# LE 517
# Data Communications and Networks

Week 9:- Protocol Controls

By

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## Protocol Controls

- **Basic Flow Control**
  - Signaling
  - Frame-Oriented Control
- Sliding Window Protocols
  - Frame Format
  - Go-Back-n Protocol
  - Selective Repeat Protocol
- Data Link Control Protocols
  - High-Level Data Link Control (HDLC)
  - Binary Synchronous Communications (BSC) Protocols

# Basic Flow Control

- **Flow Control** defines the way in which many frames are sent and tracked and how the stations do error control.
- Error Control defines how a station checks frames for errors and what it does if it finds them.
- **Automatic Repeat Request (ARQ)** is type of error control which request and resend the frame when needed.

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# Signaling

- DTE-DCE Flow Control
  - There is DTR and DST lines to indicate the readiness
  - DTE send to DCE by
    - 1. RTS (Request To Send)
    - 2. Wait for CTS (Clear To Send)

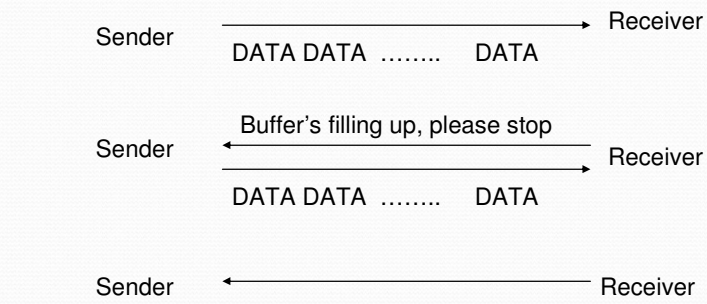
# Signaling

- X-ON/X-OFF
  - In ASCII character defines DC3[19] and DC1[17]
  - They are X-OFF (DC3) and X-ON (DC1)
  - X-OFF is a signal that use when buffer is filling up so sender will stop sending.
  - X-ON is signal that use to resume the transmission.

  - **Note:** There is delay when sending X-OFF so generally receiver sends X-OFF signal when buffer is reached the threshold.

# Signaling

- The simple example is




I'll wait until receive request signal

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## Frame-Oriented Control

- X-ON/X-OFF is byte oriented and asynchronous communications. (Can pause at any given byte)
- Synchronous communication are frame oriented and require more organization.
- Generally, these protocols send as a large piece of data. So buffer must able to store the whole frame.

## Unrestricted Protocol

- This protocol is an example that assumes receiver has un limited capacity and fast enough so the buffer space is always available.
- This is count as easiest protocol where it does not consider problem on flow control.
- Text book give an example as post office with normal mail.

# Stop and Wait Protocol

- Every time the receiver gets a frame it sends an acknowledgement back to sender.
- After Sending a frame, sender waits for an acknowledgement before sending the next frame.
- The receiver sends acknowledgement as error or ack depends on the received data.
- What if data/acknowledgement lost?
- What if data/acknowledgement damage?

# Protocol Efficiency

**Channel Utilization**

R = transmission rate (e.g. 10 Mbps)
S = signal speed (e.g. 200 meter per µsec)
D = distance between the sender and receiver (e.g. 200 meters)
T = time to create one frame (e.g. 1 µsec)
F = number of bits in a frame (e.g. 200)
N = number of data bits in a frame (e.g. 160)
A = number of bits in an acknowledgement (e.g. 40)

# Protocol Efficiency

- Time (UP) = $T + F/R$
- Time (SWP)= $2^* (T+D/S) + (F+A)/R$
- P (UP) = $100 * (F/R)/ (T+ (F/R))$
- P (SWP) = $$\frac{100 * (F/R)+ (D/S)}{2^*(T+D/S) + (F+A)/R}$$
- Effective data rate (UP) = $N/(T+F/R)$
- Effective data rate (SWP) = $$\frac{N}{2^*(T+D/S) + (F+A)/R}$$

