

Data Link Protocols

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Data Link Protocols

Asynchronous Protocols

- Xmodem
- Ymodem
- Zmodem
- BLAST
- Kermit

Synchronous Protocols

- Character-oriented
- Bit-oriented

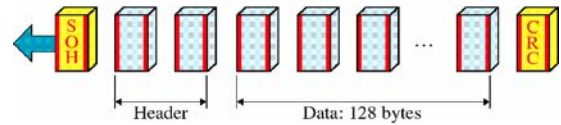
Asynchronous Protocols

- Long, long...time ago
- Not complex and easy to implement
- Slow
- Required start/stop bit and space
- Now mainly used in modem
- → Replaced by high speed synchronous

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XMODEM frame

Each character contains start and stop bits (dark portion of the box). Characters are separated from each other by gaps. The header consists of two bytes: sequence number and its one's complement.



Half-duplex, stop-and-wait ARQ protocol

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Synchronous Protocols

- Character-oriented (Byte-oriented)
- Bit-oriented
- BSC

Synchronous Protocols

- Character-oriented protocol
 - Based on one byte (8-bit)
 - Use ASCII for control character
 - Not efficient → seldom used
- Bit-oriented protocol
 - Based on individual bits
 - One or multiple bits for control
 - More efficient

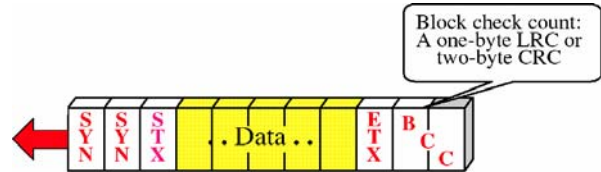
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IBM's Binary Synchronous Communication (BSC)

- Character-oriented protocol
- Half-duplex, stop-and-wait ARQ
- 2 frame types
 - Data frame (data transmission)
 - Control frame (connect/disconnect and flow/error control)

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A simple BSC data frame



SYN = Synchronous idle = 0010110
 STX = Start of text = 0000010
 ETX = End of text = 0000011

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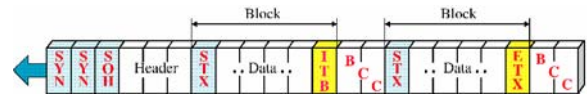
A BSC frame with a header



- Header Fields:
- address (sender/receiver)
 - #frame identifier (0/1 for stop-and-wait ARQ)

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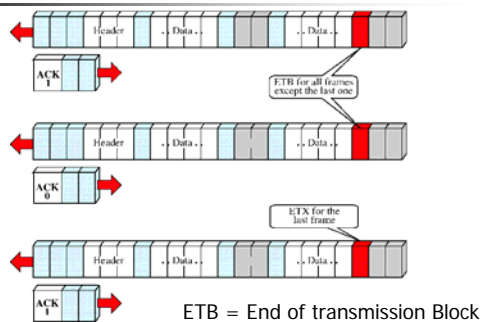
A multiblock frame



ITB = Intermediate text block

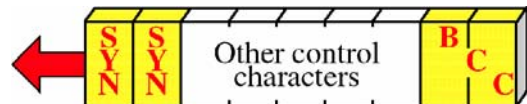
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Multiframe transmission



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Control frame

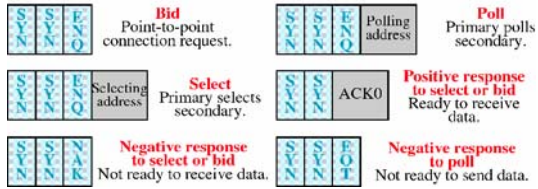


- Note:** Control Frame is used to send command
- * Establish connection
 - * Maintaining flow & error control
 - * terminating connection

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Control frames

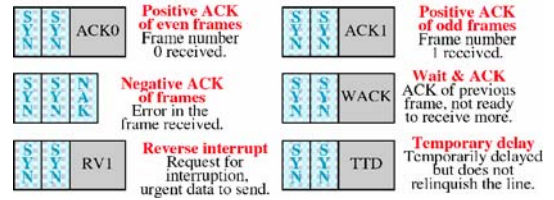
Connection establishment



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Control frames

Flow and error control



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Control frames

Connection termination



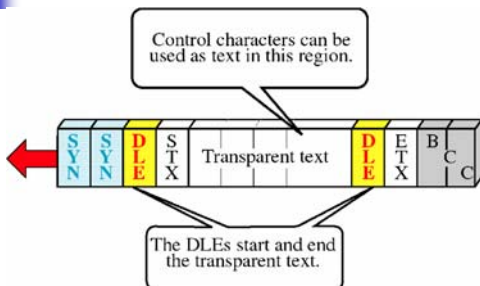
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Data Transparency

