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Construction of model for performance comparison between SNA and TCP/IP in computer network communication

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Abstract. TCP/IP is known as a communication protocol. SNA is the exclusive network framework developed by IBM. The industry's analysis of TCP/IP and SNA is almost saturated, but there are no corresponding laboratory data to compare the performance of the two in multiple scenarios. In this paper, the transmission protocols of TCP/IP and SNA were studied. IBM was used to achieve the SNA network construction process, as well as a simple end-to-end network and multi-client network were designed. On this basis, a multi-client network context was proposed and used to test two parties, and simple end-to-end network and multi-client network were implemented. On the basis of this, the test comparison in different conversation situations was carried out. Practice has proved that TCP/IP has better transmission efficiency, and SNA can guarantee fairness better.

Key words. TCP/IP, SNA, performance comparison.

1. Introduction

Computer network communication combines computer technology with communication technology and designs data communication mode according to requirements [1]. Computer network communications can connect hosts, terminals and other network devices located in different regions. Combined with the application software corresponding to the host, a complete communication system is formed. The resource sharing in the system is realized through this communication system [2]. TCP/IP is known as a communications protocol that replaced the old network control protocol in 1983 and becomes the cornerstone of the Internet in twenty-first Century [3]. In the middle of the 90s of the last century, TCP/IP began to flourish. Today, TCP/IP has become the mainstream of computer network communication, and has a decisive position [4]. TCP/IP is a layered communication protocol, which consists of four layers and they are application layer, transport layer, network layer and network interface layer [5].

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SNA is the proprietary network framework of IBM, and is widely used in IBM host environment [6]. SNA is the major networking protocol of IBM's large and medium-sized machines, and is a large group of network protocol and standard, which contains configuration in IBM mainframe network environment and managing system resource services [7]. The reason why SNA is concerned is that SNA appears earlier than OSI. As early as the 70s of last century, the proprietary network architecture has been widely used [8]. Initially, a single host is designed to connect to the terminal. As technology matures, multi host communications are allowed until SNA joins and supports LAN and any topology [9]. The SNA network includes both the physical part and software part. The physical part consists of a processor, a communication controller and a terminal controller. The software part includes access mode, application subsystem, user application program and network control program [10].

2. State of the art

The development route of TCP/IP has a great relationship with the development track of internet. Since 1960, American Gordon research network began to sprout, which was the rudiment of international network. The advanced research planning network begins with experimental packet switching system linking computers and slowly transitions to the host to host network control protocol by using master-slave architecture. As early as the beginning of the Internet development, the demand for network interconnection based on different protocols has been paid attention, and the development of network connection technology is on the rise. Network connection technology has been developing very rapidly in the past few decades, which makes it easy and fast for users to access resources and information. But at the same time, there is a difficult problem. Problems can arise when integrating different types of networks. Therefore, people need to solve them through open protocols and public applications. Subsequently, the TCP protocol is invented. Until the late 70s of the last century, TCP development was basically completed.

SNA was created in the 70s of last century and was widely used in IBM host environment. In order to provide inter procedural communication, IBM introduces APPCAPPC which is a high-level program for program communication. In order to combat the threat of TCP/IP, IBM then introduces an advanced peer-to-peer network. This peer to peer network is regarded as the second generation SNA network, which is named APPN. The presence of APPN ensures the diversity of host systems. At the same time, APPN can provide enterprises with a non-centralized network computing [14]. Peer-to-peer operations of large and small systems can be completed on the APPN network and IBM' strategies are embodied clearly in the networking program. That is to say, the inclusive industry standard protocols such as TCP/IP continue to support APPN, but SNA is still at a disadvantage in the competition between SNA and TCP/IP.

3. Methodology

3.1. TCP/IP network building

In order to compare the overall performance of the SNA and the TCP/IP in the practical application, a series of different end-to-end network scenario tests were designed in this paper and they were discussed from multiple perspectives, so as to choose the protocol with better performance to use. The hierarchical communication protocol for TCP/IP is shown in Table 1. In the TCP/IP hierarchical model, the lower layer is the upper layer structure service, and it can provide additional function for the upper layer structure. But each layer is usually communication with the peer layers in the remote computer. For example, the network layer is responsible for forwarding data to the computer in the best way and providing services to the transport layer. The TCP transport layer communicates with the TCP peer layer of the remote computing when processing congestion control and stream control. By collaboration, the two TCP transport layers provide service for the application layer.

