Fujitsu's Activities for Next-Generation Network

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The Internet has expanded to cover every corner of consumer and enterprise activities, and the user community has devised new applications for and uses of Internet technologies. As the network takes shape as a social infrastructure, it is becoming increasingly important for the network to support these new uses not only by addressing ever-increasing bandwidth requirements but also by improving serviceability and usability through the convergence of new services, addressing such aspects of security and safety as the quality of services and robustness against cyber-threats or disasters, and tailoring service according to the user's location or circumstances. This paper discusses the future direction of network technology and Fujitsu's activities toward enabling greater innovation in the user community.

1. Introduction

Network-related keywords are in the process of changing from technical terms such as broadband and IP service implementation to words that reflect user expectations, for example, safety, security, and convergence (fixed-mobile, communication-broadcast, and IT-communication convergence).

In this paper, we provide an overview of the future direction of network technology and outline Fujitsu's activities for supporting user innovations.

2. Changes in network usage

In this section, we describe the changes that have occurred in the ways networks are used in the consumer community and in corporations.

2.1 User-led network usage

In the middle of the 1990s, the Internet became commercialized, and the way in which it was used expanded from the sending of E-mail and browsing to creating business opportunities such as consumer-oriented auctions. The corporate world also saw an increase in marketing activities that targeted the general consumer and business-to-business auctions. As of 2004, the scale of e-business in Japan exceeded 100 trillion yen.[1)] With regard to effective network usage, it is no exaggeration to state that established business practices in the consumer community have flowed back into areas of corporate activity. The widespread diffusion of the sending of short E-mail messages and E-mail with photos attached via mobile phones has clearly exceeded the expectations of service providers. Blogs and full browsers for mobile phones are new uses that were developed by people based in the user community instead of by corporate entities, as would normally be expected. The creative power of the users far exceeds that of the people providing the services, and the consensus seems to be that the user community has taken the lead in new uses. In the future, we can expect this trend to continue as we move toward the realization of a ubiquitous society.

2.2 Corporate network use

In the past, the role of corporate networks was focused on optimizing tasks by expediting the inter-office transfer and sharing of information, reducing travel expenditures, and so forth. Recently, the emphasis has moved to the creation of new business opportunities. Corporations are taking advantage of the spread and immediacy that networks provide to integrate different types of businesses, approach a wider client base, and revolutionize business conditions. In other words, corporations are making the transition from intra-company networks to Internet-based ICT applications. Initiatives such as service-oriented architecture (SOA), an architecture that has been actively adopted in the IT field, and Fujitsu's "Field Innovation" proposal, an innovation that uses the field as the starting point, are supporting this transition.

3. Recent network trends

In this section, we discuss recent network trends and give some examples of research and development activities geared toward supplying solutions to the changes in telecommunication carrier services necessitated by the changes in network usage that were described in the preceding section.

3.1 An open environment for the promotion of creative network usage

The development of new network uses and their expansion into different fields have resulted in strong demands for a more open environment without any service restrictions imposed by the network infrastructure itself. Making the environment more open gives rise to further new uses, resulting in the formation of a development spiral. The diverging usage scene is supported by the diverse ways of accessing networks and the use of software for service applications. IP-based networks play a role in integrating these functions with the architecture in order to provide a more open environment.

3.2 Changes to telecommunication carrier services and business conditions

The relationship between the user trends mentioned earlier and changes to telecommunication services is an interactive one. To meet user expectations, telecommunication carriers are proceeding with service diversification and business reforms. Carriers worldwide are simultaneously reducing the costs of existing services and providing new, high-level services. Japan's NTT now starts to offer an optical line-based telephone service called Hikari Denwa and Fixed-Mobile Convergence (FMC) services; British Telecom (BT) has launched its 21st-century network plan; and major North American carriers have committed to providing optical access and video services. Services that originated in the user community such as the standard provision of a full browser capability in mobile phones are also being actively implemented. Furthermore, the switch to IP-based networks, the proliferation of mobile phones, and the charge systems applied to these services have considerably reduced the validity of the traditional concept of telecommunication distances. Integrations of fixed telecommunications carriers with mobile telecommunications carriers and integrations of long-distance carriers with regional carriers have been common recently.