- BSC is designed for text message
- Now, non-text message (graphics,...)
- Problem?
 - BSC control character problem
- **Data transparency**: should be able to send any data

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Byte stuffing



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Data Link Protocols

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Synchronous Protocols

Character-oriented (Byte-oriented)

- BSC

Bit-oriented

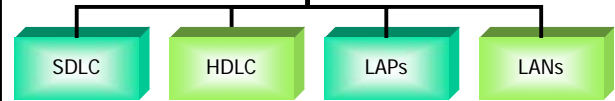
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Bit-oriented protocol

- Represent more information into shorter frame
- Avoid the transparency problems

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Bit-oriented Protocols



SDLC: Synchronous data link control – IBM
HDLC: High-level data link control – ISO
LAPs : Link access procedure

HDLC

- Support half/full – duplex over point-to-point and multipoint links
- HDLC system characterization
 - Station types
 - Configurations
 - Communication modes
- Frames

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HDLC station types

- Primary station
 - The station that controls the medium by sending “command”
- Secondary station
 - The station that “response” to the primary station
- Combined station
 - The station that can both command and response

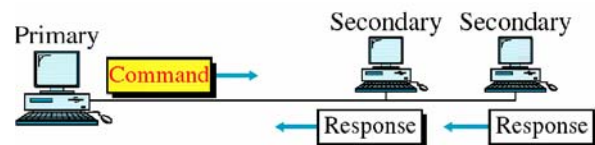
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HDLC configurations

- The relationship of hardware devices on a link
- 3 configurations of all stations (primary/secondary/combined)
 - Unbalanced
 - Symmetrical
 - Balanced

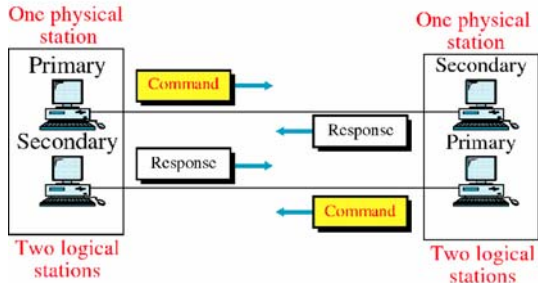
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HDLC Configurations: Unbalanced (master/slave)



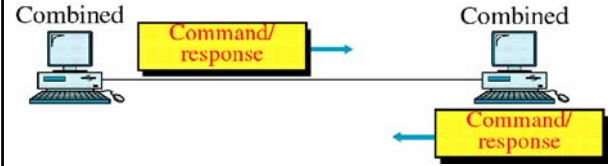
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HDLC Configurations: Symmetrical



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HDLC Configurations: Balanced



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HDLC communication modes

Mode : describe "Who controls the link"

	NRM	ARM	ABM
Station type	Primary & secondary	Primary & secondary	Combined
Initiator	Primary	Either	Any

NRM: Normal response mode (master/slave)

ARM: Asynchronous response mode

(secondary can initiate if idle, all transmissions are made to primary station)

ABM: Asynchronous balanced mode (point-to-point equal)

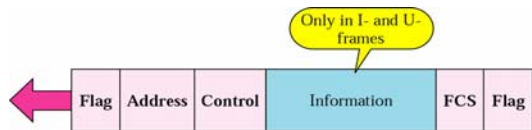
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HDLC frame

- 3 frame types
 - Information frame (I-frame)
 - Supervisory frame (S-frame)
For ACK, Flow/Error controls
 - Unnumbered frame (U-frame)
For Mode setting, Initialize, Disconnect

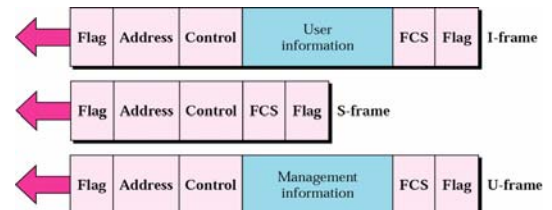
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HDLC Frame



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HDLC Frame

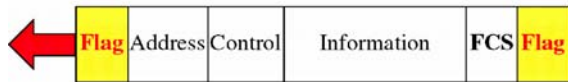


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HDLC Frame: Flag field

The flag is 8 bits of a fixed pattern.

