CS 352: Internet Technology- Midterm 07/19

Exam Content

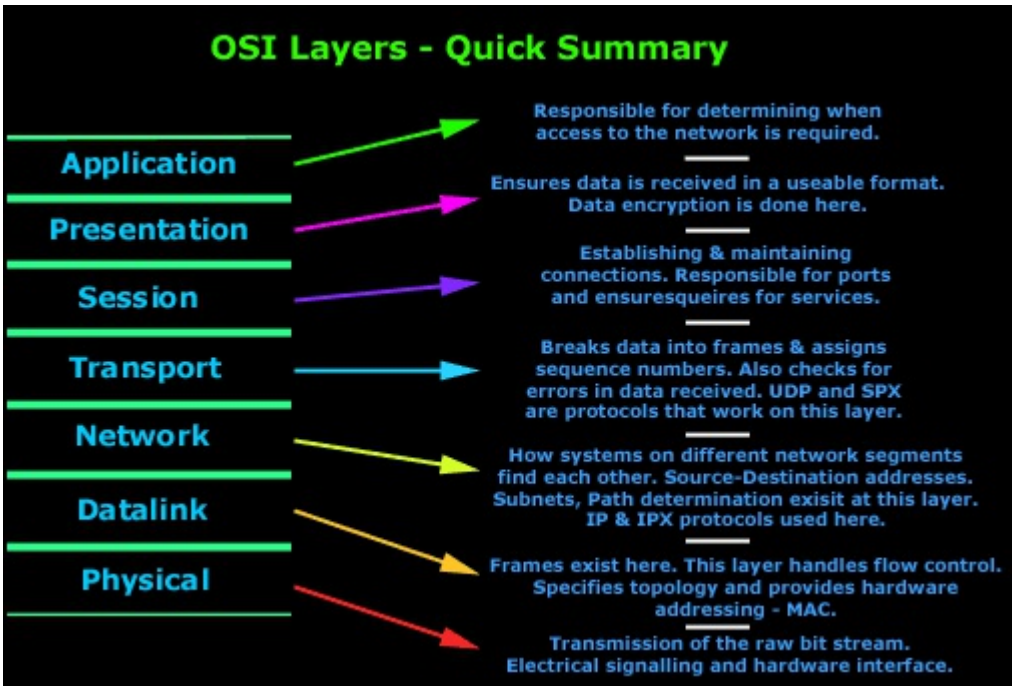
The exam has been partitioned into 6 sections totaling 114 pts:

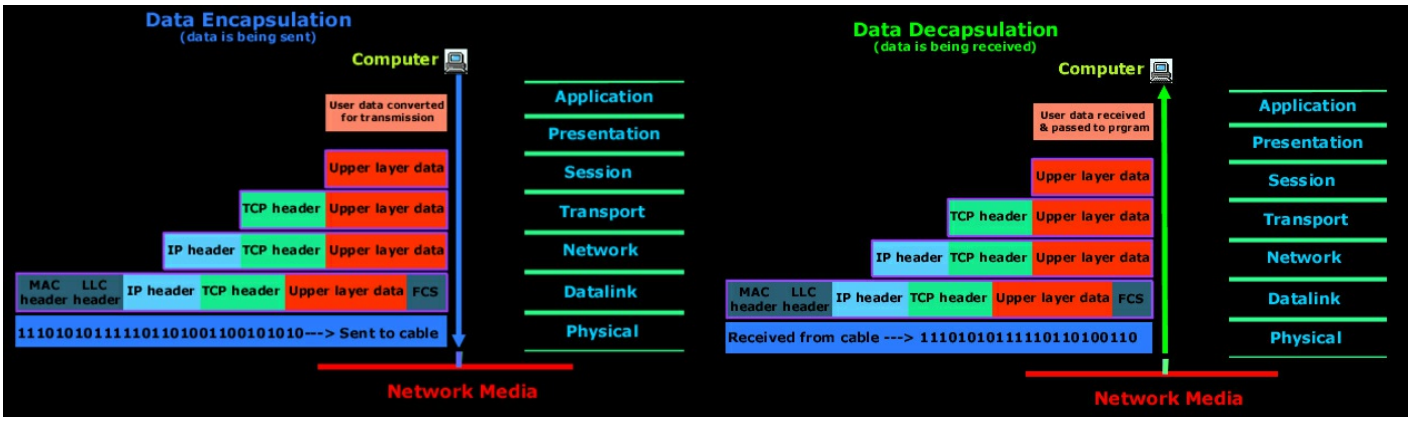
1. Internetw orking ~ 24 pts
2. TCP Details ~ 20 pts
3. Delay and Transport ~ 20 pts
4. Transport Calc ~ 20 pts
5. HTTP Protocol ~ 30 pts
6. Extra ~ 3 pts

