WAN Acceleration Technology for Enhanced Data Transmission Performance

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In tandem with the recent globalization in business, data center consolidation with server virtualization, as well as the increasing use of cloud computing and mobile terminals, there are growing needs for faster data transmission via a wide area network (WAN). However, the transmission control protocol (TCP) which is most widely used by many applications today is often unable to attain the maximum speed on a WAN due to the restrictions of the congestion control. Fujitsu Laboratories has developed two types of protocol that replace TCP, and also technology for automatically selecting these protocols depending on the conditions of the WAN and characteristics of the applications. Furthermore, we have developed technology to surpass the maximum speed only by software, through data compression and enhanced efficiency of transmission sequences, leading to a faster transmission speed via a WAN. This paper explains this best-in-industry WAN acceleration technology developed by Fujitsu Laboratories. It then describes Fujitsu's middleware product (FUJITSU Software Interstage Information Integrator) to which the technology is applied.

1. Introduction

In tandem with the diffusion of mobile terminals and cloud services in recent years, many communications applications such as file transfer, data backup and virtual desktop are becoming widely used via wireless and wide area networks (WAN). For these applications, the transmission control protocol (TCP) is the standard protocol.

It is likely that the use of international lines and wireless connections will increase in the future as businesses globalize and the use of mobile terminals increases. There are high expectations for the development of technology that further enhances data transmission performance in terms of the throughput and response time even over a network with high latency.

This paper explains the issues with communications via WAN, and describes Fujitsu Laboratories' WAN acceleration technology, with examples of products that use the technology. We will also state the future directions for this technology.

2. Issues in communications via Wide Area Network

Performance of communications via WAN may deteriorate due to the following three factors.

1) Decline of transport protocol performance

TCP throughput is considerably influenced by transfer delays and packet losses related to its self-control mechanism. In the case of communication to a cloud server outside Japan, for example, there is an inevitable delay of between around 20 and 200 milliseconds due to the limitation of the speed of light, depending on the physical distance. In a wireless environment, transmission errors due to a weak signal cause retransmissions, leading to a transmission delay. Furthermore, congestions at certain relay devices along the transmission route on the network may result in packet losses. These factors significantly slow down the TCP throughput.

2) Insufficient maximum transmission speed of WAN

In the case of low-speed networks, such as for remote islands or wireless environments, not the communication performance of transport protocol but the maximum transmission speed of the networks may

become a bottleneck.

3) Applications' complicated communication sequences

Some applications employ complex communication sequences, which may work well on LAN with a short delay, but which result in longer response times via a WAN.

3. Fujitsu's unique WAN acceleration technology

The WAN acceleration technology is applied at both ends of a WAN to convert TCP sessions from terminals or servers into high-speed protocols, thereby improving the TCP's communication performance (**Figure 1**). Fujitsu Laboratories' WAN acceleration technology achieves an all-software solution (WAN acceleration middleware). Therefore, it is possible to install the software on general-purpose servers at the edges of networks as gateways, or install it on the terminals themselves.

The WAN acceleration technology we developed employs optimization technology for various protocol layers, as shown in **Figure 2**. Each component is described in the following sections.

3.1 Transport optimization technology

TCP cannot always leverage the maximum network speed due to its modest congestion control

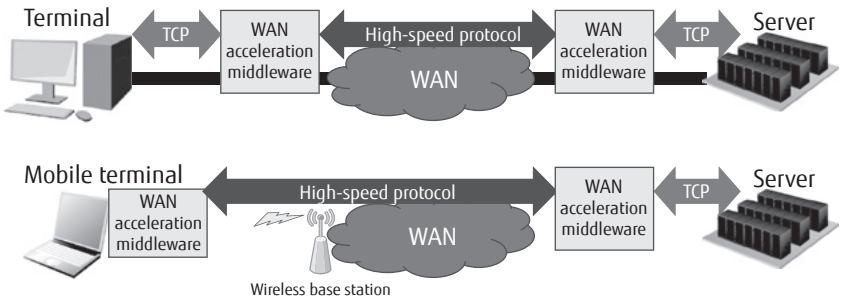

Figure 1
Usage of WAN acceleration technology.

