ENHANCED PRIVATE SWITCHED COMMUNICATIONS SERVICE

PDSP SOFTWARE

DESCRIPTION

2-WIRE NO. 1 ELECTRONIC SWITCHING SYSTEM

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1. GENERAL

1.01 This section describes the software for the enhanced private switched communications service (EPSCS).

1.02 This section is reissued to include the 2A generic. Since this reissue is a general revision arrows ordinarily used to indicate changes have been omitted.

1.03 EPSCS customers communicate with No. 1 Electronic Switching System (ESS) switches from their customer network control center (CNCC) via a network of peripheral processors. The EPSCS network consists of No. 1 ESS machines with a peripheral data storage processor (PDSP) attached to each. The peripheral processors, in turn, are connected to one another by data link. However, any two peripheral processors may be connected through one or more intermediate PDSP machines.

2. MESSAGE ROUTING

2.01 The job of the PDSP network is to transfer messages between No. 1 ESS offices and status centers. These status centers are the customer network control center (CNCC) and the customer service administrative control center (CSACC). There may be several CSACCs monitoring the network. Each customer's information is sent to that customer's CNCC as well as to one of the CSACCs. Each CSACC may receive all of the information for one or more customers. One of the CSACCs is designated to receive all network information which is customer independent. A status center is connected to the PDSP network by data link. Network status information supplied by ESS machines is channeled to the PDSP nearest to the appropriate status center. This PDSP then transmits the information to the status center. Similarly, the status center may send information to the ESS machines via the PDSP network. One PDSP can serve more than one EPSCS network (or customer). A data base is therefore generated and maintained in each PDSP so that each PDSP knows to which network(s) it belongs. It is, therefore, able to respond to inquiries from a status center (CNCC or CSACC) about the system configuration.

2.02 Messages can be transmitted from any PDSP to any one or more PDSPs in the system. A CNCC can send messages to any particular PDSP in its network or to all PDSPs in its network. The CSACC can send messages to any PDSP, all PDSPs, or the nearest PDSP.

SWITCH IDENTIFICATION

2.03 Switch identification for routing purposes is independent of the switch identification scheme used for EPSCS translation purposes. The manner in which switches are identified is important for routing messages correctly and efficiently. The validity of source and destination addresses must be checked. Each switch has one unique number for all customers assigned to it by AT&T Long Lines. Each PDSP has lists of all the other switches, enabling routing programs to validate destination and source addresses.

MESSAGE ROUTING PROCESS

2.04 The EPSCS employs message switching; that is, EPSCS transmits variable length messages, and whenever possible keeps one message intact in one transmission block. However, extremely long messages can be transmitted in several parts.

2.05 The itinerary for each message is mapped on a link-by-link basis rather than calculating at one time the entire path that a message is to follow. The destination of a message is examined at each station. If the message has not yet reached its final goal, then the next link in the route is calculated and the message is forwarded there. This implies that at each switch there is a list specifying the next link based on the final destination of the message.

2.06 For link-by-link routing, each PDSP must have a routing table of all other PDSPs in the entire system. Each time a PDSP is added or deleted, or each time a new link is added between PDSPs, the data base in each PDSP must be updated.

2.07 Given the ultimate destination for a message, the next link is specified by the PDSP routing table which provides the data link group number associated with the PDSP. The data link group table lists the data links in each group.

APPLICATION ROUTING TABLES

2.08 The EPSCS routing section has two items:

(1) The EPSCS customer identification table

(2) EPSCS customer routing table.

The EPSCS customer ID table contains a DEST field which determines where the MDR packets are to be sent as follows:

0 = CNCC/CSACC 1 = CSACC

2 = DROP MSG

The EPSCS customer identification table also has the customer index for every customer belonging to the PDSP. The customer index is used to point to the EPSCS customer routing table which has a list of PDSPs belonging to the network of the customer.

2.09 The EPSCS customer routing table is consulted:

(1) When an EPSCS message enters the PDSP network and

(2) When an EPSCS message reaches its destination.

When a message is merely being passed along to the next PDSP, only the PDSP routing table needs to be consulted.

