Evolution of Network Society and Technological Innovation

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It has been long time since information and communications systems started evolving in a cycle that begins with their effect on society and daily life followed by innovation and its penetration through society. In wide area networks which provide the infrastructure for such evolution, Next Generation Networks (NGNs) are now deployed in commercial operation and fiber to the home (FTTH) systems for the household and broadband wireless access systems for mobile users are actually penetrating in the network as a variety of access options. Those trends are leading and driving further innovation in social activities. In this paper, we examine changes in everyday life that are actually taking place in society and advances in corporate and business systems from the viewpoint of network technology. We also present trends in technology innovation with an eye to the future and introduce Fujitsu's activities in this area.

1. Introduction

Based on an idea that the evolution of social activities is supported by information and communications systems and the evolution of information and communications systems accelerate the innovations in the everyday world, Fujitsu has set forth a concept that "IT systems are a reflected image of the real world" and continuously works on building a comfortable and secure information-oriented society.

The advanced technologies capable of bringing about evolving social activities, which are mentioned in the concept above, are currently realized, becoming popular and taking root in the everyday world.

This paper verifies the actual conditions of evolution of social activities and technological innovations and focuses on the network systems, which have become essential as a lifeline of an information-oriented society, to present Fujitsu's technological creative activities toward the future.

2. Expansion of network use in social activities

The permeation of the Internet into society and daily life has established a structure in which innovations in the use of a network in society is led by users.[1]

This social trend has been continuously accelerating and spreading and the infrastructure services, which have been independently established so far, have become interconnected via networks, leading to unceasing innovation.

First, this section gives an observation on the changes that have taken place in society and daily life because of the wider use of networks.

The first thing to point out is that people's styles of communication have become diversified. The forms have developed from communication between a limited number of individuals such as family members and friends via telephone

and E-mail into those enabling exchange of information and sharing of knowledge with an unspecified large number of people via blogs and SNSs.

The second point is that the dissemination of TVs with network connectivity and the start of broadcasting services taking advantage of communications infrastructure such as video on demand (VOD) and forwarding service of terrestrial digital broadcasting have brought about the age of integration of communications and broadcasting. The interaction of various information media including TV, newspapers and magazines with networks has provided new added values.

Third, all commercial transactions can now take place over networks. For example, the mainstream of ticket sales has shifted from over-the-counter transactions to online sales, which has firmly established itself in society. Financial-related operations such as stock trading and banking have long been online. On top of ticket purchasing, airline check-in procedures have shifted from a manual procedure at airports to completion online. In the past, ordinary business models included online settlement of sales contracts and mailed merchandise separately but now the merchandise itself is exchanged over networks. For example, sales of music and video products used to be mainly via sales of CDs and DVDs, which have now changed into purchasing by downloading online.

The fourth point to mention is that networking via machine, which is often referred to in relation to keywords such as machine to machine (M2M), is also becoming popular. Network utilization is expanding in all fields such as the monitoring of rivers and streets with live cameras, the control of building facilities and consumer electronics and the aggregation of control information from different types of sensors.

In this way, the use of networks has become permeated in many scenes of life and an increase in such use in the fields of applications is estimated to continue in the future. Regarding meter reading for electricity, gas and water supply and diversification of billing plans, for example, systems based on telemetering will become the mainstream. In the medical sector, use of networks will allow centralized management of personal medical information including treatment records and medicine administration history and telemedicine. The day will also come in the near future when elections for national and local governments are operated over networks.

These are all premised on a nonstop, stable, wide area network environment and always-on connectivity. In addition, an environment is required that allows users to use services anytime and anywhere and, clearly, mobile devices are likely to become the mainstream as a means of network access.

While the expansion of network usage is enhancing convenience, the negative side of the use of networks has become a public concern such as a fraud by the abuse of the Internet, damage caused by malwares and infringement of copyrights. To address these problems, networks are required to further advance by technologies that ensure security and privacy so that users feel secured in using networks as a social infrastructure.

3. Expansion of network usage in corporations

Now, what kinds of changes are taking place in corporations?

