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TDX-10 패킷처리기의 성능측정을 위한 트래픽발생기의 설계

(Traffic Generator for Performance Test of the TDX-10 Packet Handler)

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요 약

ISDN 서비스를 실현하기위한 중요한 기능중 패킷교환기능은 TDX-10에서 개발중에 있으며, 이는 CCITT 권고안 X.31의 Case B를 근거로 한다. 패킷교환의 기본기능 개발 완료후 요구된 성능목표치를 만족하는지 점검되어야 하는데, 일반적으로 전부화 상대하에서 성능 측정을 수행할 수 있는 시험환경구축은 매우 어렵다.

본 논고에서는 전부하 상태하에서 TDX-10 패킷처리기의 성능시험을 할 수 있도록 기존에 사용된 하드에어 시스템의 변경없이 소프트웨어 프로그램만 변경하여 트래픽발생기의 설계를 제시하였다.

Abstract

Packet switching is an important aspect of ISDN. In the TDX-10 switching system, which is being developed as an ISDN exchange in Korea, the packet switching function is implemented on the basis of Case B scenario of X.31. After implementing the packet switching function the performance test must be executed to check whether the design objectives of performance are satisfied or not. However, it is not easy to set up test environment for performance measurement under full load conditions.

This paper presents the design of the traffic generator which enables us to do performance test of the TDX-10 packet handler under full load conditions. To generate packet traffic we change only software programs without any change of the hardware system of the packet handler.

I. Introduction

For a number of applications packet switching has clear advantages, especially flexible bandwidth allocation and multiple simultaneous use of the same physical channel by virtual connections. For these reasons the introduction of packet switching into Integrated Services Digital Network(ISDN) is well understandable. recommendation X.31 a pragmatic approach has been defined for packet switching in ISDN. This approach allows to use existing X.25 terminal equipments and protocols.

To support existing X.25 packet terminals accessing the ISDN, X.31 describes two

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scenarios according to the place the packet handler is and the method to access the packet handler, Case A and Case B. In Case A, ISDN provides the X.25 packet terminal with access to a Public Switched Packet Data Network (PSPDN).

Therefore PSPDN makes an offer the X.25 packet terminal ISDN packet service through the ISDN circuit path. In Case B, the packet handler can be located in a local ISDN exchange or a remote exchange.

ISDN provides access to the packet handler for packet data on B-channel and D-channel. D-channel supports the transport of low speed packet data and also the signaling information for the establishment of the telecommunication path between the terminal and the packet handler. But B-channel supports the transport of high speed packet data in general.

In the TDX-10 switching system, which is being developed as an ISDN exchange in Korea, the packet switching function is implemented on the basis of Case B of X.31 in order to provide the maximum functionality and enhanced capabilities of ISDN. This approach allows the TDX-10 to offer a wide range of ISDN packet services.

After implementing the packet switching function the performance test must be executed to check whether the design objectives of performance are satisfied or not. However, it is not easy to set up test environment for performance measurement. Particularly, it is very hard to do the performance test under full load conditions.

In this paper, we present the design of the traffic generator which enables us to the performance test of the TDX-10 packet handler under full load conditions from the point of traffic view. In order to generate packet traffic to the TDX-10 packet handler we change only software programs without any change of the hardware system. This traffic generator can be used to measure the packet call processing capacity and the data handling capacity of the TDX-10 packet handler. In the subsequent section, the traffic generator configuration related to the architecture of the TDX-10 packet handler is explained.

Section 3 describes the design method and the specification of the traffic generator. Some results of the performance measurement are given in section 4. Finally, we give the conclusion of this paper.

II. Traffic Generator Configuration

1. TDX-10 Packet Handler

The packet switching function in the TDX-10 system is provided according to Case B scenario of X.31. Fig. 1 shows the TDX-10 subsystems that are related to integrated packet handling. For complete packet switching functions, a new the ASS_P is introduced. The ASS_P has function-centralized capability for packet switching, which means that all packet traffics are concentrated to the ASS_P and handled by the ASS_P.

Besides common equipments of the ASS, the ASS_P contains the Packet Handling Subsystem(PHS), which performs layer 2 and layer 3 functions of packet protocols. It is composed of Packet Layer Control Processor(PLCP), Packet Handling Module (PHM) and Packet Bus(PBUS). There are several types of PHMs according to the functions. The PHM_B and PHM_P process packets transferred through B-channel and a PSPDN respectively. Up to 8 DTEs can be connected to a PHM_B, abbreviated as PHM in this paper, which processes B-channel packet switching in TDX-10 packet handler. The ASS_P is to be designed with the following objectives of capacity: for 25,000 ISDN subscribers, the packet call handling capacity is 210,000 packet calls per hour and the data packet handling capacity is 1,700 data packets per second on the condition that the number of PLCP is 4 and the number of PHM is 120 according to the TDX-10 ISDN general requirement.