Table 1. Layered list of TCP/IP

Application layer	FTP, Telnet, DNS, SMTP, HTTP, ...
Transport layer	TCP, UDP
Network layer	IP, ICMP, IGMP, ARP, ...
Network interface layer	LAN, X25, SNA, ATM

The TCP/IP transport layer protocol serves each task and another process communication. The port number is 16 bits. The host to host protocol is used to identify the protocol, and the incoming message must be forwarded to high-level protocol or application program. However, these high-level application programs such as Telnet and FTP are protocols in the TCP/IP tables. So it is needed to use the same port in your implementation. The port with number 23 is used for Telnet and port with number 20 is used for FTP. Ports that have been assigned port numbers are called well-known ports. In order to avoid two different applications by using the same port number of a host, when applications are written, they can get a usable port by sending a request to the TCP/IP. However, the port assigned is dynamic, so the port numbers that are called each time are not the same. Ports used by UDP and TCP are interlinked. A socket is a special type of file handle that is requested by a process from the operating system. In other words, sockets are used for naming and addressing in the network, and are used in communication terminal nodes. UDP is the application interface to IP, which is shown in Fig. 1. UDP does not provide additional possibilities, flow control, and congestion control. It can only send or receive IP data as a multiplexed signal multiplexer, and use the port to forward datagrams.

TCP cannot recognize data patterns in any application. It can only write data to a byte stream of the TCP window cache as the sending application program.

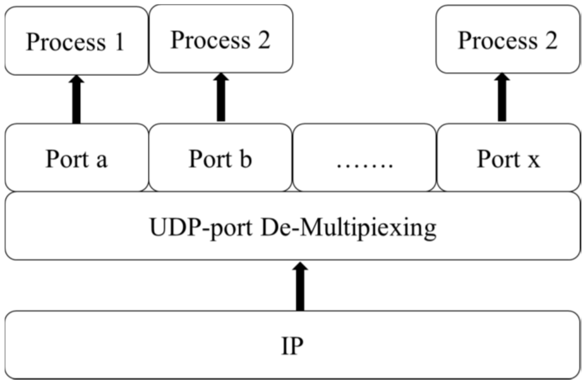

Fig. 1. UDP-based multi-channel signal resolution

TCP uses the three-grip technique to establish the connection, and the TCP data sequences sent are shown in Fig. 2. The network node A initiates the TCP link and executes the CONNECT primitive. The specified parameters are as follows: destination IP address and port, MSS received and other TCP optional parameters. These parameters are waiting for reply. When the network node B receives the SUN, it replies SYN and ACK. The TCP option corresponds only to the TCP optional parameter sent by the node A. After the network node A receives the SYN and ACK, it replies the ACK segment to the network node B and confirms it at the network node B. The TCP connection is completed.

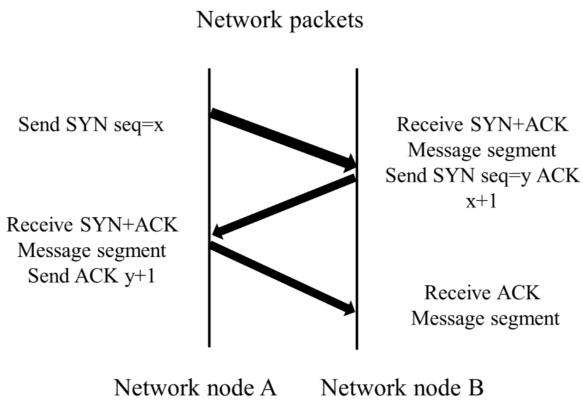

Fig. 2. Simple connection process of TCP

3.2. SNA network construction

SNA is a network architecture developed by IBM, including a large set of network standards and protocols. SNA defines a centralized architecture of mainframe and control terminals that is applied to the IBM host environment. SNA has received extensive attention because SNA appears very early. It not only defines the logical structure of the data communication network, and describes network configuration to control the network cyber source, information transmission and other operation orders. The SNA network includes the physical part and software part. The purpose of designing SNA is end-to-end communication, which allows users to pass the complex data communication system through the application so that users can feel the head shape of the communication system. SNA has 7 protocol layers, including transaction service layer, indicates service layer, data flow control layer, transmission control layer, path control layer and data link control layer as well as physical layer, which is shown in Fig. 3.

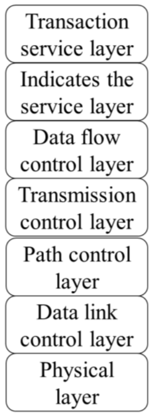

Fig. 3. Seven-tier structure of SNA

The APPN architecture has a number of features. Among them, three important basic characteristics form the basic functions of APPN. These three basic characteristics are the transport group, the network addressable unit and the address and session identifier. An array is a link between APPN nodes, and the underlying APPN schema can only support single link arrays. A network addressing unit is any part that can establish sessions with corresponding components in APPN environment, such as control nodes and logical units. Addressing and session identifiers play a very important role in session management and routing. In traditional SNA subarear, each resource is assigned a unique network element. In the APPN environment, routing information is session oriented. The address selected by the APPN transmission head is one to one. The address used by the HPR/IP transport header contains not only the HPR session identifier, but also the IP address involved in the terminal node.

