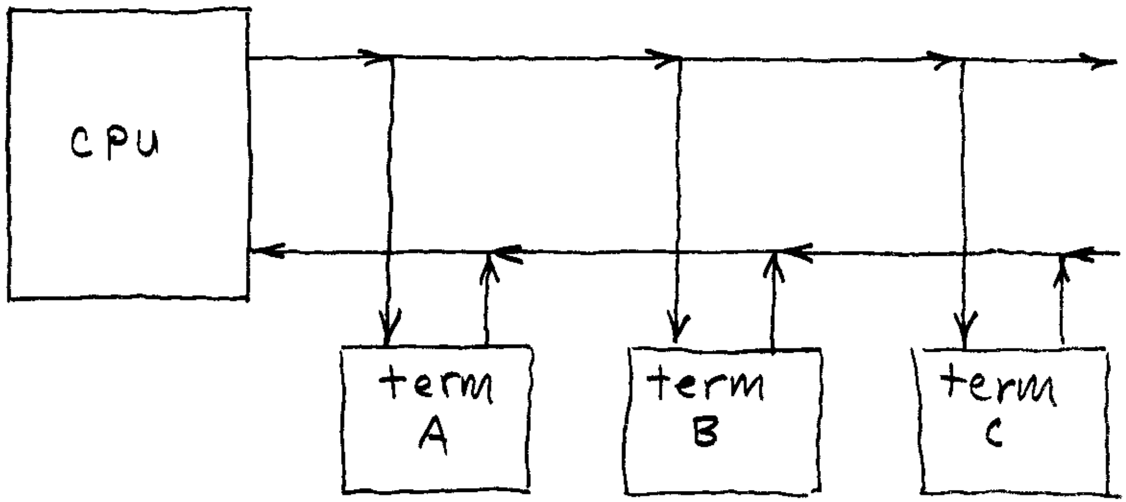


Terminal Polling

POLLING AND ADDRESSING MECHANISMS

SIMPLE ERROR-CONTROL MECHANISMS

STATE-DIAGRAM DESCRIPTIONS

FRAME FORMATS

TRANSPARENCY MECHANISMS

RETRANSMISSION STRATEGIES

DATA-LINK CONTROL

PROTOCOL FEATURES AND CHARACTERISTICS

FEATURE	DDCMP	BISYNC	SDLC	ADCCP	HDLC
FULL DUPLEX	YES	NO	YES	YES	YES
HALF DUPLEX	YES	YES	YES	YES	YES
SERIAL	YES	YES	YES	YES	YES
PARALLEL	YES	NO	NO	NO	NO
DATA TRANSPARENCY	COUNT	CHARACTER STUFFING	BIT STUFFING	BIT STUFFING	BIT STUFFING
ASYNCHRONOUS OPERATION	YES	NO	NO	NO	NO
SYNCHRONOUS OPERATION	YES	YES	YES	YES	YES
POINT-TO-POINT	YES	YES	YES	YES	YES
MULTIPOINT	YES	YES	YES	YES	YES
ERROR DETECTION (CRC)	CRC-16	CRC-16	CRC-CCITT	CRC-CCITT	CRC-CCITT
RETRANSMIT ERROR RECOVERY	YES	YES	YES	YES	YES
BOOTSTRAPPING CAPABILITY	YES	NO	NO	NO	NO

BINARY SYNCHRONOUS COMMUNICATIONS BSC (IBM)

DIGITAL DATA COMMUNICATIONS MESSAGE DDCMP (DEC)

SYSTEMS NETWORK ARCHITECTURE SNA (IBM)

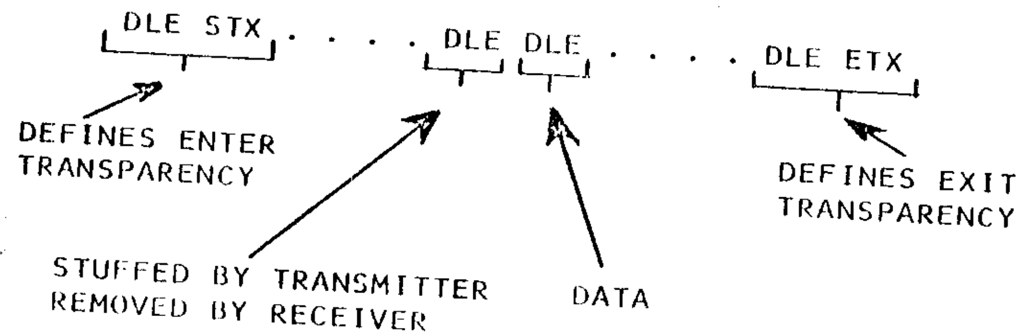
ANSII DATA COMMUNICATIONS CONTROL ADCCP (ANSI)

