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Technical Trend of Network Systems

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Abstract:

The infrastructure of the coming network computing era, the consequence of network systems, is attracting public attention. Keywords of the network computing era are intranet, distributed object and multimedia. To keep up with these keywords, the network systems are required to have ever-greater performance, reliability and quality of services. In this paper, the trend of network system technologies and their development in the future are outlined.

1. Introduction

With the advent of the network computing era, the increasing importance of networks is a primary focus of attention in corporations. Systems built up on the networks not only increase business efficiency in the company but also serve as strategic systems for survival in a given competitive business field. It is no exaggeration to say that networks can determine the future of corporations.

This paper clarifies items required for networks in the network computing era and describes the trend of technologies developed in order to solve such problems.

2. Network Computing Environment

Fig. 1 illustrates a network computing environment. There are several keywords to accurately express the network computing environment, representatives of which are intranet, distributed object environment and multimedia. In this paper, these three keywords are described.

2.1 Intranet type platform

The architecture of a computer platform has shifted, as shown in **Fig. 2**, from a host/terminal type to a client/server type and further to an intranet type. The intranet type architecture has a 3-tier architecture and comprises a client incorporating a WWW browser, a WWW server and a backend server such as a database server.

Intranet has various advantages for both the end user and the system administrator. Advantages for the end user include: no limitations to variety, ensuring of integrated operation, no requirement of specified applications and so on. This is because it is only necessary to install a WWW browser in the client. No special applications are necessary, either. Advantages for the system administrator include: a reduction in the burden of user education, facilitation of application improvement, provision of security and

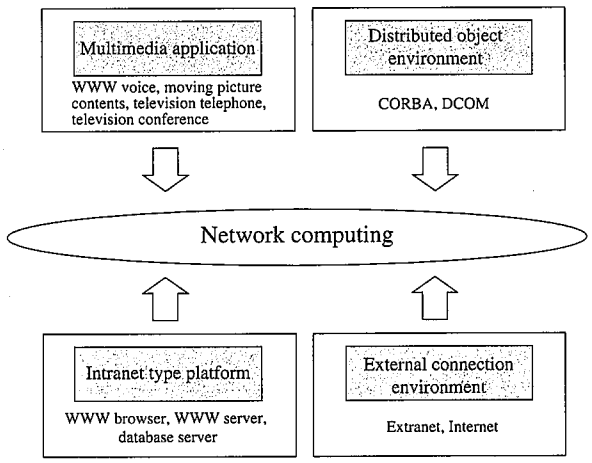

Fig. 1 Network computing environment

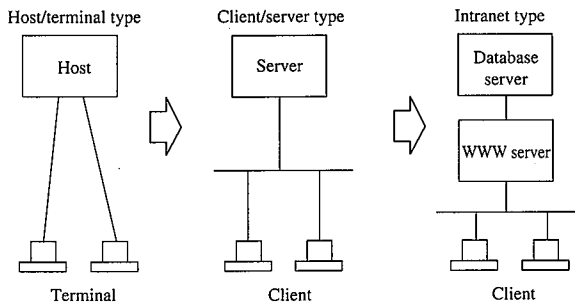

Fig. 2 History of platform

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a reduction in the number of objects for system administration. Only a WWW browser needs to be installed in the client. Accordingly, instead of conventional PCs, lightweight and reasonably-priced products, or so-called thin-clients, have been put on the market. A network computer (NC) by Oracle and a NetPC by Intel Corp., are examples of such products.

In the case of the intranet type architecture, after the WWW browser is actuated on the client side, an application is transferred from the server in the form of ActiveX*1 control or Java applet. Also, since data transmission is always performed with the server even after the actuation of the application, a higher speed is necessary for the network. Further, since continuous connection with the server must be maintained, the demand for network reliability is increased.

2.2 Distributed object environment

Practical use of a distributed object environment has started as represented by the use of NCA (network computing architecture) advocated by Oracle Corp. In the distributed object environment, objects distributed and arranged on the network communicate with one another to execute one processing as a whole. It works as if the entire network functions as one computer.

Available as standard specifications for realizing the distributed object environment is CORBA (common object request broker architecture)*2. **Fig. 3** illustrates an outline of CORBA. ORB (object request broker) is a software bus*3 for providing a communications channel between objects. CORBA service is a group of service objects necessary for managing and maintaining the distributed object environment. CORBA facility is a group of class objects*4 used as a general library by an application object*5. Microsoft Corp. has presented and advocated DCOM (distributed component object model)*6 to be used against CORBA.