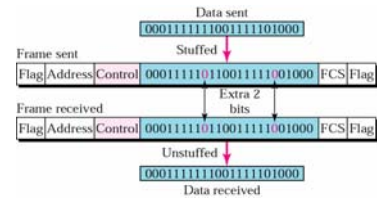
01111110



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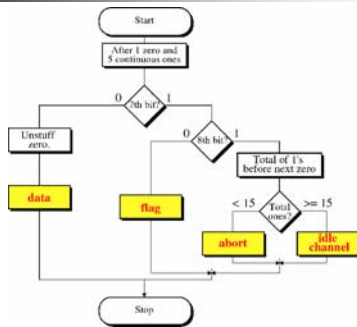
Bit Stuffing

- How to differentiate data and flag?
- Adding one extra 0 whenever there are five consecutive 1s in the data



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HDLC: Bit stuffing



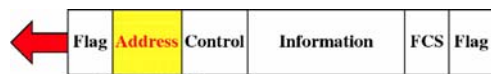
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HDLC frame: Address field

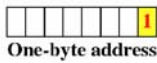
- Primary station creates a frame → destination address
- Secondary station creates a frame → source address
- Can be one byte or more

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HDLC Frame: Address field



The address is one byte or a multiple of bytes.



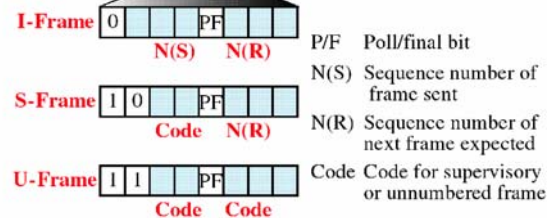
One-byte address



Multi-byte address

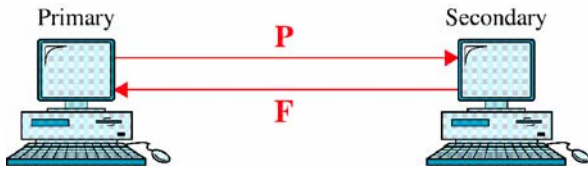
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HDLC Frame: Control field



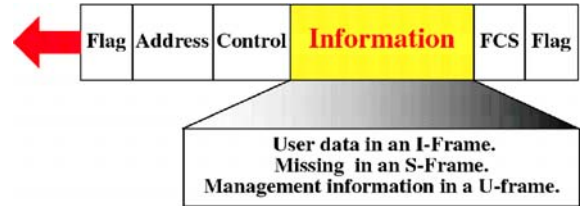
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HDLC frame: Poll / Final



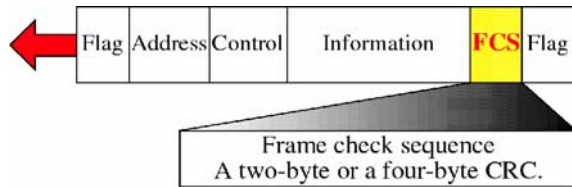
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HDLC Frame: Information field



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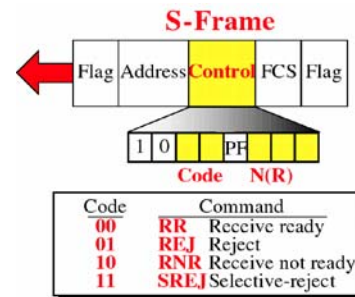
HDLC Frame: FCS field



FCS: Frame check sequence

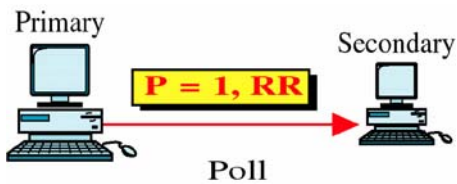
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HDLC: S-Frame



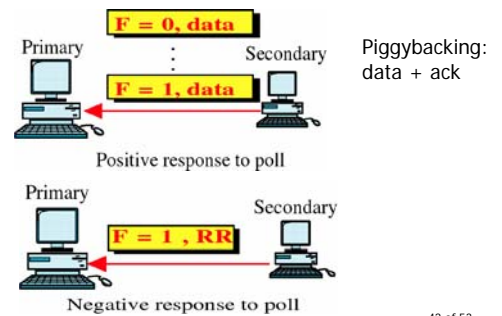
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HDLC: Use of P/F field