HIGH-LEVEL DATA LINK CONTROL HDLC (ISO)

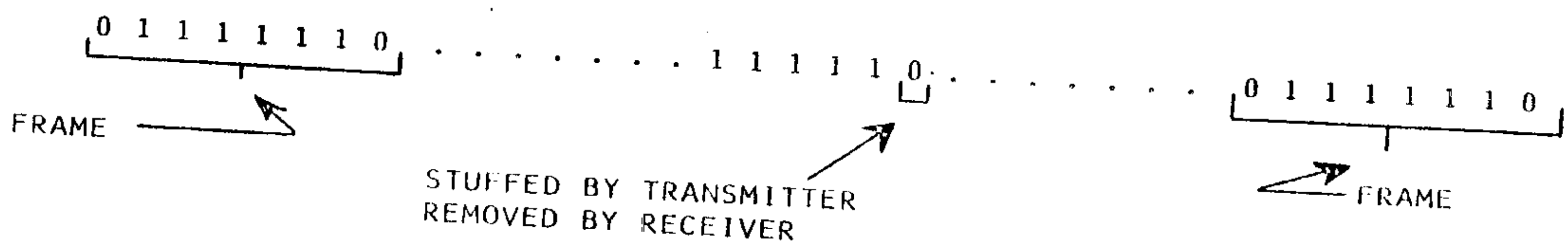
LINK ACCESS PROTOCOL BALANCED LAPB (CCITT)

TECHNIQUES FOR ACHIEVING TRANSPARENCY

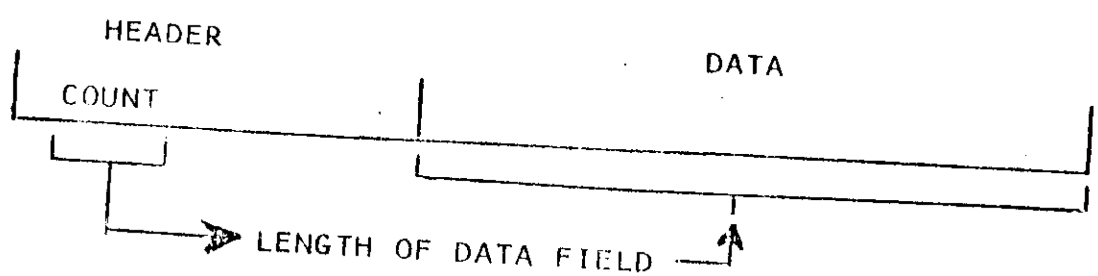
1. CHARACTER STUFFING (BISYNC)



2. BIT STUFFING (HDLC, ADCCP, SDLC)



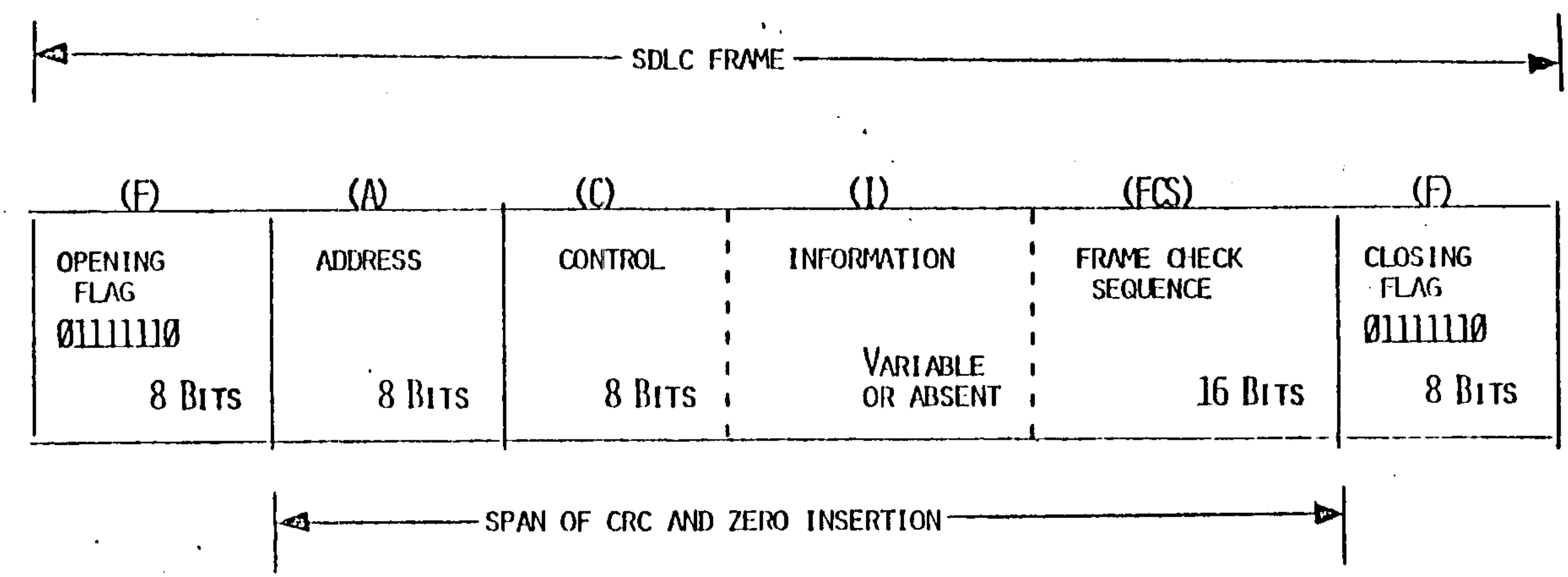
3. COUNT (DDCMP)