In any event, there is no doubt that the distributed object environment will take a mainstream position. Since frequent data transfer occurs between objects under the distributed object environment, a higher speed must be provided for the network. In addition, since inter-object communications are essential and the stopping of the network leads to the stopping of all kinds of processing, reliability must be improved.

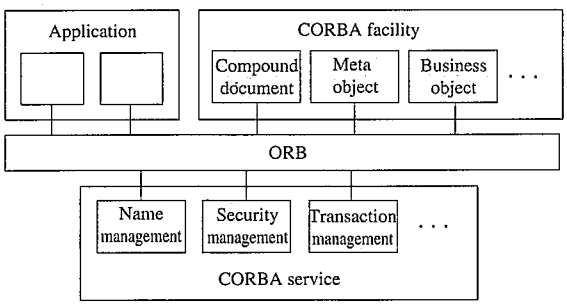

Fig. 3 Outline of CORBA

*1 ActiveX is a registered trademark of Microsoft Corporation in the U.S.A and other countries.
*2 CORBA (common object request broker architecture): International standard specifications for distributed object environment.
*3 Bus: Logical communication channel.
*4 Class object group: Object group commonly used by applications. Equivalent to a conventional subroutine.
*5 Application object: Object specialized in each application.
*6 DCOM (distributed component object model): Distributed object model advocated by Microsoft.

2.3 Multimedia application

On the network, not only data but also voices and images (still and moving pictures) are now transmitted generally. In the contents of WWW home pages, the use of multimedia*7 including music and moving pictures has progressed. It is only natural that a multimedia application imposes a high load on the network. Thus, speed must be increased still more. The network qualities (delay time, error rate, and so on) required of the network by multimedia are varied. Service quality (QOS: quality of service) must be provided according to each requested quality.

3. Speeding-up Technology

3.1 Collapsed backbone

In the past, FDDI, a 100Mbps looped type optical LAN, was the mainstream backbone. However, improvements in router*8 performance led to the appearance of a collapsed backbone as a speeding-up method, which uses a high-speed bus in the router as a backbone. **Fig. 4** illustrates its concept.

3.2 Switched network

A prototype of Ethernet*9 is a shared type LAN based on a common bus. A HUB internal bus is shared even in a star type 10BASE-T HUB based on a twisted pair cable. Thus, only one pair of communications is allowed simultaneously. It is a switching technology that has appeared as a speeding-up technology to solve such bottlenecks. According to the switching technology, multiple pairs of communication are allowed between opposing parties. In the example in **Fig. 5**, HUB has only a bandwidth of 10Mbps. But by using the switching technology, a bandwidth of 30Mbps at the maximum can be secured.

3.3 100M Ethernet

100M Ethernet (or fast Ethernet) is one provided by increasing only the speed to 100Mbps without making any changes in the Ethernet system of CSMA/CD*10. Almost all 100M Ethernet products are switched types. Moreover, to facilitate transfer from 10M to 100M in the client side, products that automatically identify interfaces with 10M/100M are mainly used as switched types.

3.4 Big pipe

Even if a high speed is attained for the network, there is still a bottleneck in the entrance of the server. A big pipe system has been developed to solve this bottleneck by increasing the speed so the server side can cope with the speed of the client side. **Fig. 6** shows an example of a big pipe that has increased the speed to 100Mbps for the server side while the speed for the client side is 10Mbps. In this example, since the speed for the server side is ten times as fast as that for the client side, the number of simultaneous accessings allowed to the server is ten at the maximum with no server bottlenecks.

3.5 ATM

ATM (asynchronous transfer mode) has appeared to deal with the multimedia network. In ATM, data is transferred in short units (cells) of 54 bytes based on a given priority. Accordingly, for data having strong realtime characteristics such as voices or moving pictures, a higher priority must be given to secure the necessary

*7 Use of multimedia: Not only data but also voices and images are included.
*8 Router: Device for relaying data in the network. Path for next transfer is selected based on an IP (Internet protocol) address and data is relayed.
*9 Ethernet is a registered trademark of Fuji Xerox Corporation.
*10 CSMA/CD: Carrier sense multiple access with collision detection. Access control method of Ethernet.

