MUXPORT Protocol

codex

MOTOROLA

MUXPORT PROTOCOL SEMINAR
INTRODUCTION

The goal of this seminar is to provide advanced training for HDLC like protocols in general and Codex Muxport Protocol specifically. The seminar will focus on protocol definition and examination not on strapping or programming.

Upon completion of this seminar the student should be familiar with the Codex Muxport protocol and be able to do basic Muxport troubleshooting and problem determination/recognition.

The accompanying document may be used as a reference for the seminar or as a stand alone tutorial/reference on HDLC/Muxport protocol interpretation.

The following prerequisites must be met to take this seminar:

- 6000/6050 CSE Course
- 6760/6740 Launch Training
- RTS or Senior CSE

The following topics will be covered in the Muxport/BOP seminar.

1. ISO REFERENCE MODEL
2. HDLC/SDLC
3. MUXPORT PROTOCOL
4. 6740 MUXPORT/NP PROTOCOL
5. 6760 EXTENDED MUXPORT OVERVIEW
6. X.25 OVERVIEW

MUXPORT SEMINAR OUTLINE

I. INTRODUCTION

A. Objectives
B. Why
C. What's Covered
D. Training Participation

II. ISO REFERENCE MODEL

A. Definition Of ISO
B. Layer Concept
C. Layer Definition
D. Data Flow Example

III. BIT ORIENTED PROTOCOL

A. Introduction
  1. What is BOP
  2. Comparison with BSC
  3. HDLC SDLC comparison
B. Station Configurations
  1. Types
  2. Data links
  3. Modes
C. Data Link Controls
  1. Zero insertion
  2. Window concepts
  3. Frame numbering
D. Frame Structure
  1. Definition of frame components
  2. Explanation of each field
E. Information Frame
F. Supervisory Frame
G. Unnumbered Frame

IV. MUXPORT PROTOCOL

A. Overview
   1. What is Codex Muxport Protocol
   2. Definition of CMP layers
   3. Comparison with other protocols
   4. Frame structure

B. Line Layer
   1. Function
   2. Idle sequences

C. ARQ Layer
   1. Functions
   2. Addressing
   3. Frame types supported
   4. Remote reset sequence
   5. System states

D. MUX Layer
   1. Functions
   2. Control status byte
   3. Control slots
   4. Data slots
   5. Supervisory slots

E. Connection Layer
   1. Functions
   2. Escape sequence
   3. CSU
   4. DPI
   5. Break
   6. Data termination
   7. Autospeed
   8. Flow control

F. Data Scope Sequences
   1. Idle
   2. Boot
   3. ISCC sequences

VII. X.25 OVERVIEW

A. Definition of X.25
   1.Packet switching concepts
   2. Virtual circuits
B. X.25 Structure
   1. Definition of layers
   2. Physical
   3. Frame
   4. packet
C. Packet Layer Structure
   1. Format
   2. GFI
   3. LCN / LCGN
   4. Packet types
D. Calling Sequences
   1. Call establishment
   2. Call Clearing
   3. Data transfer
E. PAD Overview
   1. Definition of PAD
   2. Definition of protocols used

MUXPORT Protocol

Student Guide

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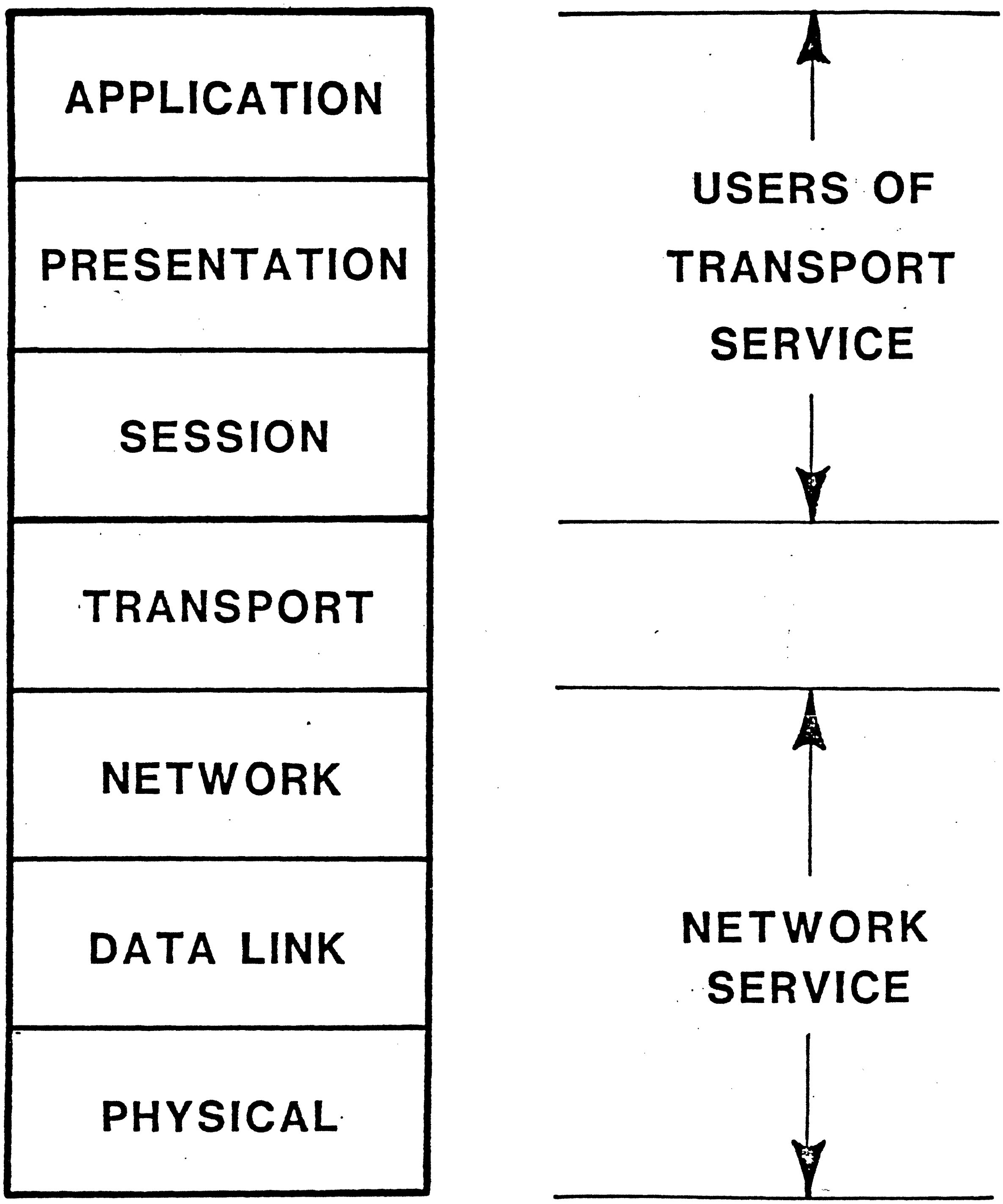
MUXPORT SEMINAR

NATIONAL TECHNICAL SUPPORT

STUDENT HANDOUT

Prepared by: Bart M. Zaino

LAYERS OF MODEL



REF. Pg 1-2

LAYERS OF OSI REFERENCE MODEL

APPLICATION LAYER - Directly serves the end-user, which is the application process (AP), by providing the distributed information service to support the AP and manage the communication.

PRESENTATION LAYER - Provides the services to allow the AP to interpret the meaning of the information exchanged. Translation and formatting of information is performed at this layer.

SESSION LAYER - Supports the dialog between cooperating APs binding and unbinding them into a communicating relationship.

TRANSPORT LAYER - Provides end-to-end control and information interchange with the level of reliability that is needed for the application. The services provided to the upper layers are independent of the underlying network implementation.

NETWORK LAYER - Provides the means to establish, maintain, and terminate the switched connections between end-systems. Included are addressing and routing functions. An additional global sublayer may also be provided to ensure a consistent quality of service on connection traversing more than one network. The interface between this layer and the transport layer provides services that are independent of the underlying media.

DATA LINK LAYER - Provides the synchronization and error control for the information transmitted over the physical link.

PHYSICAL LAYER - Provides the electrical, mechanical, functional, and procedural characteristics to activate, maintain, and deactivate the physical connection.

LAYER CONCEPT

o Each layer requests services from the layer below and provides servicees to the layer above.

o Each layer is built on the capabilities of the layers below it.

o Layers appear to communicate only with their Peer layer.

```
  SERVICES                                               (Functions
      ^                   (n + 1) layer                   Provided)
------+---------------------------------------------------------
      |
+-----------+                                   +-----------+
| SYSTEM A  |                                   | SYSTEM B  |
| LAYER X   |<------- PEER PROTOCOL --------->| LAYER X   |
+-----------+                                   +-----------+
                        n layer                       ^
------------------------------------------------------+--------
(Requirements           (n -1) layer                  |
 of the layer)                                    SERVICES
```

REF Pg 1-3

REF. pg 1-6

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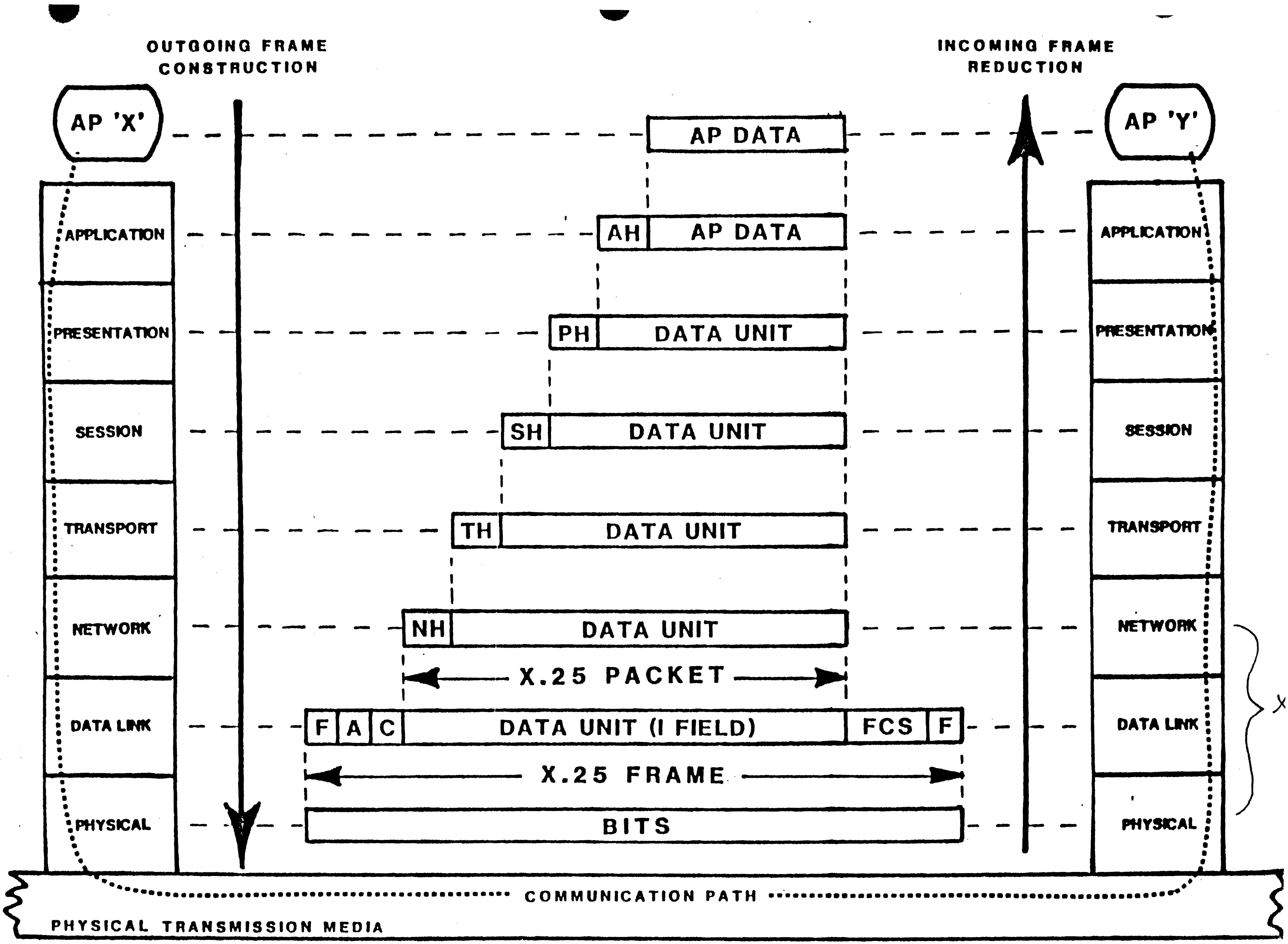
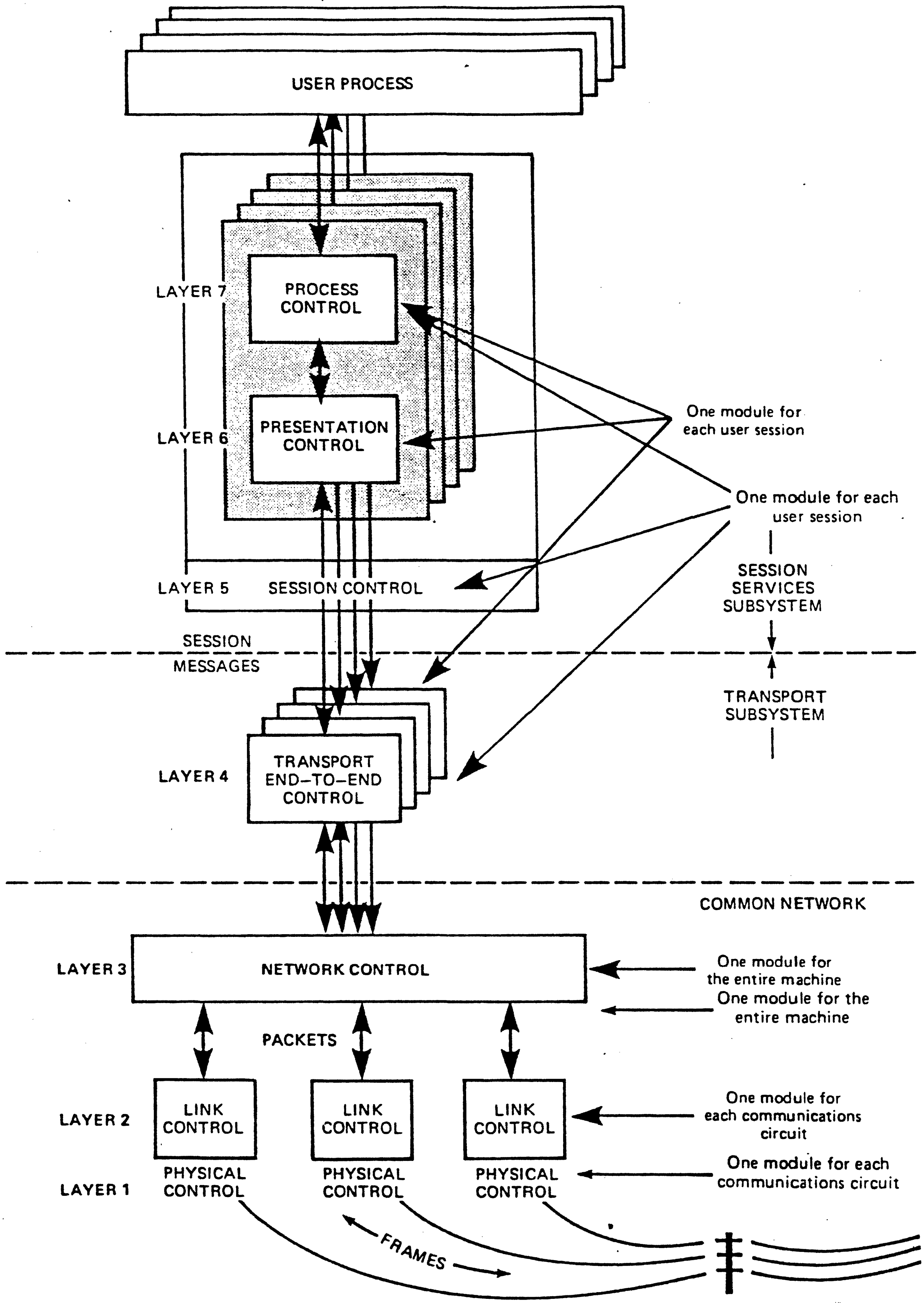
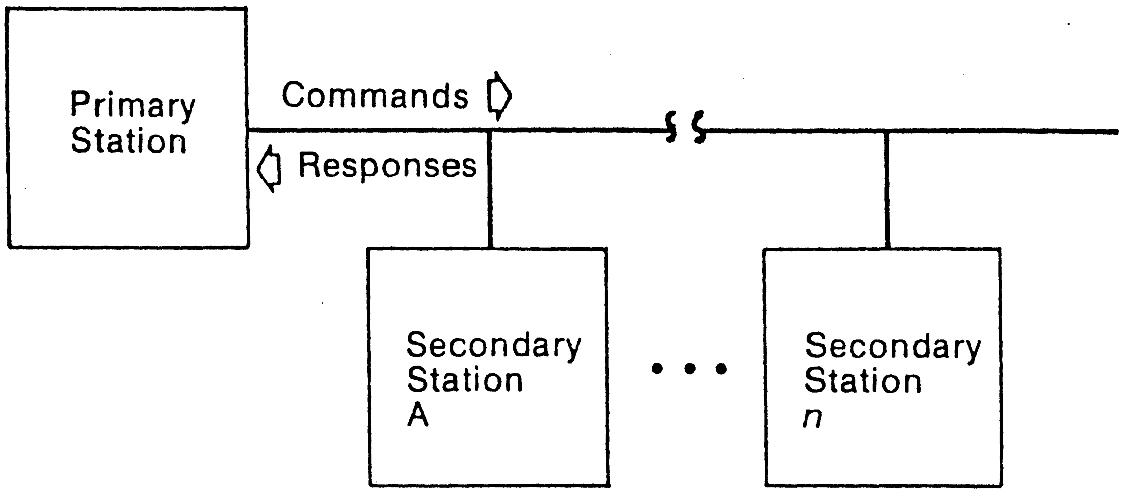
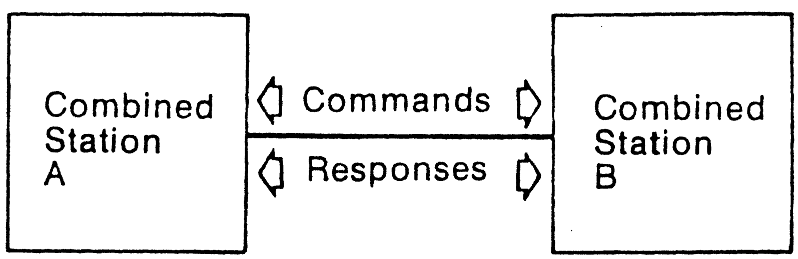