ROUTING ALGORITHM

2.10 The data link device handler program handles all the message buffering and transmission protocol. If a message needs to be broken into transmission blocks, this is done at the originating PDSP by the data link sorting program. A PDSP may receive messages from its associated ESS machine, from a CNCC, from the CSACC, or from another PDSP.

2.11 When a PDSP receives a message from its associated ESS, a general header with destination elements is attached to the message at the PDSP. A destination element consists of the SINK TYPE, DEST TYPE, and SINK ID. The SINK TYPE indicates the type of receiving system (CSACC, CNCC, or PDSP). The DEST TYPE indicates whether the final destination is a network or local data link. Network indicates that the final destination is not directly connected to the PDSP that is interrogating the header information. Local indicates that the final destination is connected directly to the interrogating PDSP. The SINK ID, in the case of a network destination, indicates the PDSP identification that is the next link in the routing of the message. In the case of a local destination, the SINK ID indicates the data link group (DLG) number that communicates with the desired destination.

2.12 If the final destination is the CSACC and it is not local, the message header will contain a SINK ID which is a PDSP ID. When the message reaches the PDSP that is associated with the CSACC, the DEST TYPE in the general header is changed to local and the SINK ID is changed to a data link group number which is obtained from the CSACC routing table for a customer's CSACC or the office parameter table for the common CSACC. A particular data link is then obtained from the data link group table.

2.13 If the message is destined for a non-local CNCC, the identification of the next PDSP in the link is obtained from the CNCC routing table. Once the CNCC becomes local to a PDSP, the DEST TYPE in the general header is changed to local and the SINK ID is changed to a data link group number which is obtained from the CNCC routing table. The data link group table is then indexed by the data link group number and the particular data link number to the CNCC is extracted.

MESSAGE FORMAT

2.14 A message consists of:

Protocol header

General header

Application header

Data

Protocol trailer.

The protocol header and protocol trailer are added by the data link device handler routine after all other elements of the message are complete. Protocol refers to the transmission convention for communicating over data links. The other elements of the message are provided by the message processing and routing programs. The general header has information about routing that is needed for all applications such as destination designation, destination type, number of destinations, and sequence number for multipart messages. The application header may be defined by each application in accordance with its needs. The data is the core of the message.

2.15 The PDSP may break a long message into a sequence of transmission blocks. Each sequence of blocks for one message is identified by a sequence identification number assigned by

the PDSP in the general header. This enables the receiving processor to correctly reassemble a message when blocks are received out of sequence and when several sequences are on the network at the same time.

2.16 Very long messages from the No. 1 ESS to the PDSP are broken into segmented messages. Each segment is processed as a separate message by the PDSP. Segments are identified by segment number and a completion code to indicate the last segment of a segmented message. Figure 1 shows the format of the message data. Figure 2 is a representation of a sequence of packets.

CONFIRMATION TYPE (CT) (DATA WHEN THERE IS NO CT)	MESSAGE NUMBER– FIRST 8 BITS
COMPLETION CODE	SEGMENT NUMBER
BYTE COUNT = TWICE THE NUMBER OF WORDS	
THIS PDSP ID	
SEGMENT ID (SCHEDULED MESSAGE ONLY)	
DATA	

CONFIRMATION TYPE - RESPONSE FROM ESS TO CNCC OR CSACC

Fig. 1—Segmented Message Data Format

3. CNCC MESSAGES

3.01 The CNCC is located on the customer's premises and communicates with its EPSCS network via a data link to the nearest PDSP. The PDSP data network provides the CNCC with information regarding the use and status of the EPSCS voice network. The CNCC is able to control certain parameters of the EPSCS voice network by transmitting commands to its ESS machines via the PDSP data network.

3.02 The ESS supplies call detail messages which allow the EPSCS customer to bill network users. The ESS also supplies network status information in several forms:

(1) Periodic summaries of traffic and load on various segments of the EPSCS network

(2) Maintenance reports for facilities taken out of service

(3) Information from which unusual network conditions, such as all trunks busy or trunk nonusage information can be derived.

(4) Acknowledgment of CNCC commands.

3.03 CNCC messages are used primarily to provide network control. For example, they can:

(1) Select one of the three routing patterns (normal, special, emergency)

(2) Change treatment of specified authorization code

(3) Select number for selected Off-Hook Service Access Lines.