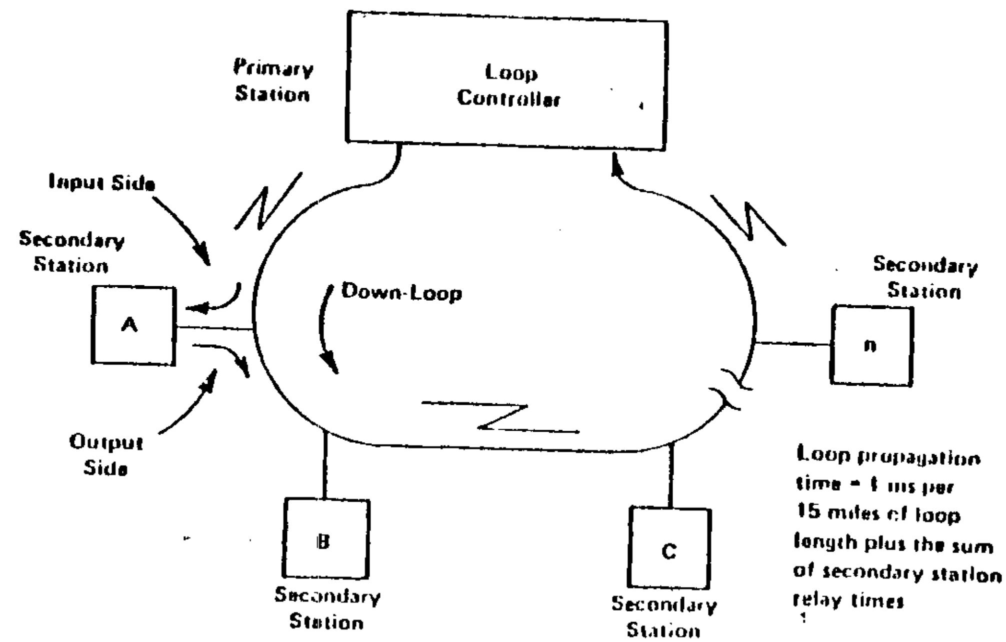
SYN	SYN	SOH	COUNT 14 BITS	FLAG 2 BITS	RESPONSE 8 BITS	SEQUENCE 8 BITS	ADDRESS 8 BITS	CRC 1 16 BITS	INFORMATION ANY NUMBER OF 8 BIT CHARACTERS	CRC 2 16 BITS

DDCMP MESSAGE FORMAT

SDLC FRAME FORMAT



SDLC - LOOP CONFIGURATION



LOOP CONSIDERATIONS

- ALL SECONDARY STATIONS ARE REPEATERS
- LOOP CONTROLLER INITIATES BY TRANSMITTING
  - A. SPECIFIC POLL TO A UNIQUE SECONDARY
  - B. AN ORP (OPTIONAL RESPONSE POLL) TO A COMMON LOOP ADDRESS
- LOOP CONTROLLER TRANSMITS THE GA (GO AHEAD) SIGNAL
- SECONDARY CAPTURES LOOP BY CONVERTING GA TO A TRANSMIT FRAME
- SECONDARY RELEASES LOOP BY RETURNING TO REPEATER OPERATION

LOOP CAPTURE EXAMPLE

• INPUT SIGNAL TO A (GA PATTERN FROM PRIMARY)	01111111111111
• OUTPUT SIGNAL FROM A (REPEATER - NO CAPTURE)	0111111111111
• OUTPUT SIGNAL FROM B (LOOP CAPTURE)	01111110XXXXX01111110 OPENING FRAME CLOSING FLAG CONTENTS FLAG
• OUTPUT SIGNAL FROM B (LOOP RELEASE)	0111111111111

