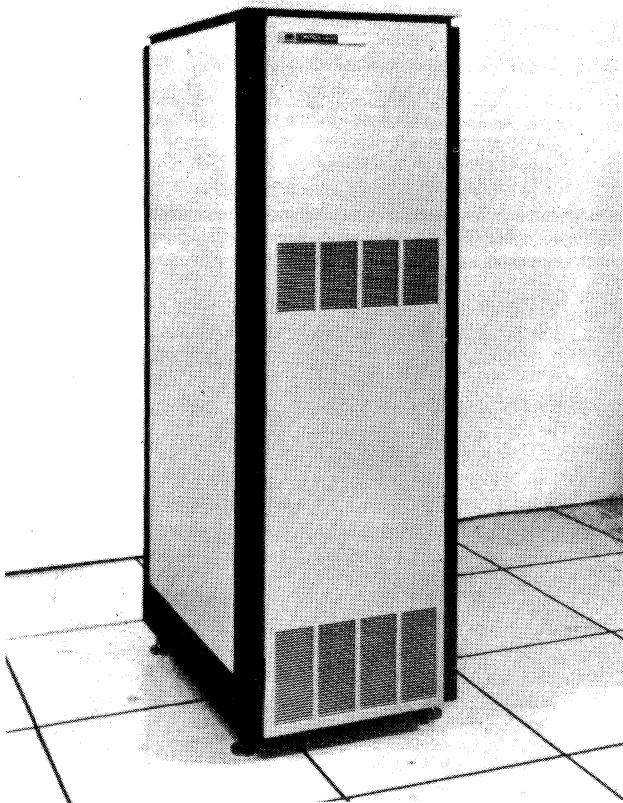# Control Data 2551 Network Processing Unit

The entry level 2551-1 represents the standard Control Data communications processor. The main cabinet, shown above, includes processor with a minimum of 64K bytes of main memory, power supply, and a loop multiplexer with a capability of terminating up to 32 communications lines.

MANAGEMENT SUMMARY

Both communications processors in this family are based on the same microprocessor and can accommodate synchronous communication lines up to 56,000 bps and asynchronous communication lines up to 9600 bps. All lines can be full- or half-duplex. A 2551 interfaces with Control Data's CYBER 170, CYBER 70, and 6000 Series host computer systems.

The basic 2551-1 includes 32K words (16-bit words) of memory expandable to 128K words. One Loop Multiplexer is standard and will support up to 32 communications lines. The 2551-1 communications processor can service a data flow of up to 10,000 characters per second regardless of the number of lines.

The basic 2551-2 has 32K-word memory which can be expanded to 128K words. Two 32-line Loop Multiplexers are standard, and with the addition of up to six more Loop Multiplexers, the processor can support up to 254 lines. Despite the increased line attachment capacity, the maximum processor throughput is still limited to about 10,000 characters per second. Both 2551 models can serve ▷

Two programmable front-end processors for CDC's CYBER 70, CYBER 170, and 6000 Series computers, either of which could also be configured as remote communications concentrators.

The 2551-1 supports attachment of 32 communications lines; the 2551-2 can be expanded to accommodate the attachment of up to 254 lines. Both contain 64K bytes of memory, expandable to 256K bytes. Synchronous lines are supported, half- or full-duplex, at up to 56K bps. Async lines are likewise supported to 9600 bps.

A basic 2551-1 with 32 communications lines rents for $2,600 per month, which includes maintenance, or can be purchased for $60,000.

CHARACTERISTICS

VENDOR: Control Data Corporation, 8100 34th Avenue South, Minneapolis, Minnesota 55440. Telephone (612) 853-8100.

DATE OF ANNOUNCEMENT: April 1974.

DATE OF FIRST DELIVERY: 2550-2—September 1975; 2551-1 and 2551-2—November 1977.

NUMBER DELIVERED TO DATE: 800 (all models).

SERVICED BY: Control Data Corporation.

CONFIGURATION

The 2551 Network Processing Unit is a 16-bit microprocessor with a 168-nanosecond micro-cycle time and a 550-nanosecond main memory cycle time. Currently, two models are available; the 2551-1 and the 2551-2. The 2551-1 can service 10,000 characters per second from a maximum of 32 communications lines; the 2551-2 model can service 10,000 characters per second from a maximum of 254 lines. Both models interface with Control Data's CYBER 170, CYBER 70, and 6000 Series host computer systems. Both can be configured as front-ends or remote concentrators.

A 2551 implemented as a remote concentrator requires a system autostart module, which includes a cassette tape unit that loads the remote system. The remote 2551 is connected to the 2551 front-end local to the host via a single high-speed HDLC link. An additional software load, the Link Interface Program, is required in both the local and the remote end when a remote 2551 is attached.

Common to both available models are: 32K words of 16-bit MOS main memory (i.e. 64K bytes), one Channel Coupler for attachment to the host computer, Loop Multiplexer(s) that accommodates 1 to 32 communication lines each (the 2551-1 has one, and the 2551-2 has two, as standard equipment), a programmable Cyclic Encoder, console attachment interface, and a maintenance panel and maintenance cassette drive. The models differ in their ▶

Control Data 2551 Network Processing Unit

as remote communications concentrators, connected to a local 2551 via a high-speed HDLC link.

The Communications Control program (CCP) is the software package operative in the 2551. CCP's major elements are the Base System Software, the Host Interface Program, and the Terminal Interface Program. CCP will interface with NOS and NOS/BE (with Intercom) in the host computer. PASCAL, which is similar to ALGOL, is the compiler language for user programming of the Communications Processor.

The latest version of CCP, Version 3.1, supports the 2551 as either a front-end or a remote concentrator in a single-host environment or in a multi-host/multi-communications processor networking environment. CDC has also recently released a no-charge enhancement to the CCP that allows the 2551 to operate as a certified X.25 gateway to GTE Telenet's public packet-switching network. CDC has stated that they plan to obtain certification to Tymshare, France's Transpac, and Canada's Datapac as well.

The 2551 models are essentially an upward migration from two predecessor models; the 2550 and 2552. The same hardware configuration is used, but functionality via software has been enhanced. In addition to the remote configurability of the 2551, HDLC protocol support has been added, which provides for high-speed bit-oriented synchronous transmission. The HDLC capability permits support of the X.25 packet protocol.

Control Data has a corporate policy of not providing lists of users names to the public, and we were unable to locate a sufficient number of users among our subscribers to provide a meaningful analysis of user experience. Therefore, no User Reaction section appears in this report.□

expansion capabilities in that the 2551-2 can be expanded to include additional Loop Multiplexers, and subsequently supports the attachment of more communications lines.

Main memory can be expanded in increments of 16K or 32K 16-bit words, in either model, to a system maximum of 128K words (256K bytes).

By the addition of Loop Multiplexer Line Expansion Units, the 2551-2's communication lines capacity can be expanded in increments of 32 lines. The 2551-2 can be expanded to a capacity of 254 lines via a total of up to eight Loop Multiplexer Line Expansion Units. One or more Expansion Cabinets are required if more than two Loop Multiplexer Line Expansion Units are configured; each Expansion Cabinet holds up to two additional Loop Multiplexer Line Expansion Units.

Both models permit a second Channel Coupler to be added for a second attachment to the host processor or for attachment to a second host processor. When two Channel Couplers are attached to the Communications Processor, only one Channel Coupler can be active at a time. However, the multi-host computer system can achieve considerable fall-back capability. The coupler provides the means for transfers between the CYBER host, or hosts, and the 2551 at high-speed channel rates. The host peripheral processing unit initiates all coupler operations. Supervision of the

coupler involves software commands, instructions and control words common to both the host peripheral controller and the 2551.

Under NOS and NOS/BE, networking allows a maximum of eight (under NOS) or twelve (under NOS/BE) 2551 front-ends to be connected to a single CYBER 170 host, with one or two 2551s attached per host channel. Remote 2551s are supported under NOS only, and are connected to local 2551 front-ends via high-speed HDLC links. A maximum of eight remote 2551s can be connected to any one 2551 front-end, each by a single HDLC link. A remote 2551 can be connected to a maximum of four 2551 front-ends.

The 2551 system will accept any console that conforms with EIA RS-232-C standards, uses ASCII TTY protocol, and operates asynchronous up to 9600 bps.

The 2551-1 is field-upgradeable to 2551-2. To do so requires the installation of the 2580-3 Upgrade Kit.