COMMUNICATION PROTOCOL

3.04 Communication between PDSP and CNCC utilizes the Digital Equipment Corporation (DEC) protocol, DDCMP. A DDCMP message consists of a DDCMP header, DDCMP data, and a DDCMP trailer (Fig. 3) and may be independently transmitted and routed. A DDCMP message is referred to below as a packet of EPSCS information.

3.05 The amount of data contained within any packet is determined by two considerations:

(1) A maximum packet size which is defined by buffer space available for handling communications

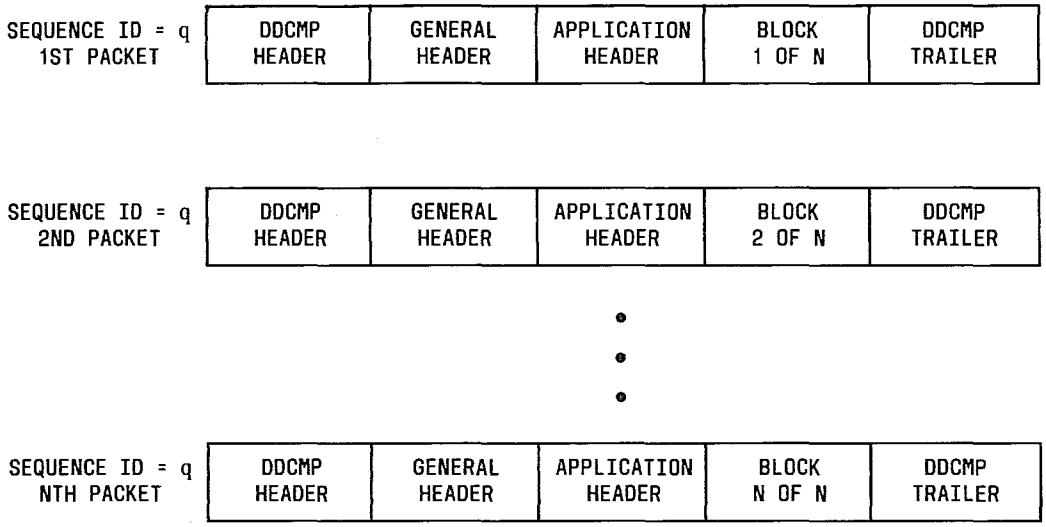

Fig. 2—Sequence of Packets

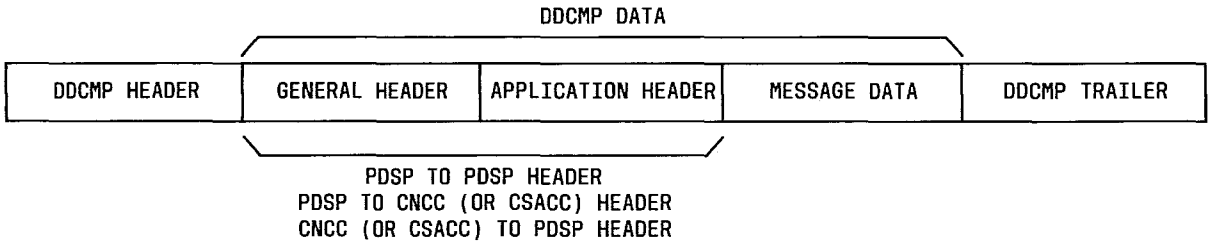

Fig. 3—DDCMP Message Format

(2) A maximum time allowable for a message to be delayed before transmission in a packet.

The maximum packet size is 300 characters.

MESSAGES

3.06 Messages between the CNCC and PDSPs are composed of a message header to identify message type and, in the case of variable length messages, a byte count and data. Fixed length messages do not require a byte count since the message header implies the byte count for that message.

A. Regularly Scheduled Messages

3.07 The regularly scheduled messages between the CNCC and network ESS offices are:

(1) Half-hour traffic summary for trunk and access line groups: This message is output

periodically on the half hour and provides such information as:

- Incoming peg count
- Outgoing peg count
- Overflow
- Traffic busy usage
- Maintenance usage
- Total queue usage
- Number of calls longer than a specified time
- Intraflow count
- Outflow count.