OUTGOING FRAME CONSTRUCTION
INCOMING FRAME REDUCTION
AP 'X'
AP 'Y'
AP DATA
AH
AP DATA
PH
DATA UNIT
SH
DATA UNIT
TH
DATA UNIT
NH
DATA UNIT
X.25 PACKET
F
A
C
DATA UNIT (I FIELD)
FCS
F
X.25 FRAME
BITS
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL
COMMUNICATION PATH
PHYSICAL TRANSMISSION MEDIA


USER PROCESS
LAYER 7
PROCESS CONTROL
LAYER 6
PRESENTATION CONTROL
One module for each user session
One module for each user session
LAYER 5
SESSION CONTROL
SESSION SERVICES SUBSYSTEM
SESSION MESSAGES
TRANSPORT SUBSYSTEM
LAYER 4
TRANSPORT END-TO-END CONTROL
COMMON NETWORK
LAYER 3
NETWORK CONTROL
One module for the entire machine
One module for the entire machine
PACKETS
LAYER 2
LINK CONTROL
LINK CONTROL
LINK CONTROL
One module for each communications circuit
LAYER 1
PHYSICAL CONTROL
PHYSICAL CONTROL
PHYSICAL CONTROL
One module for each communications circuit
FRAMES



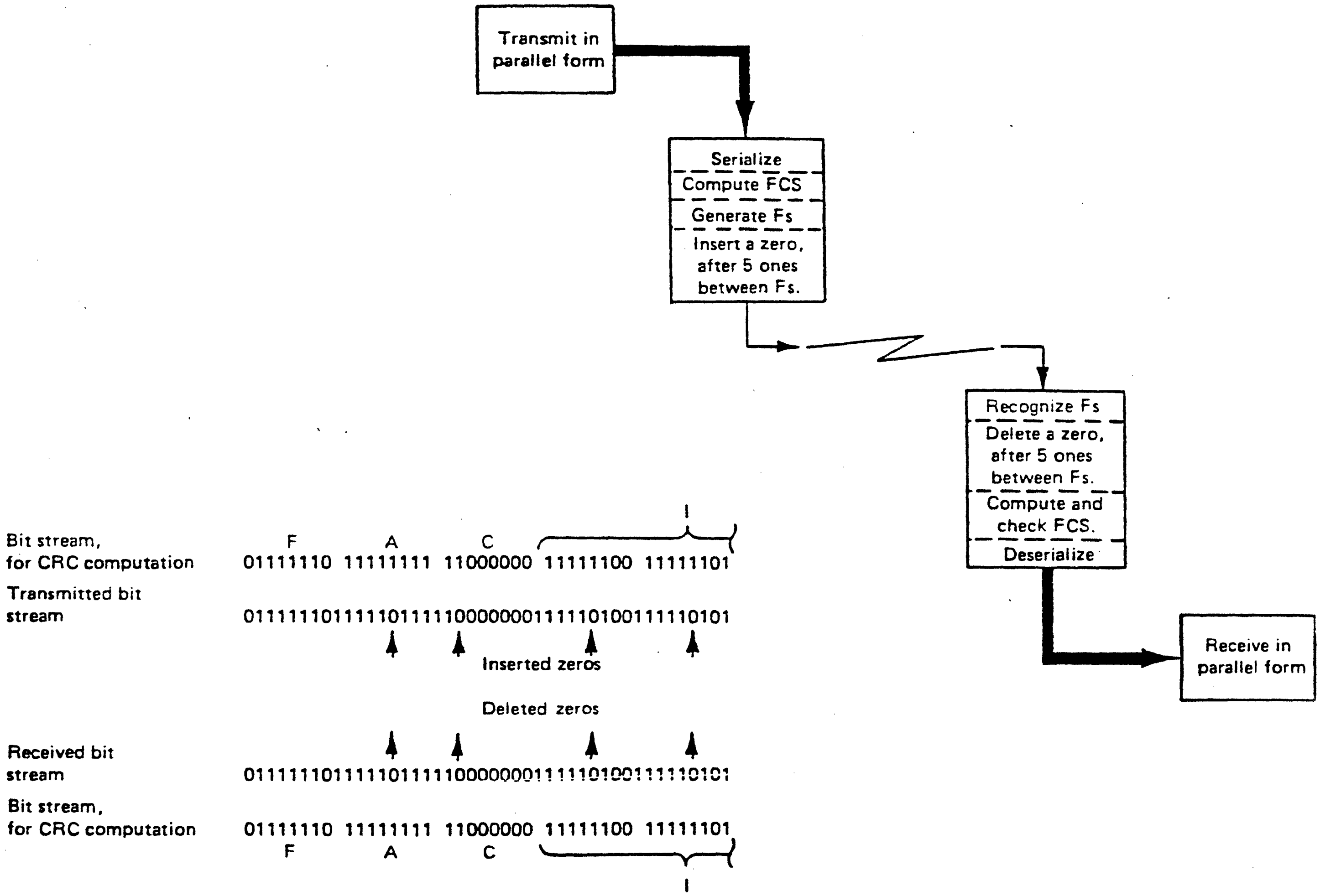
a. Unbalanced Configuration



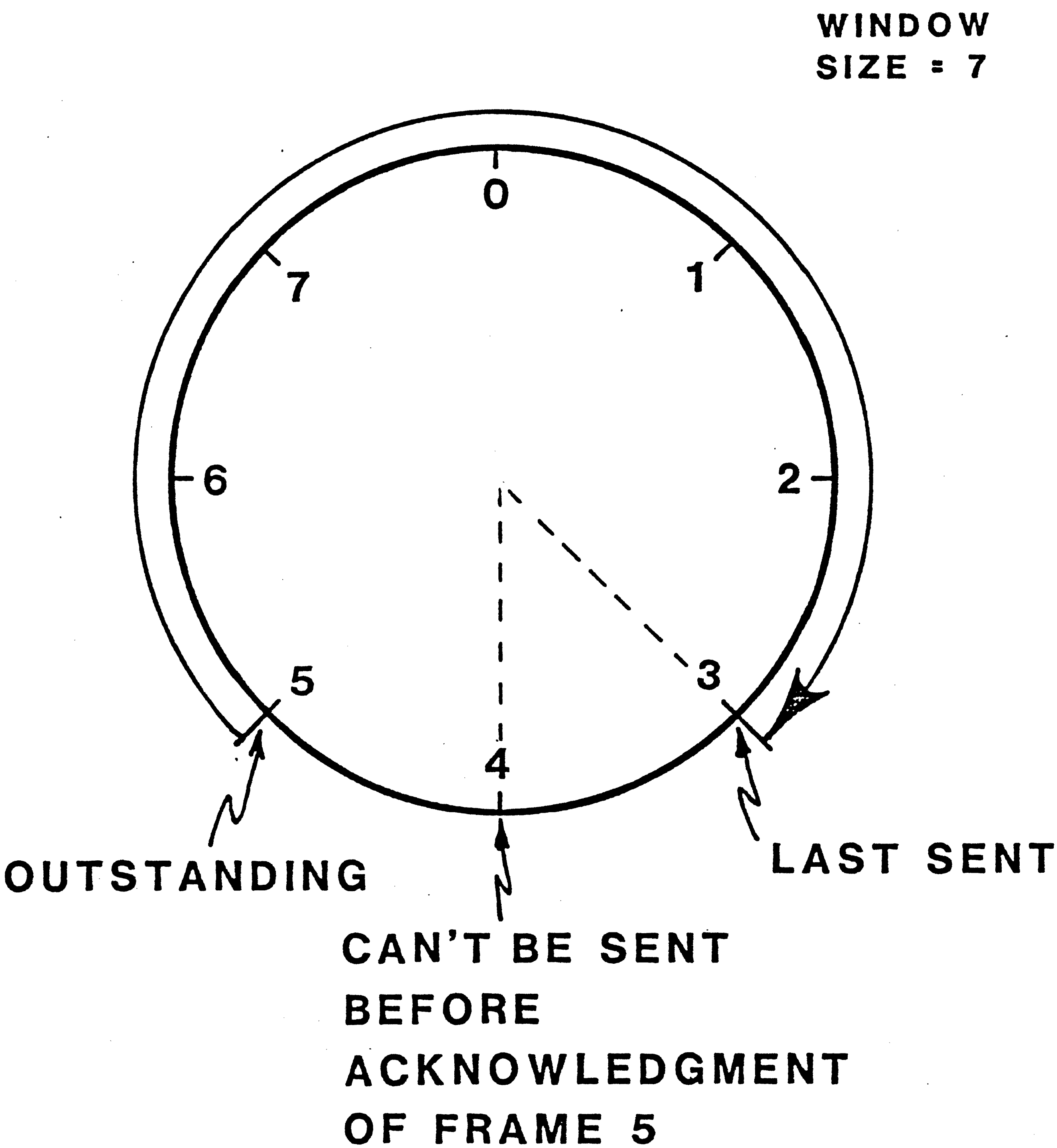
b. Balanced Configuration

REF. Pg 2-2

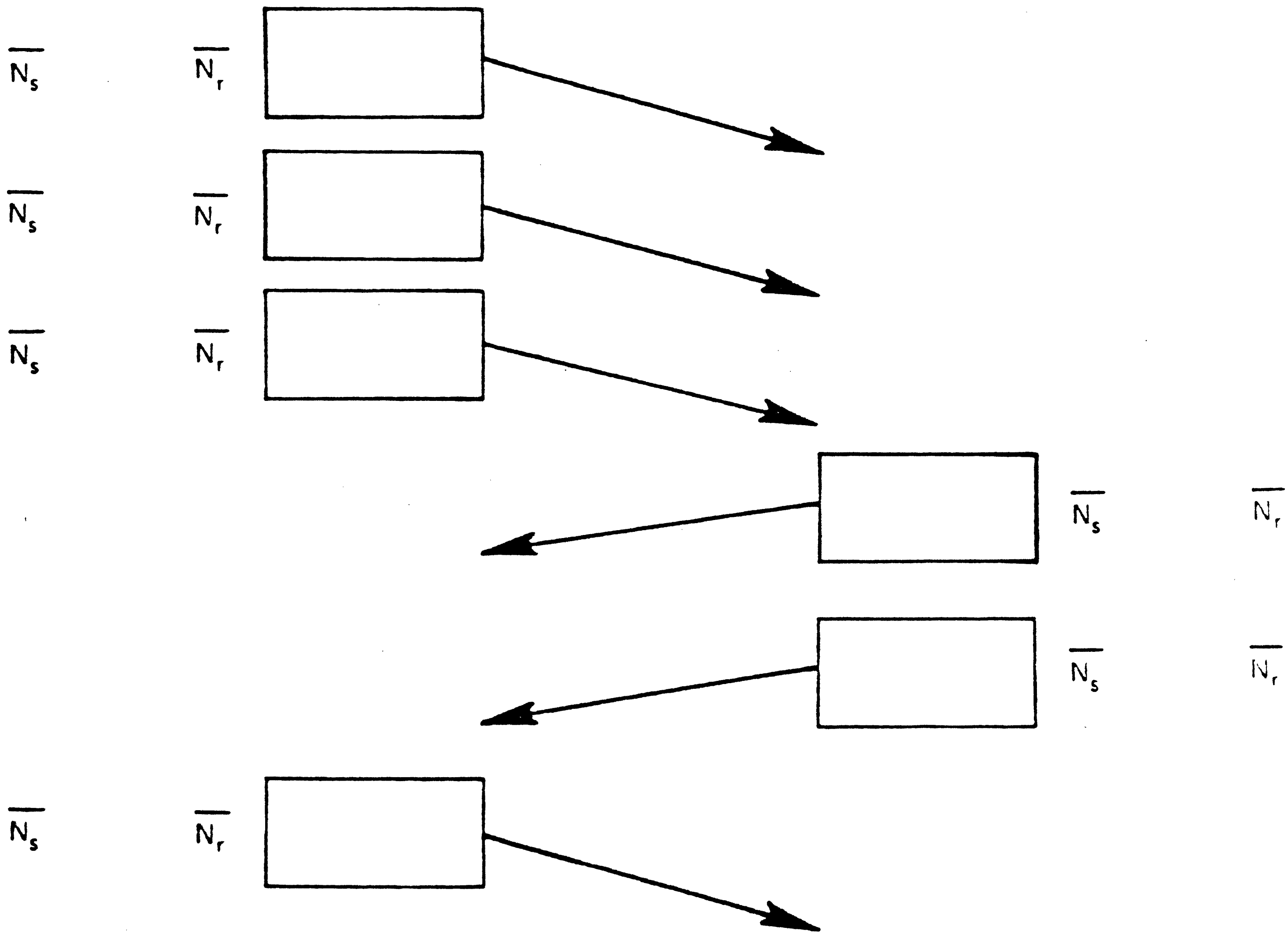
ZERO INSERTION (BIT STUFFING)