TRANSMISSION SPECIFICATIONS

The modems for communication lines are cabled to a Communication Line Adapter (CLA). Direct lines to local terminals are also supported. Each CLA can have two communication lines attached. All of the CLA types available will accommodate full-duplex, half-duplex, or echoplex lines. For asynchronous transmissions of up to 9600 bps, the CLA #2561 Series will support modems or terminals meeting EIA RS-232-C or CCITT V.24 interface standards, and is compatible with AT&T 103, 113, and 202 data sets. Automatic speed recognition is provided for speeds up to 1200 bps. For synchronous transmissions of up to 19.2K bps, the CLA #2560 Series will support modems meeting EIA RS-232-C interface standards, and is compatible with AT&T 201 and 208 data sets. For character-synchronous transmissions of up to 56,000 bps, CLA #2560-21 and #2560-31 will support AT&T 301/303 data sets, and CCITT V.35 (including AT&T digital data facilities) interface standards, respectively. For bit-synchronous transmission of up to 19.2K bps, an HDLC CLA #2563 Series is available with an RS-232-C interface. For more information on CDC's Communications Line Adapters, see Table 1.
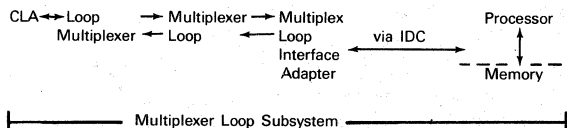
PROCESSOR

The hardware and firmware that Control Data employs for moving data between the lines and the Communications Processor's memory is called the Multiplexer Loop Subsystem. Control of this subsystem is performed by the processor's resident software and microprogram.

Up to 16 CLA's can be attached to one Loop Multiplexer, for a maximum total of 32 lines. The Loop Multiplexer serves as the physical and electrical connection of CLA's to the Multiplexer Loop. The Multiplexer Loop can be viewed as two data paths, one inbound and one outbound.

All Loop Multiplexers in the system are connected to the Multiplexer Loop, which in turn is attached to the Multiplexer Loop Interface Adapter. The Adapter can place incoming data directly into memory under program control through the Interrupt Data Channel (IDC) interface. Outgoing data likewise uses the IDC interface.

The similarity of names for the attachments in the Multiplexer Loop Subsystem is confusing. The following schematic should help while reading the description of data flow through the subsystem.

Control Data 2551 Network Processing Unit

TABLE 1. CDC 2551 COMMUNICATIONS LINE ADAPTERS

Interface Type	Transmission	Maximum Transfer Rate (bps)	Number of Lines Supported	Feature Number	Comments
RS-232-C/V.24	Synchronous	19,200	2	2560-11	Compatible with Bell 201 A, B, C/203A, or 208B Modems
RS-232-C/V.24	Synchronous	19,200	2	2560-12	Compatible with Bell 208A or 209 modem
RS-232-C/V.24	Synchronous	9,600	2	2560-13	Direct connection to terminal with Bell 201 or 208B interface
Coax cable	Synchronous	56,000	2	2560-21	Coax cable connection to host via Bell 301/303 modem
CCITT V.35	Synchronous	56,000	2	2560-31	Connection to host via CCITT V.35-compatible circuit
RS-232-C	Asynchronous	9,600	2	2561-11	Compatible with Bell 103A/B, 113B or 202 C/D (without reverse channel) modems
RS-232-C	Asynchronous	9,600	2	2561-12	Direct connection to terminal with Bell 103A/B or 202 interface
RS-232-C	Asynchronous	9,600	2	2561-13	Compatible with Bell 103F modems
RS-232-C	HDLC	19,200	1	2563-11	Compatible with Bell 201A/B, 203A, or 208B modem
RS-232-C	HDLC	19,200	1	2563-12	Compatible with Bell 208A or 209 modem
RS-232-C	HDLC	9,600	1	2563-13	Direct connection to terminal with Bell 201 or 208B interface

► Under control of the Communications Processor, outbound data must leave memory via the IDC interface.

Instead of periodically scanning each CLA for incoming traffic, the Multiplexer Loop Interface Adapter (MLIA) periodically sends empty Input Loop Batches around the inbound data path of the Multiplexer Loop. (Actually, what is taking place physically is that the processor transmits to the first CLA on the first Loop Multiplexer which retransmits to the second CLA and so on until all CLA's on the first Loop Multiplexer have been serviced, and then on to the other Loop Multiplexers.) The Loop Batch consists of a series of Loop Cells; each cell consists of 12 bits: 1 start-of-cell bit, 3 bits identifying the type of information contained in the cell (or that the cell is empty), and 8 bits of information. The Loop Batch travels past each Loop Multiplexer and then back to the MLIA. If any CLA has filled its character buffer with incoming data, it will "demand service" of its Loop Multiplexer. The Loop Multiplexer will respond by filling the next three empty Loop Cells. The first cell receives the CLA address, the second cell receives the transmitted information, and the third cell receives error checking information (Cyclic Redundancy Checksum). If, in addition to information, the CLA has supervisory information to send to the processor, that information would be placed in Loop Cells following the data cell and before the error checking cell.

When the Loop Batch, filled with data from many CLA's, completes its travel around the loop and arrives at the MLIA, error checking is performed by the programmable Cyclic Encoder. The Encoder can be programmed to accommodate most error detecting schemes. If an error is found, error recovery for retransmission is initiated. If the data is acceptable, the MLIA places the data directly into memory through the Direct Memory Access Interface Channel. Control tables, updated by the MLIA, and the operating software indicate where the data is to be stored in memory. If the transmission is complete, the MLIA triggers an interrupt for processor action. It is the return of a Loop Batch to the MLIA that causes the MLIA to initiate another empty Loop Batch around the loop.

Outbound data travels in Loop Batches on the outbound data path. Once a CLA has received the beginning of an outbound transmission, servicing the CLA with the remainder of the transmission is, again, not done by scanning, but by the CLA demanding service, or more data. The MLIA cannot take output data directly from memory but receives it via the Interrupt Data Channel Interface. As on the input side it requires several cells to supply the CLA address, the data, supervisory information, and error checking information. The Loop Batches leaving the MLIA will contain data for many CLAs.

SOFTWARE

The software operative in the 255X Communication Processors is the Communication Control Program (CCP). CCP is composed of three major elements. The first element is called Base System Software and performs the function of an operating system, related utility functions, queue manager, and console support. The second element is called the Host Interface Program and services the interface with the host. This element controls and formats data moving between the Communications Processor's memory and the host computer. The host's operating system can be either NOS or NOS/BE. The third element is called the Terminal Interface Program (TIP) and accommodates the necessary interface between the different terminal protocols and the standard internal protocol of the processor. Among the terminal protocols supported are: Teletype, IBM 2741, CDC Mode 4, APL-mode terminals, IBM 2780/3780, IBM HASP Multileaving, and the CCITT X.25 interface.

Since CCP is written in a higher level language, PASCAL, other terminal types can be supported by generation of a new TIP, or modification of an existing one. This is accomplished through use of the CYBER Cross System, which executes on a CYBER host. CROSS provides a series of CCP support tools including a PASCAL compiler, macro/micro assembler, link editor, and a library maintenance capability. All of these utilities run on a CYBER host computer. ►