(2) Line usage—last 100-second scan: This is a usage list of all trunk and access line groups and is generated periodically following the last 100-second usage scan.

(3) Two-hour nonusage data: Every two hours (on the half hour) a list is sent of trunks or access lines which were not used within a two-hour interval.

B. Real Time Messages

3.08 The real time messages that occur between the CNCC and the network ESS offices are concerned with:

(1) Message detail records: An originating record message provides such information as:

- Call not completed
- Call continuing
- Midnights passed
- Originating PDSP number
- Outgoing trunk group number
- Outgoing trunk member number
- Calling station identifier
- Authorization code
- End of dialing time
- Answer time and date
- Disconnect time
- Called number.

A terminating record message provides:

- Terminating PDSP number
- Incoming trunk group number
- Incoming trunk member number
- Outgoing off network access line (ONAL) group number
- Outgoing ONAL member number
- End of outpulsing time and date
- Called number.

(2) Circuit removed from service, or returned to service: This message provides:

- Facility group number
- Trunk member number
- Trouble code
- Explanation
- Time and date.

(3) Conference bridge seized or abandoned: This message provides the facility group number and the status (seized = 1, abandoned = 0).

(4) Short holding time (sent only to CSACC). This message format provides the facility group number and the trunk member number.

C. Audit and Reconfiguration Messages

3.09 These messages are performed on request from the CNCC. A confirmation type is included in every audit response message from the ESS or PDSP.

(1) Basic system parameters—switching machines: This provides a list of PDSPs in the customer's network. The information provided is the confirmation type, the byte count, and the PDSP numbers.

(2) Basic system parameters—current routing status: This message provides the confirmation type and the current routing pattern. The possible comfirmation types to the CWCC are:

Type	Meaning
0	Will do
1	Action taken-initiated by CNCC
2	Action taken-initiated by CSACC
3	Already doing it
4	Can't do now
5	Audit failure-change occurred
6	Error-invalid facility
7	Error-invalid data
8	Error-authorization code not stored
9	Error-recent change full
10	Authorization code not in list
11	Authorization code out of sound
17	Action taken—RC near full-initiated
18	Action taken—RC near full-initiated by CSACC.

(3) System configuration information—lines, trunks, and queues: The following information is provided:

- Confirmation type
- Segment number
- Completion code
- Byte count
- Facility type
- Number of trunks
- Number of queue slots.

The possible facility types are:

Type	Facility
0	Network access line
1	Network trunk
2	Foreign exchange (FX)
3	ONAL (other than FX)
4	conference bridge.

(4) Circuits out of service:

- Confirmation type
- Segment number
- Completion code
- Byte count
- Facility group
- Trunk member number
- Trouble code.

(5) Status of Off-Hook service controls: The following fields are provided by this message format:

- Confirmation type
- Segment number
- Completion code
- Byte count
- Access line group number
- Access line member number
- Directory number

- Active number.

(6) Status of queue controls: This message provides:

- Confirmation type
- Segment number
- Completion code
- Byte cont
- Queue number
- Status (1 = on, 0 = off).

(7) CSACC positive data delivery check: Every 100 seconds CSACC generates a request to each PDSP in the data network for a report of the PDSPs hardware status. Each PDSP reports back to CSACC the following information:

- All data link group communication status
- All data link communication status
- PIU communication status
- Machine overload state.

D. CNCC Information Request Messages

3.10 The CNCC information request messages are composed of the following:

(1) Audit request.

Audit Type	Audit
1	Switching machine
N1-2	Current routing status
N1-3	System configuration
N1-5	Treatment of treatments
N1-6	Circuits out of service
N1-7	Status off-hook service controls
N1-8	Status of queue controls.

(2) Request time and date.

(3) Request treatment on authorization code(s). For a single code, the fields in the CNCC message format are the access line group number and the code. The reply message for a range of active codes for a particular PBX or access line group contains the following information (the CNCC message format is the same as required for single code):

- Confirmation type
- Segment number
- Completion code
- Byte count
- Access line group number.

(4) Verify conference bridge. The CNCC message format provides the bridge access code number and the treatment. The reply message contains fields representing the confirmation type, the bridge access code number, treatment, and facility group number.