WINDOW CONTROL



REC. PG. 2-10


$\overline{N_s}$ $\overline{N_r}$
$\overline{N_s}$ $\overline{N_r}$
$\overline{N_s}$ $\overline{N_r}$
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$\overline{N_s}$ $\overline{N_r}$
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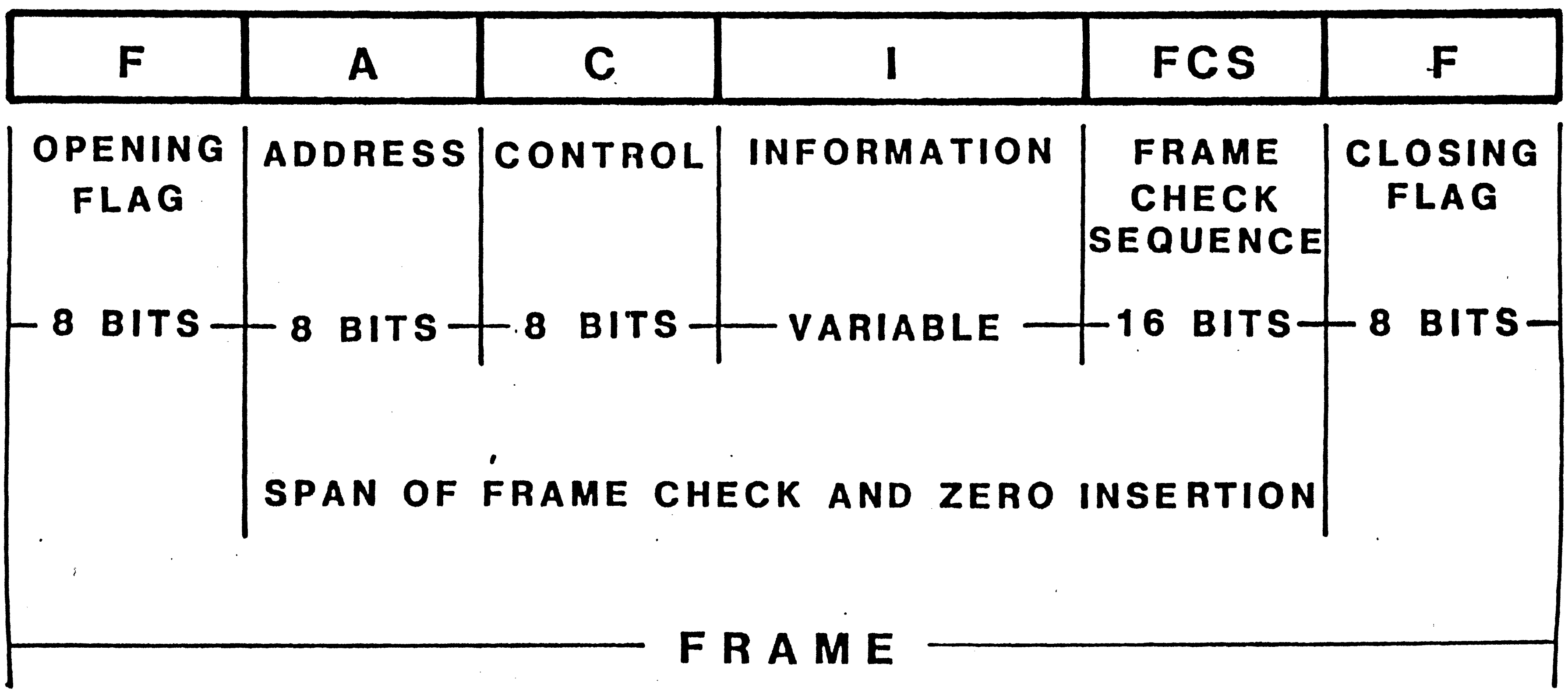
REF. Pg. 2-10

REF. Pg 2-4

FRAME STRUCTURE



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NON EXTENDED

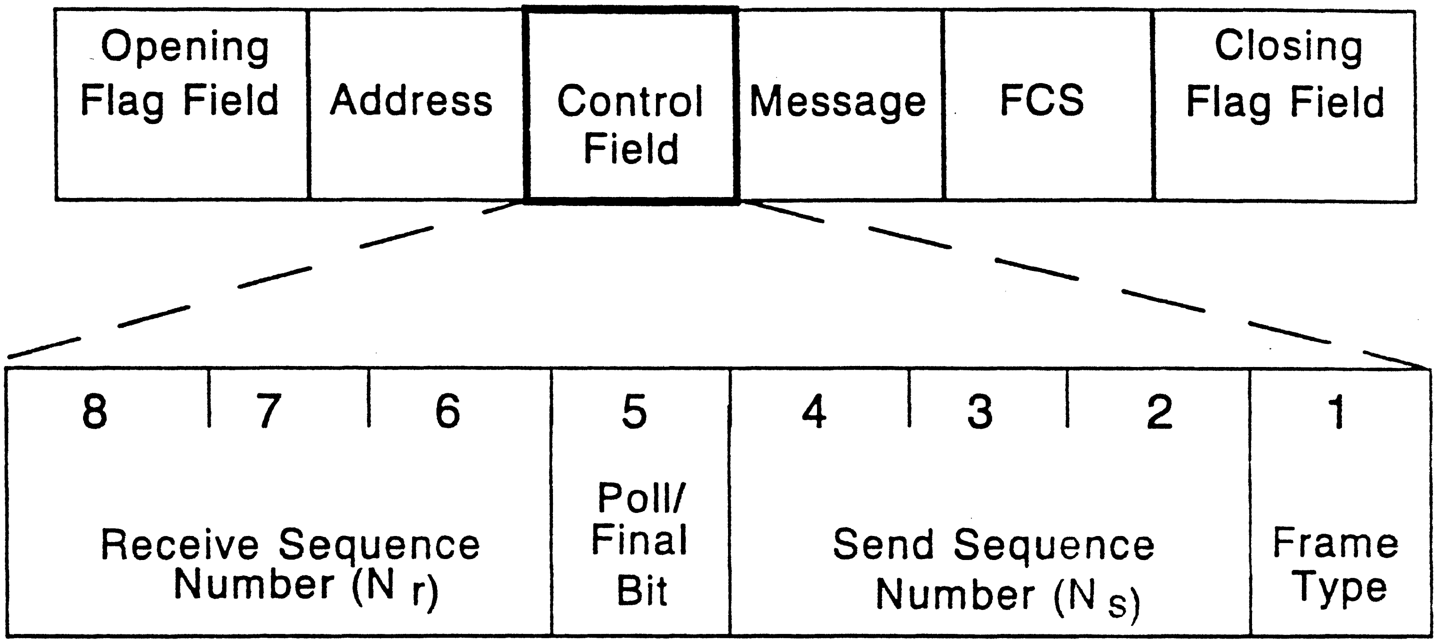
FRAME TYPE	8	7	6	5	4	3	2	1
I-FRAME	Nr			P/F	Ns			0
S-FRAMES	Nr			P/F	S	S	0	1
U-FRAMES	M	M	M	P/F	M	M	1	1
								LSB

EXTENDED

TYPE	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
I-FRAME	Nr							P/F	Ns							0
S-FRAME	Nr							P/F	X	X	S	S	S	S	0	1
U-FRAME	0	0	0	0	0	0	0	P/F	M	M	M	X	M	M	1	1
																LSB

Ref. pg 2-5

Information "I" Format



REF. Pg. 2-10

Supervisory "S" Format

Opening Flag Field	Address	Control Field	FCS	Closing Flag Field

8	7	6	5	4	3	2	1
Receive Sequence Number (N_r)			Poll/ Final Bit	Command/ Response		Frame Type	

REF. Pg. 2-9

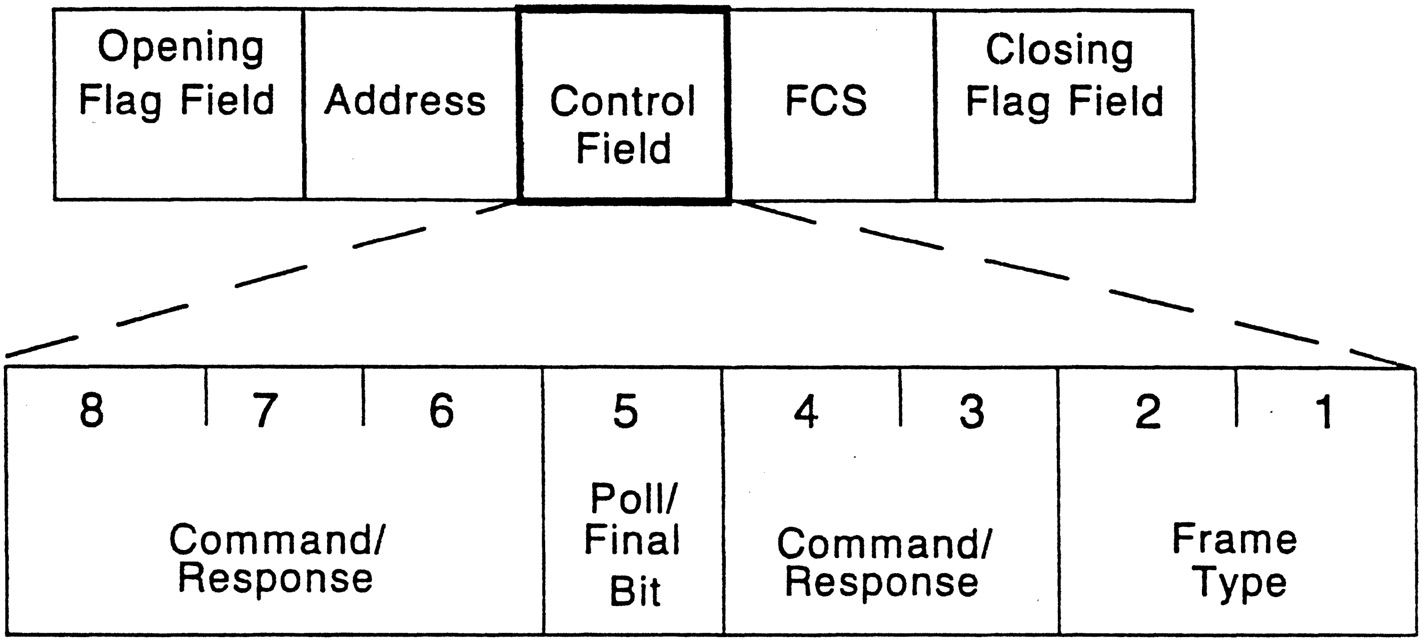
SUPERVISORY FORMAT (S-FRAME)