Control Data 2551 Network Processing Unit
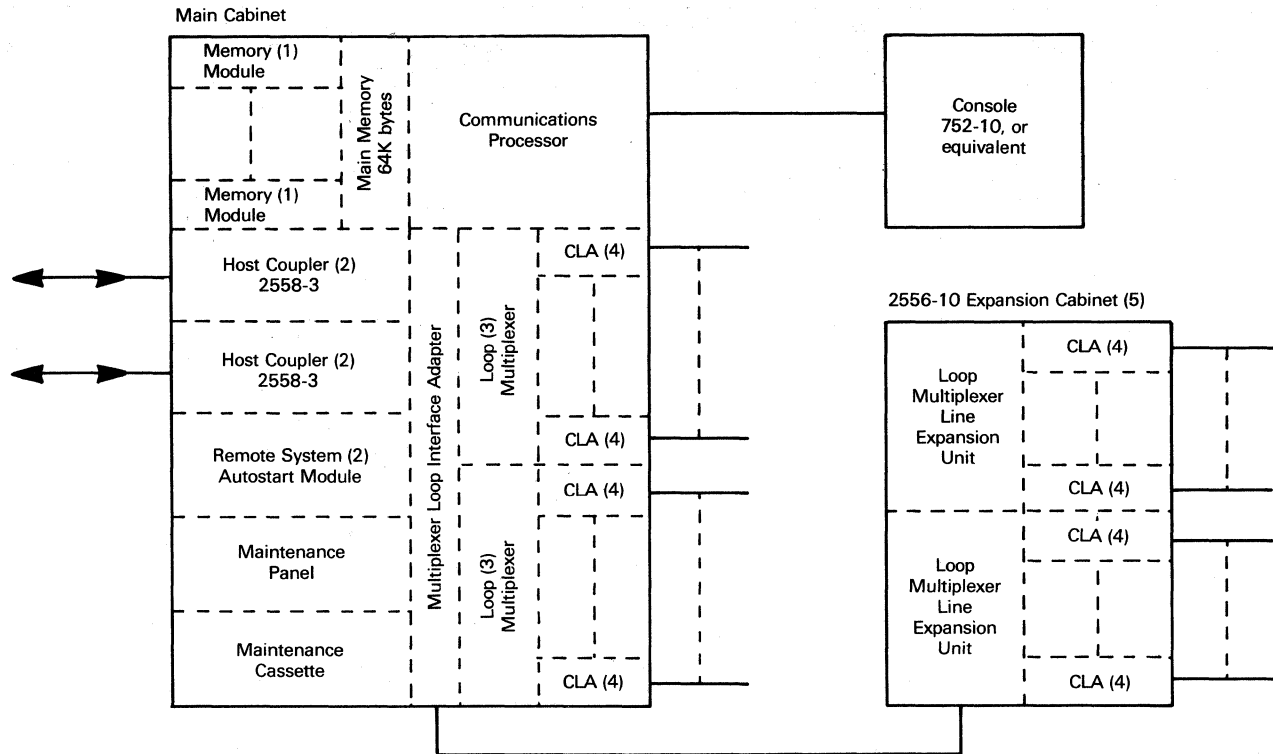
Configuration

(1) Memory Modules available in 32K-byte or 64K-byte increments, up to a system maximum of 256K bytes, including main memory.

(2) One Host Coupler basic to system; one additional may be implemented. If system is used as remote concentrator, would require Autostart Module instead of Host Coupler(s).

(3) 2551-1 supports only one Loop Multiplexer. 2551-2 may support up to eight, but only two are resident in main cabinet.

(4) Up to 16 Communication Line Adapters (CLA) can be implemented per Loop Multiplexer or Expansion Line Unit. Each CLA supports up to two lines.

(5) Applicable only to 2551-2 systems. Each expansion cabinet supports up to two Loop Multiplexer Line Expansion Units.

▶ The Base System Software handles the internal operation of the communications processor. Included are: a system monitor, which controls allocation of the programs running in the processor; an interrupt handler, which controls the transition of the processor between different program-interrupt levels; a console utility, which processes service messages such as commands, alarms, reports and diagnostic information received from the local console; buffer maintenance and queue utilities, which dynamically allocate memory in varying buffer sizes and provide for the queuing and dequeuing of data buffers; and debug and diagnostic utilities, which permit system dumping during program development or system failures and isolation of communications line problems.

Diagnostics are performed on-line, and are initiated by supervisory commands from the network operator. Base System Software also allows for date and time stamping services, and basic message processing which includes code conversion, insertion, CRC/LRC generation and character counting.

The Host Interface and Terminal Interface Programs are part of the interface software which includes processor support of virtual terminal connections in conjunction with CYBER host network products. The 2551 cooperates with the host in establishing a link with certain interactive and batch terminal stations wherein, once the link is established, the physical characteristics of the source terminal are transparent to the host.

CDC has also added a Line Interface Program which controls information transfer between a local and remote 2551. Such links utilize the Control Data Corporation Control Procedure (CDCCP), which is CDC's bit-synchronous version of ISO's HDLC standard. Other CCP software modules are collectively grouped as the Network Control Software, which define the processor's role in relation to the network. These modules perform functions which include network routing, statistical reporting, and processing of service messages.

PRICING

The 255X Communications Processors can be purchased or leased either directly or through Control Data's Commercial Credit subsidiary. When leasing directly, only a one-year lease agreement is available. At the end of the year, unless other action is taken, the equipment will automatically be on a 90-day notice agreement. Credit towards purchasing the equipment is part of the one-year agreement; 30 percent of the first year's rental can be applied as a credit toward the purchase price, 45 percent of the second year's rental, 60 percent of the third year's rental, and 75 percent of all subsequent rentals. From Commercial Credit, a three-year lease agreement is available. It is non-cancellable for 24 months and its term is non-extendable. Five-year arrangements are also available through Commercial Credit. ▶
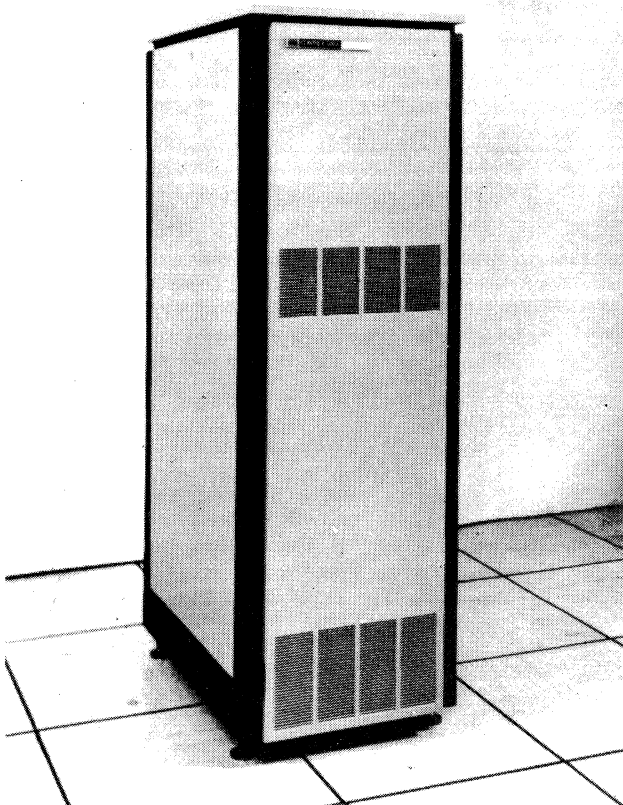
Control Data 2551 Network Processing Unit

		Monthly 1-Year	Rental* 3-Year	Purchase	Monthly Maintenance
2551-1	Network Processing Unit	$1,205	$1,184	$33,400	$318
2551-2	Network Processing Unit	1,527	1,499	43,400	366
2580-3	2551-1 to 2551-2 Upgrade Kit	327	321	10,000	53
2554-16	MOS Memory Expansion, 16,384 words	204	200	5,500	48
2554-32	MOS Memory Expansion, 37,768 words	391	384	9,920	96
2556-10	Expansion Cabinet	181	178	6,000	27
2556-11	Loop Multiplexer Line Expansion Unit	152	149	4,029	32
2558-3	Host Computer Coupler	138	136	3,938	39
2580-4	Remote System Autostart Module/Cassette Unit	63	62	1,500	21
2560-11	CLA; sync; RS-232-C; 201/8B-compatible	43	42	997	9
2560-12	CLA; sync; RS-232-C; 203A/9-compatible	43	42	997	9
2560-13	CLA; sync; RS-232-C; direct connection to terminal	43	42	997	9
2560-21	CLA; sync; coax; 301/303-compatible	62	61	1,553	9
2560-31	CLA; sync; V.35	43	42	997	9
2561-11	CLA; async; RS-232-C; 203-compatible	36	35	785	8
2561-12	CLA; async; RS-232-C; direct connection to terminal	36	35	785	8
2561-13	CLA; async; RS-232-C; 103F-compatible	36	35	785	8
2563-11	CLA; SDLC; RS-232-C; 201/8B-compatible	49	48	925	17
2563-12	CLA; SDLC; RS-232-C; 208A-compatible	49	48	925	17
2563-13	CLA; SDLC; RS-232-C; direct connection to terminal	49	48	925	17

Software		Initial Fee	Monthly Charge*	Paid Up License
N221-01	CCP 3; for NOS host	$570	$125	$3,370
N221-02	Link Interface Program; for remote 2551	120	50	1,320
N222-01	CCI; for NOS/BE host	570	125	3,370

*Includes maintenance.■

Control Data 2551 Network Processing Unit

The entry level 2551-1 represents the standard Control Data communications processor. The main cabinet, shown above, includes processor with a minimum of 64K bytes of main memory, power supply, and a loop multiplexer with a capability of terminating up to 32 communications lines.