PHYSICAL LEVEL X.21

LINK (FRAME) LEVEL X.25

NETWORK (PACKET) LEVEL X.25

ADDRESSING X.121

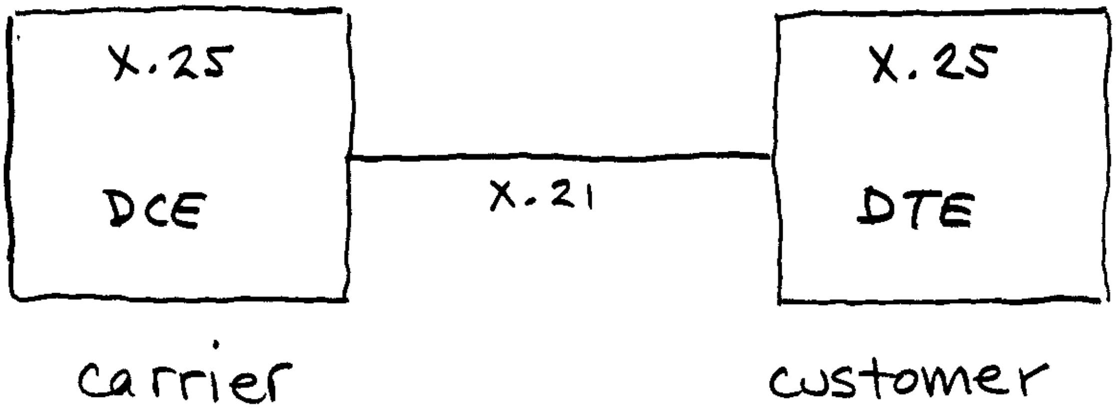
PACKET ASSEMBLY/DISASSEMBLY X.3, X.28, X.29