3.3 Advances in network technology

As IP-based networks develop and enter into various aspects of social life, certain problems have become noticeable when we view networks as social infrastructures. The implementation of new network technology in this scenario solves these problems, and trials are already underway that will bring reforms in the provision of next-generation services and applications. Here, we describe the advances made in research and development in Europe and the U.S. and then summarize the direction in which networks are advancing.

3.3.1 Research and development trends in the U.S.

In April 2003, the United States National Science Foundation (NSF) sponsored the National Science Foundation Workshop on Fundamental Research in Networking. The workshop identified future trends in research of networking and concluded that fundamental research in networking with regard to topics such as communication theory, economic theory, and overlay networks was essential to stimulate the development of next-generation services and applications.[2] As a result of this report, several organizations were established for the promotion of industry-government-university collaborative projects: the PlanetLab Consortium in June 2003, the 100 × 100 Project in September of the same year, and the Global Environment for Networking Investigations (GENI) Initiative in August 2005. In particular, the PlanetLab Consortium configures new virtual networks on the Internet and 130 universities, companies such as Intel and HP, and government organizations are pooling ideas and technology for verification in this organization so that diversified and decentralized services can be realized over a wide area.

3.3.2 Research and development trends in Europe

In November 2004, the European Commission began accepting applications for the Communication Paradigms for 2020 project as part of the EC's Framework Program (FP-IST FET: Framework Program-Information Society Technologies Future and Emerging Technologies). Under this program, organizations research and develop communication systems with autonomic control and self-organization capabilities so they can respond to changes in the environment and contextual circumstances.

If we put together all these trends in network research, we can predict that networks will evolve as shown in **Figure 1**. First of all, networks will become aware of the environment around the user and of their own status (x-aware networks). They will then evolve into networks that can respond to changes in their status and autonomically control services (self-x networks).

4. Fujitsu initiatives

In this section, we look at the future network requirements, some Fujitsu products for supporting next-generation networks, and some of the

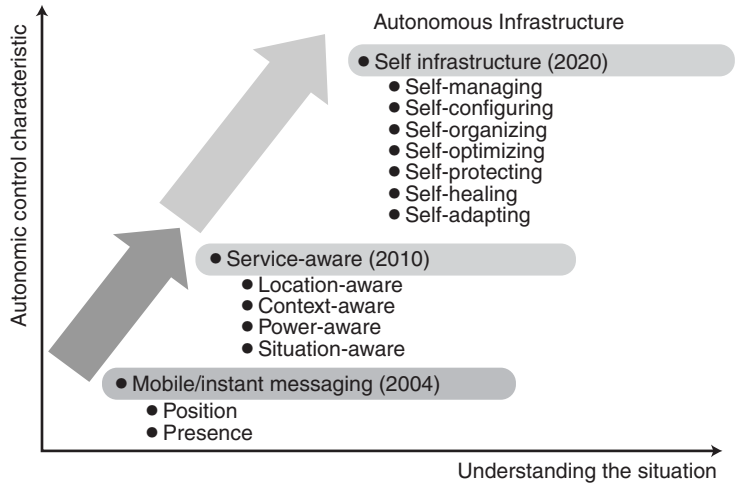

Figure 1
Direction of network evolution.

current standardization activities.

4.1 Future network requirements

Future networks must be developed to support new uses and must meet two major requirements.

The first requirement is the functionality to cope with the demand for continuous broadband service. If we take a major Japanese telecommunications carrier as an example, from the end of 2004 to the middle of 2005, the number of new fiber to the home (FTTH) subscribers was greater than the number of new ADSL subscribers.[3] In the U.S., telecommunication carriers who have integrated phone, Internet, and video distribution services into a Triple Play package are battling fiercely with CATV carriers. Major telecommunication carriers are rushing to provide fiber to the premises (FTTP) and fiber to the node (FTTN) services. In the mobile communications field, intense competition caused by the appearance of new players and the introduction of mobile number portability (MNP) can be expected. In this field, a high-speed data communication service enabled by high speed downlink packet access (HSDPA) that will be available from the middle of 2006 and the new "worldwide interoperability for microwave access" (WiMAX) high-speed wireless access technology are attracting attention. To considerably expand the traffic capacity on key networks in response to the speeding-up of access networks, major telecommunication carriers are starting to use wavelength division multiplexing (WDM) technology to reinforce their key optical networks. Fujitsu has applied world-class, leading-edge technology to key optical networks of major telecommunication carriers that are designed for the broadband field and is providing them to major telecommunication carriers worldwide.