Enterprise extender is based on the implementation of SNA over ATM. Among them, the UDP port identifies the destination of the datagram. IP implements the routing function as a UDP host. The mapping to the UDP port number is the SNA transport priority. Because many IP routers can be configured to the data flow of Venus line according to the port number, the five UDP ports have been registered for EE use, which is also called the enterprise expander use. Table 2 shows the correspondence among the APPN priority, the IP preamble and the UDP port number.

Table 2. APPN priority, IP precedence and UDP port number

APPN priority, IP precedence and UDP port number		
N/A	B’llO’	12000
Network	B’llO’	12001
High	B’lOO’	12002
Medium	B’OlO’	12003
Low	B’OOl’	12004

4. Result analysis and discussion

4.1. Simple end-to-end network testing

Sensitivities of applications program to operating systems and host performance are considered. This creates errors and affects data results. Therefore, several hosts with the same configuration and installed Windows 2003 server operating system at the same time are selected as the test system in this paper. The windows platform integrates the TCP/IP protocol. The SNA network still relies on the IBM communications server for windows installation to achieve communications server for windows fully supporting APPN, HPR and DLUR functions, and provides a full set of enterprise network solutions. Users can achieve a variety of ways to connect through the system. Because Windows NT has only one TCP/IP protocol, and only one EE port can be defined. Therefore, defining the EE process is relatively simple in the CS for OS/390 process. First of all, SNA node Configuration is initiated to create a new configuration file and then create nodes. Nodes are virtually invisible in the APPN network environment, which is similar to the hosts in the TCP/IP network.

The fully qualified control node name consists of two parts. One part is the NETID of the SNA network and the other is the server. The control node name in the SNA network is unique. The name of the control node in the same NETID network can’t be repeated. Moreover, the control node is unique in the APPN network. This uniqueness is similar to the host naming of the TCP/IP network. Another point to note is that CP alias, which is the alias of the control node. Typically, the terminal nodes participating in the SNA network are IBM communication server for windows. But sometimes it can be set as terminal node. For example, when there is no need to route SNA sessions in actual applications, nodes should be set to terminal nodes.

Cstest is defined as server and scwin35 is defined as client. The following tests are designed in this paper. File FTP transfer test is carried out between server and client nodes and connections are established. When the server sends data to the client, the connection is closed after the end of the transmission. Measuring time is the total time to establish connection and disconnect and file transfer time. In addition, socket buffers received and sent by FTP are the SNA MODE setting of

2048 bytes. The result is shown in Fig. 4.

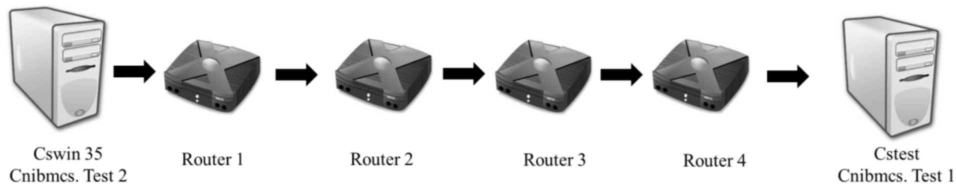

Fig. 4. Simple end-to-end network

The test uses 500MB's large file for transmission, which is designed to avoid interference from broadcast traffic in the network and to facilitate the distinction between results. It is found that large file transfer has higher transmission rate in TCP/IP protocol in single process. Moreover, the average transmission rate is nearly 50 % higher than the RTP transmission rate. Therefore, the gap between the two is very obvious. In addition, the TCP/IP protocol can be transmitted quickly at the beginning of the link. It can also be maintained at a higher transmission rate during transmission, so flow control of TCP based on sliding window can be implemented. At the same time, data can be sent at any point. TCP/IP peer to peer window design is to provide traffic control for the receiver. The window is designed to receive the data range of the byte stream allowed by the other party, but it can only send bytes in the byte stream within the window.

In order to indicate the size of the receiving port, the TCP/IP Baotou contains window fields 16 bits. When the receiver receives the data, sending the ACK indicates that the receiver has successfully received the byte. When the maximum receive window is filled, the sending end must stop sending data.

