IP Network Trends and Fujitsu's Strategy

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Internet protocol (IP) networks are now used in various ways by individuals and companies and are expected to become even more important in future. One trend for IP networks is the convergence of their core platforms and another is the diversification of segments closely linked to services. An important issue for the future is how to provide frameworks that can handle highly diversified services on converged IP network platforms. One example of a product that can handle diversified services is WANDIRECTOR, which has recently been commercialized by Fujitsu. WANDIRECTOR provides high-speed communications for file backup and video distribution applications over a wide area network (WAN). In this paper, while referring to past shifts in IP networking, we describe future directions and give an overview of WANDIRECTOR.

1. Introduction

Internet protocol (IP) networks have gradually evolved from applications intended for general information exchanges such as E-mail and the Web to more expanded fields of applications to now include use in social infrastructure such as banking and securities systems. IP technology has also come to be used widely in next-generation networks (NGNs) and carrier networks including mobile communications networks.

This paper presents an outlook on the future development of networks and Fujitsu's strategy based on the present situations, in which IP networks have become widespread.

2. IP network trends

In this section, we take an overview of IP network trends from the perspective of technologies and applications to identify the features of the networks.

2.1 Changes in technologies

As transmission technologies for local area networks, transmission methods such as Asynchronous Transfer Mode (ATM) and Frequency Division Duplex (FDDI) were occasionally used in the past but today Ethernet is the mainstream as a wired system. Transmission technologies for wide area network (WAN) have shifted from the conventional Frame Relay (FR) and ATM to Layer 1 technologies such as Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH) and Wavelength Division Multiplexing (WDM).

Various communication protocols including FNA, IPX, and AppleTalk on networks have been used in the past. However, there was a gradual increase in the number of operating systems implementing IP that are not related to a specific vender, and many protocols finally converged onto IP only in the second half of the 1990s.

Exchanging technologies used in the conventional telephone, mobile communications networks and broadcast transmission technologies are now tending to be implemented by IP and all communication systems are shifting toward IP-based systems.

As described above, the overall trend in network technologies is apparently toward convergence. This may be partly because network designers and administrators have been demanding efficient and lower-cost infrastructure networks.

2.2 Changes in applications

In corporations, IP networks were at first mainly intended to be used as easy communication tools such as E-mail and Web access. Subsequently, all backbone systems came to be built on IP networks and today use of IP has become pervasive enough to include voice communications. Ranges of access are no more confined to connections to corporate servers but have expanded to Internet connections and are now evolving to include Cloud computing such as Software as a Service (SaaS) and Platform as a Service (PaaS).

Personal usage of IP networks has diversified in such a way that the networks are closely linked to lifestyles such as blogs, social networking service (SNS), online games and music downloads and the equipment used for those purposes is also becoming wide-ranging to include PCs, mobile phones, game machines and flat-screen TVs and so on. Concerning the access path, Peer to Peer (P2P) systems for file sharing have become popular, and the existing server access path and traffic models have become diverse as well.

Figure 1 shows a conceptual diagram of the transitions in technologies and applications.

2.3 Network trends

To summarize such changes in technologies and applications, while technologies are being converged, applications in use are apparently becoming diversified on corporate as well as