Operations conducted via E-mail and Web systems in which all employees are provided with PCs have become commonplace in corporations. LAN facilities that support this form of business operation are widely in place across organizations.

On the other hand, information systems are often built individually for each function, organization or base, for which an improvement in efficiency is desired. An effective use of IT

resources (servers, storages, networks and software applications), a reduction in the number of system administrators and quick and flexible provisioning are among the challenges posed.

Meanwhile, the implementation of an environment is called for that offers business and service applications via networks to users in such a way that the physical entities of the IT resources are transparent, and that allows system administrators to centrally manage IT resources at the same time: the so-called Cloud computing environment. The emergence of intra-company Clouds and a technological field called Hybrid SaaS, which combines intra-company Clouds and Clouds offered on the Internet, can bring about innovations in corporate information systems.

There are also demands for innovations in the existing business processes and business models by taking advantage of networks. For example, application of mobile broadband services, which are estimated to expand from now on, to operations and services of a company for creating new values is anticipated.

These innovations in corporate information systems also require, as absolute conditions, high reliability and always-on connectivity of networks as an infrastructure. In other words, the entire system including various mobile and fixed line access environments, operational environments that integrate them, high-speed and wide area network infrastructure, server infrastructure and data centers for offering network services and various security mechanisms are required to provide a nonstop and stable environment 24 hours a day, every day as an absolute prerequisite. These requirements for networks are being standardized in wide area networks of telecom service providers and intra-company networks, and activities such as the unification of technologies for constructing networks, devices based on them, and their operation and management method are in progress.

Legal compliance is strongly demanded in corporations, and to achieve it requires the reinforcement of internal control. Measures with information systems alone are not enough for ensuring internal control including IT control, personal information protection and digital forensic control, and thus measures integrated with networks are called for.

4. Evolution of technologies and Fujitsu's initiatives

Along with the increase in new ways of utilizing social infrastructure and the expansion of use across different fields, the network infrastructure itself is required to have openness that does not restrict services offered, and attempts to achieve this started a few years ago based on looking at the conventional architectures from a revolutionary perspective.

One example is that major telecom service providers in Japan, the U.S. and Europe are steadily moving ahead with the building of Next Generation Network (NGN) based on IP technologies as a transformation from the existing TDM-based networks, in view of the characteristics of the respective networks. Fujitsu has been making contributions to the building of NGN and offering of services by providing major telecom service providers in Japan, the U.S. and Europe and Japanese private corporations with products and service solutions that employ leading-edge technologies.

In terms of network traffic volumes, while architectures of social infrastructure networks go through a dramatic transformation, IP traffic caused by mobile phones and the Internet is still increasing. One recent study on the total volume of Internet traffic in Japan already gives a figure of over 900 Gb/s[2] and the trend of an increase in traffic is unlikely to change in the future.

In addition to the increase in traffic volume, qualitative changes of traffic are taking place as well. The traffic has largely been voice and data, but it is now being replaced by image traffic. Furthermore, the distribution of video traffic between general users via methods such

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as YouTube is said to have tended to reduce the difference between upstream and downstream traffic volumes.

Currently, this traffic distribution is supported by large-capacity optical submarine communications systems that achieve intercontinental communications and Fujitsu's optical submarine communications systems have completely connected together across the globe.

These quantitative and qualitative changes in traffic have produced an effect of accelerating technological development for broadening access network bandwidth and increasing the capacity and speed of trunk systems.

While telecom service providers have different competitive environments, among wired access methods, practical application of FTTH technologies that can leverage the benefit of broad bandwidth in place of the conventional ADSL technologies with copper lines have started to advance rapidly in Japan and North America, and the speeding up of access by wireless technologies such as WiMAX and LTE that take advantage of nomadic convenience specific to wireless systems is about to get under way. With these market trends in view, Fujitsu has made global approaches to the development of major access infrastructure technologies for fixed line and mobile wireless systems by collaborating with overseas R&D bases.