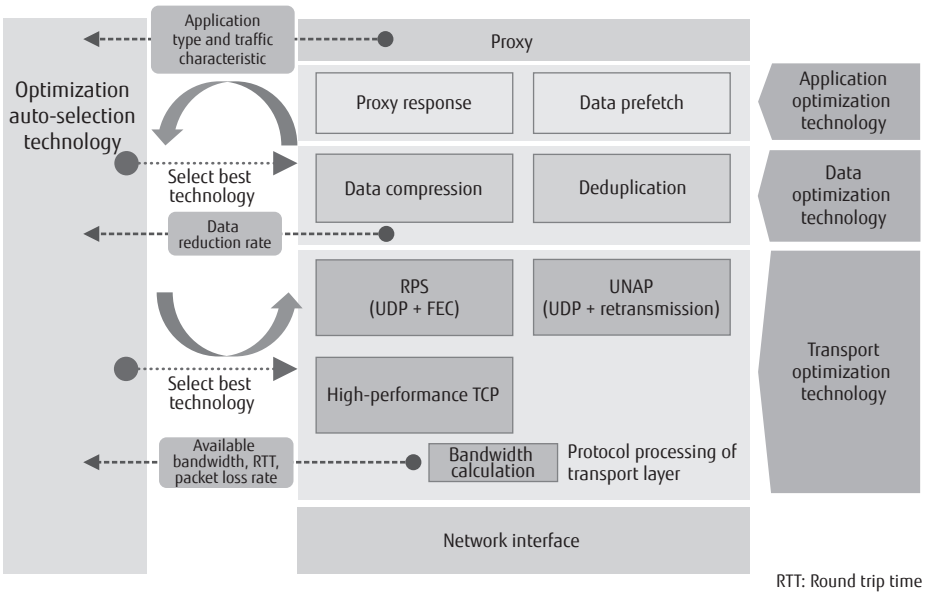

Figure 2
Middleware architecture for WAN acceleration.

mechanism as stated in 1) above. The user datagram protocol (UDP), on the other hand, can fully utilize the maximum speed of networks since it does not have any congestion control mechanism. However, to provide reliable communication, some retransmission and congestion control mechanisms are essential.

In view of this, we have developed two protocols: random packet stream (RPS), that combines UDP with forward error correction (FEC) codes, and universal network acceleration protocol (UNAP) with an efficient retransmission mechanism.[1)]

RPS is effective in networks with frequent packet losses. The transmitter generates redundant data from original data, and the receiver can decode the original data from it without retransmission even if packet losses occur.

Meanwhile, UNAP can be employed in networks with high transmission delay. It retransmits data on detecting a packet loss. To reduce redundant retransmissions, it constrains further retransmission until reception of a retransmission has been confirmed.

In addition to the data for transmission, both protocols carry data for measuring the maximum available bandwidth, and this helps to minimize the impact on other data traffic.

3.2 Data optimization technology

To support low-speed networks, as stated in 2) above, and networks where UDP-based protocols such as RPS and UNAP are not applicable for a security policy, we have developed a data optimization technology, designed to accelerate data transmission by reducing the data size through compression and omission of duplicated data.[2)]

Compression is a technique to search for repeated patterns in the data to be transmitted, and to replace any found repetitions with smaller codes, thereby reducing the overall data size. This is effective particularly with text data.

The deduplication works in such a way that the transmitted data are stored as a cache at both the transmitter and receiver, and thus the same data patterns are not transmitted from the next time (**Figure 3**). It detects the data patterns matched with the cached data and replaces them with cache identifiers before transmission. At the receiver, the identifiers are used to reconstruct the original data from the stored cache. In this way, the data size for transmission is reduced. This data optimization technology enables faster transmission without having to extend the network line speed; for example, reducing the data size to one-tenth means the transmission speed can be practically ten times faster.