Terms

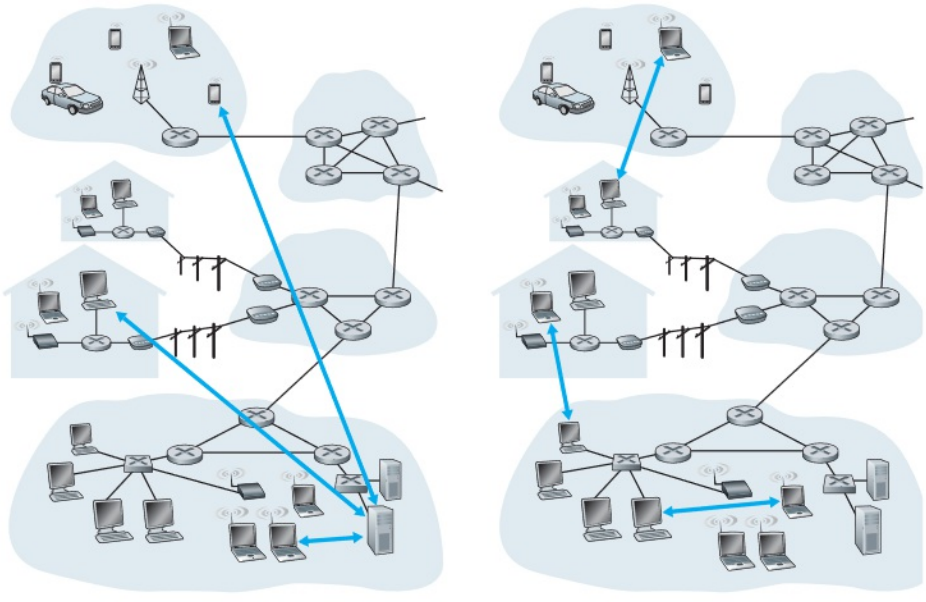
- **Network**: Collection of interconnected *machines*
- **Internetwork**: Collection of interconnected *networks*
- **Host**: Machine running user application
- **Channel**: *Logical* line of communication
- **Medium**: Physical process used (e.g. fiber optics, copper w ire, satellite link)
- **Network Core**: The mesh of packet sw itches and links that interconnect the Internet's end systems
- **EDGE Network**: A netw ork w hich provides for the main or CORE netw ork; companies and organizations w ith a default route
- **CORE Network**: ISP tiers w ith the biggest ISPs in tier 1 and smaller, regional ISPs in tiers 2, 3
- **Protocol**: Defines the format and the order of messages exchanged betw een tw o or more communicating entities, as w ell as he actions taken on he transmission and/or receipt of a message or other event
- **Packets**: Smaller chunks of data broken off from longer "messages"
- **Packet Switching**: Group data transmitted over the netw ork into packets w hich then get transmitted (e.g. routers, link-layer sw itches)
- **Store-And-Forward**: Packet sw itch must receive the entire packet to transmit the first bit of packet onto outbound link
- **Output Buffer**: An *output queue* that stores the packets that the router is about to send into a link
- **Queueing Delays**: Variable delays that depend on the level of congestion in the netw ork and occurs w hen an incoming packet finds the link busy w ith transmission of another packet
- **Processing Delay**: The time required to examine the packet's header and determine w here to direct the packet
- **Transmission Delay**: Amount of time required to push/transmit all of the packet's bits into the link
- **Propagation Delay**: The time required to propagate from the beginning to router B
- **Packet Loss**: The arriving packet or an already-queued packet may be dropped if an arriving packet finds that the buffer is completely full w ith other packets w aiting for transmission
- **Forwarding Table**: Each router has one of these that maps destination address (or portions of it) to that router's outbound links
- **Circuit Switching**: A circuit-based netw ork that guarantees a constant transmission rate betw een a sender and receiver. For these purposes, a dedicated *end-to-end* connection exists
- **Frequency-Division Multiplexing**: The frequency spectrum of a link is divided up among the connections across a link; the link dedicates a frequency band to each connection for the duration of the connection.
- **Time-Division Multiplexing**: Time is divided into frames of fixed duration, and each frame is divided into a fixed number of time slots. When netw ork establishes a connection across a link, the netw ork dedicates one time slot for the sole use of that connection in every frame to this connection.
- **Statistical Multiplexing**:
- **Encapsulation**: The process of passing information through the OSI stack, usually by appending header and payload.
- **Client-Server Architecture**: An alw ays-on *host* accepts service requests from incoming *clients*, but the clients do not directly communicate w ith each other
- **P2P Architecture**: The application exploits direct communication betw een intermittently connected hosts, or *peers*, w ithout passing through a dedicated server
- **Socket**: The interface betw een your application and the netw ork; one of the endpoints in a tw o-w ay communication link betw een tw o programs running on the netw ork
- **Round-Trip Time (RTT)**: Amount of time for a small packet to travel to the server and back; Response Time = 2RTT + FTT
- **Maximum Segment Size (MSS)**: The maximum amount of data that can be grabbed and placed in a segment