Meanwhile, toward the improvement of the operational efficiency of network infrastructure that is essential to corporate activities, corporate networks via Ethernet lines have become widespread and the interface capacity has increased from the Mb/s to the Gb/s level in large-volume data exchange between corporate offices and communications with data centers that provide huge quantities of applications and services, which has been driven by the increase in the amount of data handled.

To adequately support such networks without causing stress to the access networks in which continuous bandwidth broadening is taking

place, the backbone transmission networks need to have ultra-large capacity. As a core technology to achieve this goal, the WDM technology that makes use of the characteristics of optical communications technology is employed and large-capacity optical transmission multiplexing 10 to 40 Gb/s signals is now becoming the mainstream. In response to this request, Fujitsu developed for the first time in the world a 40-Gb/s, ultra-high-speed, large-capacity optical technology and brought it to the market. The technological development of trunk networks can be characterized as a history of challenges for higher speed and larger capacity (**Figure 1**).

As the transformation to next-generation networks and dissemination of Ethernet services deployment, smooth migration from the existing networks and improvement of operational efficiency can have an enormous effect on recipients as well as providers of services. Fujitsu was timely to propose the multi-layer convergence platform integrating optical and IP layers that is capable of meeting this need, which is attracting attention as one solution to the challenge.

While everything is expected to be linked with networks and information explosion progress from now on, 100-Gb/s, ultra-large-capacity transmission technology is beginning to draw attention and raise expectations as a backbone transmission technology that supports networks, which are increasing in capacity. On top of the study of technological breakthroughs, standardization activities for a new hierarchy system[note] of these high-speed optical systems are under way among standardization organizations such as ITU-T and IETF. Fujitsu is also actively involved in contributing to the standardization.

To further improve network efficiency, ambitious attempts at technological development

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note) New interfaces (OTU4, OTU3e, etc.) were added to OTN (Optical Transport Network) grades of multiplexing by ITU-T SG15 and 40 Gb/s and 100 Gb/s mapping was defined.
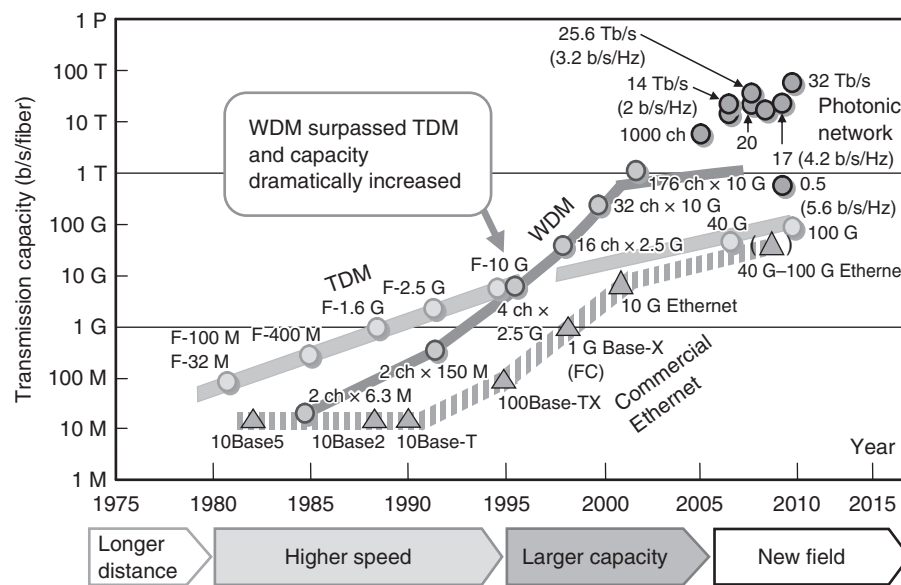
Figure 1
Changes in speed and capacity of transport technology.

will continue in the future to make everything optical from access to core networks.