FLAG	ADDRESS	CONTROL	FCS	FLAG

Command/Response	8 7 6	5	4	3	2	1	Name
Receiver Ready	Nr	P/F	0	0	0	1	RR
Receiver Not Ready	Nr	P/F	0	1	0	1	RNR
Reject	Nr	P/F	1	0	0	1	REJ
Selective Reject	Nr	P/F	1	1	0	1	SREJ

REF Pg 2-9

Unnumbered "U" Format



REF. Pg 2-7

UNNUMBERED FORMAT (U-FRAME)

FLAG	ADDRESS	CONTROL	FCS	FLAG

Command/Response	8	7	6	5	4	3	2	1	Name
Set Normal Resp. Mode	1	0	0	P	0	0	1	1	SARM
Set Normal Resp. Mode Ext.	1	1	0	P	1	1	1	1	SNRME
Set Async Resp. Mode	0	0	0	P	1	1	1	1	SARM
Set Async Resp. Mode Ext.	0	1	0	P	1	1	1	1	SARME
Set Async. Balanced Mode	0	0	1	P	1	1	1	1	SABM
Set Async Bal. Mode Ext.	0	1	1	P	1	1	1	1	SABME
Disconnect	0	1	0	P	0	0	1	1	DISC
Set Initialize Mode	0	0	0	P	0	1	1	1	SIM
Exchange Station ID's	1	0	1	P/F	1	1	1	1	XID
Unnumbered Acknowledge	0	1	1	F	0	0	1	1	UA
Disconnect Mode	0	0	0	F	1	1	1	1	DM
Request Disconnect	0	1	0	F	0	0	1	1	RD
Request Initialize Mode	0	0	0	F	0	1	1	1	RIM
Command (Frame) Reject	1	0	0	F	0	1	1	1	CMDR
Unnumbered Poll	0	0	1	P	0	0	1	1	UP
Unnumbered Information	0	0	0	P/F	0	0	1	1	UI

REF 2-7

Layer	ISO / X.25	SNA	DECNET	MUXPORT
7	APPLICATION	END USER	APPLICATION	NOT USED BY MUXPORT PROTOCOL
6	PRESENTATION	NAU SERVICES		
5	SESSION	DATA FLOW TRANSMISSION		
4	TRANSPORT		NETWORK SERVICES	
3	NETWORK/PACKET	PATH CONTROL	TRANSPORT	CONNECTION MUX
2	DATA LINK/HDLC	SDLC	DDCMP	ARQ LINE
1	PHYSICAL	PHYSICAL	PHYSICAL	PHYSICAL

MUXPORT PROTOCOL SUMMARY

- o GENERAL
  - Four layer protocol
  - X.25 level 2 & HDLC line layer compatible
  - Balanced mode operation

- o LINE LAYER
  - FCS calculation
  - Zero insertion
  - Idle fill
  - Abort & flag generation/detection

- o ARQ LAYER
  - Address & control field processing
  - Error recovery
  - State machine/timer maintenance

- o MUX LAYER
  - Compiles data & control information
  - Multiplex data
  - VCTP operation
  - Formats data, control & supervisory slots

- o CONNECTION LAYER
  - Transfer data to/from customer equipment
  - Perform ISCC functions
  - Manage flow control

Ref 3-2

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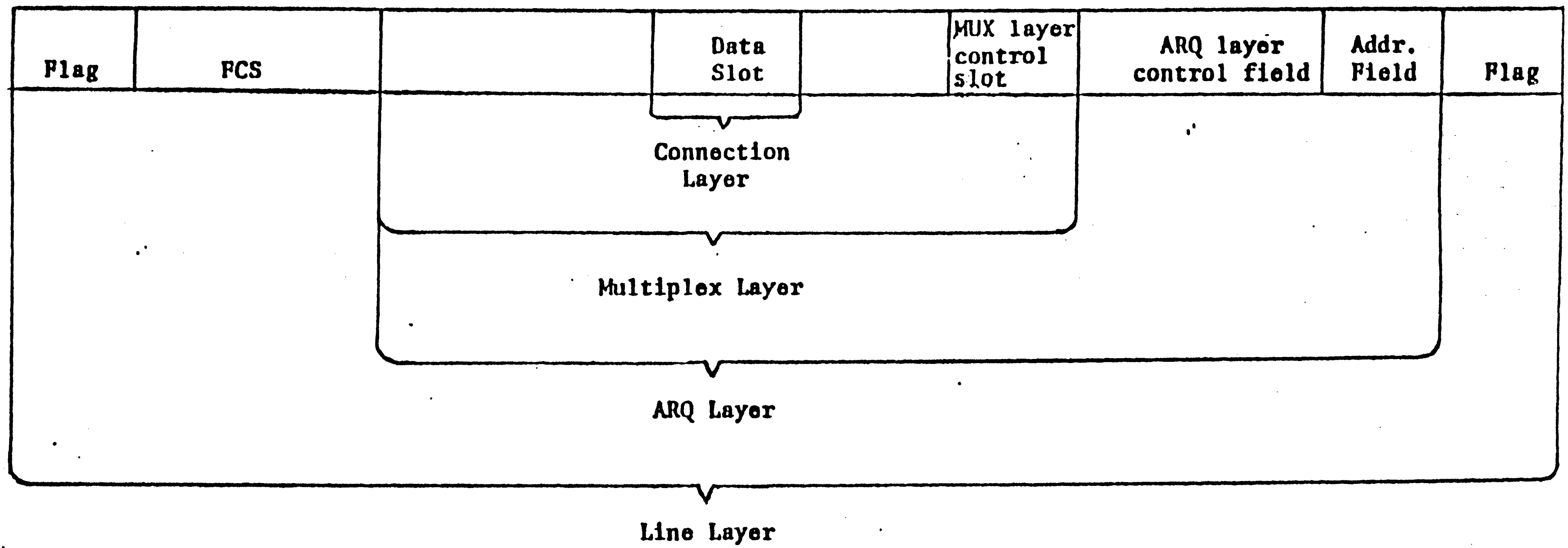


Protocol Layers

Line Layer Functions

- Performs FCS calculation.
- Maintains data transparency through zero insertion technique.
- Performs frame pacing and idle line fill.
- Idle fill is the transmission of flags (7E).
- Frame pacing is the transmission of 'empty' frames to keep the muxports in sync when no traffic is present.

Ref 3-3

Idle Sequences By Product

6005 - Sends RR's when connected to 6050, 6040, 6760.
Connected to a 6740 it sends a RR then an empty I-Frame.

6050 - Sends empty data frames (I-Frames).

6040 - Same as the 6050.

6740 - Sends a RR then an empty I-Frame.

6760 - Same as the 6050.

REF Pg 3-3

MUXPORT ARQ LAYER FUNCTIONS

- o Addressing of each station using X.25 LAPB notation.
- o Frame definition (control field interpretation).

REF A 3-3

MUXPORT FRAME ADDRESSING

- o Primary is addressed as 'B' = 0000001 = 01 = DCE.
- o Secondary is addressed as 'A' = 00000011 = 03 = DTE.
- o Commands contain the address of the receiving unit.
- o Responses contain the address of the transmitting unit.
- o The exception is the 6050 who always sends address 'A'.

REF 2-13 & 3-3

FRAME TYPES SUPPORTED

FRAME	8 7 6	5	4 3 2 1	DESCRIPTION
	control field			
I-FRAME	Nr	P/F	Ns ¦ 0	Information
S-FRAME	Nr	P/F	0 0 0 1	RR (Receiver ready)
	Nr	P/F	0 1 0 1	RNR (Receiver not ready)
	Nr	P/F	1 0 0 1	REJ (Reject)
U-FRAME	0 0 1	P	1 1 1 1	SABM async balanced mode
	0 1 1	P	1 1 1 1	SABME (SABM - extended
	0 1 1	F	0 0 1 1	UA (unnumbered Ack.)
	1 0 0	F	0 1 1 1	FRMR (Frame reject)

REF Pg 3-3

FRAME REJECT COMMAND

Normal Mode

FRMR	8	7	6	5	4	3	2	1
Byte #1	1	0	0	F	0	1	1	1
Byte #2		Rejected Control field						
Byte #3		Vr		C/R			Vs	
Byte #4	0	0	0	0	Z	Y	X	W

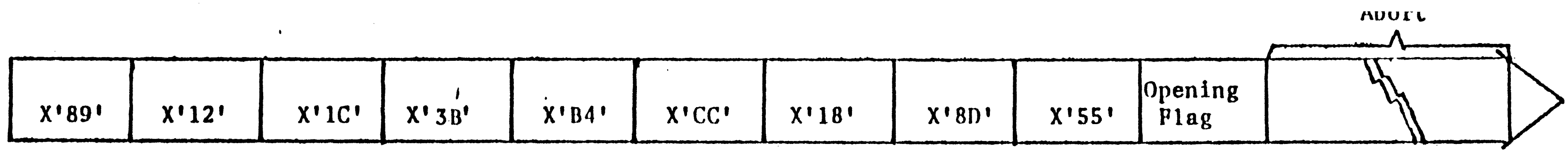
Where:

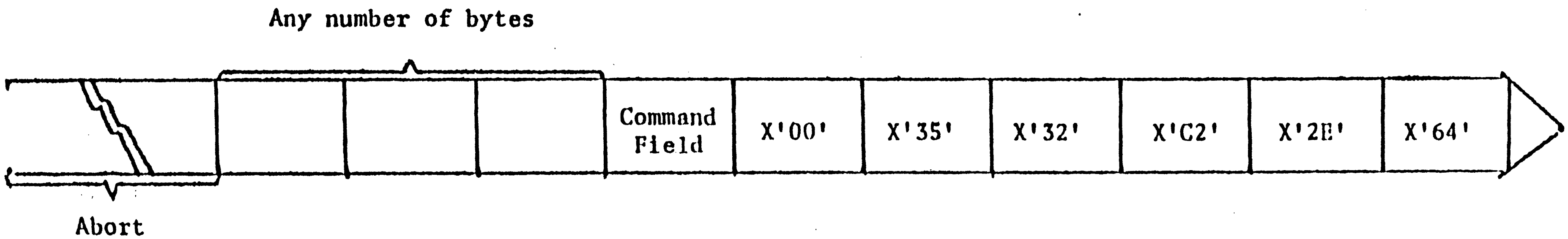
Byte #1 = The Frame reject command control field.
Byte #2 = The rejected control field.
Byte #3 Vs = The current value of the XMT state variable.
Vr = The current state of the RCV state variable.
C/R = Indicates if the frame rejected was a command (0) or a response (1).
W = If = to "1" indicates the control field is invalid.
Byte #4 X = If = to "1" indicates the control field received is invalid because a data field was in an S or U-Frame.
Y = If set to "1" indicates that the I-field received exceeded the maximum allowable limit.
Z = If set to "1", indicates the control field received contained an invalid Nr count.

Extended Mode

FRMR	8	7	6	5	4	3	2	1
Byte #1	1	0	0	X	0	1	1	1
Byte #2	0	0	0	0	0	0	0	F
Byte #3	First byte of rejected control field							
Byte #4	Second byte of rejected control field							
Byte #5				Vr				0
Byte #6				Vs				C/R
Byte #7	0	0	0	0	Z	Y	X	W

REF R 3-4





Command Field	Unit B	Unit A
Go to Loopback	X'BA'	X'B8'
I am going in Loopback	X'47'	X'45'
Go to Normal	X'46'	X'44'

Remote Reset

MUXPORT STATE MACHINE TIMERS

- T1 TIMER - Used in Link Set-Up to check for its completion. If Link Set-up is not complete when T1 expires the procedure (SABM or SABME) is restarted. T1 is a 3 second timer.

