

Computer Networks


Link Layer Protocols

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Fall 2021



want to try starlink yourself? at uvic parking lot 1
wifi ssid: csc361
password: ecs116now

Review

- 
- Application layer: HTTP, DNS
 - Transport layer: TCP, UDP
 - Network layer: IP/ICMP; RIP, OSPF, BGP
 - Link layer
 - frame control
 - byte stuffing, bit stuffing
 - error control
 - error detecting code, error correcting code

Error recovery

- Positive acknowledgment
 - cumulative acknowledgment
 - acknowledge packet x: acknowledge packets 1..x
 - when timeout, go-back-N
 - selective acknowledgment
 - acknowledge packet x: packet x is received OK
 - when timeout, selective repeat
- Negative acknowledgment
 - report: x is corrupted or *missing*

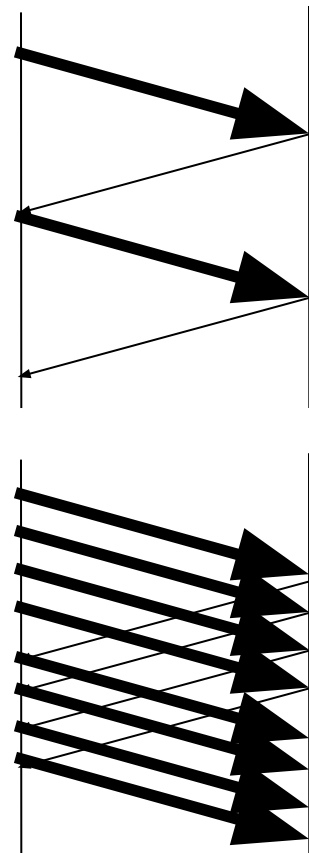
Today's topics

- Link layer
 - flow control
 - sliding-window-based flow control
 - representative link layer protocols
 - HDLC (High-level Data Link Control)
 - SLIP (Serial Line Internet Protocol)
 - PPP (Point-to-Point Protocol)