The second requirement is ease of use and ease of service provision. If we look at this requirement in more detail, it can be further divided into three sub-requirements.

The first sub-requirement is to realize new services provided by convergence, for example, the integration of mobile communication and fixed communication (FMC), the fusion of communication and broadcast functions, and the integration of networks and IT. As the use of mobile phones becomes more widespread, users will want to use the same services in a mobile environment that are available in a fixed network. They will also want the choice of accessing a mobile or fixed network from a single mobile phone according to their current location. Services that will have a significant blurring effect on the boundaries between the telecommunications and broadcasting industries are one-segment broadcasting, which gives mobile phones the ability to receive terrestrial digital TV broadcasts, and network video. We can therefore expect the supporting network infrastructure to change.

The second sub-requirement is to deal with the issues of quality, security, and robustness that arise as networks become more IP-based and more open. Among other things, this will require a strengthening of the measures for 1) guaranteeing communication quality (connectivity, bandwidth, delay), 2) enabling a grasp of a network's status (configuration, performance, capacity) and the usage conditions (sender, application), and 3) dealing with abnormalities (obstacles, disasters, overloads, attacks, spam, misoperation, and bugs). Next-generation networks will need to be safe, secure, and large-scale yet economical and will need to act as a social infrastructure that can also be used for mission-critical tasks.

The third sub-requirement is the development of a communication system with autonomic control and self-organization functions that enable it to adapt to environmental and contextual changes. Service providers are requesting new types of networks: networks that are aware of the environment around the user and of their own status (x-aware networks) and networks that can adapt to these changes and autonomically

control services (self-x networks). Meeting these requests will involve a paradigm shift from networks with computers and terminals at the center to networks with people at the center. The most important factor is the ability to provide convenient, safe, yet economical services that anyone can use easily and freely whenever they want.

At Fujitsu, we are working on the development of service platforms, service applications, network servers, network management systems, and other products so we can realize our stated aims of providing services and ease of use.

4.2 Fujitsu products for supporting next-generation networks

At Fujitsu, we are proceeding with the development of systems for the next-generation networks. An example of a next-generation network is shown in **Figure 2**. The network comprises two layers: the transport network layer for the administration of user traffic transmissions and the service network layer for managing and controlling the network and providing the various types of services.

The transport network layer can be divided into three categories: the optical core network, optical metro network, and access network (mobile & wireless, as well as broadband access). For each of these networks, we are proceeding with plans to provide more broadband capability and make them more economical to maintain. To enable a large volume of traffic to be transmitted economically between regions, the optical core network is configured with terrestrial and submarine WDM systems (FLASHWAVE 7000 series for the terrestrial system and FLASHWAVE S650 series for the submarine system). The optical metro network is configured with a multi-service provisioning platform (MSPP: FLASHWAVE 4000 series) and an Ethernet transport system (FLASHWAVE 5000 series) in addition to a WDM system for transmitting information within one region and multiplexing and transmitting information to other regions. Moreover, the Fujitsu-Cisco CRS1 router has been deployed for the transmission of information in IP packet units in the optical core and optical metro networks. Wired and wireless access