3.3 Application optimization technology

Regarding the issue stated in 3) above, we have developed a technology that accelerates the communications of target applications by employing proxy response and prefetching.[3)]

For example, upon downloading a data folder containing several data files, the common Internet file system (CIFS)/server message block (SMB) issues a command to open those files and obtain attribute information. As each command may be affected by the transmission delay, they become a factor that slows down the overall transmission speed.

When the optimization technology detects a folder download, it starts to prefetch the files included in the folder from the server before the client transmits requests for downloading those files. By transmitting

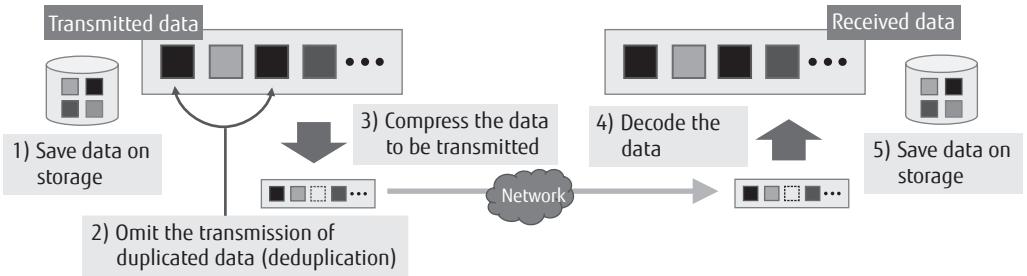

Figure 3
Data optimization mechanism.

the files to the client collectively, it can minimize the impact of the transmission delay and prevent a decline in the transmission speed (**Figure 4**).

3.4 Optimization auto-select technology

UNAP can significantly improve the transmission speed on a network with a large delay, where applications that require higher throughput such as file transfer are used. RPS can improve the transmission latency significantly on an extremely lossy network, where response-sensitive applications such as interactive communication tools are used. The requirement for WAN acceleration technology varies depending on the applications used and characteristics of networks along the transmission paths. Similarly, it is affected if users move or change the locations of communication. Nevertheless, it would be difficult for users to choose the best data transport protocol according to the network characteristics without expert knowledge and skills.

Reconfigurable transport (R-TSP) technology is an automated selection technology designed to measure performances of the applications and networks for the users, and automatically select the best-suited data transport protocol among TCP, UNAP and RPS upon estimating their performance based on the measurement results (**Figure 5**).

We are also pursuing R&D for technologies that can dynamically select data and application optimization technologies as necessary. We will achieve these

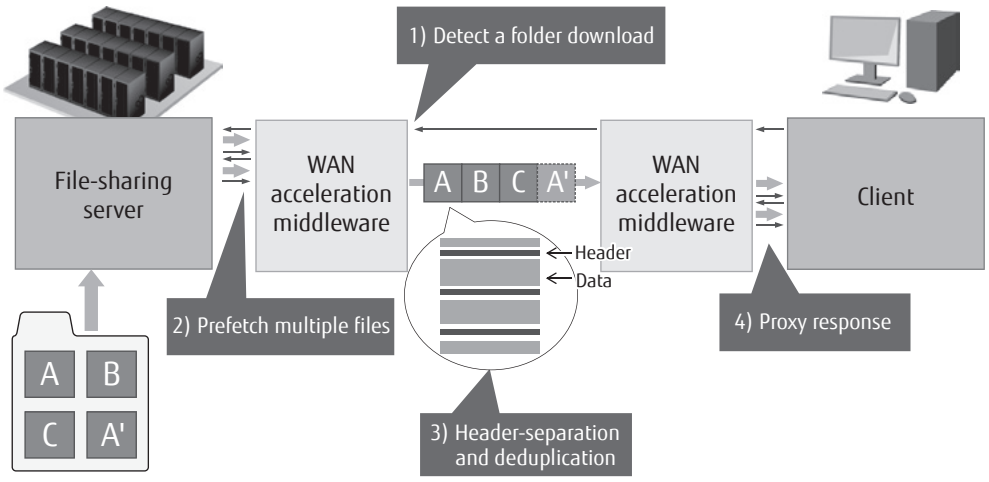

Figure 4
Application optimization mechanism.