GATEWAYS X.75

TRANSPORT PROTOCOLS

SMART PADS

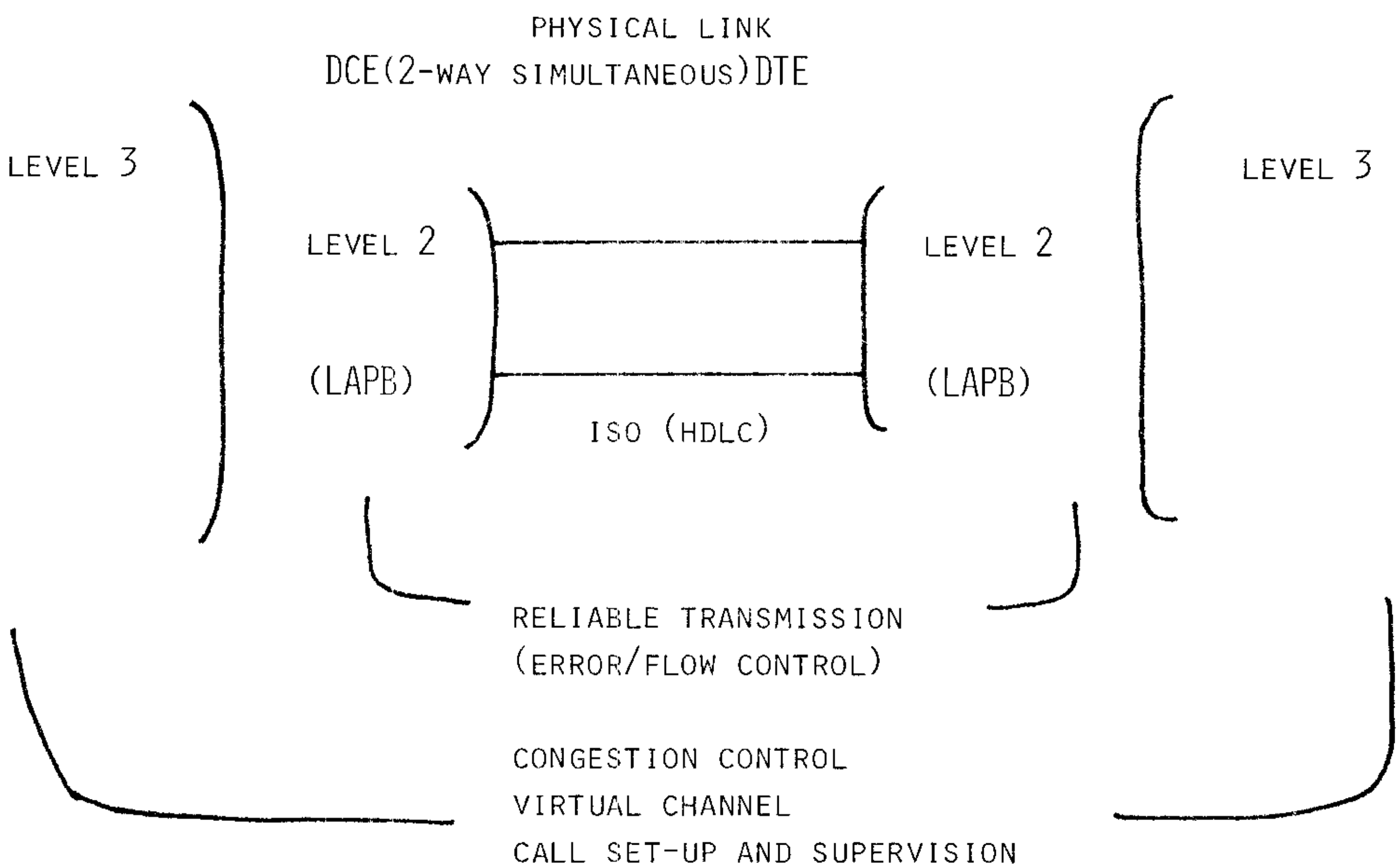
CCITT PROTOCOL SUMMARY



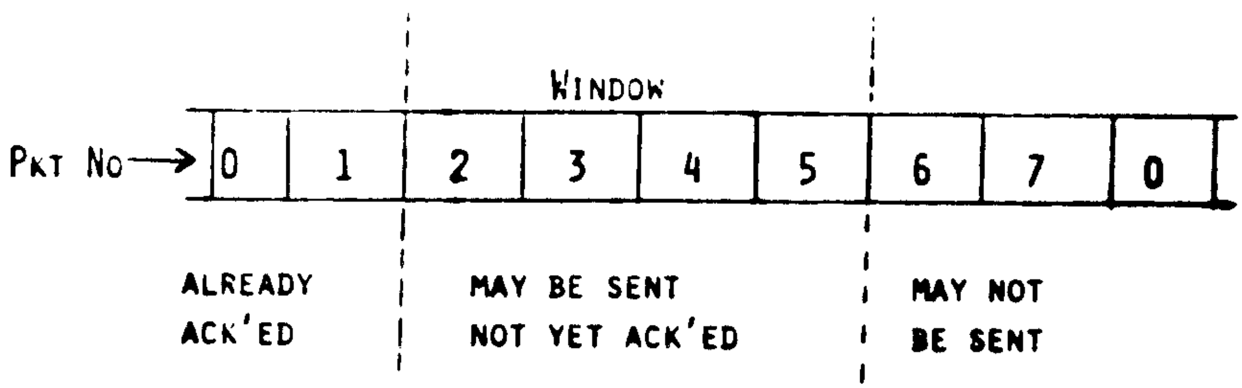
X.25 Virtual-Circuit Interface

- Between DCE and DTE (only)
- Transparent data
- Reliable transmission
    - error detection and retransmission
        - sequencing guaranteed
- Virtual call set-up and supervision
- Full-duplex data with end-end interrupt and reset
- Private Virtual Circuits