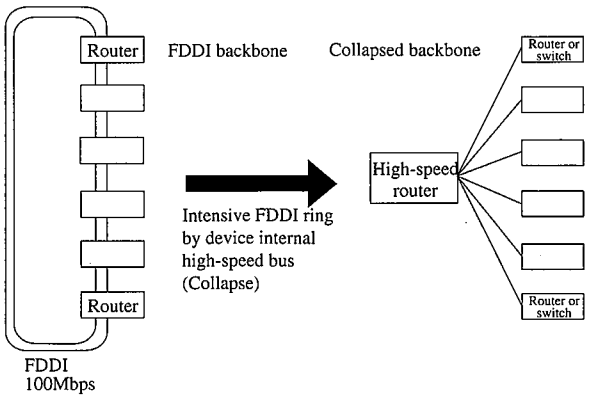

Fig. 4 Collapsed backbone

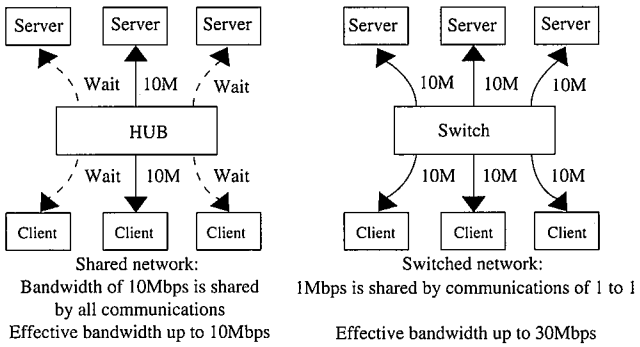

Fig. 5 Switched network

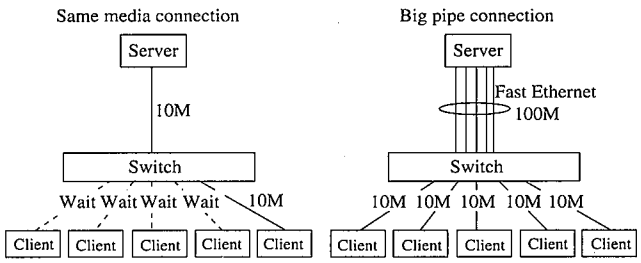

Fig. 6 Example of big pipe

bandwidth. A high speed of 155Mbps or 622Mbps is provided. Thus, ATM can also be used as a high-speed backbone.

3.6 Gigabit Ethernet

The latest in speeding-up technology is Gigabit Ethernet. Study for standard specifications is now under way by the IEEE802 Committee*11, and first specifications will be decided in the spring of 1998. **Table 1** shows the schedule of standardization work and **Fig. 7** illustrates the content of standardization.

Prior to standardization, a series of products have been presented based on individual specifications mostly by US venture corporations. These products have already been sold in the Japanese market. It is expected that Gigabit Ethernet may form a market of 1.2 billion dollars or more by the year 2000.

4. Reliability Technology

For technology to improve reliability, duplex devices or duplex networks have conventionally been used generally. However, in the case of the conventional method using a spanning tree*12 or RIP*13, even if a redundant path is secured, since recalculation for the redundant path takes 30 seconds to one minute or more, communication disconnection usually occurs. More advanced technology must be provided for construction of a so-called non-stop network that makes the terminal be unaware of any path changes. Here, as one method for constructing the non-stop network, HSRP (hot standby routing protocol) mounted in the router provided by Cisco Corp., is described. In HSRP, since path changing is completed in three seconds at the shortest, users can continue communications without being aware of the changes in connected devices.

Table 1 Standardization schedule of Gigabit Ethernet

Year/month	IEEE802.3z
November 1995	HSSG (high speed study group) organization
June 1996	PAR (project authorization request) approval
November 1996	Proposal deadline
January 1997	Compilation of Daft 1
March 1997	Compilation of Draft 2
July 1997	Compilation Draft 3 and working group vote
November 1997	Compilation of Draft 4 and sponsor vote
March 1998	IEEE Standard approval (Draft 5)

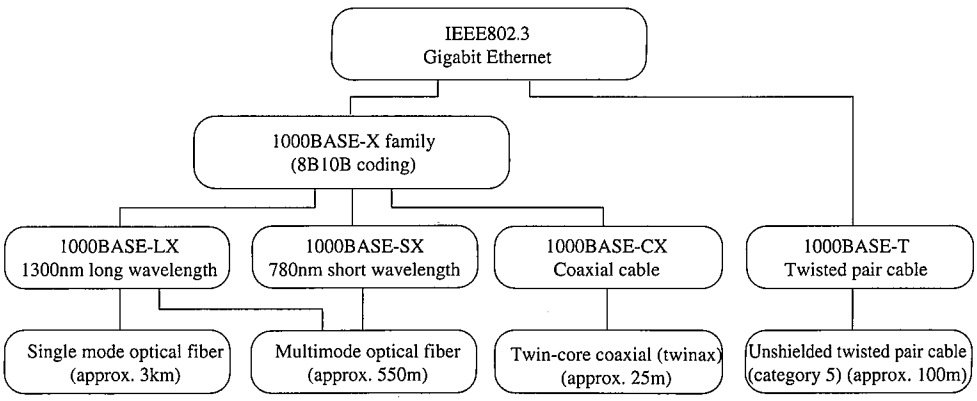

Fig. 7 Content of standardization of Gigabit Ethernet

*11 IEEE802 Committee: Project 802 of IEEE (Institute of Elictrical and Electronic Engineers). Engaged in LAN standardization.