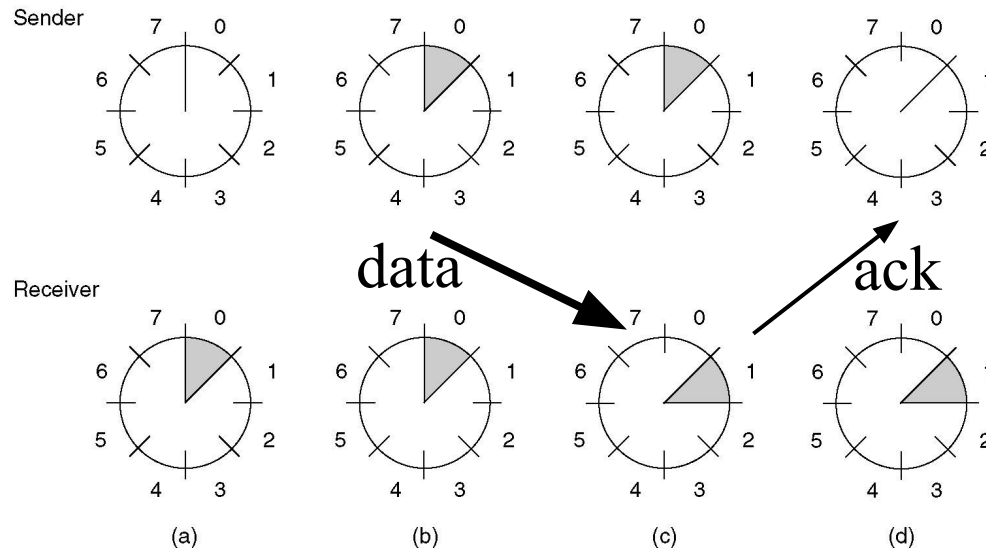
Transmission control

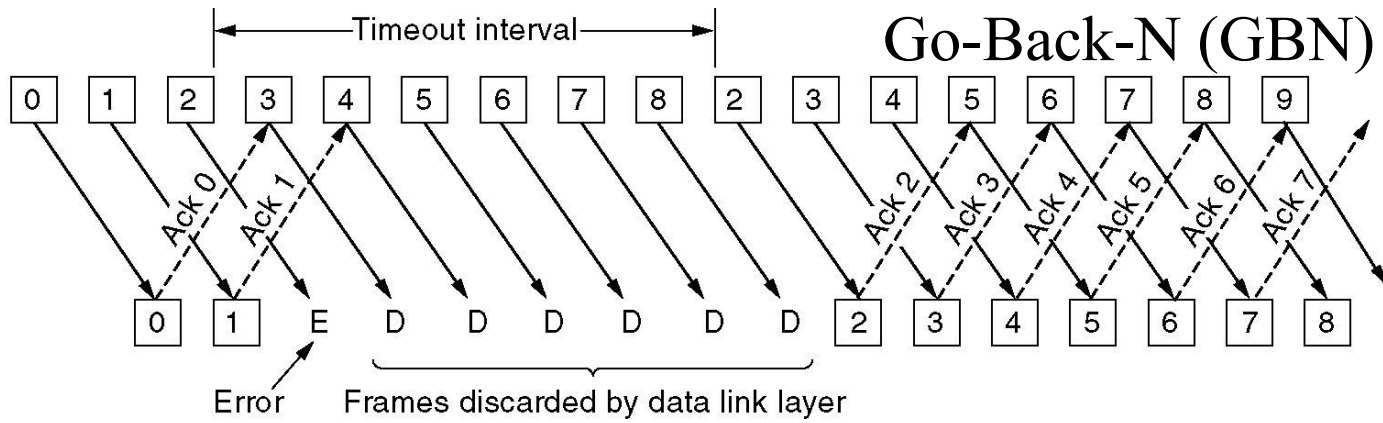
- Stop-and-wait
 - transmit the next packet
 - wait for its acknowledgment
 - or retransmit if timeout
 - low link utilization
- Pipelining
 - higher link utilization
 - issues at receiver
 - buffer limit? out-of-order packets?



Flow control

- Sliding window
 - window size $<$ buffer size
 - e.g., window size = 1, i.e., stop-and-wait



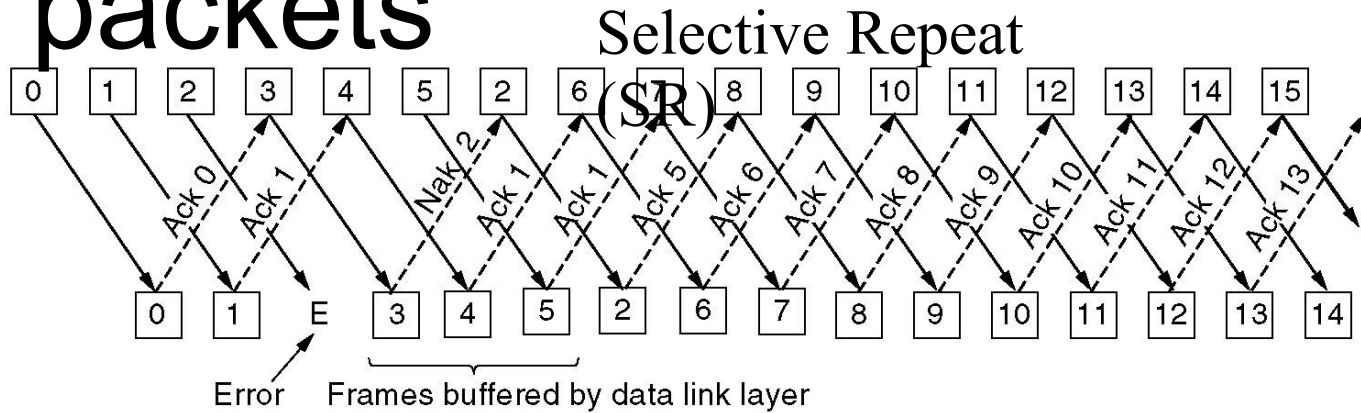


Out-of-order

Time →

(a)