E. CNCC Control Messages

3.11 The following types of messages constitute CNCC control messages:

(1) ***Change treatment on an authorization code:*** The CNCC message format includes the access line group number, the code, and the treatment. The confirmation message format contains the confirmation type, the access line group number, the code, the old treatment, and the new treatment.

(2) ***Conference bridge controls:*** The CNCC message format includes conference bridge trunk group number and the action (1 = disconnect, 0 = preemption). The format of the confirmation message includes confirmation type, conference bridge trunk group number, and action (1 = disconnect, 0 = preemption).

(3) ***Change routing pattern:*** Stage number and pattern number are part of the CNCC message format. The confirmation message contains the confirmation type, the stage number,

the old pattern number, and the new pattern number.

(4) ***Change status of designated off-hook service access line:*** The access line group number and the new number help make up the CNCC message. The confirmation message contains the confirmation type, the access line group number, the old number, and the new number. If the selected access line group is not an off network access line, an error message will be produced.

(5) ***Change status of queue:*** The CNCC message contains the queue trunk group number, the action (1 = on, 0 = off), and the queue data. The confirmation message contains the confirmation type, the queue trunk group number, the action, the old queue data, and the new queue data.

F. Miscellaneous Messages

3.12 The two miscellaneous message types are:

(1) ***Echo following data:*** This message is used by CNCC and CSACC only. It contains the segment number, completion code, byte count, and the data. The reply consists of the data (echoed).

(2) ***Text message:*** This message is used by CNCC and CSACC only. The message contains segment number, completion code, byte count, and the text.

4. NO. 1 ESS MESSAGES

4.01 The No. 1 ESS communicates with the EPSCS data network via its PDSP. A message is composed of a header, the body (if any), and an end-of-message (EOM) indicator. The header includes a unique label for each message type. The symbolic header label consists of an alpha-numeric code which identifies the origin and destination of the message type.

Ex - from ESS to CNCC or CSACC

Nx - from CNCC or CSACC to ESS

EPx - from ESS to its PDSP

PEx - from PDSP to its ESS

where the x is an assigned number: This symbolic labeling scheme is consistent with that of CNCC to PDSP messages. The CNCC communicates only E and N type messages with the ESS-PDSP community.

4.02 The ESS word consists of twenty-three data bits and a nine-bit operation code field. This latter consists of a beginning-of-message bit, an end-of-message bit, and a seven-bit type of message designation. The ESS message is converted to two sixteen-bit words in a Processor Interface Unit (PIU) buffer for use by the PDSP. The first word contains sixteen of the twenty-three ESS data bits. The remaining seven ESS data bits are placed in the second PDSP word along with the nine op code bits. A message from the PDSP to the ESS must combine two PDSP words to form one thirty-two bit ESS message. The nine-bit op code is used to build completed messages and distinguishes them as EPSCS.

MESSAGES

4.03 The PIU driver wiill buffer completed messages when three messages of 25 words or less per message have been received. The buffer will be sent via the operating system and system memory to EPSCS executive task. Messages greater than 25 words will not enter the buffer. They will be sent directly to the EPSCS task. Messages between the ESS and its PDSP may be grouped in three classifications:

A. PDSP Common

4.04 These messages are available to all applications:

(1) Time and date.

(2) No. 1 ESS clock changed - the old time of day, old date, new time of day, and the new date are given.

(3) No. 1 ESS clock passed through midnight - the time of day and the date are given.

B. Processor Interface Unit Maintenance

4.05 The PIU maintenance messages are:

(1) Maintenance test message from ESS to PDSP —every two seconds, a one-word message is sent to the PDSP.

(2) Power and fuse alarm messages from ESS to PDSP.

(3) Maintenance test message from PDSP to ESS —upon receipt of a maintenance test message from ESS, the PDSP will send a test message to the ESS.

(4) Diagnostic raw data message from PDSP to ESS—result of a failure of the PDSP portion of the PIU diagnostic.

C. EPSCS

4.06 The EPSCS messages are described in this section.

5. HOLDING TIME ANALYSIS

5.01 The PDSP receives a seizure message and a seizure time from its No. 1 ESS every time a trunk is seized, and it receives a release message and release time every time a trunk is released. From these times, the PDSP calculates the duration that the trunk was held. Comparing this holding time with a specified threshold is a means of tracking possible trunk troubles.