ISO-OSI Seven-Layer Stack





Client-Server vs. P2P



a. Client-server architecture

b. Peer-to-peer architecture

HTTP 1.0

Response Codes

Status Code	Response	Meaning
200	OK	Success
304	Not Modified	Redirection
400	Bad Request	Client error
403	Forbidden	Client error
404	Not Found	Client error
408	Request Timeout	Client error
418	I'm a Teapot	For Fun
500	Internal Server Error	Server error
501	Not Implemented	Server error
503	Service Unavailable	Server error
505	HTTP Version Not Supported	Server error

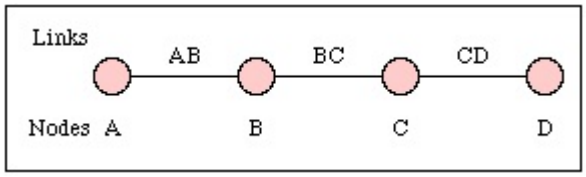
MIME Types

HTTP 1.0 also supports multi-parts and messages

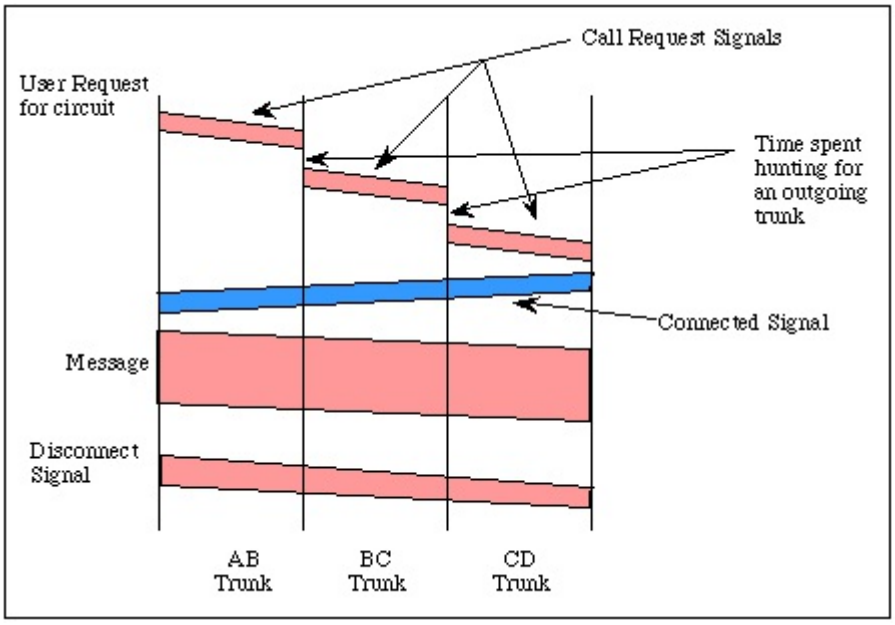
Extension	Kind of Document	MIME Type
.txt	default text file	text/plain
. htm, . html	HTML	text/html
. *	default for all other file types	application/octet-stream
. gif	GIF	image/gif
. jpg	JPEG Images	image/jpeg
. *	Basic Audio Files	audio/basic
.mpeg	MPEG Video	video/mpeg

Delay and Transport (with Calculations)