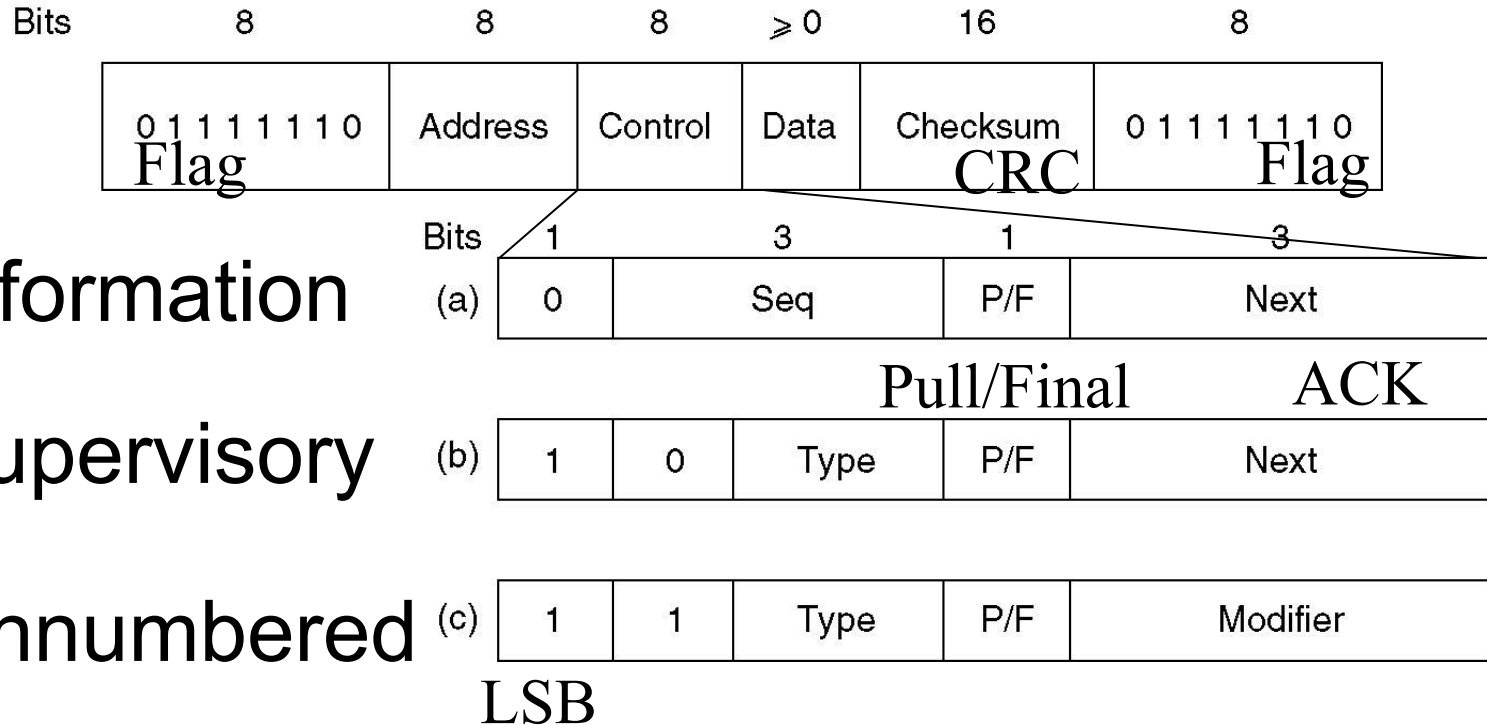
packets



(b)