As robust transport networks that allow a free flow of traffic with no recognizable stress are being built, virtualization and operation technologies for IT systems are also advancing, which is making various services available on demand and at lower investments by using methods such as SaaS and PaaS. In line with these movements toward provision of services, Fujitsu has been working on the R&D of a Service Delivery Platform that allows networks to offer various common functions to applications as service components. Sharing service components allows service development costs and periods to be reduced. By absorbing differences between terminal functions as well as protocols, service components also allow the linking of terminals, which may widely range from sensors to HDTVs, with services without the need for any advanced network expertise. Attempts are also being made to achieve innovation in field operations and collaborate with service providers by sharing data in addition to the shared use of service components.

Fujitsu has been working on field solutions that allow a detailed understanding of field situations by introducing wireless and sensing technologies to the fields where IT technologies have not traditionally been in place, such as agriculture and healthcare, for collecting, analyzing and sharing field data, namely real-time field management (**Figure 2**), and proposed optimization of management resources, improvement of eco-friendliness and sensor solutions.

In addition to such development of network and IT system technologies, diverse mobile devices including mobile phones, smartphones, PDAs and note PCs have become widespread and come to be used in various environments. Along with this, issues such as information leaks and theft or loss of mobile devices have been posing major concerns, and efficient management of these various devices for integrated operation together with networks and IT infrastructure is gaining importance. For example, when users access internal business systems from business trip destinations or their homes, the individuals and devices can be identified and authenticated

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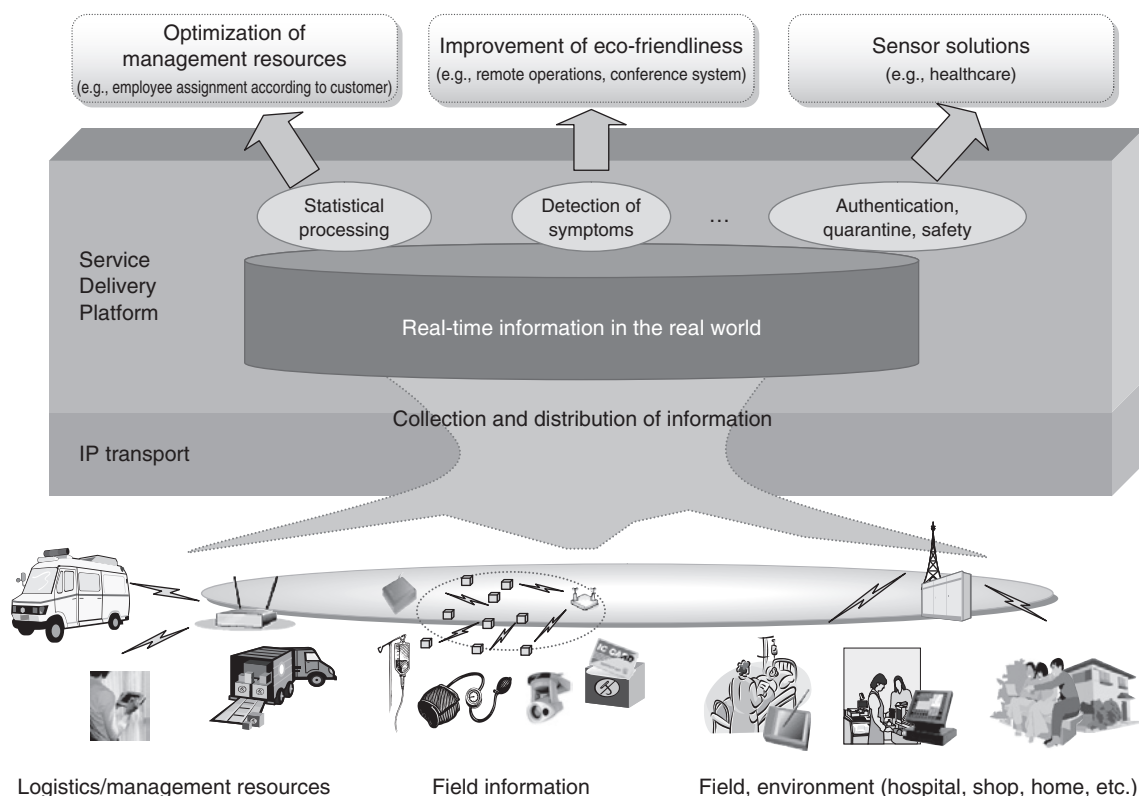
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Figure 2
Real-time field management.

to allow enforcement of access control in accordance with the authenticated users and device environments based on the business system access policies.