5.02 The Office Parameter Table contains the two parameters OPMATH (minimum allowable holding time) and OPHTFCT (hold time failure count threshold) which are utilized for holding time analysis. They are office engineered parameters. For example, if the OPMATH value were 12 and OPHTFCT were 45, then 45 consecutive seizures of a trunk which held for less than 12 seconds each would result in a holding time analysis failure. A message indicating this would be sent to the No. 1 ESS. At the ESS, the TNN is translated to obtain the trunk group number and the trunk member number. Then the TNN, the trunk group number, and the trunk member number are sent back to the PDSP which transmits the message to CSACC.

5.03 Each time a seizure time is less than the OPHTFCT, a failure count is incremented. Once the failure count threshold is reached, a message is generated to indicate a possible trunk trouble. When a seizure time greater than the OPHTFCT parameter is received, the failure count is returned to zero.

5.04 The no hold time TNN table contains a list of TNNs that are allowed to exceed the OPMATH parameter. When a TNN is indicated as a possible trunk trouble, the no hold time TNN table is checked. If the TNN is listed in this table, the report to the No. 1 ESS and the CSACC are inhibited.

6. CALL DETAIL

6.01 Three messages from the No. 1 ESS to the PDSP are used for the call detail information. The messages are the trunk seizure message, answer time, and trunk release message. The answer time is a copy of the No. 1 ESS Automatic Message Accounting (AMA) record up through answer time. These messages are utilized at the PDSP to create a call detail message which is sent to the customer and to CSACC.

6.02 The seizure message is utilized for holding time analysis and is not an actual part of the call detail message. When the AMA record of an originating call is received from the No. 1 ESS, an MDR block is seized in the MDR table of the data base. The AMA record is reformatted to the customer format before being stored in the MDR table. When a trunk release message is received from the No. 1 ESS, the TNN table is checked to see if there is an MDR associated with that TNN. If there is, the trunk release time is used in the MDR record to indicate disconnect time for the call.

6.03 The MDR record is then transferred from the MDR table to the customer output buffer table. When the table is full, the call detail records are sent to the customer and to CSACC. If the table has not been transferred within the last minute, the contents will be sent as if the table had been full. This assures that call detail records will be sent at least every minute.

7. AUDITS

7.01 The three types of EPSCS audits are the Executive Audit, the TNN/MDR audit, and the Data Link Audit.

EXECUTIVE AUDIT

7.02 The executive audit takes an audit message request from a teletypewriter input, from another task, or from a timed entry and generates

a message to cause the proper audit to be run. Two timed audits are executed by the executive audit. The TNN/MDR audit and the data link audit are run once per day on a timed basis. The data link audit is also run every hour.

TNN/MDR Audit

7.03 This audit looks for any error that might tie up an MDR or TNN block unnecessarily. An example would be a block that is pointed to but contains nothing. The audit would release the pointer and therefore the block would be released. The other type of error is a block with data but without a pointer pointing to it. In this case, the audit program would zero the block. A count is kept of the usage of the blocks and is reported via teletypewriter message.

DATA LINK AUDIT

7.04 Data link states are:

Available

Unavailable

Faulty

Manual

Removed

Unknown.

The data link usage table keeps track of each data link and its state. The Extended Operating System (EOS) also keeps track of the data link states. This audit compares the data link EOS status with the data link usage table status. If the two disagree, the data link usage table is updated to agree with the EOS status. This audit is run automatically every hour and may also be run manually.

8. ABBREVIATIONS

8.01 The following abbreviations are used in this section:

AMA	Automatic Message Accounting
CNCC	Customer Network Control Center
CSACC	Customer Service Administrative Control Center
DEC	Digital Equipment Corporation
EOM	End of Message
EOS	Extended Operating System
EPSCS	Enhanced Private Switched Communications Service
ESS	Electronic Switching System
FX	Foreign Exchange
ID	Identification
MDR	Message Detail Register
ONAL	Off Network Access Line
PDSP	Peripheral Data Storage Processor
PIU	Processor Interface Unit
TNN	Trunk Network Number