High-level Data Link Control

- HDLC (bit-stuffing) derived from SDLC

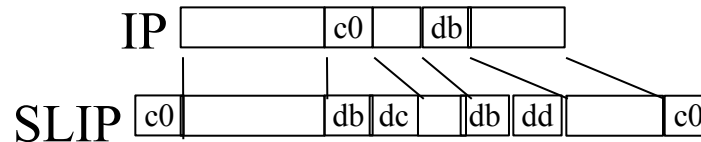


HDLC frames

- Information
 - sequence number
 - acknowledgment number
- Supervisory
 - acknowledgment number
 - Ready, Not Ready; Reject, Selective Reject
- Unnumbered
 - control frames
 - connectionless, unreliable service

Serial-Line Internet Protocol

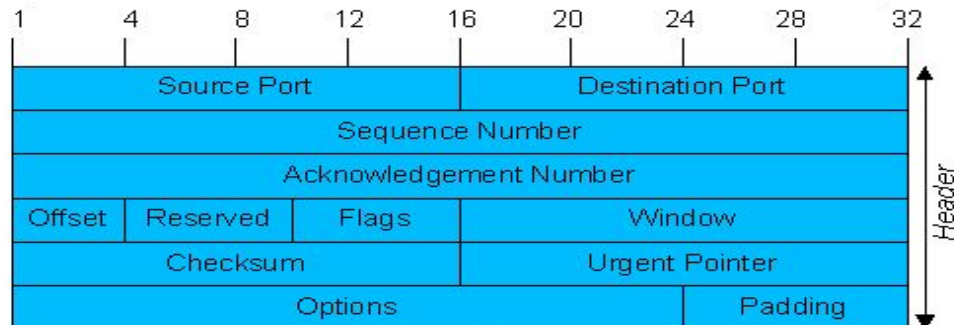
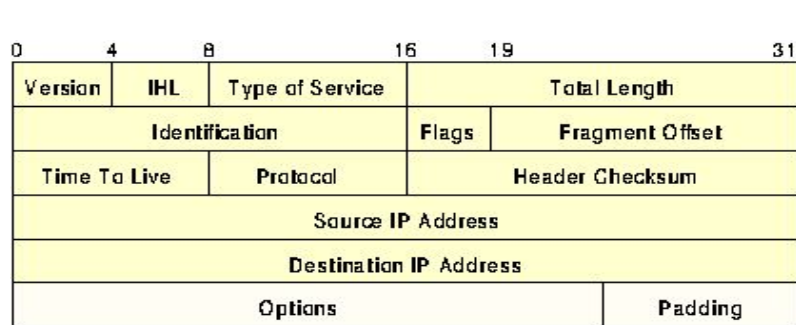
- SLIP/PLIP
 - very simple encapsulation for IP only
 - byte stuffing
 - flag: END (0xc0), escape: ESC (0xdb)
 - no flow/error control