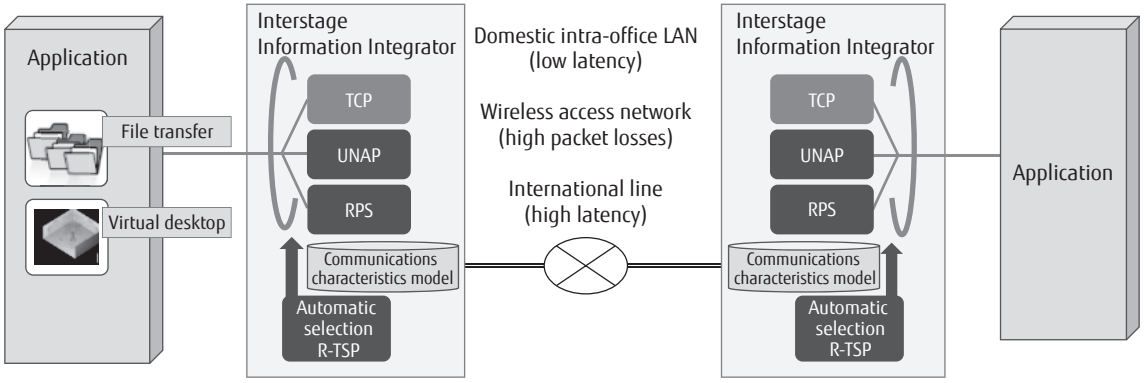

Figure 5
Optimization auto-selection mechanism.

technologies so that we can offer users the most optimized network environment.[4)]

4. Product development

Fujitsu has developed and launched FUJITSU Software Interstage Information Integrator, a middleware application that makes TCP communication between user applications faster by integrating the four technologies described above. By realizing WAN acceleration in the form of software, it can be installed on a virtual environment, cloud and a laptop, which often needs to connect to different networks, such as a visitor's network or Wi-Fi network provided on a business trip.

The software has been developed to maximize the effectiveness of these technologies in the following scenarios:

- Smooth screen transition on virtual desktop (particularly CAD-related situations where constant screen transition and large data transmission are involved),
- Accelerating file-sharing accesses from overseas or remote offices,
- Accelerating long-distance data transmission and backup for disaster recovery.

We will describe some application cases.

4.1 Smooth screen transition on virtual desktop accessed from overseas

A customer prepared its system so that it could operate a CAD program from overseas as well as from within Japan using a virtual desktop, but the screen transition was so slow when accessing from abroad that it was not practical.

The customer tried appliance-type WAN acceleration to see if the problem could be solved, but it turned out to be ineffective in improving the screen transition responses. By using our middleware, the transport optimization offered the best use of available network speed as shown in **Figure 6**, and provided users with stress-free CAD operation with smooth screen transition. As a result, the design data could be integrated into the customer's database in Japan, and the customer succeeded in achieving a shorter development lead time.[5)]

4.2 Accelerating accesses to Windows file-sharing from remote offices

Fujitsu introduced an integrated communication platform (global communication platform)[6),7)] which helped to achieve proactive communications and innovative workstyles while reducing operation cost. While the communication platform offers data sharing as part of its services, access speed from offices located far from the file server declines, affected by delays occurring in the network.