*12 Spanning Tree: Protocol for changing, if damage occurs, a path by providing a redundant path for constructing a network.

*13 RIP: Routing information protocol. One of the routing protocols for exchanging routing information between routers.

HSRP creates other virtual routers by two or more routers (see **Fig. 8**). These virtual routers have IP addresses*14 and MAC addresses*15 different from those of existing routers. If communications' destinations are over the routers, the operation is performed by using the virtual routers. For communications addressed to the virtual routers, a sequence is set among the existing routers corresponding to those addressed to the virtual, and IP addresses and MAC addresses allocated to the virtual routers are taken over. The existing routers monitor each other's condition. If damage in the router highest in the installation order is detected, then the router second in the order takes over communications addressed to the virtual router. One to three seconds are usually set for a detecting time, and time of three times the detecting time is set for switching. The client can continue communications without changing any addresses of the routers. Accordingly, with no session breaks in most applications, communications can be continued with the speed of switching time.

5. Quality of Service

5.1 QOS of ATM

ATM includes a built-in function to provide service quality. **Table 2** shows a QOS category of ATM. CBR always secures a requested bandwidth and guarantees a cell loss ratio, cell transfer delay and cell delay variation. CBR is applied to realtime communications. VBR is a class for guaranteeing an average bandwidth although the bandwidth secured fluctuates with time. ABR is a class for sharing transmission bandwidth more efficiently in a network*16. ABR secures minimum bandwidth and cell loss ratio for users. UBR is based on extended consideration of existing LAN communications and thus no guarantee is made for quality. The user gives a necessary parameter when establishing a connection with the opposite party, selecting one from the foregoing category. In this way, ATM secures QOS necessary for each application.

5.2 RSVP (resource reservation protocol)

Standardization process is now under way by IETF (Internet engineering task force) for RSVP as a control protocol for securing