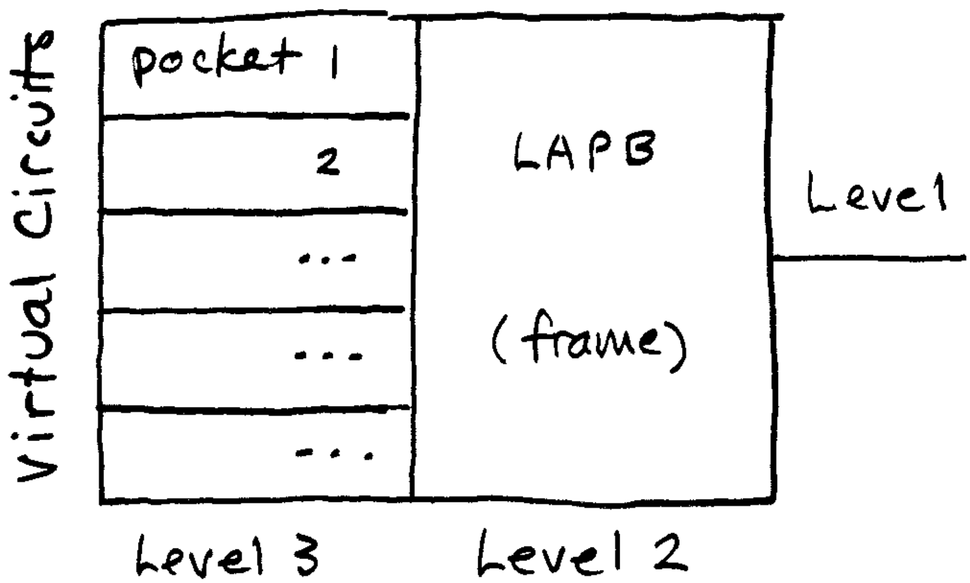
X.25 INTERFACE



FLOW CONTROL AND WINDOW

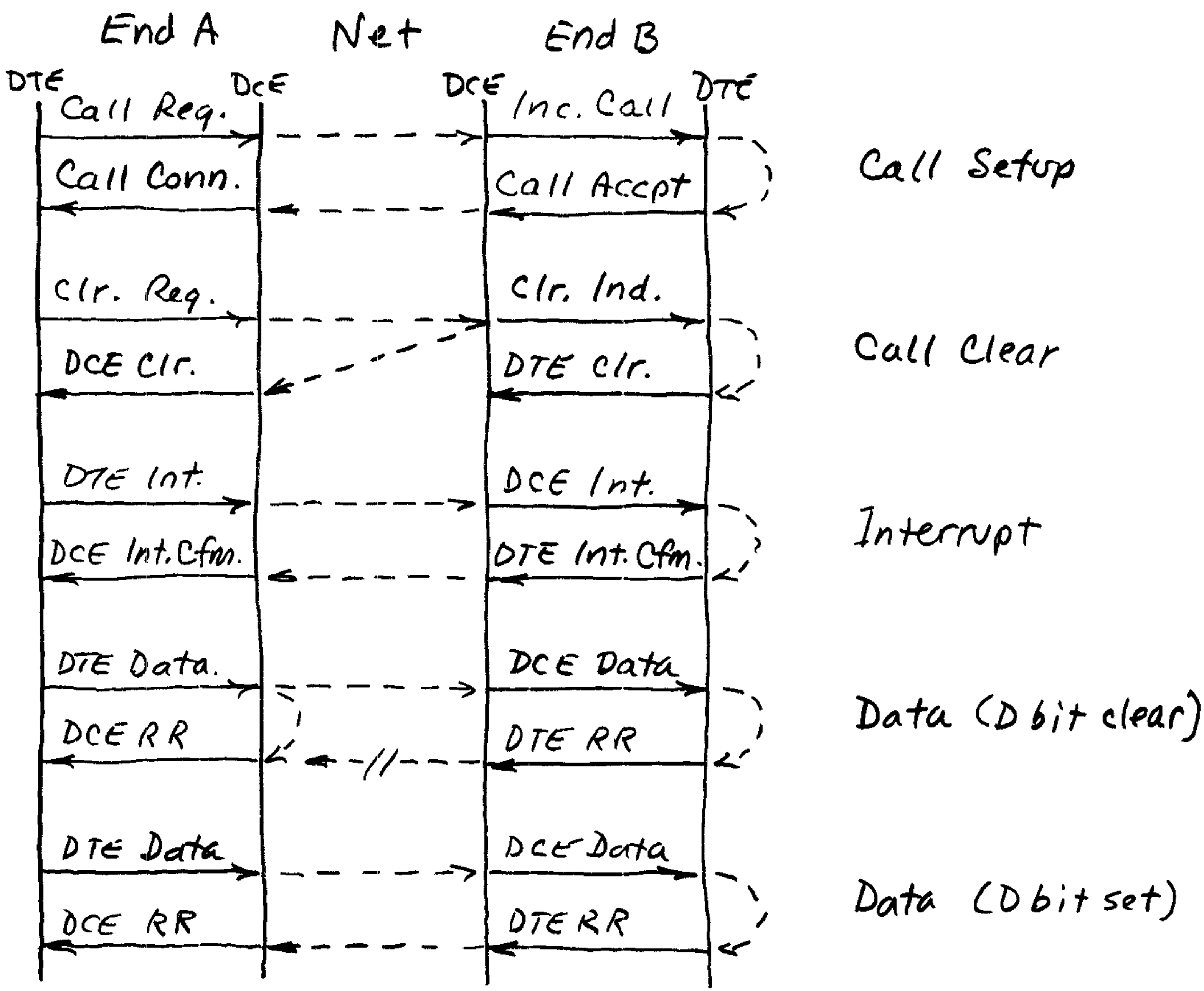


WINDOW SIZE W	IN ABSENCE OF OPTIONAL USER FACILITY IS COMMON TO ALL LOGICAL CHANNELS AND AGREED FOR A PERIOD OF TIME BETWEEN DTE AND ADMINISTRATION DOES NOT EXCEED 7, OR 127 WHEN EXTENDED
P(R)	A RECEIVED P(R) BECOMES THE LOWER WINDOW EDGE