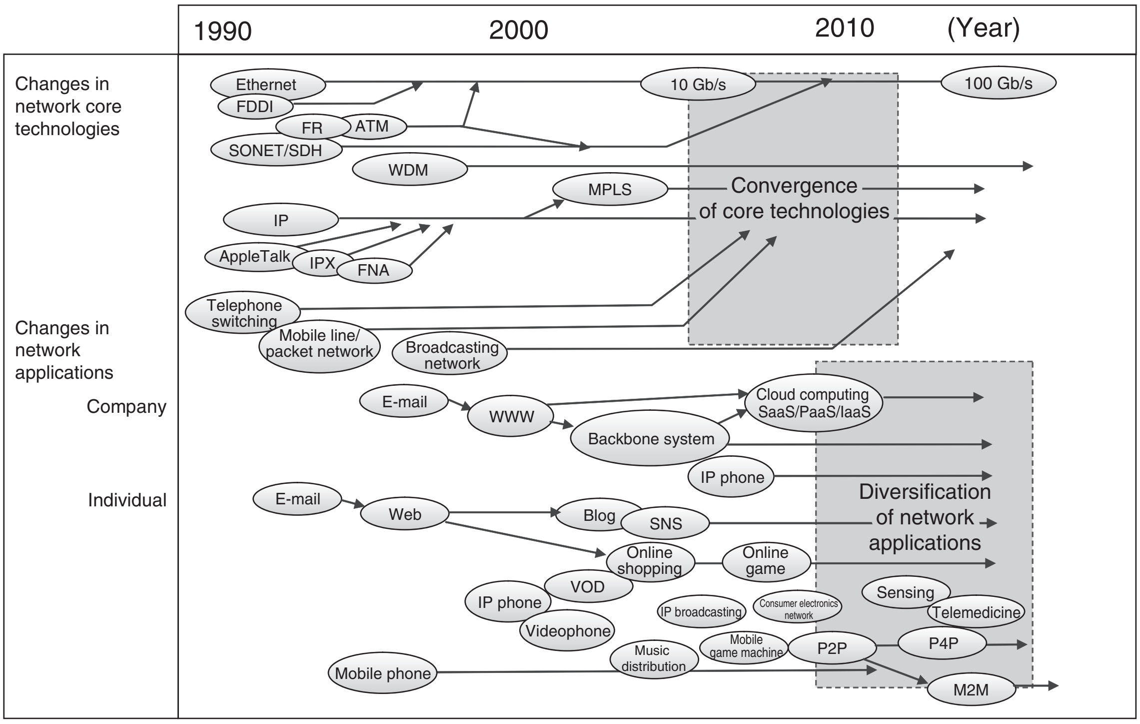

Figure 1
Trend of network technologies and applications.

personal levels.

However, network platforms built on converged technologies will be homogeneous, which will mean they are less capable of addressing the individual requirements of diversified applications. For the future development of IP networks, bridging the gap between the converged technologies and diversified applications will be necessary (**Figure 2**).

For example, NGNs, which are becoming globally popular as the infrastructure networks of carriers, can be regarded as one form of service that bridges that gap. Their additional functions such as access control and QoS control have enhanced the service level for applications that require low latency for voice communications. For NGNs, Fujitsu offers router devices such as Fujitsu and Cisco CRS-1.[1)]

Another example of a service that bridges the gap between convergence and diversification is content delivery networks (CDNs). On CDNs, many cache servers are deployed on IP networks in order to realize high-speed content distribution. This is an idea for dealing with specific applications without requiring major changes of IP infrastructure technologies.

Furthermore, there is an example adapted for a high-speed, big file transfer system. Recently corporate information has come to be often stored in data centers as exemplified by Cloud computing and in particular there is growing demand for efficient transfer of large volumes of data to remote places. To provide efficient high-capacity communications, since 2008 Fujitsu has offered a product called WANDIRECTOR A100,[2)] which achieves acceleration of TCP/IP. This device is effective for specific applications such as high-speed data backup and video data distribution and can be positioned as one product that supports diversification. The following section outlines the specifications and technology of WANDIRECTOR A100.