2. Test Environment for Traffic Generator

After implementing the packet switching function the performance test must be executed to check whether the design objectives of performance are satisfied or not. However, it is not easy to set up test environment which enables us to do performance measurement under full load conditions from the point of traffic view. In order to solve this problem we design the Traffic Generator(TG) which can generate packet traffic to the TDX-10 packet handler.

The TG, which is designed to measure performance under full load conditions, consists of the same hardware of PHM and the modified PHM application programs. In other words, for a PHM to be used as a traffic generator, the application programs only loaded on the PHM are modified without changing PHM hardware. This TG can be operated as a DTE when the softwares related to X.25 protocol are loaded on a PHM_B, or as a STE when the softwares related to X.75 protocol are loaded on a PHM_P. The TG can be connected to PHMs through the T-switch which is located in the ASS_P.

The overall configuration of the test environments which consist of the TG and the packet handler is shown in Fig. 2. As shown in the figure, the application programs loaded on PLCP and PHM loaded on the ASS_P are not changed. But those loaded on the ASP_P are changed a little after forming the test environment using the TG and because of carrying out the following functions:

- connect the T-switch through the intra-junctor in the ASS_P between the TG and

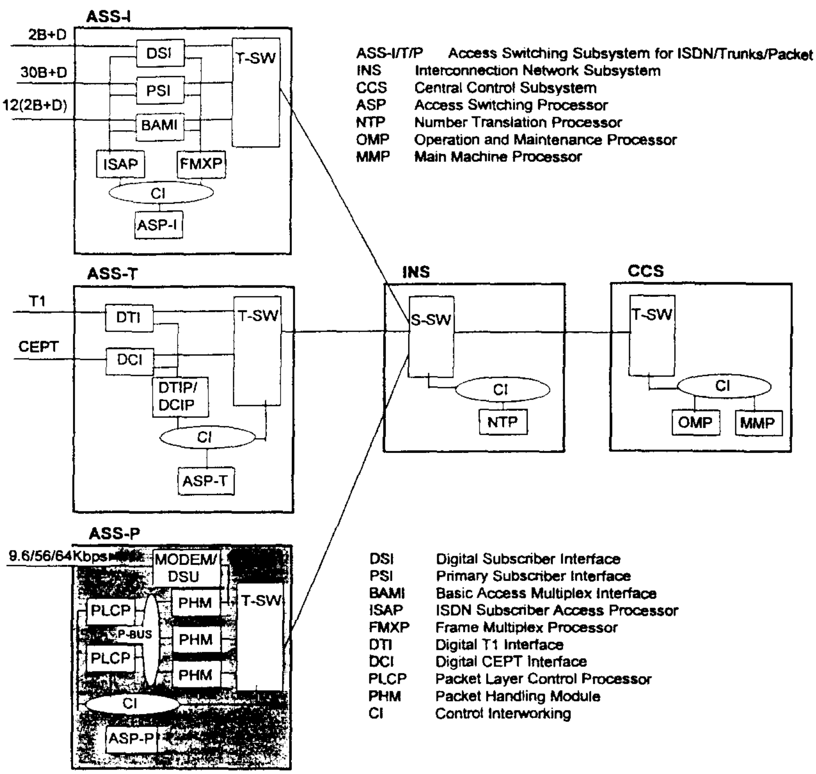

그림 1. TDX-10 교환시스템에서 패킷교환구조
Fig. 1. Packet swityching in TDX-10 switching system.

the PHM_B.

- send the initial signal which means the connection of the physical path through the intra-junctor to the originating PLCP. The PLCP can analyze the Call Request(CR) packet received from the TG via PHM_B as if received from the DTE because of making the originating process after receiving the initial signal from the ASP_P.
- do not drive the user-network protocol (Q.921, Q.931) because of having already connected the physical path under the support of the ASP_P software.
- choose the terminating PHM and the link by translating the called address of the CR packet because the called address consists of the number of a PHM and the link connected to the PHM.