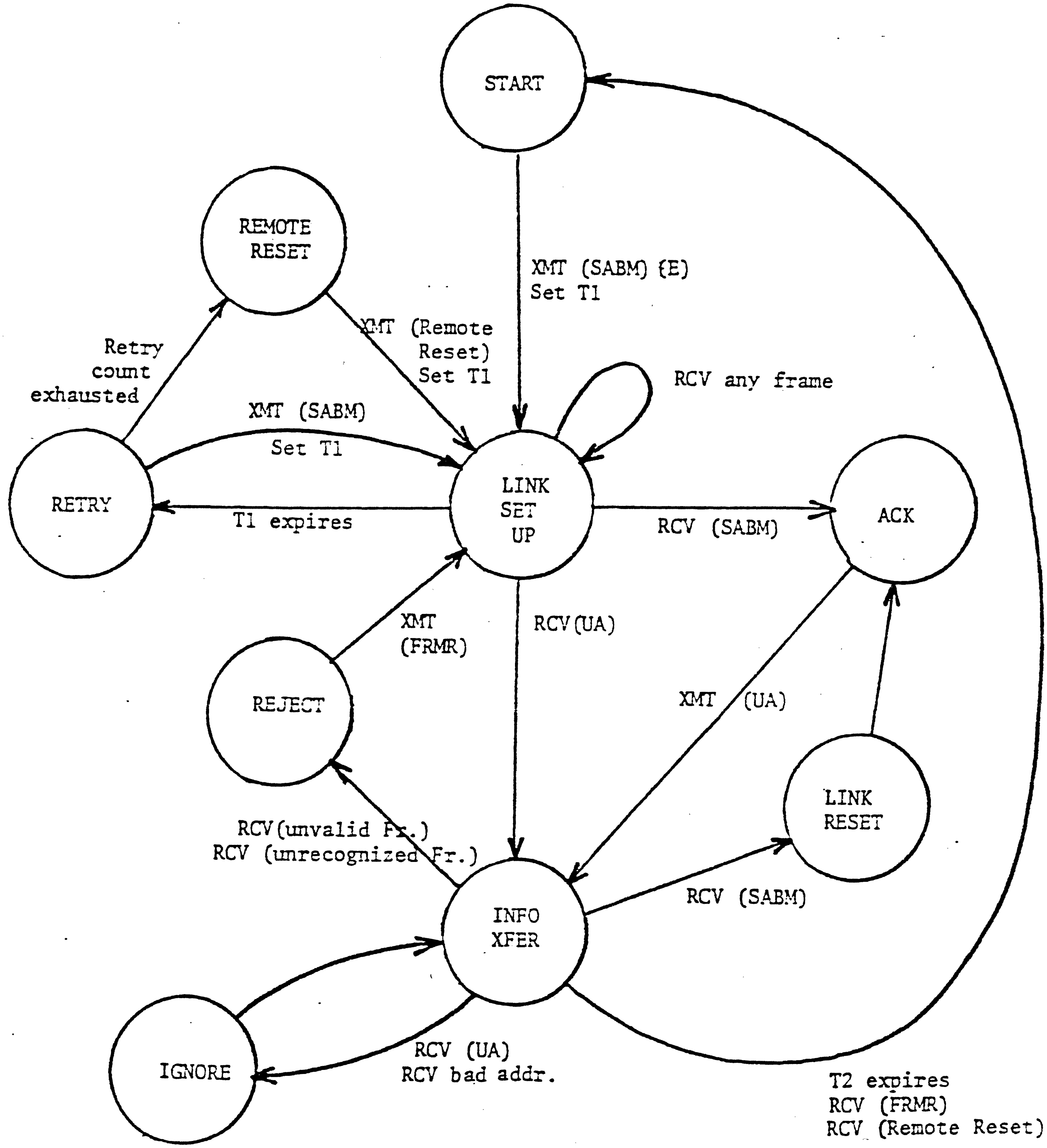
- T2 TIMER - Used in the Information Transfer state as a framing timer. When a frame is transmitted T2 starts and is not stopped until an ack. for the frame is received. If T2 expires the link set up procedures (SABME) start. T2 = 20 sec.

- N2 COUNTER - Used in link set up. The maximum number of SABM(E)'s sent before a remote resetis sent. N2 = 20 tries

- N1 COUNTER - The maximum number of bits allowed in a frame. If exceeded the frame is rejected. N1 = 16,0000 bits/frame.

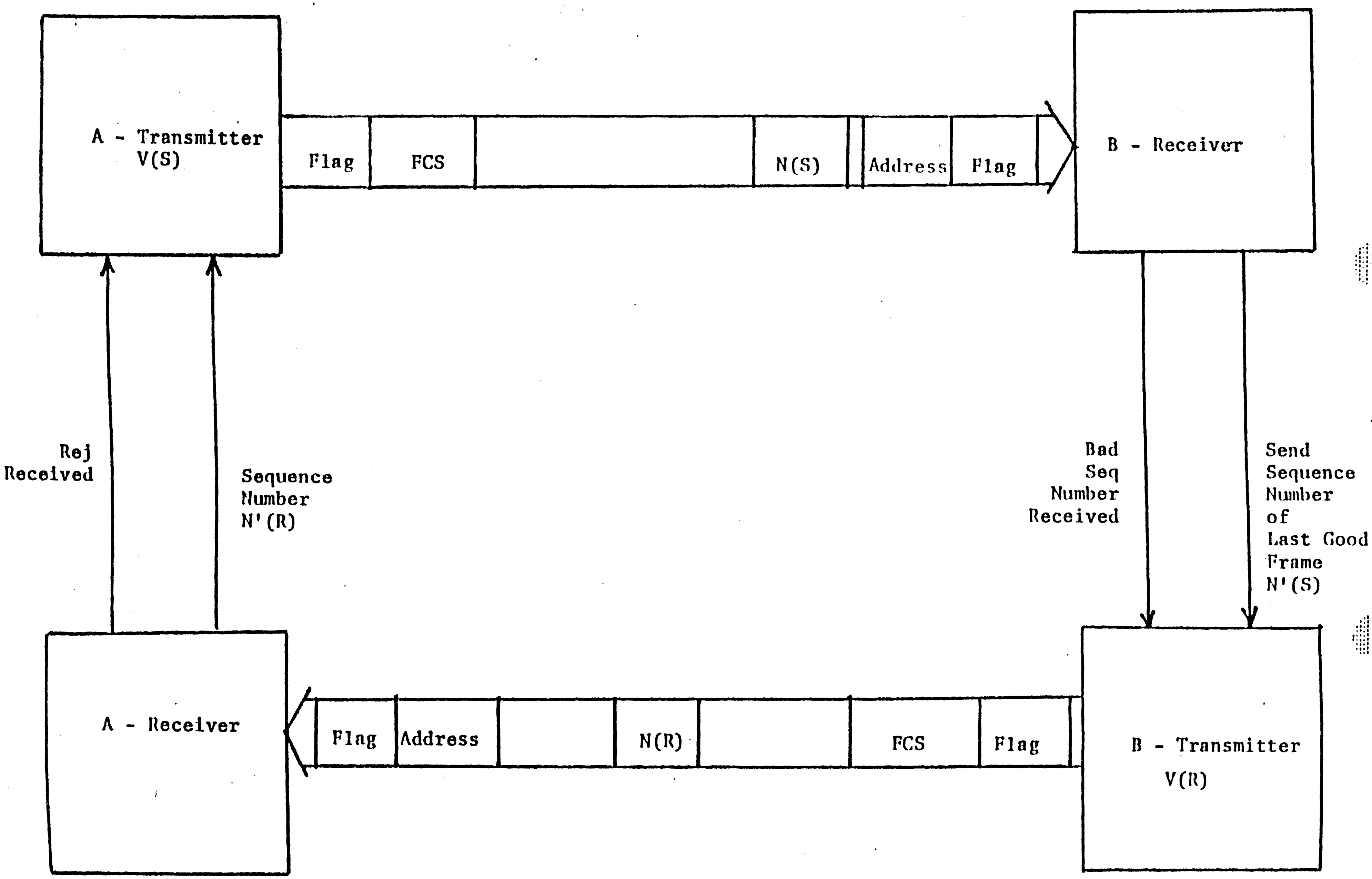
- RC COUNTER - The retransmission counter, or the number of times to retransmit a frame. RC = 20 retransmits.

REF Pg 3-6



LINK SET UP STATE and
EXCEPTION TRANSITIONS FROM INFORMATION TRANSFER STATE

REF Pg 3-10



ARQ Operation
A to B Information Transfer

Ref Pg 3-8

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MUX LAYER FUNCTIONS

- o The actual multiplexing of data occurs here.
- o Compile the information field of Muxport I-Frames.
- o Responsible for the format of data and supervisory information, provided by the connection layer.
- o Control information is added by this layer

REF Pg 3-13

MUXPORT CONTROL SLOT FORMAT

```
+------------------------------------\ /-------------------------+
| FLAG | A | C |80 AA BB  XXXXXXXXXX   Rest of Frame |FCS | FLAG |
+--------------|--|--|-------|------\ /-------------------------+
               |  |  |       |________Command Dependent Parameters
   Control slot_|  |  |_ Command Code
   Status Byte     |
                   |_ Byte Count
```

Where:

80 = Control Slot Status Byte (MSB set) indicates control information follows.

AA = Byte Count, the number of control information bytes to follow.

BB = Command Code indicates one of the following commands:

Rec Pg 3-13

CONTROL SLOT COMMAND CODES

0 Error Message Report
1 Read Port Configuration Parameters
2 Return Port Configuration Parameters
3 Write Port Configuration Parameters
4 Write Acknowledge Port Configuration Parameters
5 Read Port Statistics
6 Return Port Statistics
7 Read Statistics Threshold
8 Return Statistics Threshold
9 Write Statistics Threshold
A Write Acknowledge Statistics Threshold
20 CTP Command
21 CTP Response (continuing)
22 CTP Response (completed)
23 Unsolicited Error Messages and Reports
24 End of VCTP
25 Address Packets
27 6740 Protocol Announcement
29 6005-6005 Move TP Configuration Command

MUXPORT DATA SLOT HEADER FORMAT

```
NORMAL                     XXXXX ¦ XXX
                               ¦       ¦ LSB
                               ¦       ¦
   Thread Number              _¦       ¦__ number of bytes to follow 1 - 7
   add powers of "2"
   for max address of 31   ( 2^4 ,2^3 ,2^2 ,2^1 ,2^0  )


EXTENDED/LONG              XXXXX ¦ 000  XXXXXXXX
                               ¦       ¦      ¦
                               ¦       ¦      ¦
     Thread Number          ___¦       ¦      ¦_ bytes to follow 8 - 255
                                       ¦
                                       ¦____ Indicates - look at next byte
                                             for number of bytes to follow
```

MUXPORT DATA SLOT FORMAT

```
 ------------------------------------------------------------
|Flag | A |   C    |      I - Field                | FCS | Flag|
+ ----+---+--------+-------------------------------+-----+-----+
|  7E |03 |0Ns  Nr| 00   77   41  42  43 44 45 46 47 |xx xx|  7E |
           |   |          |    |              |
    "A"___|   |          |    |              |___ 7 bytes data (ABCDEFG)
              |          |    |
  I-Frame____|          |    |
                         |    |
Control Status Byte___|    |_Thread 14, 7 bytes to follow 77 = 01110 111
```

REF Pg 3-15

SUPERVISORY SLOT FORMAT

- o Passes end-to-end flow control information for ports.
- o Interleaved with data slots.

```
+-----------------------------------------------------+
| FLAG | A |   C    |    I FIELD        | FCS   | FLAG|
+------+---+--------+-------------------+-------+-----+
|  7E  |01 | 0Ns Nr| 00 08 02 XX XX     | FCS   | 7E  |
                     |   |  |   |
 Control Status Byte_|   |  |   |
  (DATA)                 |  |   |_ Command Dependent
                         |  |      Supervisory Function
                         |  |
 Slot Header (00001 000)_|  |__ 2 bytes to follow supervisory slot
 Thread #1, long data slot      slot (Long format less than 8 bytes)
 See next byte for length
```

Rec Pg 3-16

CONNECTION LAYER FUNCTIONS

- o Transfers data between the customer and codex equipment.
- o Transfers all data is transferred as eight bit bytes.
- o. Performs the following In-stream control functions:

  a. Control signal updates
  b. Data path initialization
  c. Autospeed
  d. Break
  e. Data slot termination
  f. Transmission of a literal X'01'
  g. Port flow control

REF Pg 3-17

CONTROL SIGNAL UPDATES

- Used to pass the value of terminal or modem signals.
- Updates for DTR, RTS and MB are passed.
- Each CSU begins with the sequence (X'01') followed by a second byte identifying the signal(s) being updated.
- A bit set indicates the signal is 'high' a bit not set (zero) indicates a signal is 'low'.

CSU = 01 1n

Where n = 0 MB RTS DTR

01 10	All signals low	
01 11	DTR high	(bit 0)
01 12	RTS high	(bit 1)
01 13	RTS & DTR high	
01 14	MB high	(bit 2)
01 15	DTR & MB high	
01 16	RTS & MB high	
01 17	Not used for CSU's	
01 40	CSU request to remote	

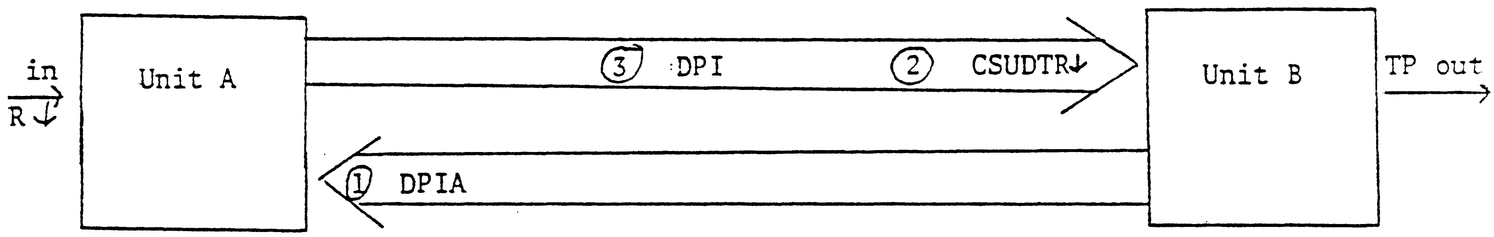
Ref.Pg. 3-17

DATA PATH INITIALIZATION

- o Prevents user data from becoming trapped after an abnormal disconnect sequence. Flushes the port buffers.
- o Two functions are used Data Path Initialization (DPI) and Data Path Initialization Acknowledge (DPIA).
- o When a high to low transition of DTR is detected, a DPI (X'01 20') is sent to the remote unit following a CSU.
- o The remote unit responds with a DPIA (X'01 30').

REF Pg 3-18

Data Path Initialization



Events

1) TP at Unit A senses drop of DTR
2) Unit A sends a CSU to signal DTR
3) Unit A send DPI
4) Unit B responds with DPIA

REF Pg 3-18

BREAK

- A break is a constant space condition.
- Two ISCC functions are used X'7n' and X'80' for break.
- The X'01 7n' is used to initiate the break. The time period (length) of the break is "n" character times.
- If n = 0 the break is continuous.
- The X'01 80' is used to stop the continuous break.

REF Pg 3-13

DATA SLOT TERMINATION

- Added to the end of each of each data slot according to the protocol used.

- Signals the end of the ports allocated space in the Muxport frame. It may be continued in another frame.