Two programmable front-end processors for CDC's CYBER 70, CYBER 170 and 6000 series computers, either of which could also be configured as remote communications concentrators.

The 2551-1 supports attachment of 32 communications lines; the 2551-2 can be expanded to accommodate the attachment of up to 254 lines. Both contain 64K bytes of memory, expandable to 256K bytes. Synchronous lines are supported, half- or full-duplex, at up to 56K bps. Async lines are likewise supported to 9600 bps.

A basic 2551-1 with 32 communications lines rents for $2,300 per month, which includes maintenance, or can be purchased for $74,000.

MANAGEMENT SUMMARY

Both communications processors in this family are based on the same microprocessor and can accommodate synchronous communication lines up to 56,000 bps and asynchronous communication lines up to 9600 bps. All lines can be full- or half-duplex. A 2551 interfaces with Control Data's CYBER 170, CYBER 70, and 6000 series of host computer systems.

The basic 2551-1 includes 32K (16-bit words) memory expandable to 128K. One Loop Multiplexer is standard and will support up to 32 communication lines. The 2551-1 communications processor can service a data flow of up to 10,000 characters per second regardless of the number of lines.

The basic 2551-2 has 32K memory which can be expanded to 128K. Two 32-line Loop Multiplexers are standard, and with the addition of Loop Multiplexers, the processor can support up to 254 lines. Despite the increased line attachment capacity, the maximum processor throughput is still limited to about 10,000 characters per second. Both 2551 models can serve as remote communications ▷

CHARACTERISTICS

VENDOR: Control Data Corporation, 8100 34th Avenue South, Minneapolis, Minnesota 55440. Telephone (612) 853-8100.

DATE OF ANNOUNCEMENT: April 1974.

DATE OF FIRST DELIVERY: 2550-2—September 1975; 2551-1 and 2551-2—November 1977.

NUMBER DELIVERED TO DATE: 250 (all models).

SERVICED BY: Control Data Corporation.

CONFIGURATION

The 2551 Network Processing Unit is a 16-bit microprocessor with a 168-nanosecond micro-cycle time and a 550-nanosecond main memory cycle time. Currently, two models are available; the 2551-1 and the 2551-2. The 2551-1 can service 10,000 characters per second from a maximum of 32 communications lines; the 2551-2 model can service 10,000 characters per second from a maximum of 254 lines. Both models interface with Control Data's CYBER 170, CYBER 70, and 6000 series of host computer systems. Either processor can support attachment to two hosts, or to one host and another 2551. Both can be configured as remote concentrators.

A 2551 implemented as a remote concentrator requires a system autostart module; a cassette tape unit which loads the remote system. An additional software load, the Link Interface Program, is required in the host front end when a remote 2551 is attached.

Common to both available models are: 32K MOS main memory, Channel Couplers for attachment to the host computers, a Loop Multiplexer that accommodates 1 to 32 communication lines, a programmable Cyclic Encoder, console attachment interface, and a maintenance panel and maintenance cassette drive. The models differ in their expansion capabilities in that the 2551-2 can be expanded to include additional Loop Multiplexers, and subsequently supports the attachment of more communications lines. ▶

Control Data 2551 Network Processing Unit

concentrators, connected to a local 2551 via a high-speed HDLC link.

The Communication Control Program (CCP) is the software package operative in the 2551. CCP's major elements are the Base System Software, the Host Interface Program, and the Terminal Interface Program. CCP will interface with NOS and NOS/BE (with Intercom) in the host computer. PASCAL, which is similar to ALGOL, is the compiler language for user programming of the Communications Processor.

The latest version of CCP, Version 3, supports a communications processor as either a front end or as a remote concentrator in a single host environment. CDC has stated, however, that a new version, scheduled for release in the near future, will support a configuration of multiple hosts and multiple communications processors in a network environment. This projected configurability might be compared to IBM's Multisystem Networking Facility, which was announced in 1976.

The 2551 models are essentially an upward migration from two predecessor models; the 2550 and 2552. The same hardware configuration is used, but functionality via software has been enhanced. In addition to the remote configurability of the 2551, HDLC protocol support has been added, which provides for high-speed bit-oriented synchronous transmission. The HDLC capability permits Level 2 support of the X.25 packet protocol.

As with the previous 255X models, up to two hosts can be serviced by, or channel-coupled to, a single 2551. CDC states that, additionally, up to eight 2551's can be attached to a single host.

USER REACTION

From the 1977 and 1978 Communications Processors Survey, Datapro identified four 2551-2 users, each of whom reported their experience with a single 2551 processor. The number of lines per processor varied from 10 to 128, with a wide range of speeds and protocols. One user was interfacing to a CYBER 170; the others all had Series 6000 hosts. The average time that each processor had been in operation was 18 months. The users' ratings are as follows:

	Excellent	Good	Fair	Poor	WA*
Overall satisfaction	2	2	0	0	3.8
Ease of installation	2	1	1	0	3.3
Throughput	1	3	0	0	3.3
Hardware reliability	2	1	1	0	3.3
Promptness of maintenance	4	0	0	0	4.0
Quality of maintenance	3	1	0	0	3.8
Software	1	2	1	0	3.0
Technical support	3	1	0	0	3.8

*Weighted Average on a scale of 4.0 for Excellent.

In general, the ratings indicate satisfaction with the 2551. The high ratings given CDC's maintenance (both prompt-

Main memory can be expanded in increments of 16K or 32K 16-bit words, in either model, to a system maximum of 128K words. By the addition of Loop Multiplexers, communication line capacity can be expanded in increments of 32 lines. The 2551-2 can be expanded to a capacity of 254 lines via the addition of up to seven Loop Multiplexers. Both models permit a second Channel Coupler to be added for a second attachment to the host processor or for attachment to a second host processor.

The hardware and firmware that Control Data employs for moving data between the lines and the Communications Processor's memory is called the Multiplexer Loop Subsystem. Control of this subsystem is performed by the processor's resident software and microprogram.
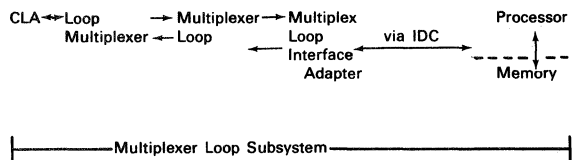
TRANSMISSION SPECIFICATIONS

The modems for communication lines are cabled to a Communication Line Adapter (CLA). Each CLA can have two communication lines attached. All five of the CLA types available will accommodate full-duplex or half-duplex lines. For asynchronous transmissions of up to 9600 bps, CLA #2561-1 will support modems meeting EIA RS232C or CCITT V24 interface standards, and is compatible with AT&T 103, 113, and 202 data sets. For synchronous transmissions of up to 19.2K bps, CLA #2560-1 will support modems meeting EIA RS232C interface standards and is compatible with AT&T 201 and 208 data sets. Both of the above CLA's will support local lines. For character-synchronous transmissions of up to 56,000 bps, CLA's #2560-2 and #2560-3 will support AT&T 301/303 data sets, and CCITT V35 (including AT&T digital data facilities) interface standards, respectively. For bit-synchronous transmission of up to 19.2K bps, an HDLC CLA #2563-1 is available with an RS-232C interface.

PROCESSOR

Up to 16 CLA's can be attached to one Loop Multiplexer, for a total of 32 lines. The Loop Multiplexer serves as the physical and electrical connection of CLA's to the Multiplex Loop. The Multiplex Loop can be viewed as two data paths, one inbound and one outbound.

All Loop Multiplexers in the system are connected to the Multiplex Loop, which in turn is attached to the Multiplexer Loop Interface Adapter. The Adapter can place incoming data directly into memory under program control through the Interrupt Data Channel (IDC) interface. Outgoing data likewise uses the IDC interface.

The similarity of names for the attachments in the Multiplexer Loop Subsystem is confusing. The following schematic should help while reading the description of data flow through the subsystem.

CLA→Loop → Multiplexer → Multiplex Processor
Multiplexer ← Loop Loop via IDC
← Interface ←→ ----|--
Adapter Memory

|————————Multiplexer Loop Subsystem————————|

Under control of the Communications Processor, outbound data must leave memory via the IDC interface.