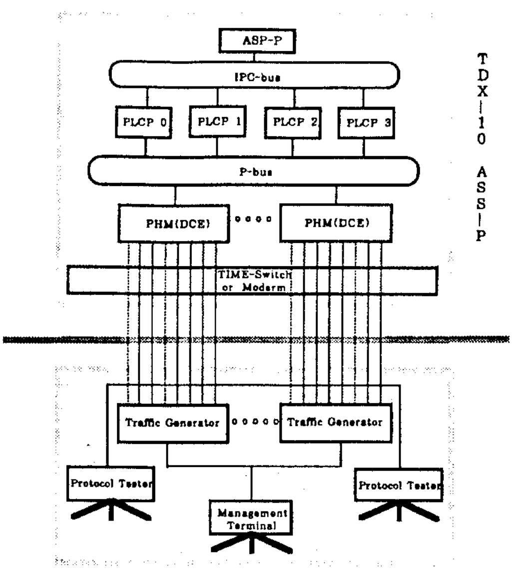

그림 2. 트래픽 발생기의 시험환경
Fig.2 Test environment of traffic generator.

III. Design of Traffic Generator

The software of the TG is operated as monoprocess-like as the application software loaded on the PHMs. Since the hardware of the TG is the same as one of the PHM, X.25 link layer functions are processed in the VLSI chip. However, the TG has simpler software structure for processing Packet Layer Protocol(PLP), comparing with the software loaded on the PHM.

The main software of the TG can be activated by receiving the command from the operator or X.25 link layer information from the PHM_B. The software of the TG consists of Operating System(OS) and the application program. OS is the same as Packet Handler OS(PHOS) used for PHM and the application program is designed once more for the purpose of the TG. The application program has several tasks driven by an event received from the PHM and the operator command received from the MT, handling the subscriber information and X.25 protocol.

1. Task Processing

Tasks driven by an event received from the PHM are concerned with link management related to the link layer and the virtual call management related to the PLP. The link layer management starts from the link establishment and disconnection between the TG and the PHM. The virtual call management is handled according to the X.25 state machines and the procedures. The task on the PLP is driven by a packet received from the PHM. Tasks driven by the operator command received from the TG are classified into two kinds: subscriber information output task related to displaying Lowest Outgoing Channel(LOC), Lowest Incomming Channel (LIC), Highest Outgoing Channel(HOC), Highest Incomming Channel(HIC), packet size, window size and state of a virtual call on a link connected to the PHM on the MT handled by the operator, and internal task related to the traffic generation degree and gathering of the test result. These tasks are carried out on a virtual call by operator commands explained at the following section.

2. Operator Commands

The following commands can be used to do performance test using the TG.

The similar functions are carried out among CALL SETUP_DATA, THROUGHPUT and CALL_PRO command. In case of CALL_SETUP_DATA command, after the call is set up, the number of the finite data packet (e.g :22 data packet) is sent and the call is cleared. The TG carries out this job continuously till the command is canceled.

표 1. 트래픽발생기에서 운영자명령어의 종류
Table 1. Operator commands for TG.

Command	Purpose
CALL_SETUP_DATA	throughput and call processing capability measu rementrecommended in TDX-10 requirement for packet handler
CALL_PRO	call processing capability measurement only
THROUGHPUT	throughput measurement only
STATISTICS	display of the test result
TIME	display of time unit for thetest

The TG sends the data packet continuously after the data transfer state over the established virtual call in case of THROUGHPUT. In case of CALL_PROC command, The TG tests the call processing capacity till the command is canceled. The established call is cleared directly without sending a data packet after the data transfer state. TIME command means the time unit to measure the call processing capacity and the throughput. STATISTICS command is used for measuring throughput, total tried calls or total successful calls per time unit as the response to the input command such as CALL_SETUP _DATA, THROUGHPUT and CALL_PRO.

3. X.25 Protocol Processing

X.25 protocol processing is concerned with link layer and packet layer at the aspect of the software development. X.25 link layer functions are processed in the VLSI chip and the packet layer functions are processed based on PLP state machines and procedures. X.25 PLP state adapted for the TG are classified into three kinds: "p" state consisted of p1, p2, p4 and p6 related to call set-up, data transfer and call clearing, "d" state consisted of d1 and d2 related to reset and "r" state consisted of r1 and r2 related to restart.

Every virtual circuit tries to set up a call after CALL_SETUP_DATA, THROUGHPUT or CALL_PRO commands. If the TG receives the CALL_SETUP_DATA command from the MT, the TG set up a link layer and then send a CR packet to the PHM_B. At this time if the TG receives a Call Connected(CC) packet from the PHM_B, the call state enters into the data transfer state. In case of receiving the CALL_PROC command from the MT, the TG sends a Clear Request(CLR) packet without sending data packet after call set-up.