Slot Type	Termination sequence
Asynchronous	No termination required
Synchronous	X'01 17'
BOP (flag idle)	X'01 72'
BOP (mark idle)	X'01 72 01 17'
BOP (abort)	X'01 17'

REF Pg 3-18

AUTOSPEED

```
+-------------------------------------------------------------------------------+
|FLAG | A |  C | 00 08 08 01 A6 01 A1 01 A0 01 A2 | FCS | FLAG |
+---------------   |    |       |       |      |      |     --------------+
                   |    |       |       |      |      |
      Status Byte  |    |       |       |      |      |
                        |       |       |      |      |_Hi nibble ARC
    Port 1, 8 bytes    _|       |       |      |
     to follow                  |       |      |_ Lo nibble ARC
                                |       |
      Lo nibble speed code_|    |_ Hi nibble speed code
```

SPEED CODES

SPEED	CODE	SPEED	CODE
50	01	1800	14
75	06	2000	15
110	08	2400	16
134.5	0A	3600	17
150	0B	4800	18
300	0E	7200	1A
600	10	9600	1C
1200	13	19200	1E

REF. Pg. 3-19

FLOW CONTROL

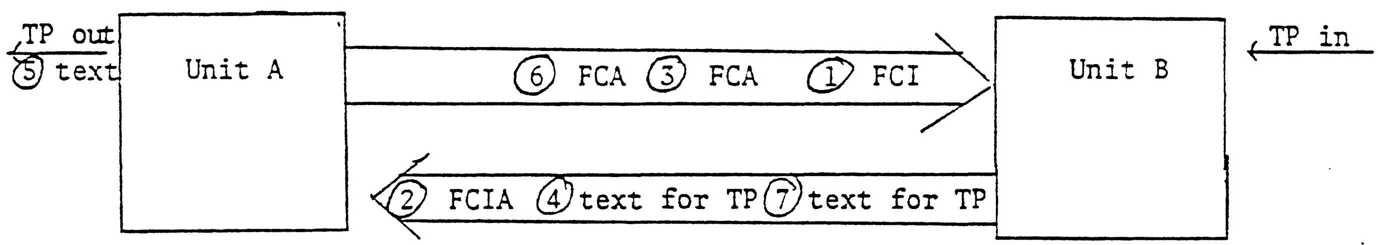
- Does not use an X'01' escape sequence.
- Transmitted in supervisory slots.
- Used to regulate the flow of data between ports.

X'10'	FCI - (Flow Control Initialization) sent by the controlling port to initiate flow control.
X'11'	FCIA - (Flow Control Initialization Acknowledge) Affirmation sent by port to be controlled.
X'2n'	FCA - (Flow Control Authorization) Sent to controlled port (n+1) *16 = number of bytes authorized for transmission.
X'12'	FCIR - (Flow Control Initialization Request) Sent by controlled port asking to send more data.
X'01 40'	FCD - (Flow Control Disable) Signal to controlled port that data flow is not controlled.

REF Pg 3-20

Figure 2.4-3

Flow Control - No lost FCAs



Events

1) Unit A sends FCI
2) Unit B responds with FCIA
3) Unit A responds with FCA
4) Unit B sends text
5) Unit A outputs text
6) Unit A sends FCA
7) Unit B sends text

Ref Pg 3-21

JUPITER PROTOCOL OVERVIEW

- o An enhanced version of Codex Muxport Protocol.
  - o Requires a 6740 Network port or Muxport.
  - o Runs in extended mode only.
  - o Enhancements over CMP for 6740 delta networks.
    1. Multiple 'paths' for data transfer.
    2. Frame routing at the ARQ level.
    3. Flow control on a per path basis.

REF Pg 4-1

NPP OVERVIEW

- o Network Port Processor.
- o Used to transfer data between the master processor and the configured links.
- o Up to 4 links are available per NPP.
- o NPP's can run a combination of Jupiter or CMP.
- o Link connection establishment.
- o Thread and link routing and rerouting.
- o Act as an endpoint for Muxport connections.

o Provide 'special' Muxport 'EXTRA FUNCTIONS"

1. Loopback.
2. Data monitoring.
3. FOX diagnostics.
4. UDR (Hunt Group)

NPP DATA FLOW - RECEIVE

- A valid HDLC address is received.
- If the frame is destined for another node, the frame is held in a buffer until it is complete then sent to its final destination.
- Local frames are scanned by the NPP for frame type.
- U and S-Frames are processed immediately and discarded.
- I-Frames are demultiplexed, flow control information reformatted, extra functions invoked and sent to the Switch processor for distribution to the TP's.

REF Pg 4-2

NPP DATA FLOW - TRANSMIT

- o NPP obtains data for the specified link and path.
- o The data is 'packed' (stored) for the frame.
- o Extra functions are performed for Mux links.
- o The data is multiplexed into data slots.
- o Flow control information is added.
- o Control slots are added (if required).
- o The HDLC address and sequence numbers are added.
- o The frame is transmitted over the link.

REF Pg 4-2

PATH DEFINITION

- Defines the routing information for traffic between nodes.
- Identifies the route a frame travels between nodes.
- Each path is uni-directional.
- Two paths are required for two-way traffic.
- Multiple slots may travel on the same path.

REF Pg 4-7

PATH NUMBERING

- o Identifies a specific path.
- o Path '0' is used on data sent directly from source to destination.
- o Path '1' is used for frames sent to an intermediate node.
- o Path '2' is used for frames transmitted from an intermediate node to the final destination node.

REF PG 4-7

PATH ENABLING

- o At boot up all paths are disabled, no data flow allowed.
- o Upon NPP initialization path '0' is automatically enabled.
- o Enabling of paths 1 & 2 requires explicit Addressed Packet commands.

```
+----------+                +-----------+                +-----------+
| Node 1   | a            b | Node 2    | c            d |  Node 3   |
|          |--------------->|           |--------------->|           |
|__________|   path 0 & 1   |___________|    path 2      |___________|
```

The interaction to enable the paths from node 1 to node 3 is:

```
|------- Node 1 -------><------- Node 2 -------><------ Node 3 ------|

            Jupiter link Set-Up is complete for all nodes

Link 'a' path 0 enabled

Link status broadcast ----->

 Enable path AP (addressed packet)
 link 1 path 'b' --------->
                   <---------Path Enabled

                             Enable Path AP --------->
                             Link 'c'path 2
                                           <----------Path Enabled

                             Enable Path AP ---------->
                             link 'd' path 2

                                            <----------Path Enabled
                <----------- Path Enabled
```

Ref. Pg. 4-8

PATH REROUTING

```
                              +-------------+
          path 0          f   |   Node 3    |  d      path 1
          +-------------------|             |-----------------+
          |                   |_____________|                 |
          |                                                   |
        e |                                                   | c
+-------------+                                     +--------------+
|   Node 1    |  a       path 2              b      |    Node 2    |
|             |<-----------/x/----------------------|              |
|_____________|                                     |______________|
```

```
<------------ Node 1 -------------><-------------Node 3 -------------

1. Link 'a' goes down
2. Link Status message broadcast ------>
                              <------ Disable path AP is sent
                                      Link a path 2

When all data from path 2
received. Flushing the buffers.

          Disable path reply ---------->

Reconnect destination threads
to alternate path 0 link 'e'
          RRTPATH (reroute)   ---------->
          Link 'd' path 1
                                        Disable path (link 'd' path 1)
                                        Do Not Flush buffers

                                        Send trapped data of path 1
                                        over new path 0 of new link
                                        Remove all outgoing threads
                                        on path 1.

                                        Reconnect source threads
                                        to link 'e' path 0

                              <---------- RRPATH ACK  (data rerouted)
```

JUPITER ARQ LAYER FUNCTIONS

- o Retains the major functions of the CMP ARQ layer:
- o Extended Control field only.
- o Performs path addressing.
- o Frame routing in a 6740 delta network.
- o Link error recovery via the Nrete variable.

Ref Pg 4-3

JUPITER ADDRESS FIELD

- o Path addressing.
- o Frames cannot travel over more than 2 links.

```
        | F | ADDRESS | CONTROL |    DATA    | FCS | F |
         ----     |     -----------------------------
                  |
Bit # | 8  7  6  5  4  3  2  1 |
------+------------------------+
      | 0  0  0  0| PATH | A/B |
```

REF. PG. 4-3

JUPITER CONTROL FIELD

- o Extended control field only
- o Nrete = the window feature used for end to end acknowledgement.
- o Used for error recovery and flow control for paths 1 & 2.

```
 ______________________________________________________
| F | ADDRESS | CONTROL | DATA // | FCS | F |
 --------------          |          -------------------
                         |
                         |
 Bit # | 8   7   6   5   4   3   2   1 |
 ------+-------------------------------+
Byte 1 |             Ns              0 |
Byte 2 |             Nr              P |
Byte 3 | C           Nrete             |
```

Ref Pg. 4-4

JUPITER MUX LAYER FUNCTIONS

o Performs the same functions as the CMP MUX layer.
   1. Multiplex customer data.
   2. Control slot commands.

o Two Jupiter specific Command Codes.
   1. Addressed packet, #25.
   2. Protocol announcement, #27.

```
+---------------------------------------------------------+
| FLAG | A | C |80 BC CC  XXXXX..... DATA    |FCS | FLAG |
+--------------|  |  |     |    ---------------------------+
               |  |  |     |
               |  |  |     +-----Command Parameters
Control Slot---+  |  +--Command Code
Status Byte       |
                  +---Byte Count
```

Command Code	Definition
20	VCTP command
21	VCTP response
23	Unsolicited report
24	Quit VCTP mode
25	Jupiter address packet
27	Jupiter protocol announcement

JUPITER ADDRESS PACKETS

- o Command Code of 25.
- o Performs control functions for the NPP.
- o Reinitialize a device, processor, link or thread
- o Statistics.
- o Connection establishment.
- o Error reports.
- o Diagnostics.
- o Link error recovery.

JUPITER ADDRESS PACKET FORMAT

```
+--------------------------------------------------------------------+
¦F¦A¦ C ¦80 BC 25 DN DN DP DP DM DM SN SN SP SP SM SM  DATA...¦FCS¦F¦
+--------------------------------------------------------------------+
```

Where:

```
      80 = Control status byte.
      BC = Byte count (not including self).
      25 = Command code for Addressed Packet.
      DN = Destination node (2 bytes).
      DP = Destination port (2 bytes)
      DM = Destination software module (2 bytes)
      SN = Source node (2 bytes). MSB = 1 for response, 0 for command
      SP = Source port (2 bytes)
      SM = Source software module
    Data = Up to 242 bytes of command dependent data
```

REF Pg 4-5

JUPITER PROTOCOL ANNOUNCEMENT

- o Identified by a command code of 27.
- o Always sent by a Jupiter NPP whenever a link comes up.
- o Indicates the senders identity.
- o Defines the link parameters.
- o. Upon reception of a #27 PA by a Jupiter node:
  1. The CPS (switch) decodes the slot into link status.
  2. Updates the local NPP link variables.
  3. Respond with its own control slot of 27.
  4. both units enter Jupiter protocol data transfer.
- o. A non-Jupiter device receiving a #27 control slot,
  1. The device will reject the control slot.
  2. The original control slot is returned with a CC of A7, this is a 27 and the MSB of the byte is set.
  3. The returned control slot is decoded, by the switch.
  4. The NPP is informed to use Muxport protocol.

REF PG 45

JUPITER PROTOCOL ANNOUNCEMENT FORMAT

```
+-------------------------------------------------------------+
|F|A| C |80 BC 27 N# DC PT  LINK SPECIFICATION...|FCS|F|
+-------------------------------------------------------------+
```

Where:

```
80 = Status control byte.
BC = Byte count (not including self).
27 = Command code for protocol announcement.
N# = Source node number.
DC = Device code (internal use).
PT = Protocol type  0 = Empty
                    1 = IPL
                    2 = Muxport
                    3 = Jupiter
Link Specification = data about the source processor.
```

REF Pg 4-6

CONNECTION LAYER FUNCTIONS

- o Innermost layer of the protocol.
- o Interface to customer equipment.
- o Rerouting of thread data between Jupiter nodes.
- o All CMP connection layer functions performed.

REF PG 4-6

JUPITER SUPERVISORY COMMAND FORMAT

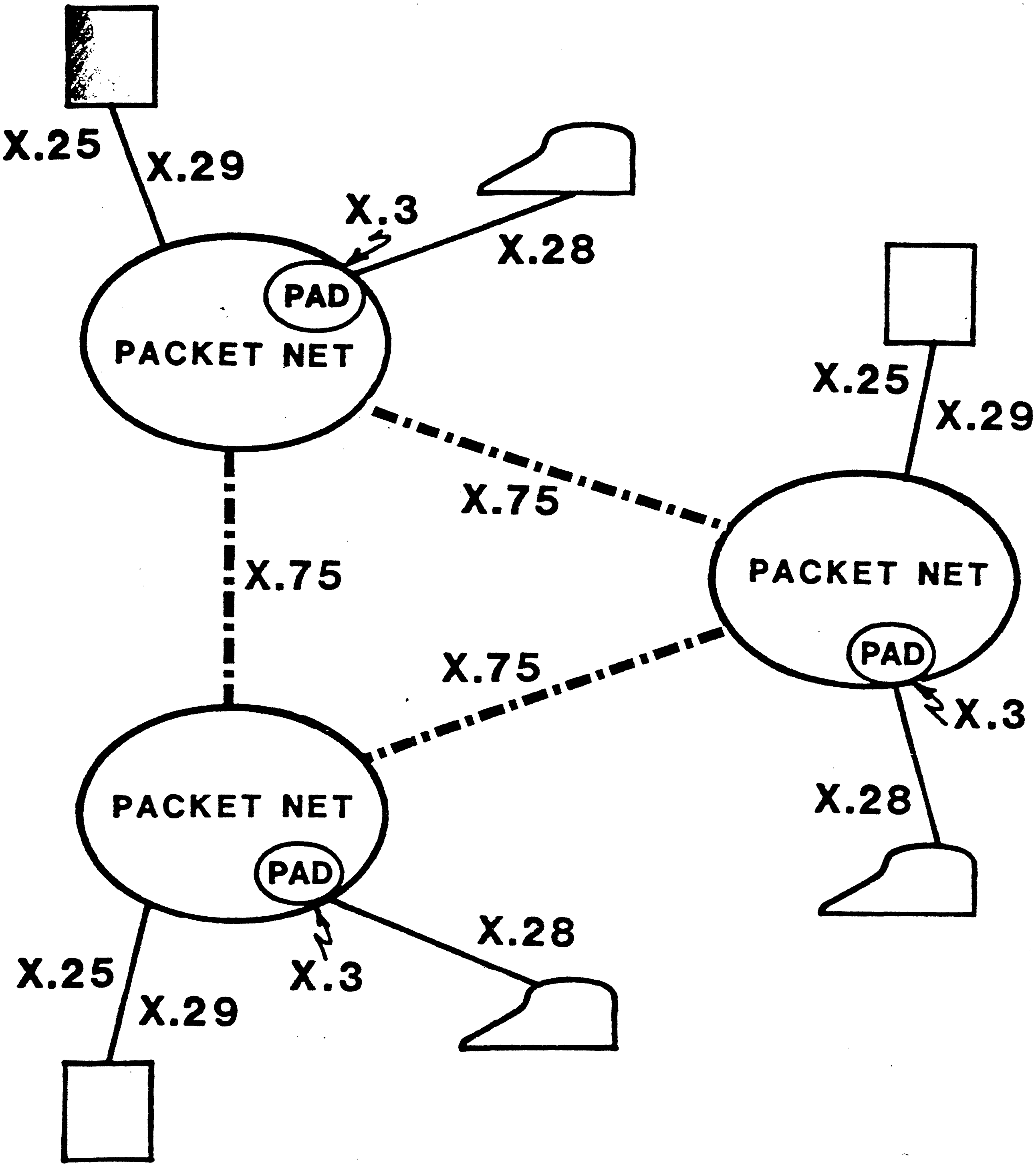
```
+----------------------------------------------+
| FLAG | A |    C    | 00   08   01   SF  | FCS    | FLAG|
+-------------------+ |    |    |    |    +-------+-----+
                      |    |    |    |
                      |    |    |    |
Control Status Byte--+    |    |    |
                           |    |    +--Supervisory Function
                           |    |
            Slot Header--+    +--1 byte to follow.
```