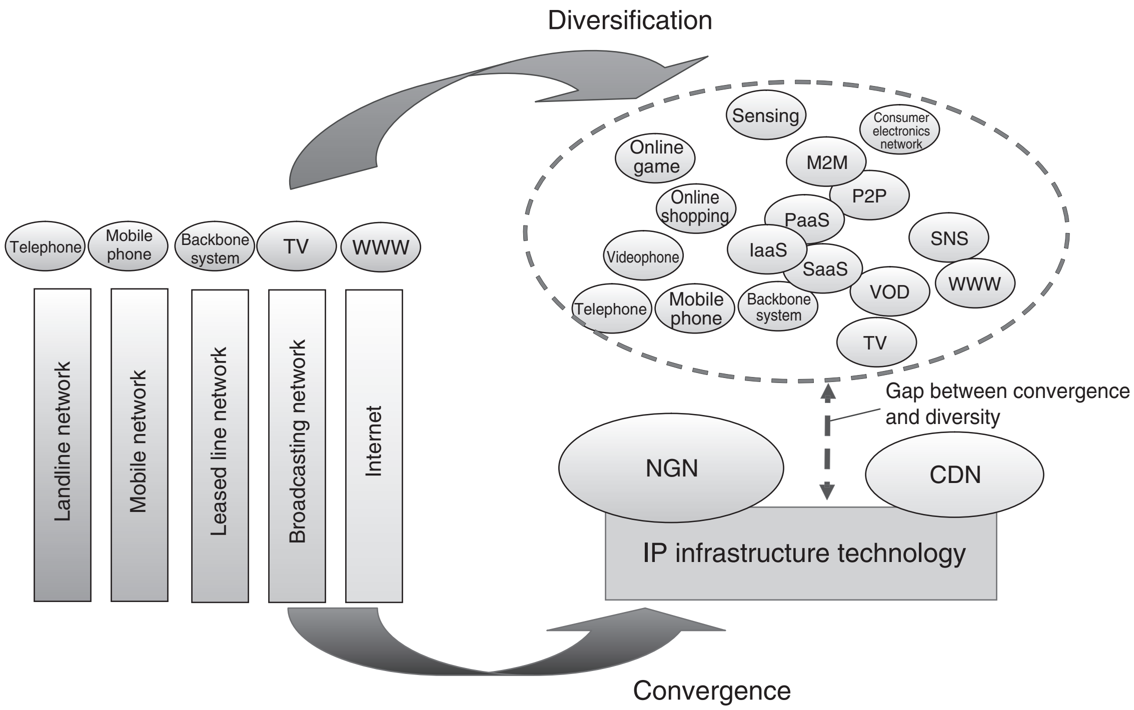

Figure 2
Gap between convergence and diversity of networks.

3. Overview of WANDIRECTOR A100

TCP/IP, which is used for most of the communications on IP networks, may show a communication performance significantly lower than the line bandwidth, at about 10 Mb/s where the line bandwidth may be more than 100 Mb/s, because of latencies generated in long-range communications. WANDIRECTOR A100 is used by installing a unit at each of the two ends of a long-range communication line to accelerate TCP/IP communications between the units to the effective bandwidth.

The device's function of accelerating TCP/IP communications does not mean that TCP/IP communications themselves are accelerated. On the WAN segment, where communication latencies tend to be high, TCP/IP is converted into a proprietary protocol that is high speed even in long-range communications in order to achieve the acceleration (**Figure 3**). TCP improvement technologies such as FAST TCP required changes to be made to the OS of the communicating host to incorporate the technologies concerned, which made it difficult to apply them to embedded systems that do not allow changes to be made to the OS, such as dedicated equipment used at broadcasting stations. The present device allows application to such embedded systems by conversion into a proprietary protocol in the middle of the network.

The proprietary protocol used for WAN communications applies the latest technologies, shown below, for speed control to achieve high speed.

- Measurement of the effective bandwidth by packet trains
- Congestion prediction by detecting an increase of the communication latency

Measurement of the effective bandwidth by packet trains is a technology in which multiple probe packets (eight packets for WANDIRECTOR) are output in succession to directly measure a bandwidth based on the transmission latency on the bottleneck link or increase in packet intervals in other traffic. The proprietary protocol uses this actual measurement as the basis for setting the communication speed. In case the network is not loaded at the time of measurement, the speed is increased in steps, which is successively approximated to the effective bandwidth in a few hundred ms (round-trip communication latency).

In the communication speed control of TCP, on the other hand, the bandwidth is not measured in advance but the speed of data communication is increased in proportion to a square (slow start mode). Any packet loss generated by exceeding the effective bandwidth in the slow start mode triggers a reduction of the speed to 1/2 for performing linear successive approximation to the effective speed (congestion avoidance mode). Acceleration in the congestion avoidance mode is in inverse proportion to the round trip time (RTT) and, for long-range communications, recovery of the communication speed to the effective bandwidth takes time. For example, a line with an RTT of 100 ms and bandwidth of 100 Mb/s requires a few minutes. On an actual line, packet losses occur due to congestion at a router, for example, before the speed is recovered to the

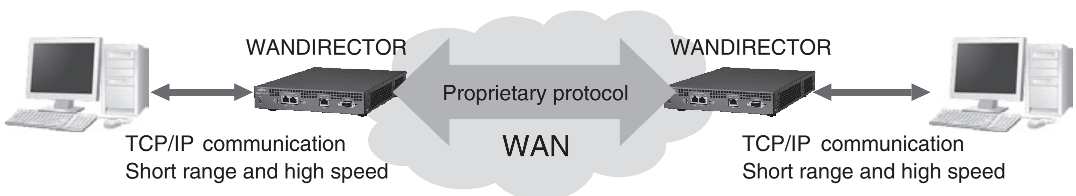

Figure 3
High-speed mechanism of WANDIRECTOR.