To overcome this problem, we tested our middleware to evaluate any possible improvement, and confirmed that it realized the same level or higher acceleration through data optimization in comparison with the appliance-style WAN acceleration. The effect was enhanced by applying application optimization. The result was faster access from remote offices to the file server. This led to solving the performance degradation without reinforcing the network line speed, and it also enabled the user to integrate the servers into one location for operation and maintenance. These evaluation results have led to gradual introduction of

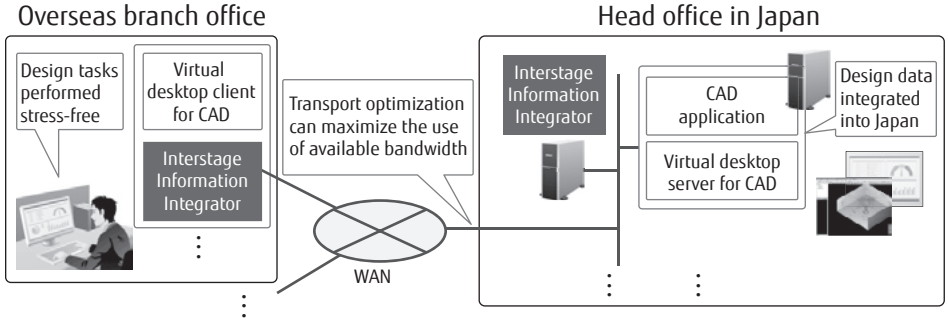

Figure 6
Acceleration of virtual desktop at overseas branch offices.

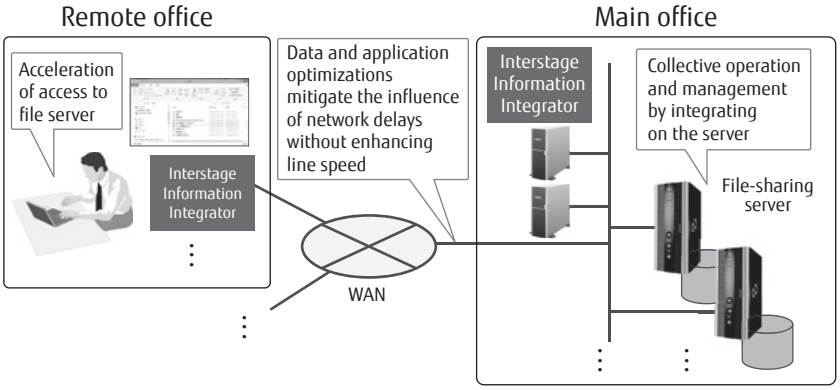

Figure 7
Accelerating access to Windows file-sharing from remote places.

the middleware at this user's remote offices for more than 10,000 users. **Figure 7** illustrates the system configuration described in this case.

5. Future prospect

Demand for WAN acceleration technology has been rising more and more to realize high-speed communication which has been globalized and diversified. So far, Fujitsu has released a packaged middleware product. In the future, we will enhance features by building on the advantages of software-based WAN acceleration, to offer WAN acceleration services for cloud providers and telecom carriers.

We envisage the Interstage Information Integrator to be a WAN acceleration service with a paid option for standard cloud services. We will be pursuing the development of features such as a controlling application programming interface (API) to introduce this middleware on the cloud.

Also, we are considering offering virtual WAN acceleration services for telecom carriers by applying these technologies to network functions virtualization (NFV), which turns networking hardware functions into software. This will provide carriers with an opportunity to expand their connection service menus, while users will benefit from the easy deployment/configuration of WAN acceleration technology. We will be considering not only control API support, but also high-availability support.

6. Conclusion

In this paper, we described the software-based WAN acceleration technology offered by Fujitsu Laboratories. WAN acceleration is seeing greater demand in tandem with the growing prevalence of the cloud and advancing virtualization technology in recent years. We also gave accounts of Fujitsu middleware, FUJITSU Software Interstage Information Integrator, in terms of its applied cases and respective effects.

As network use becomes more globalized and progressively employs cloud and mobile terminals, it is increasingly important to facilitate high-speed data communication for transmitting large amounts of data over long-distance, low-quality networks. We will continue our efforts to introduce the latest technology into products, and pursue further acceleration of data communication speed as well as adaptation to the cloud, NFV and other fields.

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