JUPITER ADDITIONAL SUPERVISORY FUNCTIONS

80	Clear Reroute - reroute a thread going to the remote unit.
81	Clear cancel - request cancelation of reroute (DPI).
82	Clear previous - data preceeding this slot to be flushed.
85	Clear previous acknowledge.
86	Clear cancel acknowledge (DPIA).
87	Clear reroute acknowledge.
FF	NPP data loss.

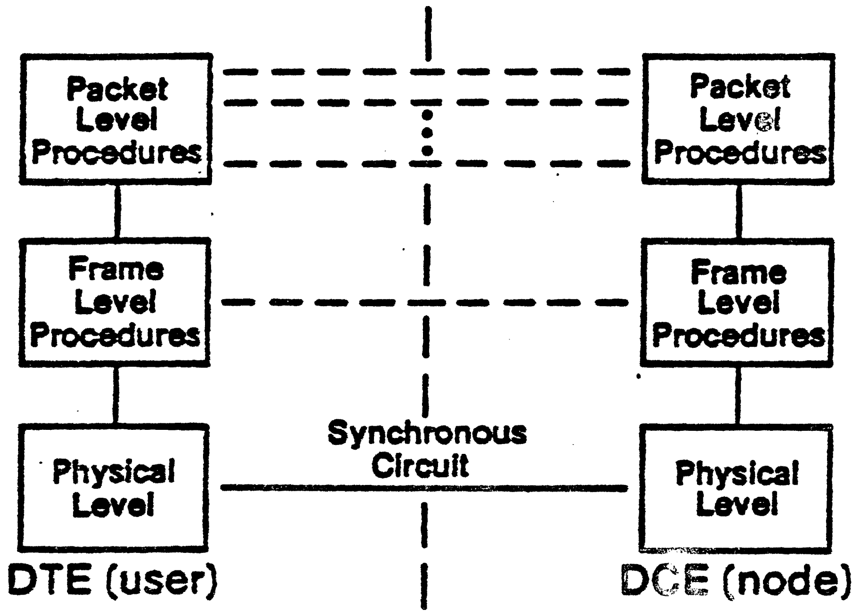
REF Pg 4-6

PACKET SWITCHING STANDARDS



REF Pg 6-1

X.25 INTERFACE



X.25 PROTOCOL

DTE/DCE Electrical Interface

- X.21 or RS 232C compatible
- Independent of other levels

DTE/DCE Frame Level Interface

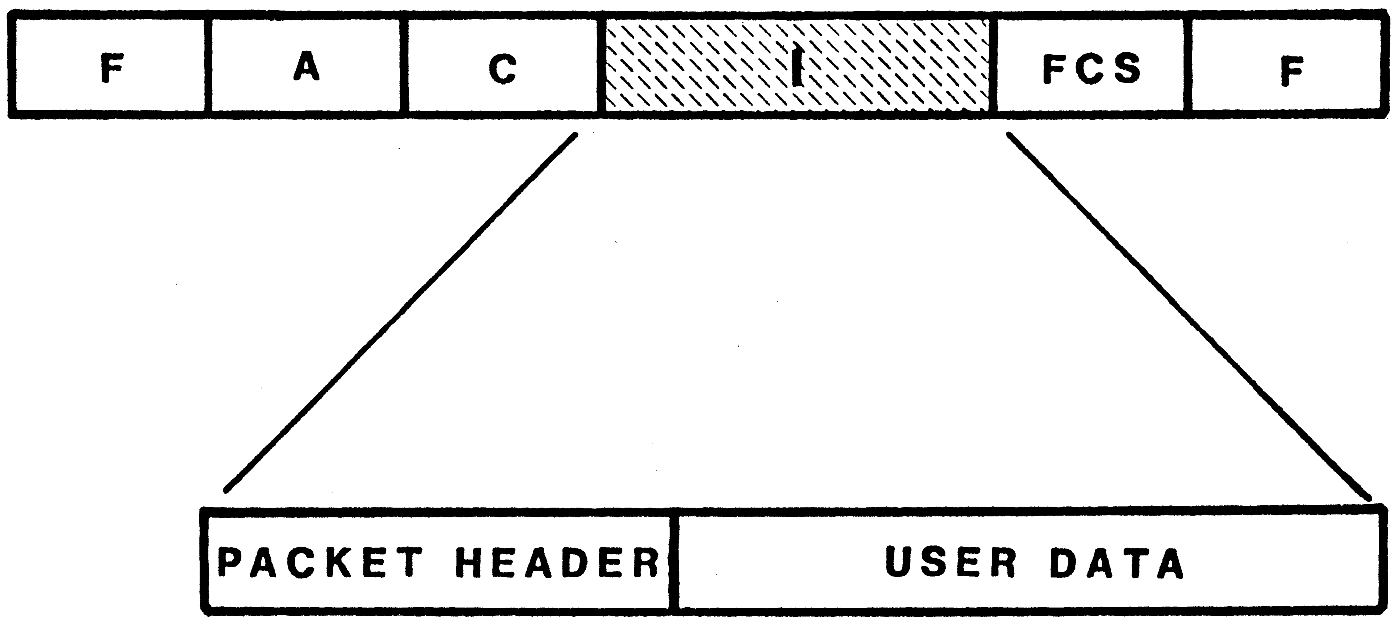
- Link access procedures
- Responsible for transferring packets between DTE & DCE error free.
- Does not know about virtual calls

DTE/DCE Packet Level Procedures

- Virtual call procedures
  (Set-up, Maintain, Flow control, Clear)
- May be end-to-end (DTE/DTE)

REF PG 6-3 & 6-4

PACKET/FRAME RELATIONSHIP



REF PG 6-4

X.25 PACKET FORMAT

- Each packet contains a 3 octet header.
- The first 4 bits = the general format identifier (GFI).
- The next 12 bits form the logical group and channel number.
- The last octet (8 bits) determines the packet type.

```
              8   7   6   5   4   3   2   1
            +---------------------------------+
   Octet 1  |    GFI         |     LCGN       |
            |---------------------------------|
   Octet 2  |               LCN               |
            |---------------------------------|
   Octet 3  |            PACKET ID            |
            +---------------------------------+
```

Where:

```
       GFI = General Format Identifier
      LCGN = Logical Channel Group Number
       LCN = Logical Channel Number
 Packet ID = Type of Packet
```


REF PG 6-5

X.25 GENERAL FORMAT IDENTIFIER

- Determines format of the packet.
- Identifies control information.

8 7 6 5	Packet Type
0 0 0 1	Clearing, Flow Control, Reset, Restart, Interrupt Packets.
0 D 0 1	Call Setup Packet
Q D 0 1	Data Packet

Where:

Bit 8 = Qualifier Bit (Q-Bit). If set (1) this bit signals that the data packet contains control information.

Bit 7 = Delivery Confirmation Bit (D-Bit). If this bit is set the acknowledgement is from end-to-end. If the bit is zero the local DCE acknowledges the packet.

Bits 6 & 5 = Idicates the modulo sequencing to be used.

01	Modulo 8
10	Modulo 128
11	Datagrams

REF Pg 6-5

LOGICAL CHANNEL NUMBERS

- o All packet entering the network are assigned a LCN.
- o LCN's range from 0 to 255, but 0 is reserved.
- o Assigned by the DTE during call request, starting with an agreed upon upper limit and working down.
- o The DCE assigns LCN's working from the bottom up.
- o. LCN's are assigned in one of four categories:
  1. Permanent Virtual Circuits (leased line).
  2. One-Way Incoming Calls (contention).
  3. Two-Way Switched Virtual Calls (dial up).
  4. One-Way Outgoing Calls.

REF PG 6-6

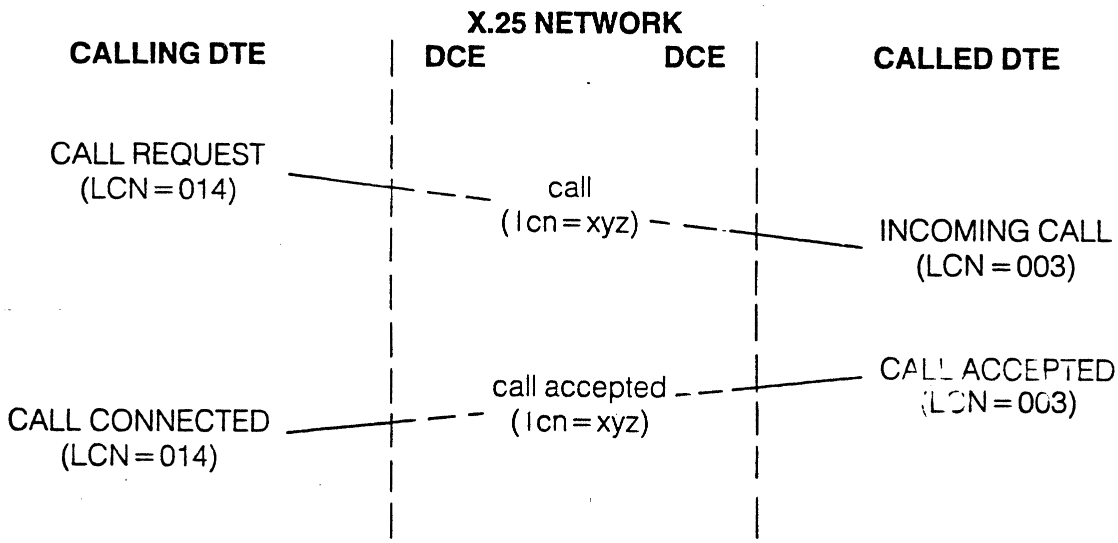
PACKET TYPE IDENTIFICATION

- The third octet of the header.
- Similar to the control field in an HDLC frame.
- Pr = Receive Sequence Number.
- Ps = Packet send sequence number.
- M = More Data Bit.

Data	P(R)			M	P(S)			0
Call request	0	0	0	0	1	0	1	1
Call accepted	0	0	0	0	1	1	1	1
Clear request	0	0	0	1	0	0	1	1
Clear confirmation	0	0	0	1	0	1	1	1
Interrupt	0	0	1	0	0	0	1	1
Interrupt confirmation	0	0	1	0	0	1	1	1
Receive ready	P(R)			0	0	0	0	1
Receive not ready	P(R)			0	0	1	0	1
Reject	P(R)			0	1	0	0	1
Reset request	0	0	0	1	1	0	1	1
Reset confirmation	0	0	0	1	1	1	1	1
Restart request	1	1	1	1	1	0	1	1
Restart confirmation	1	1	1	1	1	1	1	1
Diagnostic	1	1	1	1	0	0	0	1