What is equally important in providing networks and services is operation systems.

With the existing operation systems, high-reliability operation by monitoring networks and upper-level service infrastructure for device failure and redundancy configuration was the norm. However, recent developments including network integration by IP technologies and the complicated overlay environment built, equipment movement toward Open Platform, diversification of communication media and expansion of mission-critical areas in communications have caused a number of failures that cannot be detected or avoided just by the standard technologies mentioned earlier.

Along with the rapid development of

our network society, greater demands are being placed on operations systems and, in addition to device monitoring, the concept of service management to guarantee the quality of communication media with user experience or operation performance as parameters, has become essential. Furthermore, the development of symptom management technologies to detect failures or quality deterioration in advance and prevent the occurrence of problems is another important theme.

Fujitsu has engaged in the development of these ever-advancing operation technologies from early on and has announced several study results and products in 2008.

Global environmental consciousness is another major challenge for the future. In addition to the power-saving and energy-saving features of the devices themselves that IT technologies can provide, Fujitsu has been
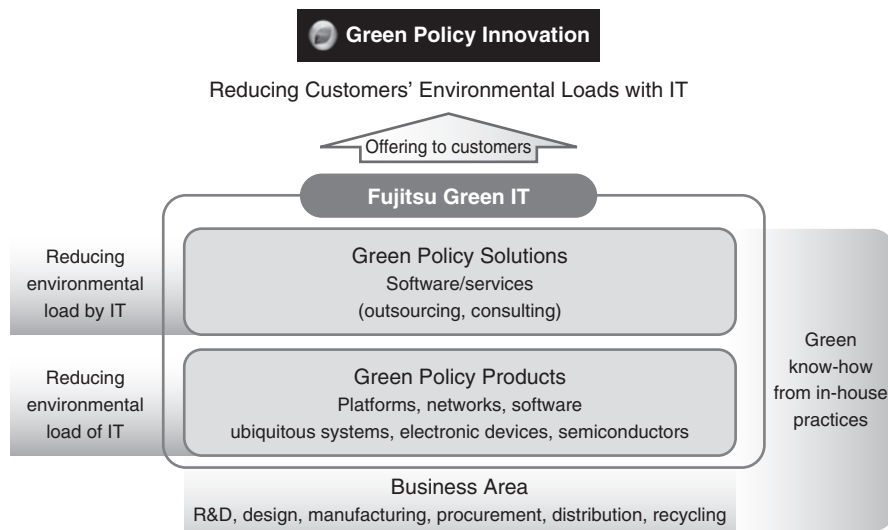
Figure 3
Concept of green policy innovation.

making efforts for a comprehensive reduction in carbon dioxide emissions by taking advantage of IT technologies.[3] **Figure 3** shows the basic concept of Green Policy Innovation.

As the trend toward higher-speed and larger-capacity network infrastructure becomes widespread, the increase in the amount of power consumed by devices has been focused on as a significant social problem that has a major effect on the global environment. Continuous technological attempts have also been made through analytical approaches in entire networks from core to LAN/access networks to reduce power dissipation by architecturally integrating devices and functions and developing new elements capable of reducing the power consumption of the sources themselves. Functional integration by means of a multi-layer convergence platform that integrates optical and IP layers is one such attempt.

5. Conclusion

Network use is steadily expanding, and this is accelerating the evolution of technologies and causing even more new usage models to appear.

As the social activities and information communications networks develop while interacting with each other, in a way that is analogous to an image and its reflection, continuous technological advances will continue to enrich social activities.

To build a comfortable and secure network society, Fujitsu will keep on refining information and communications technologies to stay at the leading edge and thereby continue to make contributions to the development of society.

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