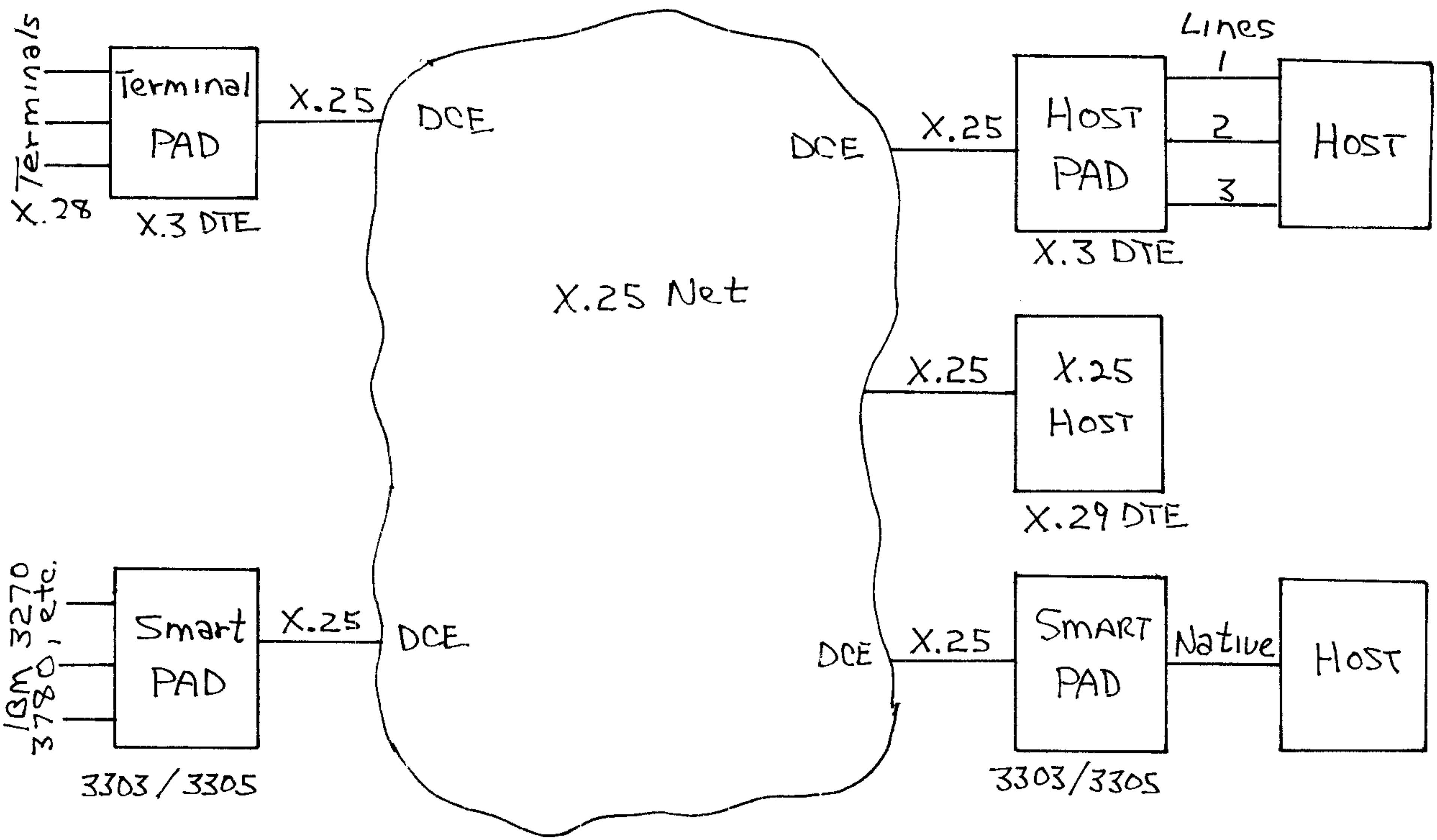


X.25 LEVEL 3

- UP TO 128 OCTETS
- 12-BIT LOGICAL CHANNEL NUMBER
- WINDOW FLOW CONTROL (8 OR 128 SIZE)
- VIRTUAL CALL (VC) OR PRIVATE VIRTUAL CIRCUIT (PVC)
- INTERRUPT CONTROL
- RELIABILITY PROVIDED BY LEVEL 2
- PROVISIONS FOR LONGER MESSAGES (MULTI-PKT) WITH RE-ASSEMBLY AT RECEIVER
- PROVISIONS FOR QUALIFIED (MULTI-PRIORITY) MSGS.