Instead of periodically scanning each CLA for incoming traffic, the Multiplexer Loop Interface Adapter (MLIA) periodaically send empty Input Loop Batches around the inbound data path of the Multiplexer Loop. (Actually, what is taking place physically is that the processor transmits to the first CLA on the first Loop Multiplexer which retransmits to the second CLA and so on until all CLA's on the first

Control Data 2551 Network Processing Unit

TABLE 1. CDC 2551 COMMUNICATIONS LINE ADAPTERS

Interface Type	Transmission	Maximum Transfer Rate (bps)	Number Lines Supported	Feature Number	Comments
RS-232C, or CCITT V.24	Synchronous	19,200	2	2560-1	Supports Local Terminal Attachment
CCITT V.35	Synchronous	56,000	2	2560-2	—
CCITT V.35	Synchronous	56,000	2	2560-3	Supports ATT's DDS, Supports Local Terminal Attachment
RS-232C or CCITT V.24	Asynchronous	9,600	2	2561-1	Supports Local Terminal Attachment
RS-232C; HDLC	Synchronous	19,200	1	2563-1	Supports Local Terminal Attachment

▷ ness and quality) and technical support are considerably above those given by users of similar products from other major vendors.

Software ranked the lowest of the rated criteria, but still faired well. CDC has made recent enhancements to both the CCP and related host software which may not have been reflected in the ratings used in this survey. Future ratings may indicate a higher degree of software satisfaction. There were no significant difficulties reported with the 2551. One user indicated difficulty with communications lines and modems that was apparently unrelated to the operation of the 2551.□

▶ Loop Multiplexer have been serviced, and then on to the other Loop Multiplexers.) The Loop Batch consists of a series of Loop Cells; each cell consists of 12 bits: 1 start-of-cell bit, 3 bits identifying the type of information contained in the cell (or that the cell is empty), and 8 bits of information. The Loop Batch travels past each Loop Multiplexer and then back to the MLIA. If any CLA has filled its character buffer with incoming data, it will "demand service" of its Loop Multiplexer. The Loop Multiplexer will respond by filling the next three empty Loop Cells. The first cell receives the CLA address, the second cell receives the transmitted information, and the third cell receives error checking information (Cyclic Redundancy Checksum). If, in addition to information, the CLA has supervisory information to send to the processor, that information would be placed in Loop Cells following the data cell and before the error checking cell.

When the Loop Batch, filled with data from many CLA's, completes it travel around the loop and arrives at the MLIA, error checking is performed by the programmable Cyclic Encoder. The Encoder can be programmed to accommodate most error detecting schemes. If an error is found, error recovery for retransmission is initiated. If the data is acceptable, the MLIA places the data directly into memory through the Direct Memory Access Interface Channel. Control tables, updated by the MLIA, and the operating software indicate where the data is to be stored in memory. If the transmission is complete, the MLIA triggers an interrupt for processor action. It is the return of a Loop Batch to the MLIA that causes the MLIA to initiate another empty Loop Batch around the loop.

Outbound data travels in Loop Batches on the outbound data path. Once a CLA has received the beginning of an outbound transmission, servicing the CLA with the remainder of the transmission is, again, not done by scanning, but by the CLA demanding service, or more data. The MLIA

cannot take output data directly from memory but receives it via the Interrupt Data Channel Interface. As on the input side it requires several cells to supply the CLA address, the data, supervisory information, and error checking information. The Loop Batches leaving the MLIA will contain data for many CLA's.

When two Channel Couplers are attached to the Communications Processor, the multi-host computer system can achieve considerable fall-back capability. The coupler provides the means for transfers between the CYBER host, or hosts, and the 2551 at high-speed channel rates. The host peripheral processing unit initiates all coupler operations. Supervision of the coupler involves software commands, instructions and control words common to both the host peripheral controller and the 2551.

Under existing software, when two host computers are attached to the same Communications Processor, only one Channel Coupler can be active at a time. However, CDC has stated that a forthcoming network software release will permit the 2551 to be shared by both hosts simultaneously, as well as trunk line connections between a local 2551 and other 2551's frontending other hosts.

The 2551 system will accept any console that conforms with EIA RS232C standards, uses ASCII TTY protocol, and operates asynchronously up to 9600 bps. Control Data offers either a 1711-4 Teletype, a 10 character per second page printer, or a 752-10 CRT, with speeds up to 9600 bps.

The 2551-1 is field upgradeable to 2551-2. To do so requires the installation of the 2580-3 Upgrade Kit.

SOFTWARE

The software operative in the 255X Communication Processors is the Communication Control Program (CCP). CCP is composed of three major elements. The first element is called Base System Software and performs the function of an operating system, related utility functions, queue manager, and console support. The second element is called the Host Interface Program and services the interface with the host. This element controls and formats data moving between the Communications Processor's memory and the host computer. The host's operating system can be either NOS or NOS/BE. The third element is called the Terminal Interface Program (TIP) and accommodates the necessary interface between the different terminal protocols and the standard internal protocol of the processor. Among the terminal protocols supported are: Teletype, IBM 2741, and CDC Mode 4. CDC has stated that future releases, which will support IBM bisynchronous (including HASP Multileaving) and the X.25 protocols, are forthcoming. ▶

Control Data 2551 Network Processing Unit
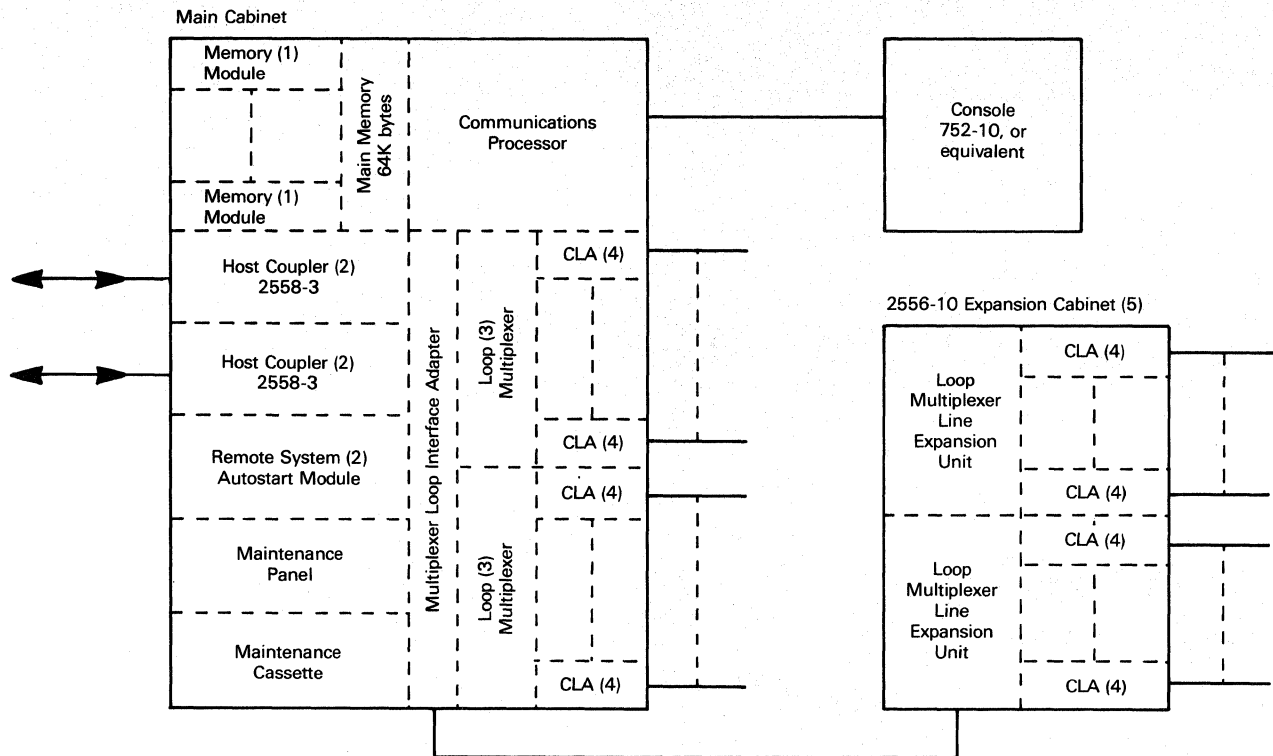
Configuration

(1) Memory Modules available in 32K-byte or 64K-byte increments, up to a system maximum of 256K bytes, including main memory.

(2) One Host Coupler basic to system; one additional may be implemented. If system is used as remote concentrator, would require Autostart Module instead of Host Coupler(s).

(3) 2551-1 supports only one Loop Multiplexer. 2551-2 may support up to seven, but only two are resident in main cabinet.