Compressed SLIP

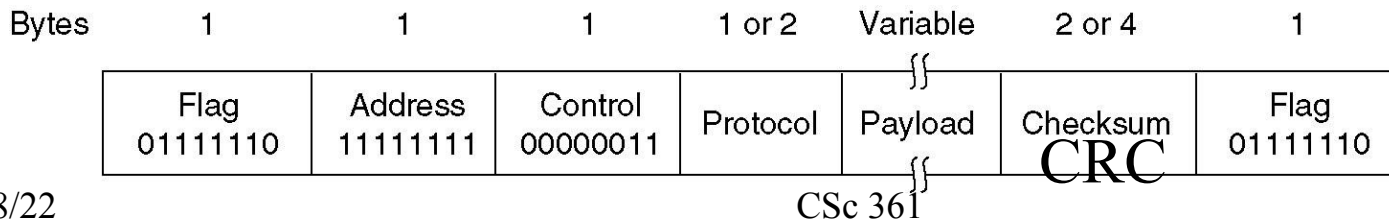
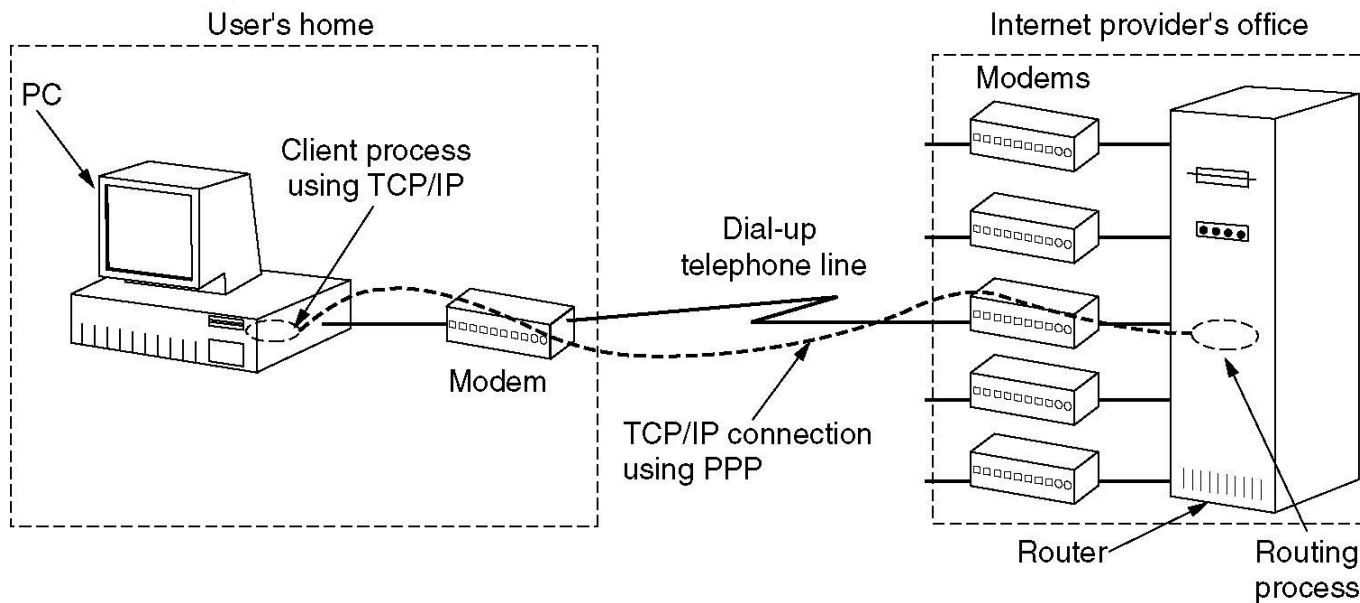


- Compressed SLIP (CSLIP)
 - TCP/IP header: at least 20+20 bytes
 - some static, some predictable
 - Telnet data payload: 1 byte
 - delta encoding
 - Von Jacobson compression to 3 bytes