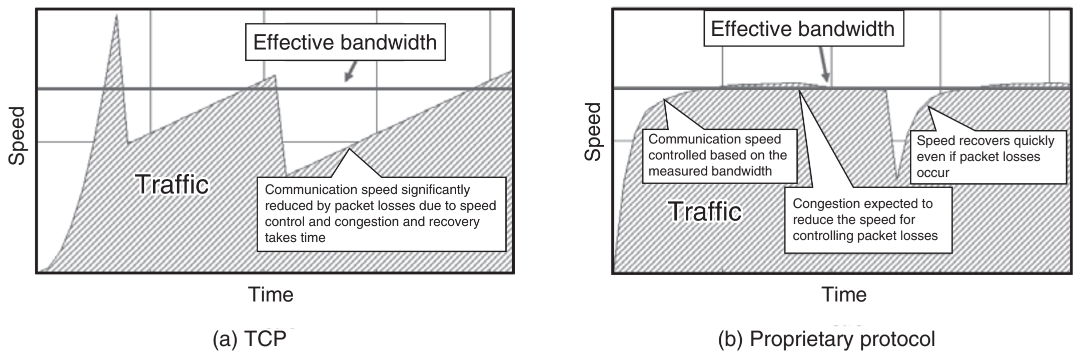

Figure 4
Bandwidth control of TCP and WANDIRECTOR.

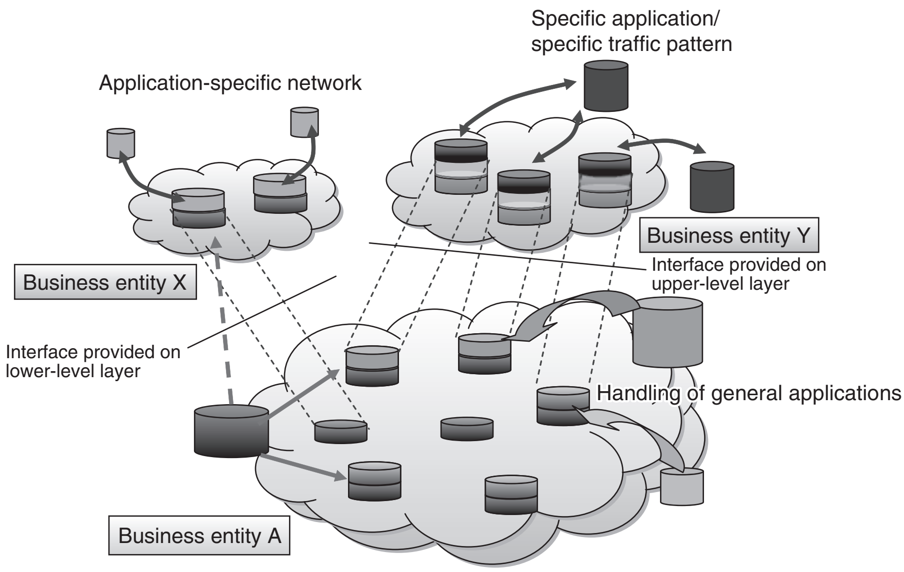

Figure 5
Image of future network development.

effective bandwidth and recovery to a bandwidth of 100 Mb/s is not possible.

In addition, resending of lost packets takes an RTT and the order of data is maintained in TCP, which means that the receiving stack cannot pass the data to the application during that time, resulting in reduced communication performance due to the non-communication period generated. TCP assumes packet losses caused by the aforementioned speed control and regular packet losses are unavoidable. With the proprietary protocol of the present device, since congestion in IP networks occurs as buffer overflows in bottleneck routers, latencies due to buffering are observed to avoid packet losses in advance, and thereby a reduction of performance can be suppressed.

The features described above enable the present product to achieve higher-speed performance in long-range communications as compared with TCP (**Figure 4**).

4. Business model changes surrounding network

Products such as WANDIRECTOR that are intended for specific services are expected to become even more widespread in the future and network business models are estimated to go in the direction of diversification along with the diversification of services. Business crossovers that are not confined within the conventional domains are progressing, such as network businesses by non-carrier enterprises and application businesses by traditional carriers. It is estimated that this trend will become even stronger in the future with business models such as mobile virtual network operator (MVNO) and business to business to customer (B2B2C). So, both services and businesses will tend to be overlaid on an IP infrastructure, while being closely linked with each other.

For vendors and carriers to provide network solutions from now on, a necessity will arise to consider, in addition to what functions to offer, to whom to offer the functions.

A future image of network development is shown in **Figure 5**.

5. Future challenges

As the perspective of diversification is being further expanded, it will be necessary in the future to provide products such as WANDIRECTOR among the solutions required for each customer as well as conducting the product business as a separate operation.

While we implement converged network platforms steadily, we will expand the lineup of network products that support applications, which are becoming more and more diversified.

6. Conclusion

This paper described the direction in which future networks are heading while focusing on convergence and diversification as important points in future networks and introducing a specific product that can realize diversification. We are committed to providing network solutions for addressing the needs of various IP applications for the future.

References

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