**UP**:- Unrestricted Protocol

**SWP**:- Stop and Wait Protocol

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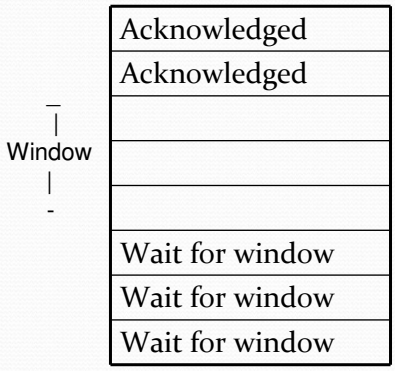
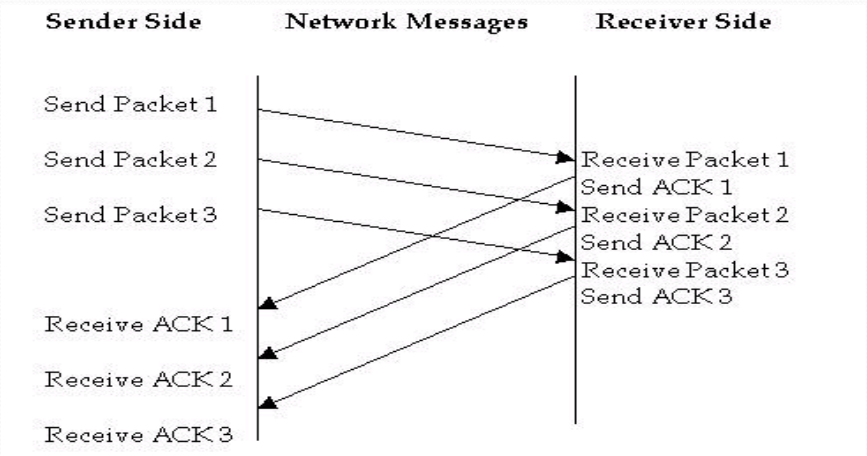
# Sliding Window Protocols

- Window :- Number of frame to be sent
- Window will move from the sender's frames from time to time.




# Sliding Window Protocols



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# Frame Format

- Protocol sends and receive frame which both must be understand.

Source | Dest | No. | ACK| Type | .. Data.. | CRC

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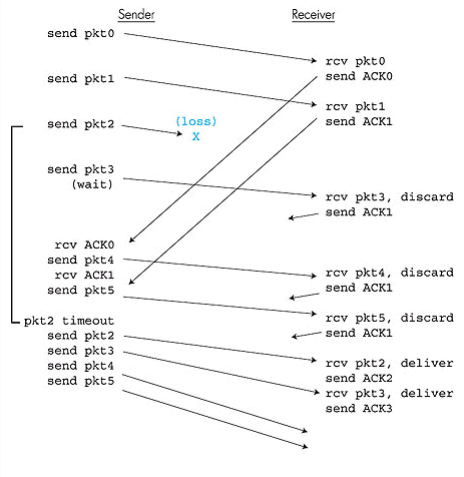
# Go-Back-n Protocol



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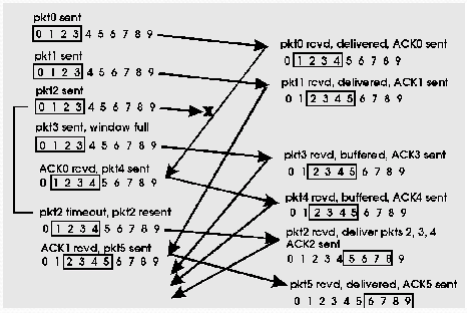
# Selective Repeat Protocol

- Go-back-n works well over reliable channels.
- Why not allow receiver sort the received frame?

- Protocol uses naks for damaged frames.



# Sliding Window Protocol Efficiency

Time to build  Time to send & receive

$W*(T+F/R) > 2*(T+ D/S + F/R)$

R = transmission rate (e.g. 10 Mbps)
S = signal speed (e.g. 200 meter per µsec)
D = distance between the sender and receiver (e.g. 200 meters)
T = time to create one frame (e.g. 1 µsec)
F = number of bits in a frame (e.g. 200)
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A = number of bits in an acknowledgement (e.g. 40)
W = number of frames in the window

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## Data Link Control Protocols

- Refer to OSI Model, this is to manage and control the flow of frames between two stations.
- Note: Previously, protocol control and maintain data frame exchange.

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## High-Level Data Link Control (HDLC)

- HDLC is a bit oriented protocol that supports both half-duplex and full-duplex communications.
  - Primary station (host station or control station)
    - It managed data flow by issuing commands to other stations and acting on their response.
  - Secondary station (target station or guest station)
    - It response to commands issued by a primary station (only one primary station)
  - Combined station
    - It acts as both primary and secondary station.

## High-Level Data Link Control (HDLC)

- HDLC can communicate in one of three modes.
  - Normal response mode (NRM)
    - The secondary station can send only when primary station instructs to do so.
  - Asynchronous response mode (ARM)
    - The secondary can send data or control information to the primary station without permission.
    - For the rest, establishing, maintaining and ending connection still resides with primary station
  - Asynchronous balanced mode (ABM)
    - This configurations connecting combined stations.
    - So, each station can send data control information and commands.