End-End Characteristics

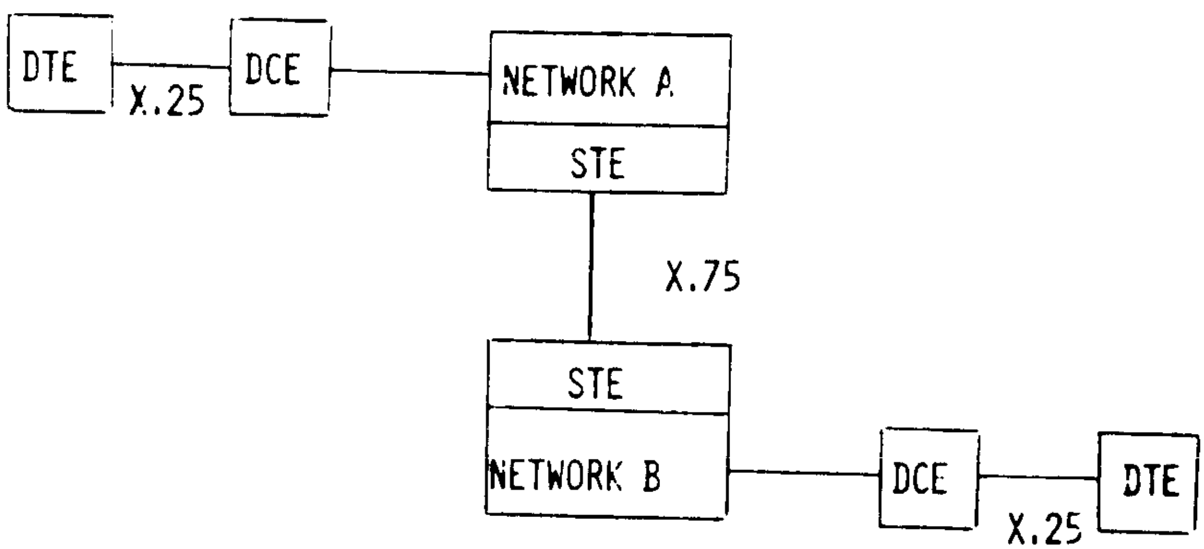


PAD CONFIGURATIONS

X.75 - "TERMINAL AND TRANSIT CALL CONTROL PROCEDURES AND DATA TRANSFER SYSTEM ON INTERNATIONAL CIRCUITS BETWEEN PACKET SWITCHED DATA NETWORKS"

- SYMMETRICAL VERSION OF X.25
- ALSO NETWORK-ORIENTED INFORMATION
- FIXED ROUTING BETWEEN NETWORKS PER VIRTUAL CALL
- INTERNATIONAL NUMBERING PLAN (X.121) USING 14 NUMERIC CHARACTERS

3	1	10
DATA COUNTRY CODE	NETWORK DIGIT	NETWORK TERMINAL NUMBER
DATA NETWORK IDENTIFICATION CODE		

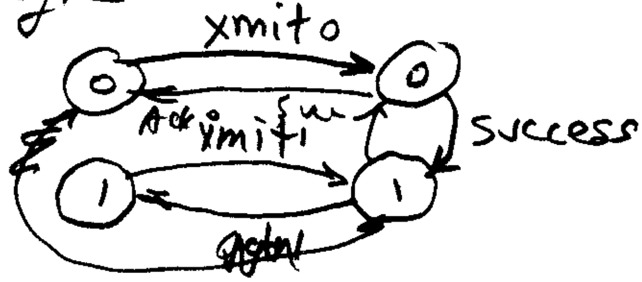


STE: SIGNALLING TERMINAL EQUIPMENT
(GATEWAY)

17 March

Retransmission Strategies

Stop and Wait



Go-back n $\quad$ SN / RN (integers)
$\quad$ xmtr $\quad$ rcvr

xmtr SN_{min} SN_{max} $\quad$ RN

1. $SN_{min} = SN_{max} = 0$

2. Do 3, 4, 5 in order, but req. bounded delay between enabling condition and execution
3. if $SN_{max} < SN_{min} + n$ and pkt ready, assign SN_{max} to it and incr. SN_{max}
4. if valid frame fm B containing $RN > SN_{min}$ set SN_{min} to RN
5. If $SN_{min} < SN_{max}$ choose SN, $SN_{min} \leq SN < SN_{max}$ and ~~transm~~ transm SN. We must retrans this if not ack and SN_{min} does not change (liveness)

Rcv
1. Set RN=0 and do 2, 3 forever
2. If error-free SN received, release pkt to upper layer and increm RN.
3. At arbitrary times bounded for liveness transm. frame w RN

(usually transmit only when recv.)

note that modulus m can be used, but $m > n$

Selective Repeat ARQ p = prob err

GBN note that $\eta \leq \frac{1-p}{1+p\beta}$ β = # frames delay

for good designs ~~[illegible]~~ in

Sel ARQ $\eta \leq 1-p$

but for Sel ARQ $m \geq 2n$

works in the same way, but need send bitmap to say what frames beyound the RN.

Tricks - increase dupes after error

NB X.25. SREJ - repeat only one frame, but resume at r. window edge.

ARPAnet mc

8 virtual channels that share phys. level
each frame has addr + octet for 8 acks bits
SAW for each v.c.

NB mercury - use Clark's reassembly alg.