(4) Up to 16 Communication Line Adapters (CLA) can be implemented per Loop Multiplexer or Expansion Line Unit. Each CLA supports up to two lines.

(5) Applicable only to 2551-2 systems. Each expansion cabinet supports up to two Loop Multiplexer Line Expansion Units.

▶ Since CCP is written in a higher level language, PASCAL, other terminal types can be supported by generation of a new TIP, or modification of an existing one. This is accomplished through use of the CYBER Cross System, which executes on a CYBER host. CROSS provides a series of CCP support tools including a PASCAL compiler, macro/micro assembler, link editor, and a library maintenance capability. All of these utilities run on a CYBER host computer.

The Base System Software handles the internal operation of the communications processor. Included are: a system monitor, which controls allocation of the programs running in the processor; an interrupt handler, which controls the transition of the processor between different program-interrupt levels; a console utility, which processes service messages such as commands, alarms, reports and diagnostic information received from the local console; buffer maintenance and queue utilities, which dynamically allocate memory in varying buffer sizes and provide for the queuing and dequeuing of data buffers; and debug and diagnostic utilities, which permit system dumping during program development or system failures and isolation of communications line problems.

Diagnostics are performed on-line, and are initiated by supervisory commands from the network operator. Base System Software also allows for date and time stamping services, and basic message processing which includes code conversion, insertion, CRC/LRC generation and character counting.

The Host Interface and Terminal Interface Programs are part of the interface software which includes processor support of virtual terminal connections in conjunction with CYBER host network products. The 2551 cooperates with the host in establishing a link with certain interactive and batch terminal stations wherein, once the link is established, the physical characteristics of the source terminal are transparent to the host.

CDC has also added a Line Interface Program which controls information transfer between a local and remote 2551. Such links utilize the Control Data Corporation Control Procedure (CDCCP), which is CDC's bit-synchronous version of ISO's HDLC standard. Other CCP software modules are collectively grouped as the Network Control Software, which define the processor's role in relation to the network. These modules perform functions which include network routing, statistical reporting, and processing of service messages.

PRICING

The 255X Communications Processors can be purchased or leased either directly or through Control Data's Commercial Credit subsidiary. When leasing directly, only a one-year lease agreement is available. At the end of the year, unless other action is taken, the equipment will automatically be on a 90-day notice agreement. Credit towards purchasing the equipment is part of the one-year agreement; 30 percent of the first year's rental can be applied as a credit toward the purchase price, 45 percent of the second year's rental, 60 ▶

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Control Data 2551 Network Processing Unit

▶ percent of the third year's rental, and 75 percent of all subsequent rentals. From Commercial Credit, a three year lease agreement is available. It is non-cancellable for 24 months and its term is non-extendable. Five year arrangements are also available through Commercial Credit.

		Monthly 1-Year	Rental* 3-Year	Purchase	Monthly Maintenance
2551-1	Network Processing Unit	$1,110	$1,090	$33,430	$300
2551-2	Network Processing Unit	1,405	1,379	43,400	345
2580-3	2551-1 to 2551-2 Upgrade Kit	250	244	10,000	45
2554-16	MOS Memory Expansion, 16,384 words	187	183	5,500	45
2554-32	MOS Memory Expansion, 37,768 words	359	353	9,920	90
2556-10	Expansion Cabinet	165	162	6,000	25
2556-11	Loop Multiplexer Line Expansion	139	136	4,029	30
2558-3	Host Computer Coupler	126	124	3,938	36
2580-4	Remote System Autostart Module/Cassette Unit	55	54	1,500	17
2560-1	CLA; Sync., 19,200 bps, EIA RS232C	36	35	853	7
2560-2	CLA; Sync., 56,000 bps, AT&T 301/303 compatible	36	35	853	7
2560-3	CLA; Sync., 56,000 bps, CCITT V35	36	35	853	7
2561-1	CLA; Async., 9600 bps, EIA RS232C	29	28	657	6
2563-1	CLA; Sync., 19,200 bps, HDLC, EIA RS232C	46	45	853	17
752-10	Display Terminal Console	55	52	1,650	17
1711-4	Teletypewriter	42	41	1,470	41

Software		Initial Fee	Monthly Charge*	Paid Up License
N221-01	CCP 3	$570	$70	$3,370
N221-02	Link Interface Program; for Remote 2551	120	30	1,320
N222-01	CCI; for NOS/BE Host	570	70	3,370

*Includes Maintenance.■

Control Data 255X Host Communication Processor
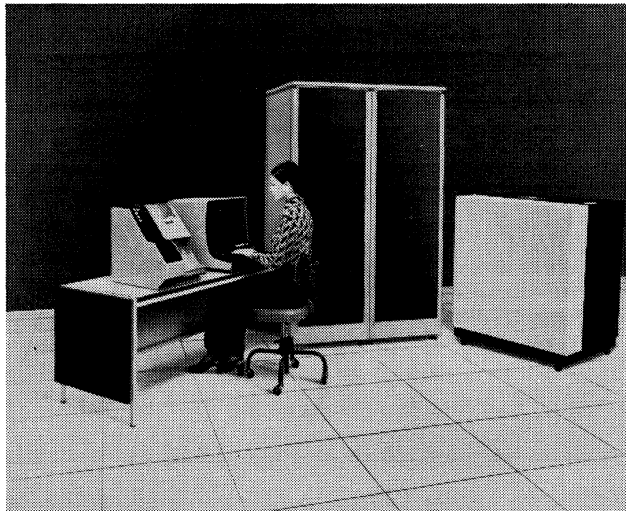
The Control Data 2552-1 Host Communications Processor is shown above.

MANAGEMENT SUMMARY

Both communications processors in this family are based on the same microprocessor and can accommodate synchronous communication lines up to 56,000 bps and asynchronous communication lines up to 9600 bps. All lines can be full- or half-duplex. A 255X interfaces with Control Data's CYBER 170, CYBER 70, and 6000 series of host computer systems.

The basic 2550-2 includes 32K (16-bit words) memory expandable to 64K. One Loop Multiplexer is standard and will support up to 32 communication lines. Addition of up to three more loop Multiplexers permits support of 128 lines. The 2550-2 Communications Processor can service a data flow of up to 10,000 characters per second regardless of the number of lines.

The basic 2552-1 has 32K memory and can be expanded to 128K. One 32-line Loop Multiplexer is standard, and with the addition of Loop Multiplexers, the processor can support up to 254 lines and handle up to 30,000 characters per second. The higher throughput is achieved by an additional microprocessor used as a line controller; the cycle time of the basic microprocessor is the same in both models. This 200 percent increase in throughput has an associated increase in basic processor cost of approximately 35 percent.

The Communication Control Program (CCP) is the software package operative in the 255X. CCP's major elements are the Base System Software, the Host Interface Program, and the Terminal Interface Program. CCP will interface with NOS and SCOPE 3.4/INTERCOM 4 in the host computer. PASCAL, which is similar to ALGOL, is the compiler language for user programming of the Communications Processor. ▷

Two programmable communications processors for Control Data's CYBER 170, CYBER 70, and 6000 series computer systems.

The 2550-2 can accommodate up to 128 communication lines and can process 10,000 characters per second. The 2552-1 can accommodate up to 254 communication lines and can process 30,000 characters per second. Synchronous lines with speeds up to 56,000 bps and asynchronous lines up to 9600 bps are supported; the mode can be either full- or half-duplex.

A basic configuration with 32 communication lines rents for $2,637 per month, including maintenance for the 2550-2, and $3,510 per month for the 2552-1; the purchase prices are $72,763 and $102,702, respectively.

Attachment to two host computers or to one host computer and another 255X Communications Processor is an option.

CHARACTERISTICS

VENDOR: Control Data Corporation, 8100 34th Avenue South, Minneapolis, Minnesota 55440. Telephone (612) 853-8100.

DATE OF ANNOUNCEMENT: April 1974.

DATE OF FIRST DELIVERY: 2550-2—September 1975; 2552-1—scheduled for third quarter 1977.

NUMBER DELIVERED TO DATE: 65 (2550-2).

SERVICED BY: Control Data Corporation.

CONFIGURATION

The 255X Host Communication Processor is a 16-bit microprocessor with a 168-nanosecond micro-cylce time and a 600-nanosecond main memory cycle time. Currently, two models are available with a variety of options. The 2550-2 model can service 10,000 characters per second from a maximum of 128 communication lines; the 2552-1 model can service 30,000 characters per second from a maximum of 254 lines. Both models interface with Control Data's CYBER 170, CYBER 70, and 6000 series of host computer systems. A third model, the 2550-1, which had substantially the same features as the 2550-2, but was limited to 64 lines and 32K core memory, is no longer available.