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HDLC: Use of P/F field



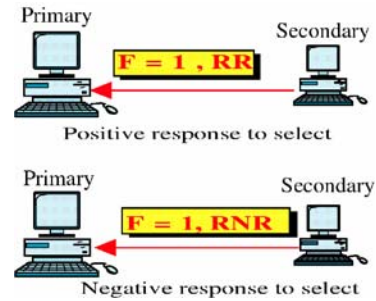
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HDLC: Use of P/F field



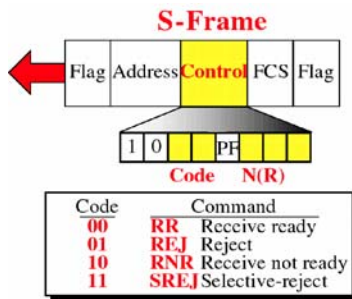
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HDLC: Use of P/F field



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HDLC: S-Frame Acknowledgement



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HDLC: S-Frame Positive Acknowledgement

- RR
 - Receiver sends "Positive Ack" (no data to send)
 - N(R) = seq of next frame
- RNR
 - Receiver sends "Positive Ack"
 - N(R) = seq of next frame
 - Receiver tells sender that sender cannot send any frame until 'RR' frame is received

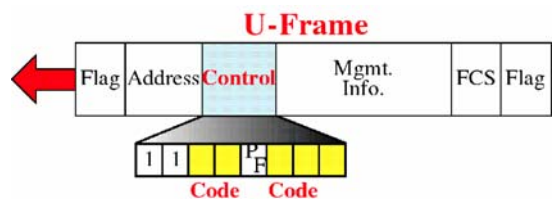
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HDLC: S-Frame Negative Acknowledgement

- Reject (REJ)
 - Go-back-n ARQ
 - N(R) = # of damage frame (and follow)
- Selective-Reject (SREJ)
 - N(R) = # of damage frame

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HDLC: U-Frame control field



For session management and control information

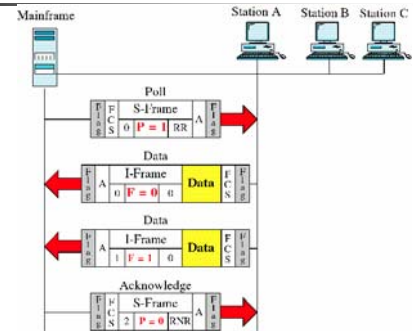
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HDLC: U-Frame control field

Code	Command	Response
00 001	SNRM	
11 011	SNRME	
11 000	SARM	DM
11 010	SARME	
11 100	SABM	
11 110	SABME	
00 000	UI	UI
00 110		UA
00 010	DISC	RD
10 000	SIM	RIM
00 100	UP	
11 001	RSET	
11 101	XID	XID
10 001		FRMR

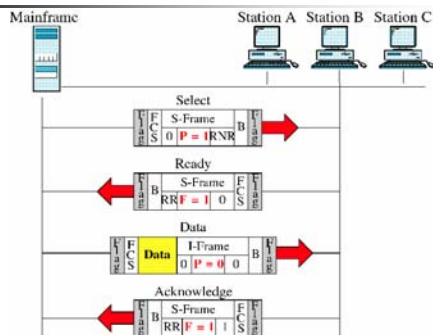
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HDLC: Polling example



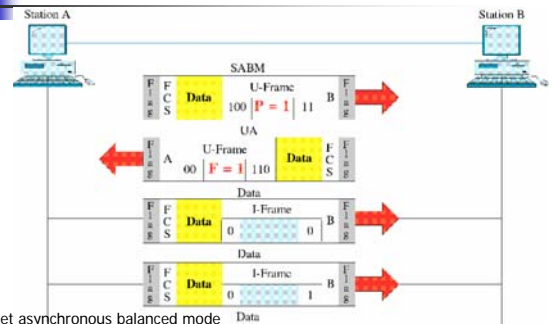
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HDLC: Selecting example



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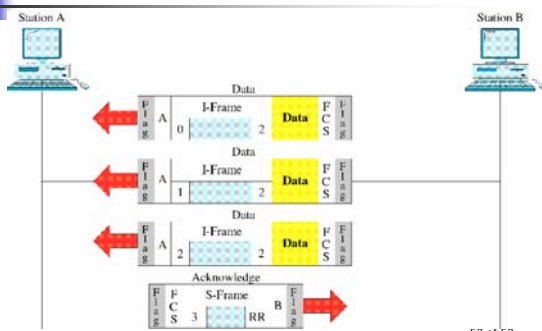
HDLC: Peer-to-peer example



SABM: Set asynchronous balanced mode
UA: Unnumbered ack

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HDLC: Peer-to-peer example



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