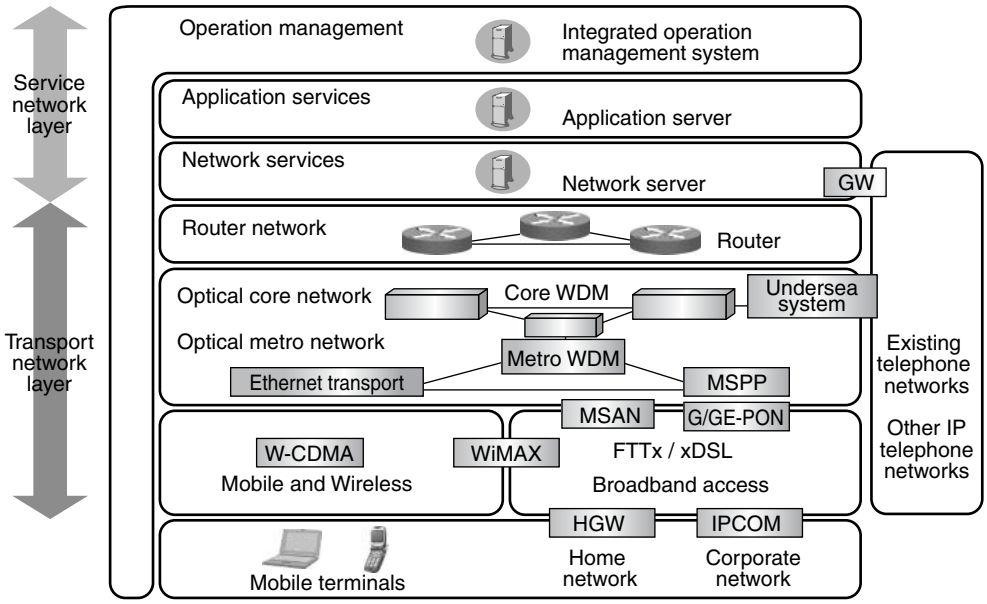

Figure 2
Example of next-generation network architecture.

networks are both becoming more diversified. FTTx optical access is the mainstream wired access technology. GE-PON, G-PON, and Multi-Service Access Node (MSAN) are other examples of systems used in the configuration. In the wireless access field, as well as using a wideband-code division multiple access (WCDMA) base station and base station control systems, we are also working with new wireless access technologies such as WiMAX. Corporate networks use an IP-PBX and router combination for intra-office connections and a dedicated network such as an IP-VPN for inter-office connections. Furthermore, a network server system (IPCOM series) has been deployed to ensure security at the connection points with public networks.

The service network layer is divided into network services, application services, and various operation management function categories. For the network services, we have deployed an advanced telecommunication computing architecture (a-TCA) based NGN service platform called UB300, which provides highly reliable middleware to realize non-interrupt, nonstop forwarding and supports application interfaces (APIs) to realize various types of convergence. In addition, the international standard session initiation protocol (SIP) is used to control high-function services such as VoIP and FMC. For operation management, integrated operation management systems (Proactnes, AW-Navi, and NetSmart) have been deployed, not only to individually manage each installation, but also to realize optimal operation of an entire network, immediate recovery processing at failures, and integrated management of each type of service, while providing safety and security. To meet the demands for an even higher level of management in the future, we have developed a measurement technique called the VoIP Network Analyzing & Planning Tool (VoIP Planner) to enable economical and continuous monitoring of a network's operating conditions, and we are currently developing a system that uses VoIP Planner. Moreover, various application services such as e-learning that make use of these types of network functions, have been realized.

4.3 Standardization activities

It is very important to provide products and services that conform to global standards as early as possible. To achieve guaranteed connectivity and economic efficiency, it is also essential to incorporate standardization activities, not only in regard to services and architecture, but also from the perspective of the key technologies. There are various requirements for next-generation networks, for example, the realization of convergence (e.g., FMC), the assurance of QoS, and a high level of security. A wide range of technologies are needed to realize the requirements, and various standardization bodies are working towards realizing them. The ITU-T has established the Next Generation Network Global Standards Initiative (NGN-GSI) and is currently standardizing services and architectures. Within the European Telecommunications Standards Institute (ETSI), the Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN) is taking the lead in this area. For the key technologies that are used to configure networks, forums such as the 3rd Generation Partnership Project (3GPP), Internet Engineering Task Force (IETF), Institute of Electrical and Electronic Engineers (IEEE), and WiMAX are at the center of standardization work. In this way, many standardization organizations and forums are cooperating to establish a substantially global standard. At Fujitsu, we have also established a global standardization implementation working group that includes overseas affiliates, and we are currently working on standardization activities for next-generation networks related to the ITU-T (NGN-GSI), ETSI (TISPAN), 3GPP, and other groups.

5. Conclusion

Because of the key role that networks play as social infrastructures, the realization of net-

works that can meet new user needs has become extremely important. At Fujitsu, our aim is to contribute to the realization of an enriched ubiquitous society through the realization of networks that can assess the continually changing needs of users and respond to the continuously growing broadband demand while at the same time are easy to use and provide improved services.

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