Common to both available models are: 32K MOS main memory, a Channel Coupler for attachment to the host computer, a Loop Multiplexer that accommodates 2 to 32 communication lines. a programmable Cyclic Encoder, capability for attachment of multiple local printers and card readers, console attachment interface, and a maintenance panel and maintenance cassette drive. The models differ in their expansion capabilities and in that the 2552-1 has a ▶

Control Data 255X Host Communication Processor

▷ When two host computers are attached to one Communications Processor, a software routine to emulate a multi-line controller is required to permit both Channel Couplers to be active at the same time. With a pending release of CCP, one Communications Processor can operate as a remote concentrator via a Channel Coupler; at the same time, each Communications Processor can be attached to its own host computer.

In general, for any mix of communication lines, the throughput limitation of the processor will be reached before the hardware expansion limits are reached.

USER REACTION

In January 1977, Datapro talked with six users of the 2550 and asked them to rate the Communications Processor. Five users had 2550-2's, one user had a 2550-1. The average length of time a processor had been installed was eight months. One user is emulating a multi-line controller, but planned to upgrade. The number of lines per installation ranged from 22 to 90, with a wide range of speeds and protocols. CYBER 170, CYBER 70, and 60000 series host computers are represented in the sample. The users' ratings are:

	Excellent	Good	Fair	Poor	WA*
Overall satisfaction	2	3	1	0	3.2
Ease of installation	2	1	2	1	2.7
Throughput	2	4	0	0	3.3
Hardware reliability	3	2	1	0	3.3
Promptness of maintenance	4	2	0	0	3.7
Quality of maintenance	3	3	0	0	3.5
Software	1	3	1	0	3.0
Technical support	1	3	2	0	2.8

*Weighted Average on a scale of 4.0 for Excellent.

In general, there is satisfaction with the reliability of the 2550-2 and the attendant maintenance support. There was a strong feeling among the users we talked with that the capability of the software in both the communications processor and the host computer didn't match the logic capability of the communications processor. In at least two installations, the users indicated that the host software was limiting the communications throughput. Control Data has made changes to host software to correct the situation, and new releases of the communications processor software promise enhanced capabilities. However, one installation has developed, and is using, its own processor software, and therefore, is not included in the Software Rating.

There were problems of installation with the earlier deliveries. However, the problems appear to be rectified. The user's ratings for Ease of Installation progress in almost chronological order, with the earliest installation rated Poor, and the most recent installations rated Excellent.□

▶ special feature permitting it to handle three times the traffic on twice as many communications lines as the 2550-2, despite the fact that both models operate at the same internal processor speed.

Main memory can be expanded in increments of 16K or 32K 16-bit words. The 2550-2 can be expanded to 64K; and the 2552-1, to 128K. By the addition of Loop Multiplexers, communication line capacity can be expanded in increments of 32 lines. The 2550-2 can be expanded to a capacity of 64, 96, or 128 lines via the addition of 1, 2, or 3 Loop Multiplexers. In similar fashion, the 2552-1 can be expanded to a maximum of 254 lines. Both models permit a second Channel Coupler to be added for a second attachment to the host processor or for attachment to a second host processor.

The hardware and firmware that Control Data employs for moving data between the lines and the Communications Processor's memory is called the Multiplexer Loop Subsystem. In the 2550-2, control of this subsystem is performed by the processor's resident software and microprogram. But in the 2552-1, a Multiplexer Loop Controller, a separate micro-programmed processor, performs the task. The communications processor, freed of this job, can manipulate greater volumes of data for an increased number of lines. The Multiplexer Loop Controler can be viewed as a "front-end processor for the 2552-1 itself."
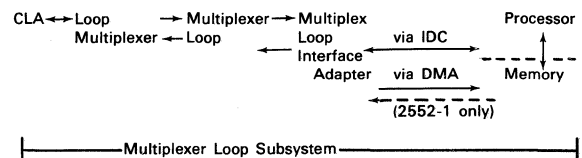
TRANSMISSION SPECIFICATIONS

The modems for communication lines are cabled to a Communication Line Adapter (CLA). Each CLA can have two communication lines attached. All four of the CLA types available will accommodate full-duplex or half-duplex lines. For asynchronous transmissions of up to 9600 bps, CLA #2561-1 will support modems meeting EIA RS232C or CCITT V24 interface standards, and is compatible with AT&T 103, 113, and 202 data sets. For synchronous transmissions of up to 9600 bps, CLA #2560-1 will support modems meeting EIA RS232C interface standards and is compatible with AT&T 201 and 208 data sets. Both of the above CLA's will support local lines. For synchronous transmissions of up to 56,000 bps, CLA's #2560-2 and #2560-3 will support AT&T 301/303 data sets, and CCITT V35 (including AT&T digital data facilities) interface standards, respectively. A Time Division Multiplexer CLA originally available, has been discontinued.

PROCESSOR

Up to 16 CLA's can be attached to one Loop Multiplexer, for a total of 32 lines. The Loop Multiplexer serves as the physical and electrical connection of CLA's to the Multiplex Loop. The Multiplex Loop can be viewed as two data paths, one inbound and one outbound.

All Loop Multiplexers in the system are connected to the Multiplex Loop, which in turn is attached to the Multiplexer Loop Interface Adapter. The Adapter can place incoming data directly into memory through its Direct Memory Access (DMA) interface or under program control through the Interrupt Data Channel (IDC) interface. Outgoing data can use only the IDC inteface.

The similarity of names for the attchments in the Multiplexer Loop Subsystem is confusing. The following schematic should help while reading the description of data flow through the subsystem.

```
CLA ◄─► Loop          ─► Multiplexer ─► Multiplex              Processor
        Multiplexer ◄─ Loop          Loop        via IDC         ↑
                                      Interface ◄────────── ──┐── 
                                      Adapter   via DMA      Memory
                                      ◄─────────── 
                                          (2552-1 only)

├──────────────Multiplexer Loop Subsystem──────────────┤
```

Under control of the Communications Processor in the 2550-2, outbound data must leave memory via the IDC interface. Under the control of the Multiplex Loop Con- ▶

Control Data 255X Host Communication Processor

troller in the 2552-1, outbound data leaves memory via the Controller's direct access port.

Instead of periodically scanning each CLA for incoming traffic, the Multiplexer Loop Interface Adapter (MLIA) periodaically send empty Input Loop Batches around the inbound data path of the Multiplexer Loop. (Actually, what is taking place physically is that the processor transmits to the first CLA on the first Loop Multiplexer which retransmits to the second CLA and so on until all CLA's on the first Loop Multiplexer have been serviced, and then on to the other Loop Multiplexers.) The Loop Batch consists of a series of Loop Cells; each cell consists of 12 bits: 1 start-of-cell bit, 3 bits identifying the type of information contained in the cell (or that the cell is empty), and 8 bits of information. The Loop Batch travels past each Loop Multiplexer and then back to the MLIA. If any CLA has filled its character buffer with incoming data, it will "demand service" of its Loop Multiplexer. The Loop Multiplexer will respond by filling the next three empty Loop Cells. The first cell receives the CLA address, the second cell receives the transmitted information, and the third cell receives error checking information (Cyclic Redundancy Checksum). If, in addition to information, the CLA has supervisory information to send to the processor, that information would be placed in Loop Cells following the data cell and before the error checking cell.

When the Loop Batch, filled with data from many CLA's, completes it travel around the loop and arrives at the MLIA, error checking is performed by the programmable Cyclic Encoder. The Encoder can be programmed to accommodate most any error detecting schemes. If an error is found, error recovery for retransmission is initiated. If the data is acceptable, the MLIA places the data directly into memory through the Direct Memory Access Interface Channel. Control tables, updated by the MLIA and the operating software indicate where the data is to be stored in memory. If the transmission is complete, the MLIA triggers an interrupt for processor action. It is the return of a Loop Batch to the MLIA that causes the MLIA to initiate another empty Loop Batch around the loop.

Outbound data travels in Loop Batches on the outbound data path. Once a CLA has received the beginning of an outbound transmission, servicing the CLA with the remainder of the transmission is, again, not done by scanning, but by the CLA demanding service, or more data. The MLIA cannot take output data directly from memory but receives it via the Interrupt Data Channel Interface. As on the input side it requires several cells to supply the CLA address, the data, supervisory information, and error checking information. The Loop Batches leaving the MLIA will contain data for many CLA's.