In the data transfer state, the TG sends the data packet every 100ms continuously. The TG regulates flow control with PHM_B according to the window mechanism recommended in X.25. For window flow control two types of mechanism may be considered: sliding window flow control related to the acknowledgement every receiving packet and ack-at-end window flow control related to the acknowledgement at the window end.

The TG adapts the ack-at-end window flow control. Therefore the TG send a Receive Ready(RR) packet to the PHM_B at the end of the window in case of the the receiving data packet. If there is a data packet to be sent to the PHM_B, the TG adapts the piggy-back method.

4. Statistics Calculation

When the TG generates the CR packet, the address scheme used is dependent upon the PHM number and the link number connected to the PHM. The number of the virtual call occurred simultaneously on a link is restricted to 10. The Management Terminal(MT) can be used for loading the TG program to the PHM. The main routine of the TG is waiting for an event from the operator or the PHM_B. When the TG is operated after receiving the command from the operator, the test menus are displayed on the MT.

When the TG receives an event from the PHM_B, the TG sends the response to the PHM_B. Every time the call set-up is tried, the number of the trial calls is incremented by one. If the tried call is set up successfully, the number of the successful call is incremented by one. After the call is set up, the data packet can be sent to the PHM using the same format given in X.25. The statistics of the data packet processing can be obtained by the same method explained above. Every time a data packet is sent, the sending number of the data packet is incremented by one. At the receiving side of the TG, the receiving number of the data packet is incremented by one after receiving the data packet.

At the every time period given as TIME command, the call processing capacity and the data packet processing capacity are calculated. The moving average concept is chosen as a method calculating the data packet processing capacity or the packet call processing capacity. The data packet processing capacity and the packet call processing capacity are calculated as follows:

$$S((k+1)T) = (S(kT) + m(kT))/2, k \geq 2$$

$$S(2T) = m(T)$$

Where S(kT) and m(kT) are statistics and measurement value during the interval between (k-1)T and kT.

Ⅳ. Performance Results

Generally there can be many performance parameters to be done for the packet switching function. The performance measurement is being carried out by using the TG. At this time, we concentrated on obtaining the throughput of a PHM. For measuring the throughput of a PHM, the TG chooses the data packet size as 128 bytes and the window size as 2 according to the default flow control parameters of the CCITT X.25 recommendation and generates a data packet every 100ms during the data transfer state. Under this test condition, the throughput of a PHM is shown in Fig. 3. As shown in this figure, the horizontal axis means that there can be maximum number of virtual calls a PHM regardless of the number of links connected to the PHM. The vertical axis indicates the throughput of a PHM which means the data packet processing capacity per second. The throughput of a PHM is proportional to the number of the virtual calls at first and then increased slowly as the number of the virtual calls are increased.

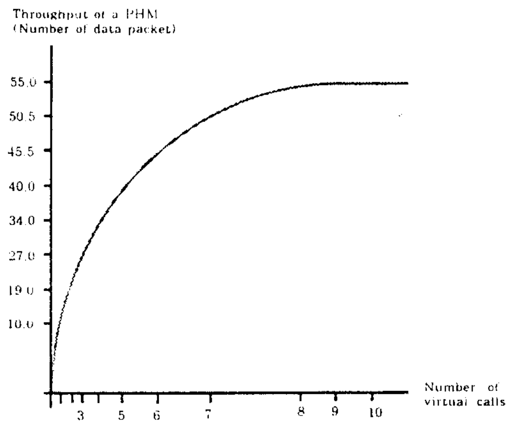

그림 3. PHM의 처리량
Fig. 3 Throughput of a PHM.

We observed the result that the throughput is not increased any more when the TG generates data packets for 8 virtual calls and obtained that the throughput of a PHM is about 55 data packets per second. The fact that the throughput of a PHM is 55 data packets per second satisfies the TDX-10 ISDN general requirement as the data packet handling capacity is 1,700 data packets per second in case the number of PHM is 120. For the packet call processing capacity of the TDX-10 packet handler, the performance test is ongoing now.

Ⅴ. Conclusion

In order to provide the maximum

functionality and enhanced capabilities of ISDN, packet switching function has been implemented in the TDX-10 system. After implementing the packet switching function we must execute thorough performance test. This paper presents the design of the traffic generator which enables us to generate packet traffic to the TDX-10 packet handler for thorough performance tests and a throughput of a PHM of which do the processing of the data packet. The result of the test satisfies the TDX-10 ISDN general requirement.

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