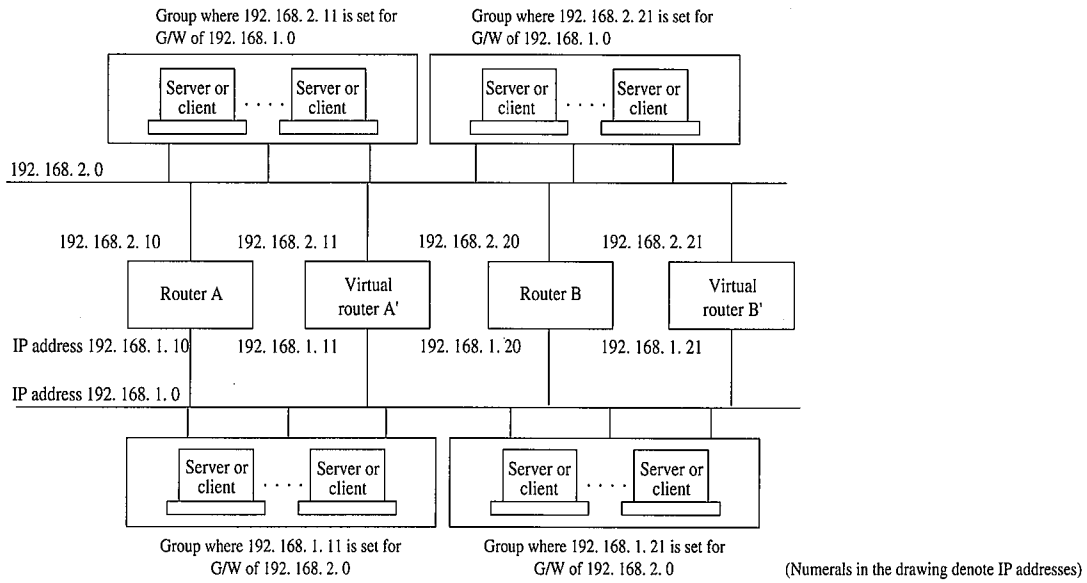

Fig. 8 HSRP by Cisco Corporation

Table 2 QOC category for ATM

	CBR (Constant bit rate)	VBR (Variable bit rate)	ABR (Available bit rate)	UBR (Unspecified bit rate))
[ATM service]				
AAL	1	2, 3 / 4, 5	3 / 4, 5	5
Traffic type	Voice/image	Voice/image, data	Data	Data
Flow control	No	No	Yes	No
[Traffic parameter]				
PCR (peak cell rate)	Declared by terminal	Declared by terminal	Declared by terminal	Declared by terminal
SCR (sustainable cell rate)	n/a	Declared by terminal	n/a	n/a
MCR (minimum cell rate)	n/a	n/a	Declared by terminal	n/a
[QOS parameter]				
CLR (cell loss rate)	Guaranteed by network	Guaranteed by network	Guaranteed by network	n/a
CTD (cell transfer delay)	Guaranteed by network	Guaranteed by network	n/a	n/a
CDV (cell delay variation)	Guaranteed by network	Guaranteed by network	n/a	n/a

n/a: no account

*14 IP Address: Address in IP as protocol for a network layer.
*15 MAC Address: Address in a MAC (media access control) layer.
*16 Network: Service unit for providing communication services to users. For example, telephone network, packet network, frame relay network and ATM network.

resources on an IP network*17. RSVP is a control protocol for supplementing IP placed in the same position as ICMP (Internet control message protocol)*18. **Fig. 9** illustrates the control procedure of RSVP.

A transmission terminal transmits a PATH message to a receiving terminal. An intermediate router relays the PATH message. The receiving terminal requests resource securing by means of an RESV message. The router may report the success/failure of resource securing by means of an RESV CONFIRM message (option). The RESV message contains information such as FlowSpec indicating communication quality. In RSVP, resource securing is continued by cyclically re-sending an RESV message from the receiving terminal side. Resource release is performed by re-sending time-out of the RESV message or transmission of RESV TEAR message. RSVP is a protocol for requesting an IP layer or a datalink layer to secure resources. RSVP does not secure or control resources by itself. Thus, even if RSVP is mounted in a shared type LAN like Ethernet, it is impossible to assure quality.

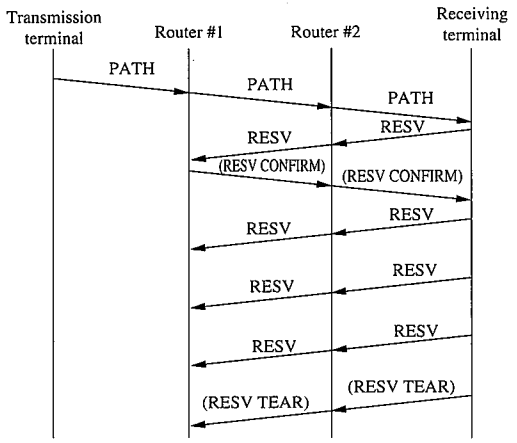

Fig. 9 Control procedure for RSVP

6. Future Development

As network computing centered on distributed object technology is established, there may be increased demand for higher speed networks, improvement of reliability and securing of service quality. For the speed increase, Gigabit Ethernet will be used generally, and a much higher-speed technology may be developed. For reliability, a technology centered on the use of a duplex device like HSRP available from Cisco Corp., along the line of the non-stop network, may be developed. For service quality, protocols for multimedia communications have been presented one after the other: for example, ST2 (Internet stream protocol, Version 2) and RTSP (real time streaming protocol). These protocols are attracting attention together with the future practical use of QOS of ATM and RSVP.

This paper has not described operations management or security, but these technologies will also be important in the future. With the increase in the importance of networks and process complexity and variety as represented by the use of duplex devices and the provision of service quality, the importance of operations management will no doubt increase. At present, various types of operations management tools are available. However, most of these types have not been developed from the standpoint of operations administrators and thus do not prove to be handy. Efforts must be made to provide tools for integrating network management and system administration together and efficiently monitoring and managing the entire system. Even if good management tools are provided, these tools will be useless without the knowhow of an operating management system or a managing method for handling it.

Security is necessary when connected to Extranet or Internet. In addition, it is expected that individual authentication and ciphering will be requested for remote accessing to a company LAN from the outside and accessing from a LAN connected terminal. A security technology includes firewall, Certificate Authority, a certificate server and a one-time password, and many products have already been presented. At present, firewalls are most generally used in internet connections. But the other products will also be generally used sooner or later. Thus, development must be constantly watched.

7. Conclusion

This paper has described the trend and future development of a network technology toward the network computing era. Nippon Steel Corp. will make continued efforts to develop its network integration business for end users based on the latest technology.

*17 IP Network: Network using IP as protocol for a network layer.

*18 ICMP: Internet control message protocol. There is no guarantee that IP surely carries information. Thus, ICMP is provided as a control protocol for supplementing IP, and errors are reported during transmission, and a network diagnosing method is provided.