With the Multiplex Loop Controller in the 2552-1, outbound data is not restricted to leaving memory via the interrupt interface, a relatively time consuming process. The Controller has a direct access port to transfer data from memory to the Multiplexer Loop Subsystem. This results in a 200 percent increase.

When two Channel Couplers are attached to the Communications Processor, the multi-host computer system can achieve considerable fall-back arrangements. The Communications Processor can be wired to two computers directly or to a Channel Coupler of another Communications Processor which has a second computer as its host.

When two host computers are attached to the same Communications Processor, only one Channel Coupler can be active at a time. With the use of a software subroutine, to emulate a multi-line controller, both Channel Couplers can be active at the same time. With a new release of CCP, attachment of two Communications Procesors via Channel Couplers will be possible along with the ability of each Communications Processor to simultaneously service its own host processor.

The 255X system will accept any console that conforms with EIA RS232C standards, uses ASCII TTY protocol, and operates asynchronous up to 9600 bps. Control Data will provide either a 1711-4 Teletype, a 10 character per second page printer, or a 713-10 CRT, with speeds up to 30 characters per second and hard copy option. The 2550 Model can be operated as a multi-line controller emulator with a package supplied by Control Data.

SOFTWARE

The software operative in the 255X Communication Processors is the Communication Control Program (CCP). CCP is composed of three major elements. The first element is called Base System Software and performs the function of an operating system, related utility functions, queue manager, and console support. The second element is called the Host Interface Program and services the interface with the host. This element controls and formats data moving between the Communications Processor's memory and the host computer. The host's operating system can be either NOS or SCOPE 3.4 with INTERCOM 4. The third element is called the Terminal Interface Program (TIP) and accommodates the necessary interface between the different terminal protocols and the standard internal protocol of the processor. Among the terminal protocols supported are: Teletype, IBM 2741, binary synchronous, and CDC Mode 4. User programs for the Communications Processor can be written in PASCAL compiler language or in Macro Assembly. Pre-compiler (a job control statement file), Library Maintenance, Link Editor, and Micro Assembler are also provided. Compilation is performed on the host computer.

When the host computer is operating under the Network Operating System (NOS), the Terminal Interface Program can operate in either device dependent or device independent mode. In the dependent mode, TIP handles only line management and leaves all device control to the computer. In the device independent mode TIP can handle certain terminals as a standard Virtual Interactive Terminal from the computer's viewpoint. Only point-to-point or multi-drop interactive devices that are either asynchronous terminals or CDC mode4A or 4C synchronous terminals can operate in the independent mode. CYBER 70 and 6000 users operating under SCOPE 3.4, require INTERCOM 4 to control the network. Binary synchronous protocol is not supported.

Control Data 255X Host Communication Processor

Configuration
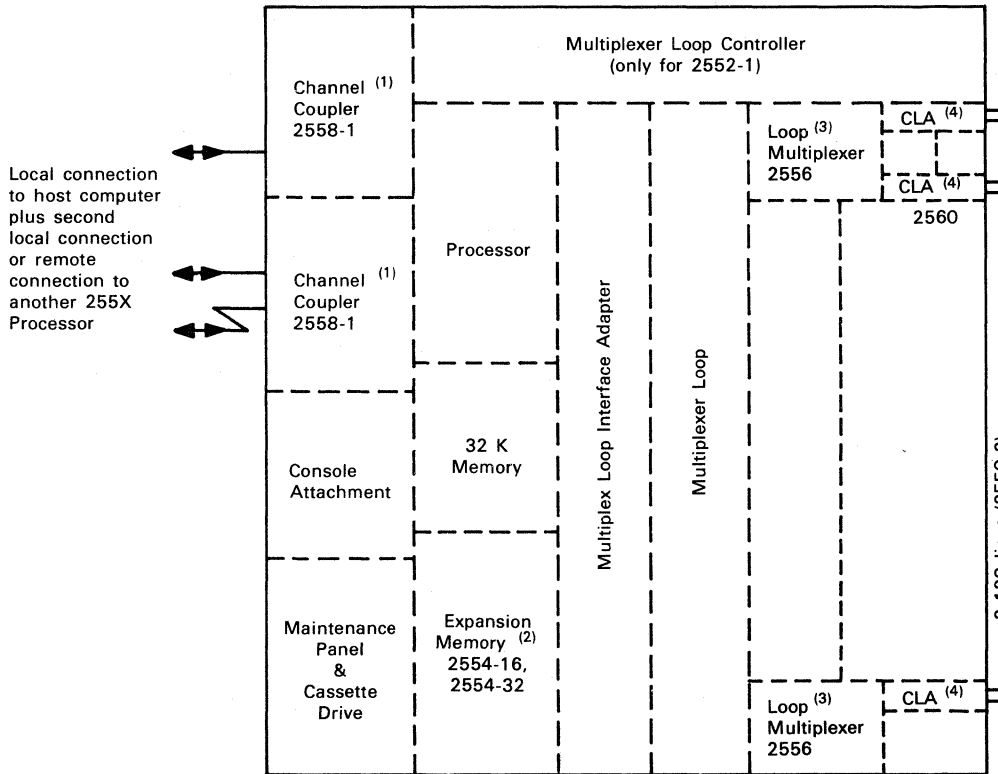
(1) One Channel Coupler is standard. A second can be added.
(2) 32K MOS memory is standard. Expansion is obtainable in increments of 16K or 32K words. The 2250-2 is expandable to 64K. The 2552-1 is expandable to 128K.
(3) One Loop Multiplexer is standard and will accommodate sixteen CLA's. Three Loop Multiplexers can be added to the 2550-1, seven Loop Multiplexers can be added to the 2552-1.
(4) Sixtenn CLA's can be added to one Loop Multiplexer. Each CLA can accommodate two communication lines, full or half-duplex. For interfaces meeting EIA RS 232C or CCITT REC V24 standards:
CLA #2561-1 will accommodate asynchronous lines up to 9600 bps.
CLA #2560-1 will accommodate synchronous lines up to 9600 bps. For interfaces with AT&T 301 and 303 data sets:
CLA # 2560-2 will accommodate synchronous lines up to 56,000 bps.
For interfaces meeting CCITT REC V35 standards or AT&T digital data system:
CLA #2560-3 will accommodate synchronous lines up to 56,000 bps.

► PRICING

The 255X Communications Processors can be purchased or leased either directly or through Control Data's Commercial Credit subsidiary. When leasing directly, only a one-year lease agreement is available. At the end of the year, unless other action is taken, the equipment will automatically be on a 90-day notice agreement. Credit towards purchasing the equipment is part of the one-year agreement; 30 percent of the first year's rental can be applied as a credit toward the

purchase price, 45 percent of the second year's rental, 60 percent of the third year's rental, and 75 percent of all subsequent rentals. For the 713-10 Display Terminal the percentages for the first three years are different. They are 55%, 55%, and 58%, respectively. The purchase price will be the price at the time the purchase option is exercised, and the actual price paid cannot be less than 20 percent of that figure. From Commercial Credit, a three year lease agreement is available. It is non-cancellable for 24 months and its term is non-extendable. Five year arrangments are also available through Commercial Credit.

		Monthly Rental* 1-Year	3-Year	Purchase	Monthly Maint.
2550-2	Communication Processor	$1,978	$1,543	$57,320	$531
2552-1	Communication Processor	2,851	2,801	87,259	648
2554-16	MOS Memory Expansion, 16,384 words	210	206	5,500	68
2554-32	MOS Memory Expansion, 32,768 words	399	393	9,920	130
2556-2	Loop Multiplexer for lines 33 to 64	139	137	4,029	30
2556-3	Loop Multiplexer for lines 65 to 96	139	127	4,029	30
2556-4	Loop Multiplexer for lines 97 to 128**	139	127	4,029	30
2558-1	Cyber Communication Coupler	126	124	3,938	36
2560-1	CLA; Sync., 9600 bps, EIA RS232C	36	35	853	7
2560-2	CLA; Sync., 56,000 bps, AT&T 301/303 compatible	36	35	853	7
2560-3	CLA; Sync., 56,000 bps, CCITT V35	36	35	853	7
2561-1	CLA; Async., 9600 bps, EIA RS232C	29	28	657	6
713-10	Conversational Display Terminal	83	82	1,795	20
1711-4	Teletypewriter	76	75	1,470	34

*Includes monthly maintenance charge.
**The cost of Loop Multiplexers for lines 129 to 254 is not yet available.■