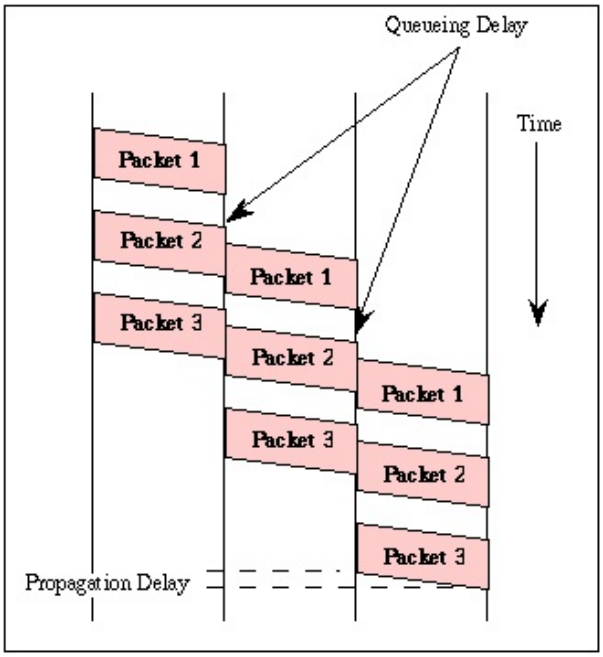
- Processing, Queueing, Transmission, and Propagation Delays are as defined in the definitions section
- Netw ork: $d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$
- Transport



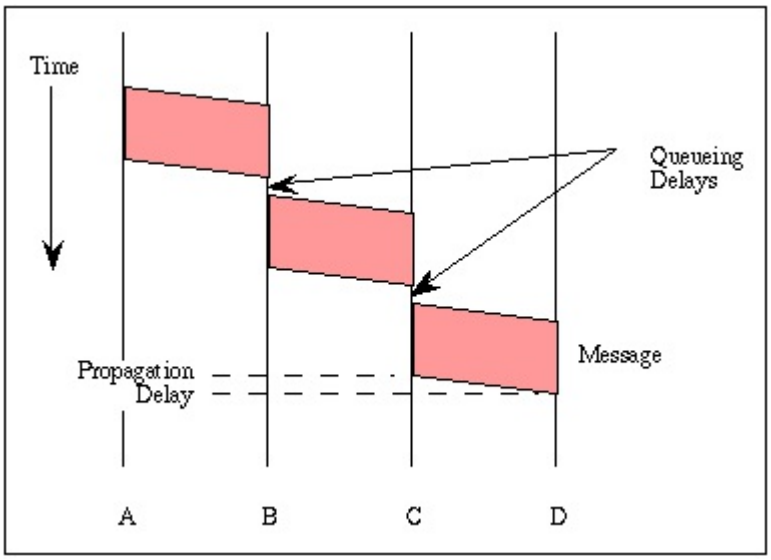
  - Circuit Sw itching: **t = C + M/B**
    - C: connection setup time (secs)
    - M: message size (bits)
    - B: bandw idth (bits/sec)



  - Packet Sw itching: **$t = t_0 * (P + S)$**
    - h: header size
    - d: packet data size (payload)
    - t0: time it takes to send one packet = (h+d)/B
    - B: bandw idth (bits/sec)
    - S: no. of stations (hops) going through
    - P: number of packets to send = ⌈M/d⌉



- Message Switching: $t = t_0 * (1 + S)$
  - h: header size
  - t0: time it takes to send one message = (h+M)/B
  - M: message size (bits)
  - B: bandwidth (bits/sec)
  - S: no. of stations (hops) going through



Useful Comparisons

TCP vs. UDP

	PRO/CON	TCP	UDP
connectionless	-	X	
faster	-	X	
more reliable	X	-	
provides ports	-	X	
more functionality	X	-	
point-to-point	X	-	
flow/congestion control	X	-	
light weight/less header	-	X	
in-order packet delivery	X	-	
higher thruput[+]	-	X	

[+] UDP packets are easier to process, esp. the source

HTTP vs. FTP vs. SMTP

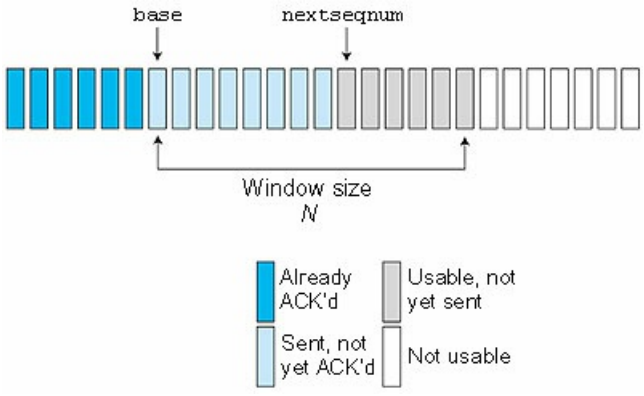
FEATURE	HTTP	FTP	SMTP
request/response protocol	X	X	X
connection semantics	-	X	X