## High-Level Data Link Control (HDLC)

- Frame Format

| Flag | Address | Control | --- Data--- | FCS | Flag |
|---|---|---|---|---|---|
| *8* | *8 or 16* | *8 or 16* | *variable* | *16 or 32* | *8* |

*Number of bits*

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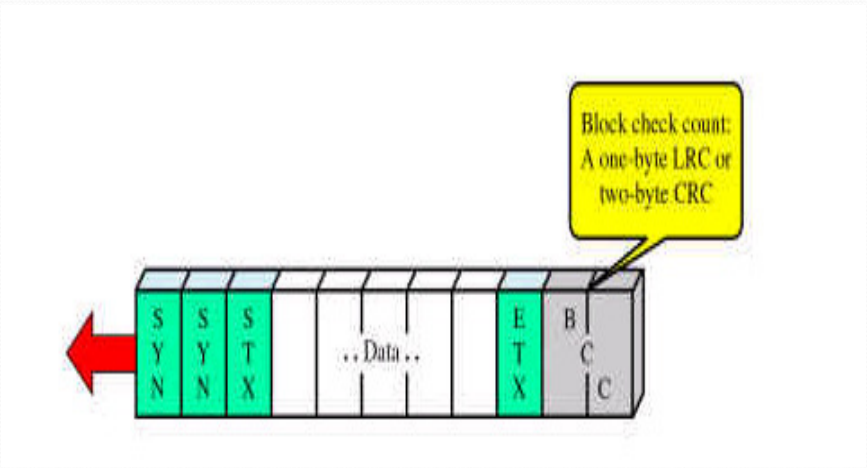
# Binary Synchronous Communications (BSC) Protocols

- BSC  was mad by IBM.
- It used with synchronous, half-duplex communications and stop and wait flow control.
- The frame starts with two SYN characters to alert the receiver that bytes are arriving.

# Binary Synchronous Communications (BSC) Protocols



# Binary Synchronous Communications (BSC) Protocols

SYN (Synchronous Idle)
Provides the hardware recognizable bit pattern rquired to establish character synchronization at the receiving adapter
ENQ (Enquiry)
Recognized as a request for a response, or a bid for line control. In some cases it may be used to signify an abnormal end of text or message 'abort'.
SOH (Start of Header)
Indicates the inclusion of auxiliary data preceding the message text.
STX (Start of Text)
Indicates the beginning of data in a block. STX may be preceded by a header. Directly behind the STX is the first character of the data field.
NAK (Negative Acknowledgement)
Indicates that there was an error in a data block. Also used as a response to a bid for line control to indicate a 'Not Ready' condition.
ETB (End of Transmission Block)
Indicates an end of data block, but more will follow. Is used to instruct the receiving unit to perform error checking and acknowledge.
ETX (End of Text)
Same as ETB, only no more blocks will follow.
EOT (End of Transmission)
Indicates that a station has no data to transmit.
DLE (Data Link Escape)
Multiple usage as a control character modifier.
ITB (End of Intermediate Transmission Block)
Same as ETB, except that the receiving statio will not acknowledge after the error checking.
ACK0, ACK1 (positive Acknowledgements)
ACK0 ackowledges 'even' numbered blocks (and as a positive response to a line bid) and ACK1 acknowledges 'odd' numbered blocks.
DLE EOT (Mandatory Disconnect)
Used on a dial-up line to indicate that the dialing unit is hangup and an instruction for the receiving unit to do the same.
RVI (Reverse Interrupt Request)
Transmitted instead of a positive acknowledgement to indicate the need to send a high priority message to the station in control of the line.
TTD (Temporary Text Delay)
Sent by a station in control, in response to a positive acknowledgement.

# Reference


- http://www.simplesat.co.uk/images/rs%20232.jpg @ 17 Nov 2008
- http://www.tutorialsweb.com/networking/tcp-ip/images/Fig10_SlidingWindow.jpg @ 17 NOV 2008
- http://astro.temple.edu/~stafford/sp05/cis320/lecture/chap3/deluxe-content_files/03-21.jpe@17 NOV 2008
- http://gaia.cs.umass.edu/cs653-1997/notes/ch5/Image4.gif @ 17 Nov 2008
- http://www.ecst.csuchico.edu/~sim/547/Old547/notes/NOTE9_1_files/image002.jpg @ 17 Nov 2008
- http://ckp.made-it.com/bisync.html@ 17 Nov 2008


Q & A