4.2. Multi-client network analysis

In a multi-session file transfer scenario, the TCP/IP protocol connection can transmit data at a higher rate. As a result, the TCP/IP protocol can still hold the edge in multi session file transmission. However, the network stability will decrease with the increase of session, which will lead to a decrease in the quality of the service. In the RTP connection, the speed drops as each session transfers speed begins. However, the relative balance is maintained, so the network stability is very good and will not be affected by the increase in the number of sessions. The session in the TCP/IP protocol corresponds to a TCP connection, and a number of TCP connections are established from the same end to the end path, which can not only improve the utilization of broadband networks, but also increase the speed of network transmission. At the same time, the number of TCP connections can be optimized so that the network can reach the highest transmission speed. GridFTP-APT algorithm explains the relationship between broadband and connection numbers and buffers, as well as link bottleneck bandwidth and round trip time. This relationship can be expressed by the following formula

$$G = \min\left(\frac{NW}{R}, \frac{N(1-p*)}{2R}\left(-3+\frac{\sqrt{6+21p*}}{\sqrt{p*}}\right)\right), \tag{1}$$

where

$$p* = \left(-2+\frac{2BR}{N}+\frac{2}{3}\left(\frac{BR}{N}\right)^2\right)^{-1}. \tag{2}$$

Here, N represents the number of TCP connections and W represents the size of the TCP connection socket buffer. Symbol B represents link bottleneck bandwidth and R represents the round-trip time of the TCP link. As the number of TCP connections increases, the system bandwidth increases. When the connection is too large, the system bandwidth drops.

After each server of the client node establish a link, the server starts sending data to the client. When the transfer is finished, the connection is closed. Test time is the sum of the time to establish connection and disconnection, and the time of file transfers. The transmission file size is 500 MB. The socket buffer received and sent of FTP is 2048 bytes, which corresponds to the SNA MODE design.

Table 3. The results of two client transfers

TCP	timel (s)	speed l (Kbytes/s)	time2 (s)	speed 2 (Kbytes/s)
1	23.15	21294. 95	23.25	21686. 63
2	22.79	21747.08	22.50	22222. 89
3	23. 25	21702.35	23. 29	21686. 63
4	22.39	22350.47	22. 49	22222.59
5	22.57	21872. 7	22.39	21030. 44
rtp	timel (s)	speed l (Kbytes/s)	time2 (s)	speed 2 (Kbytes/s)
1	52.53	9142. 88	53.39	9156. 89
2	53. 49	9119.97	53. 79	9165. 10
3	52. 79	9112.80	54.15	9164. 29
4	53.17	9150. 57	53.29	9183. 32
5	54. 13	9167. 86	54. 28	9103. 44

When the TCP/IP protocol is used in multi-client transmission, there is no obvious change in the transmission time. The SNA protocol shortens the data transmission time, so that the transmission efficiency has been greatly improved. And in the multi-client scenario, the total bandwidth of the TCP does not change, and server throughput is unchanged. Therefore, the performance changes are not obvious. However, the RTP process has changed. Unlike multiple sessions reusing the same RTP connection from single end to end networks, the RTP sets up separate RTP connections for each client's FTP session.

In summary, TCP maintains high transmission efficiency in the multi-client scenario. However, with the increase of data transmission, the TCP protocol cannot solve the problem of link fairness. The existence of this problem will lead to a sudden instability in the network, and higher bandwidth will increase the burden on the network. Practical tests show that servers in TCP/IP networks consume more resources and affect the overall network speed. In the multi-client scene, the transmission rate of the SNA protocol is slow, but it takes into account the fairness. Therefore, the stability of the transmission data stream can still be maintained.

5. Conclusion

Computer network communication is a new communication type. It combines computer technology with communication technology to meet the needs of data communication. In this paper, the development status of SNA and TCP/IP were introduced, and the transport layer of TCP/IP protocol and the network structure of SNA were expounded. The theoretical comparison between the two protocols was made and tests under different session scenarios were carried out. According to the performance of the two networks, the performance of the main transport protocols in TCP/IP and SNA networks was compared. It is found through the test that with the complexity of the application scene and the influences from external factors, network instability and other factors, the number of TCP connections increases and is at a very fast rate, which leads to worse network performance and worse serious deterioration. The ARB flow control and session connected by RTP can independently adjust and execute commands independently. They do not affect each other. As a result, SNA networks can remain stable, so TCP/IP has better transmission efficiency and SNA could better guarantee fairness. However, affected by objective factors such as experimental conditions, complex topologies are not designed in this paper. In simple networks, routing performance is not adequately represented. Therefore, further research on network routing performance can be carried out.

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