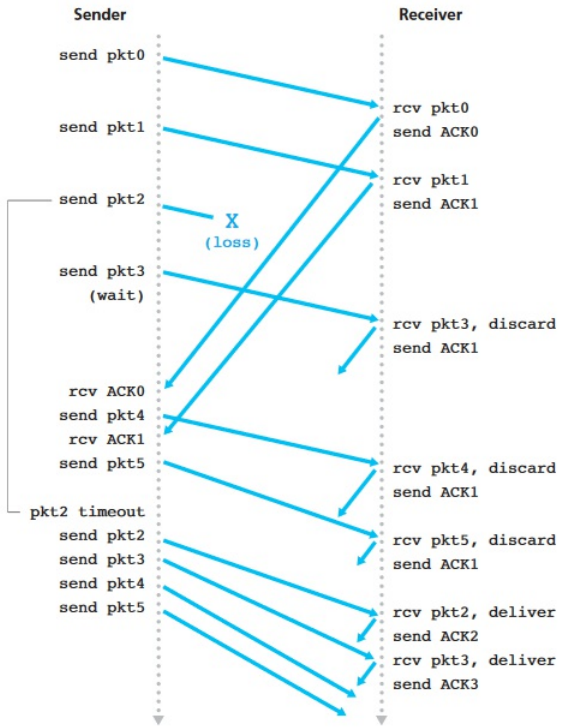
Circuit vs. Packet vs. Message Switching

- **Header Overhead**: Circuit (best) < Packet < Message (worst)
- **Transmission Delay**:
  - ***Short, Bursty Messages***: Packet (best) < Message < Circuit (worst)
  - ***Long, Continuous Messages***: Circuit (best) < Message < Packet (worst)
- Circuit vs. Packet
  - Still (TDM, FDM) vs. Statistical Multiplexing
  - Less vs. More Users

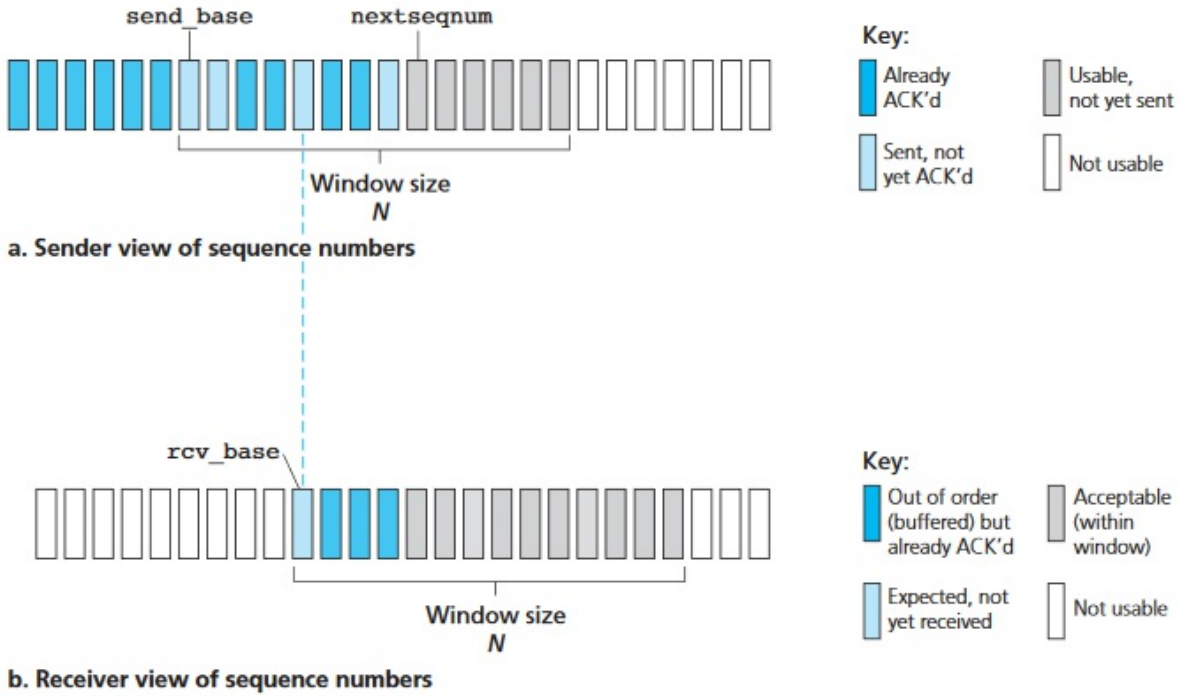
Go-Back-N vs. Selective Repeat Protocols