Point-to-Point Protocol

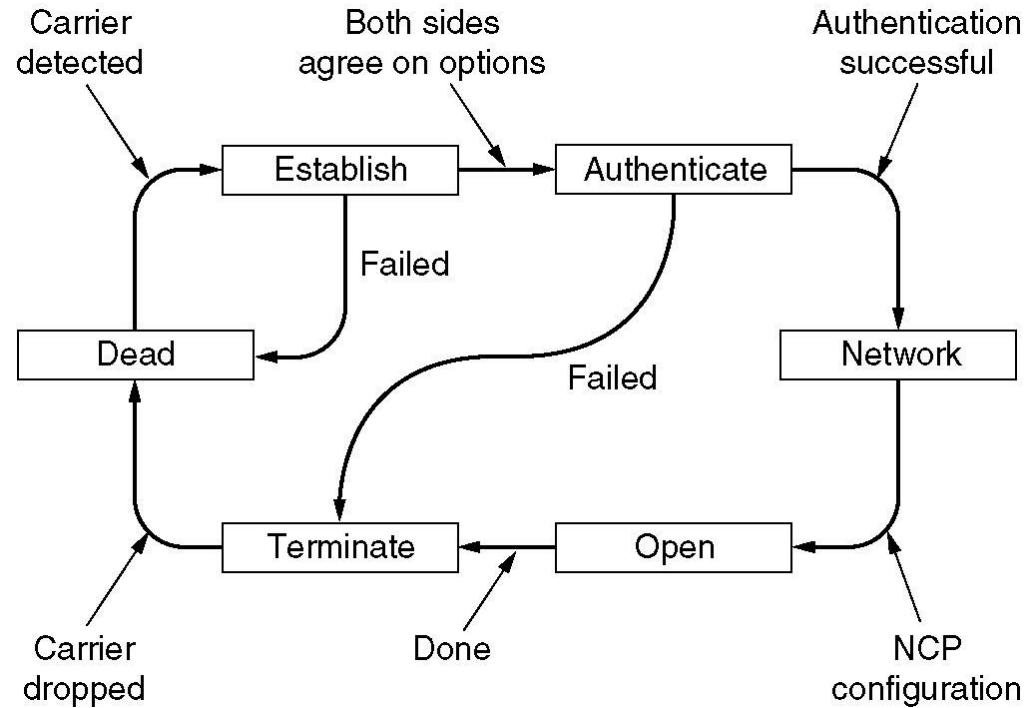
- PPP, PPPoE



Q: flow, error control?

PPP state diagram

- LCP
 - link parameters
- NCP
 - network parameters
- Authentication
 - PAP, CHAP, EAP



LCP frame types

Name	Direction	Description
Configure-request	$I \rightarrow R$	List of proposed options and values
Configure-ack	$I \leftarrow R$	All options are accepted
Configure-nak	$I \leftarrow R$	Some options are not accepted
Configure-reject	$I \leftarrow R$	Some options are not negotiable
Terminate-request	$I \rightarrow R$	Request to shut the line down
Terminate-ack	$I \leftarrow R$	OK, line shut down
Code-reject	$I \leftarrow R$	Unknown request received
Protocol-reject	$I \leftarrow R$	Unknown protocol requested
Echo-request	$I \rightarrow R$	Please send this frame back
Echo-reply	$I \leftarrow R$	Here is the frame back
Discard-request	$I \rightarrow R$	Just discard this frame (for testing)

LCP negotiation

- Maximum-Receiver-Unit (MRU)
- Authentication-Protocol
- Quality-Control
- Magic-Number (loopback detection)
- Protocol-Field-Compression (PFC)
- Address-and-Control-Field-Compression

IPCP

- Protocol
 - 0x8021: IPCP, i.e., NCP for IP
 - 0x0021: IP
- IPCP frame types
 - Configure-*, Terminate-*, Code-Reject
- Negotiation
 - compression: VJ compression (0x002d)
 - IP address: indicate or request one

PPP is more than just dialup

- PPPoA: PPP over ATM [RFC 2364]
 - some ADSL ISPs using ATM transport
- PPPoE: PPP over Ethernet [RFC 2516]
 - often used by DSL and cable modem ISPs
- Packet over SONET/SDH
 - mostly point-to-point backbone links
- L2TP: *Layer-2 Tunneling* Protocol (PPP/IP)
- PPTP: Point-to-Point TP (PPP+GRE)

This lecture

- Link layer
 - flow control
 - sliding window
 - HDLC, SLIP, PPP
 - frame, error and flow control
- Explore further
 - PPP: RFC 1661, 1332
 - <http://www.cs.uvic.ca/~pan/csc450f05/ppp.pdf>

Next lectures

- Medium access control