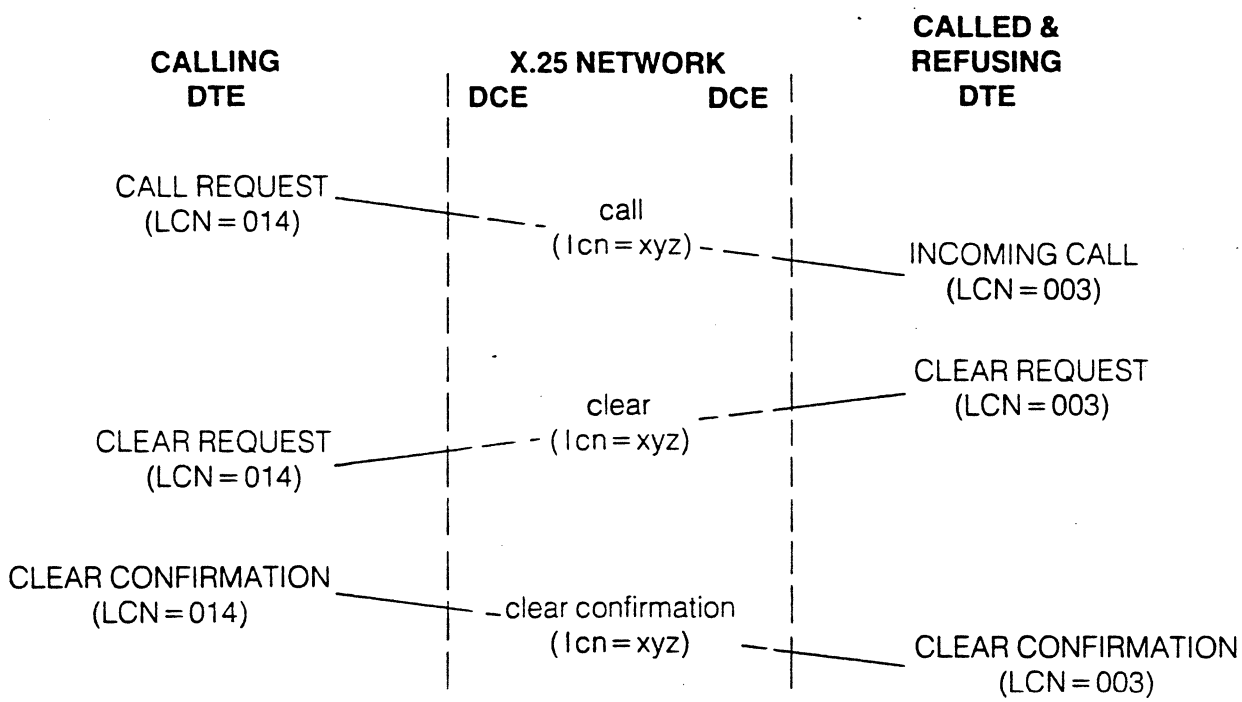
REF Pg 6-7

Call Establishment procedure

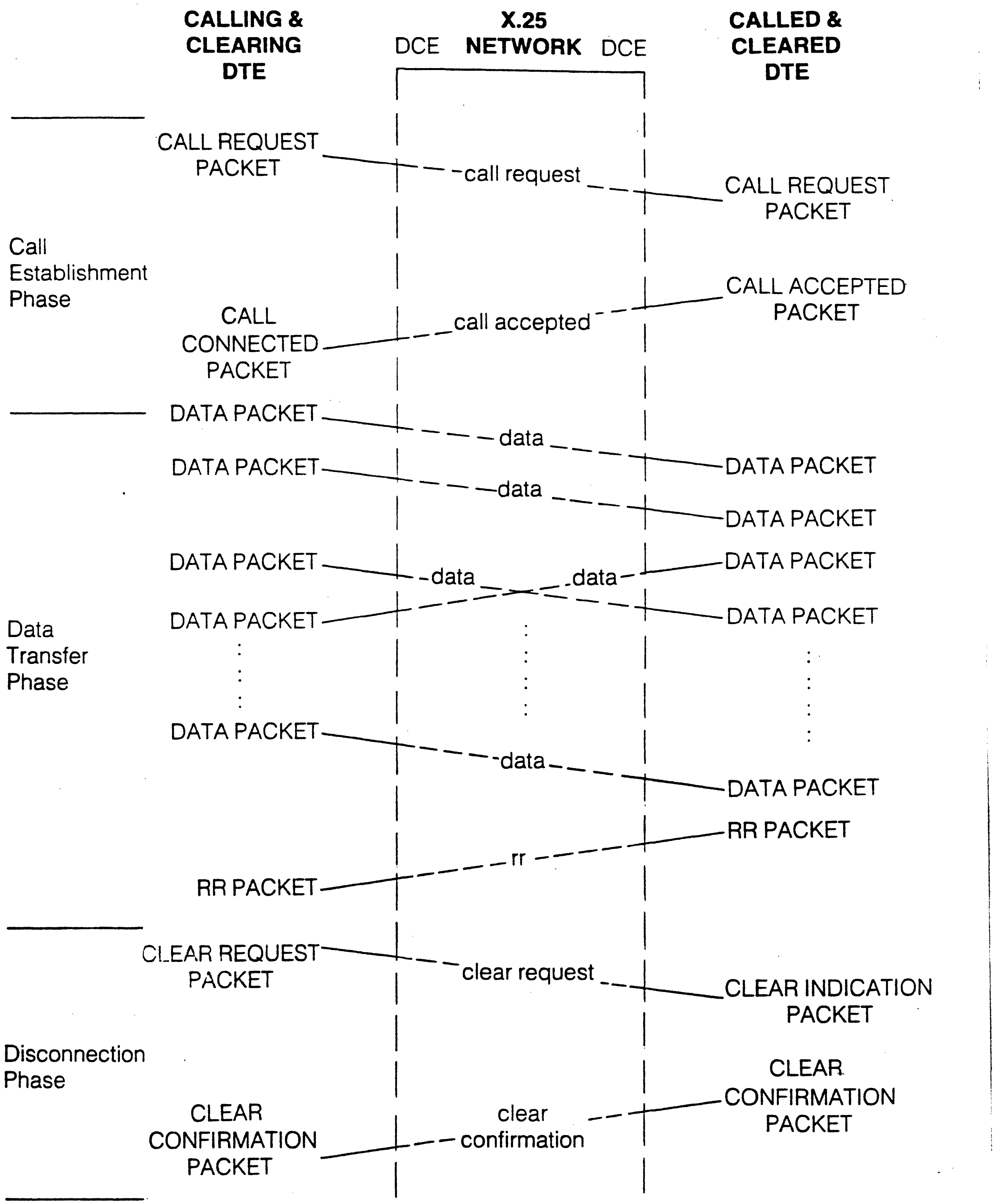


REF PG 6-8

Call Clearing Procedure



REF Pa 6-9


CALLING & CLEARING DTE
X.25 NETWORK
DCE
DCE
CALLED & CLEARED DTE
Call Establishment Phase
CALL REQUEST PACKET
call request
CALL REQUEST PACKET
CALL ACCEPTED PACKET
call accepted
CALL CONNECTED PACKET
Data Transfer Phase
DATA PACKET
data
DATA PACKET
DATA PACKET
data
DATA PACKET
DATA PACKET
data
data
DATA PACKET
DATA PACKET
DATA PACKET
DATA PACKET
data
DATA PACKET
RR PACKET
rr
RR PACKET
Disconnection Phase
CLEAR REQUEST PACKET
clear request
CLEAR INDICATION PACKET
CLEAR CONFIRMATION PACKET
clear confirmation
CLEAR CONFIRMATION PACKET

REF PG 6-10

CCITT Recommendations X.3, X.28, and X.29 define the necessary elements for a PDN to support non-intelligent asynchronous "start/stop" terminals.

When a DTE supports asynchronous terminals connected through a PDN, many of the terminal handling functions are performed by the DCE. The software in the DCE is called the Interactive Terminal Interface (ITI) Packet Assembler/Disassembler (PAD).

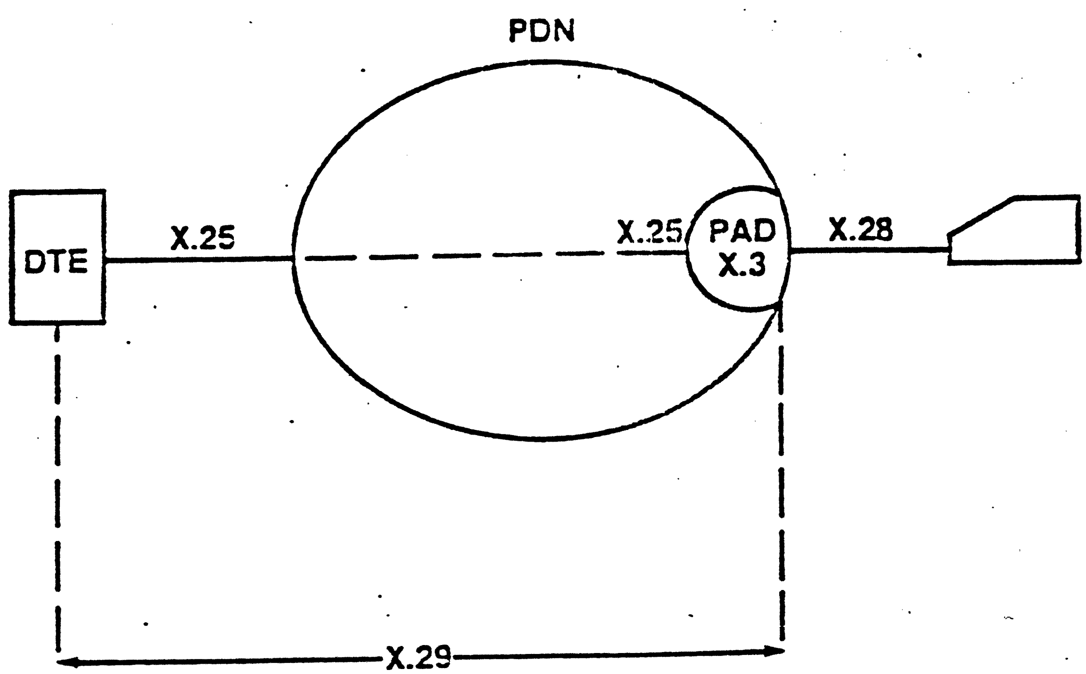
Recommendation X.28 defines control procedures used to establish the physical connection to the PDN, the commands the terminal user sends to the PAD, and the service signals sent from the PAD to the terminal user.

Recommendation X.3 defines a set of parameters that the PAD uses to control the terminal. The parameter values can be pre-set in network tables, set by the terminal user, and/or set by the remote DTE.

Recommendation X.25 procedures are used by the PAD to establish a virtual call to the remote DTE, to transmit and receive DATA packets, and to clear virtual calls.

Recommendation X.29 defines the control messages sent between the PAD and the remote DTE. All control or PAD messages are special X.25 DATA packets, called Qualified DATA packets.

INTERACTIVE TERMINAL INTERFACE



Ref Pg 6-11

HEWLETT PACKARD

Quick Reference Card

International Standards Organization (ISO) Open Systems Interconnect (OSI)

Level 1: Physical Interface

- —Mechanical
- —Electrical
- —Functional

Level 2: Data Link Interface

								ITB		
—COP	SYN	SYN	SYN	SOH	Header	STX	Text	ETX	BCC	BCC
								ETB		

- BSC
- Uniscope 100/200
- Mode 4C
- VIP7700

—BOP	Flag	Address	Control	Data	FCS	FCS	Flag

- HDLC
- SDLC
- LAP-B
- ADCCP

Command/Response Summary

Command/Response	Control Field 8 7 6	5	4 3	2 1	Name
Information (Command)	N(R)	P	N(S)	0	I
Information (Response)	N(R)	F	N(S)	0	I
Receive Ready	N(R)	P/F	0 0	0 1	RR
Receive Not Ready	N(R)	P/F	0 1	0 1	RNR
Reject	N(R)	P/F	1 0	0 1	REJ
Selective Reject	N(R)	P/F	1 1	0 1	SREJ
Set Normal Resp. Mode	1 0 0	P	0 0	1 1	SNRM
Set Normal Resp. Mode Ext.	1 1 0	P	1 1	1 1	SNRME
Set Async Resp. Mode	0 0 0	P	1 1	1 1	SARM
Set Async Resp. Mode Ext.	0 1 0	P	1 1	1 1	SARME
Set Async Bal. Mode	0 0 1	P	1 1	1 1	SABM
Set Async Bal. Mode Ext.	0 1 1	P	1 1	1 1	SABME
Disconnect	0 1 0	P	0 0	1 1	DISC
Set Initialize Mode	0 0 0	P	0 1	1 1	SIM
Exchange Station ID's	1 0 1	P/F	1 1	1 1	XID
Unnumbered Acknowledge	0 1 1	F	0 0	1 1	UA
Disconnected Mode	0 0 0	F	1 1	1 1	DM
Request Disconnect	0 1 0	F	0 0	1 1	RD
Request Initialize Mode	0 0 0	F	0 1	1 1	RIM
Command Reject	1 0 0	F	0 1	1 1	CMDR
Unnumbered Poll	0 0 1	P	0 0	1 1	UP
Unnumbered Information	0 0 0	P/F	0 0	1 1	UI

HEWLETT PACKARD

Level 3: Network Interface—X.25;

8	7	6	5	4	3	2	1
GENERAL FORMAT IDENTIFIER Q	D	0	1				
LOGICAL CHANNEL IDENTIFIER (LCGN & LCN)							
P(S)		M		P(R)		0	
USER DATA FIELD							

GFI	:	General Format Identifier.
LCGN	:	Logical Channel Group Number.
LCN	:	Logical Channel Number.
LCI	:	Logical Channel Identifier.
P(S)	:	Packet Send Sequence Number.
P(R)	:	Next Receive Packet Expected.
WINDOW	:	Maximum Number of Outstanding Packets.
PACKET SIZE	:	Maximum Number of User Data Octets.
M-BIT	:	More Data Bit.
Q-BIT	:	Data Qualifier Bit.
D-BIT	:	Delivery Comfirmation Bit.

Data	P(R)			M	P(S)			0
Call request	0	0	0	0	1	0	1	1
Call accepted	0	0	0	0	1	1	1	1
Clear request	0	0	0	1	0	0	1	1
Clear confirmation	0	0	0	1	0	1	1	1
Interrupt	0	0	1	0	0	0	1	1
Interrupt confirmation	0	0	1	0	0	1	1	1
Receive ready	P(R)			0	0	0	0	1
Receive not ready	P(R)			0	0	1	0	1
Reject	P(R)			0	1	0	0	1
Reset request	0	0	0	1	1	0	1	1
Reset confirmation	0	0	0	1	1	1	1	1
Restart request	1	1	1	1	1	0	1	1
Restart confirmation	1	1	1	1	1	1	1	1
Diagnostic	1	1	1	1	0	0	0	1

TRANSMISSION: Asynchronous—uses start/stop bits; no clocks
Synchronous—clock at both ends synchronizes the data bits.

DATA CODES: ASCII—7-bit plus parity (=CCITT Alphabet #5)
EBCDIC—8-bit (IBM)
EBCD—6-bit shifted
IPARS—6-bit shifted (airlines)
SBT—6-bit
Selectric—6-bit shifted
Baudot—5-bit shifted

ERROR CHECKING: VRC—Character Parity
LRC—Block Parity
CRC—16-bit remainder; used to generate BCC/FCS