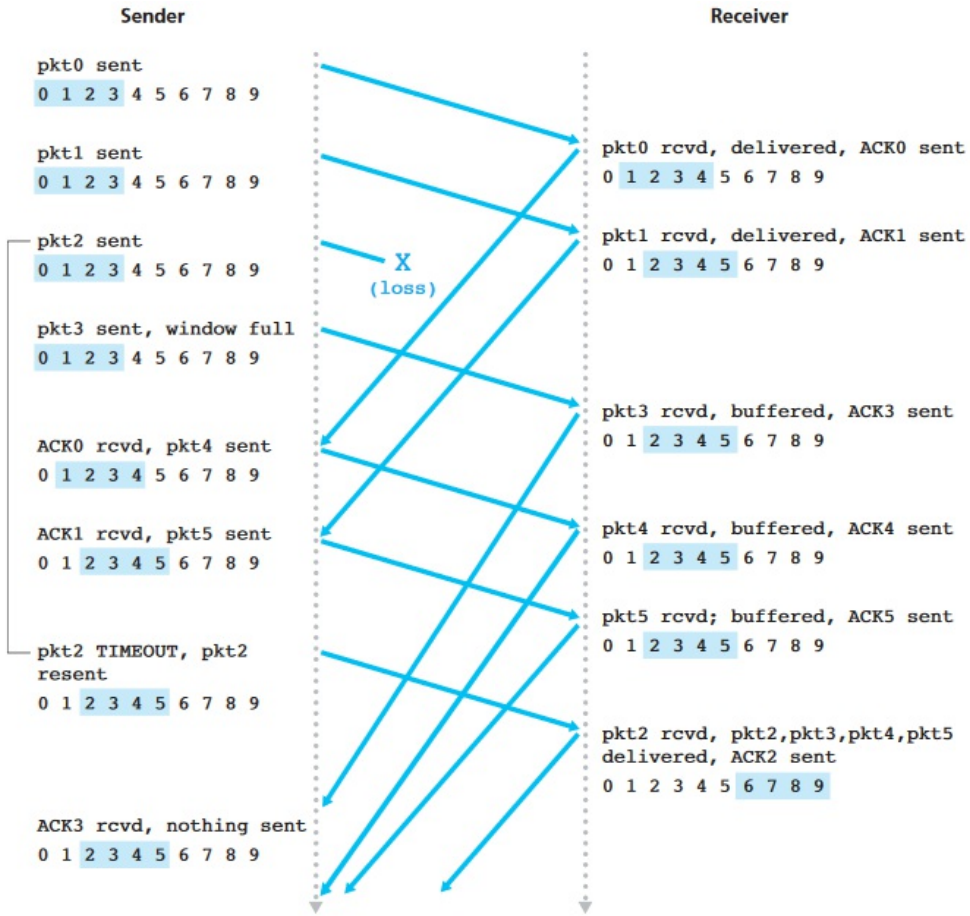
- The *Go-Back-N (GBN)*
  - Allows the sender to transmit multiple available packets without waiting for an acknowledgement but is constrained to have a maximum of *N* unacknowledged packets in the pipeline
  - *N* represents the window size





- The *Selective Repeat (SR)*
  - Avoids unnecessary retransmissions by having the sender retransmit only those that it suspects were lost or corrupted at the receiver
  - A window size of *N* will again be used to limit unacknowledged packets in the pipeline
  - However, unlike GBN, the sender will have already received ACKs for some of the packets in the window
  - The receiver will acknowledge a correctly received packet regardless of whether it is in order or not
  - The receiver *re-acknowledges* already-received packets with certain sequence *below* the window number
  - No synchronization between sender and receiver





Flow Control vs. Congestion Control

- Flow Control
  - How much the user can handle
  - Makes sure sender does not overload receiver by sending only enough data to accommodate receiver
  - Allows for more efficient bi-directional communication
  - Initiated by sender
- Congestion Control
  - How much the network can handle
  - Makes sure that the network can handle packet load
  - Reduces amount of sent packets to avoid overflowing its buffer/queue
  - Initiated by router

Exponential Math

Tip: 2^5 = 32 && 2^10 = 1024

Unit	Value
KB	2^{10}
MB	2^{20}
GB	2^{30}
TB	2^{40}
PB	2^{50}