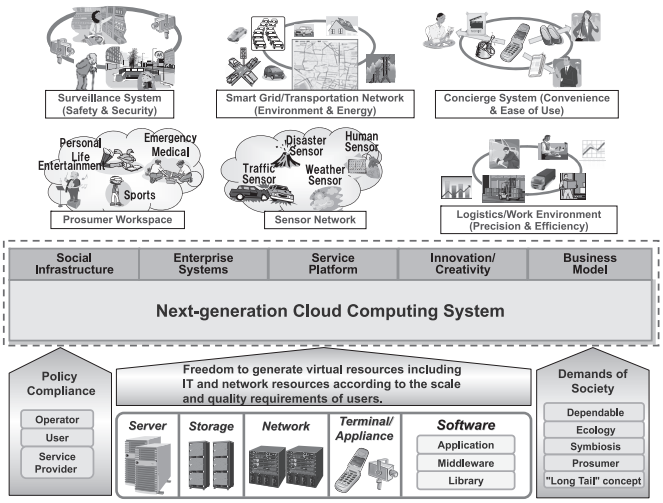


Fig. 9 NEC's vision for the next-generation cloud computing system.

boundaries of current cloud computing systems, playing a key role in diverse social infrastructure including specialized mission-critical systems, enterprise systems that require more flexibility and dynamic operation, and platforms for the creation of new services and business models that are envisaged to engage prosumers [*4] and other users. The advent of the next-generation cloud computing system will make possible a broad variety of services that tap the potential of cloud computing including surveillance systems for robust security and public safety, eco-friendly and energy-stingy Smart Grid, flexible work space provisioning for prosumers, and concierge system that realize real-time linkage between the real and virtual world.

In order to realize the above-described next-generation cloud system, it will be necessary to achieve real-time performance, mission-critical reliability and flexibility that conventional cloud computing currently cannot deliver. It will require virtualization of not only IT resources, but also network resources; appropriate functional allocation and collaborative linkage between user terminals and cloud computing systems; and technology that flexibly responds to the policies of the operator, user and service provider. NEC aims to overcome these technological challenges by constructing an optimum system for the integrated control of all ICT technology including not only computing but also networking, storage systems, databases and terminals. In addition, the next-generation cloud computing system will provide a service platform that enables any user to effortlessly access high-quality services and individual resour-

[*3] DMTF (Distributed Management Task Force): Global group comprised of IT industry companies and organizations committed to the development, validation and promotion of systems management standards for improved management interoperability among distributed multi-vendor systems.
[*4] Prosumer: Portmanteau created from the first syllable of "producer" and the last 2 syllables of "consumer" signifying a consumer engaged in production activities (proactively engaged consumers).

ces, create new business models through the convergence of computing, networking and data.

4 Conclusion

In describing how NEC sees the current and future shape of cloud computing, this article has reviewed the target markets (Enterprise, Carrier and Social), the core businesses (cloud computing services and cloud environment building), a variety of product technologies, and our vision for the next-generation cloud computing system. Through our cloud computing-related businesses, NEC aims to achieve its goal of becoming a global leading company with a priority on realizing an information society friendly to humans and the earth "empowered by innovation".