

CSE3151
COMPUTER NETWORKS



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DATA LINK LAYER

Data Link Layer: Types of errors, framing, error detection & correction methods; Flow control, Stop & wait ARQ, Go-Back- N ARQ, Selective repeat ARQ, HDLC.



- Frame –
- Flag –
- Error Detection and Correction.

Flow control deals with problem that sender transmits frames faster than receiver can accept, and solution is to limit sender into sending no faster than receiver can handle

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SIMPLE STOP AND WAIT

- Simple Stop and Wait

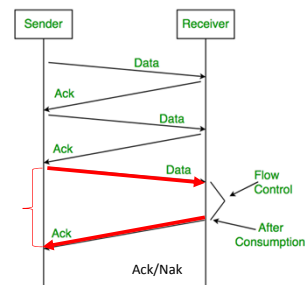
Sender:

- Rule 1) Send one data packet at a time.
- Rule 2) Send next packet only after receiving acknowledgement for previous.

Receiver:

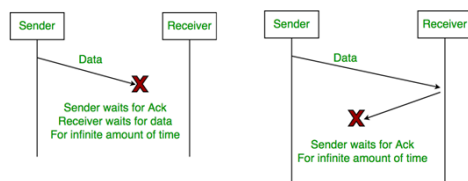
- Rule 1) Send acknowledgement after receiving and consuming of data packet.
Rule 2) After consuming packet acknowledgement need to be sent (Flow Control)

SIMPLE STOP AND WAIT



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SIMPLE STOP AND WAIT



- **DELAYED ACKNOWLEDGEMENT/DATA:** After timeout on sender side, a long delayed acknowledgement might be wrongly considered as acknowledgement of some other recent packet.

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STOP AND WAIT ARQ

- ... 3 problems are resolved by **Stop and Wait ARQ (Automatic Repeat Request)** that does both error control and flow control.
- **ARQ : AUTOMATIC REPEAT REQUEST**

Stop (and) Wait + Time Out + Sequence No.(Data) + Sequence No. (ACK)

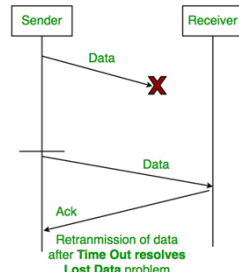
Lost Data

Lost Ack

Delayed Ack

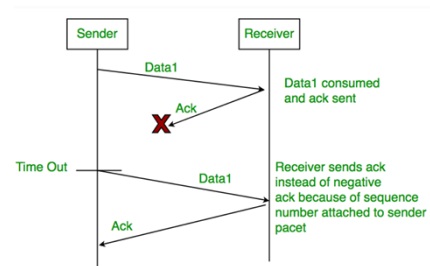
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STOP AND WAIT ARQ



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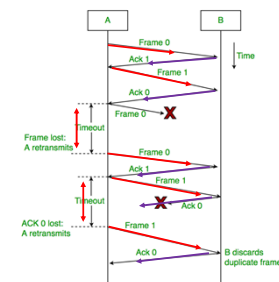
STOP AND WAIT ARQ



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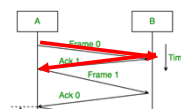
STOP AND WAIT ARQ

1. Sender A sends a data frame or packet with sequence number 0.
2. Receiver B, after receiving data frame, sends and acknowledgement with sequence number 1 (sequence number of next expected data frame or packet)



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SLIDING WINDOW ARQ



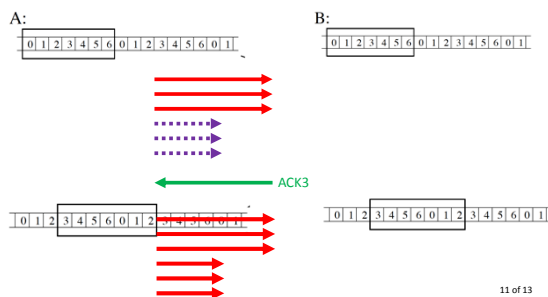
- Frames and acknowledgements are numbered using **SEQUENCE NUMBERS**.
- Sender maintains a list of sequence numbers (frames) it is allowed to transmit, called **SENDING WINDOW**.
- Receiver maintains a list of sequence numbers it is prepared to receive, called **RECEIVING WINDOW**.
- A sending window of size **N** means that sender can send up to **N** frames without the need for an **ACK**.
- A window size of **N** implies buffer space for **N** frames.

- For n -bit sequence number, we have 2^n numbers: $0, 1, \dots, 2^n - 1$, but the maximum window size $N = 2^n - 1$ (not 2^n)
- ACK3 means that receiver has received frame 0 to frame 2 correctly, ready to receive frame 3 (and rest of N frames within window)

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SLIDING WINDOW ARQ

Consider the case of 3-bit sequence number with maximum window size $N = 7$

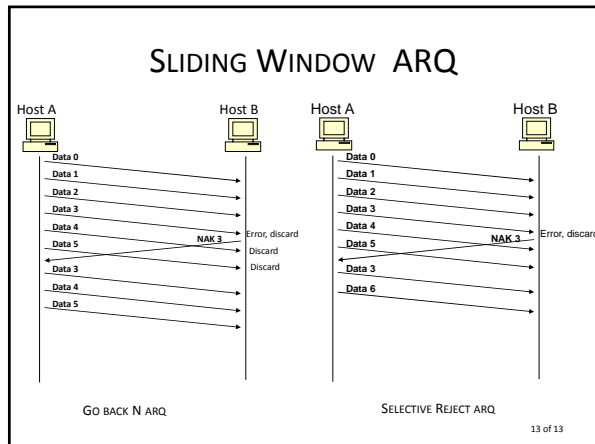


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SLIDING WINDOW ARQ

- **SLIDING WINDOW ARQ**
 - GO BACK N ARQ
 - SELECTIVE REJECT ARQ

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Data Link Layer: Types of errors, framing, error detection & correction methods; Flow control, Stop & wait ARQ, Go-Back-N ARQ, Selective repeat ARQ, HDLC.

Network Layer: Internet address, classful address, subnetting, static vs. dynamic routing, shortest path algorithm, flooding, distance vector routing, link state routing, ARP, RARP, IP, ICMP.

Transport Layer: UDP, TCP, Connection management, Addressing, Establishing and Releasing Connection, Congestion control algorithm, Flow control and Buffering, Multiplexing.

Presentation Layer: Data Compression techniques, Frequency Dependent Coding, Context Dependent Encoding.

Application Layer: Internet and intranets, Internet services and goals, DNS, SMTP, FTP, Telnet, HTTP, World Wide Web (WWW), DHCP and BOOTP.

Networking in Practice: Designing LAN, Cabling, Establishing Client-Server network, Configuring: Directory Server, Proxy server, FTP server, E-mail server, web server, DB server, Firewall, Network troubleshooting, network maintenance, network monitoring, Network programming.

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