

Lecture 9: Internetworking

CSE 123: Computer Networks
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HW 1 due TODAY



UCSD CSE



Combing Networks

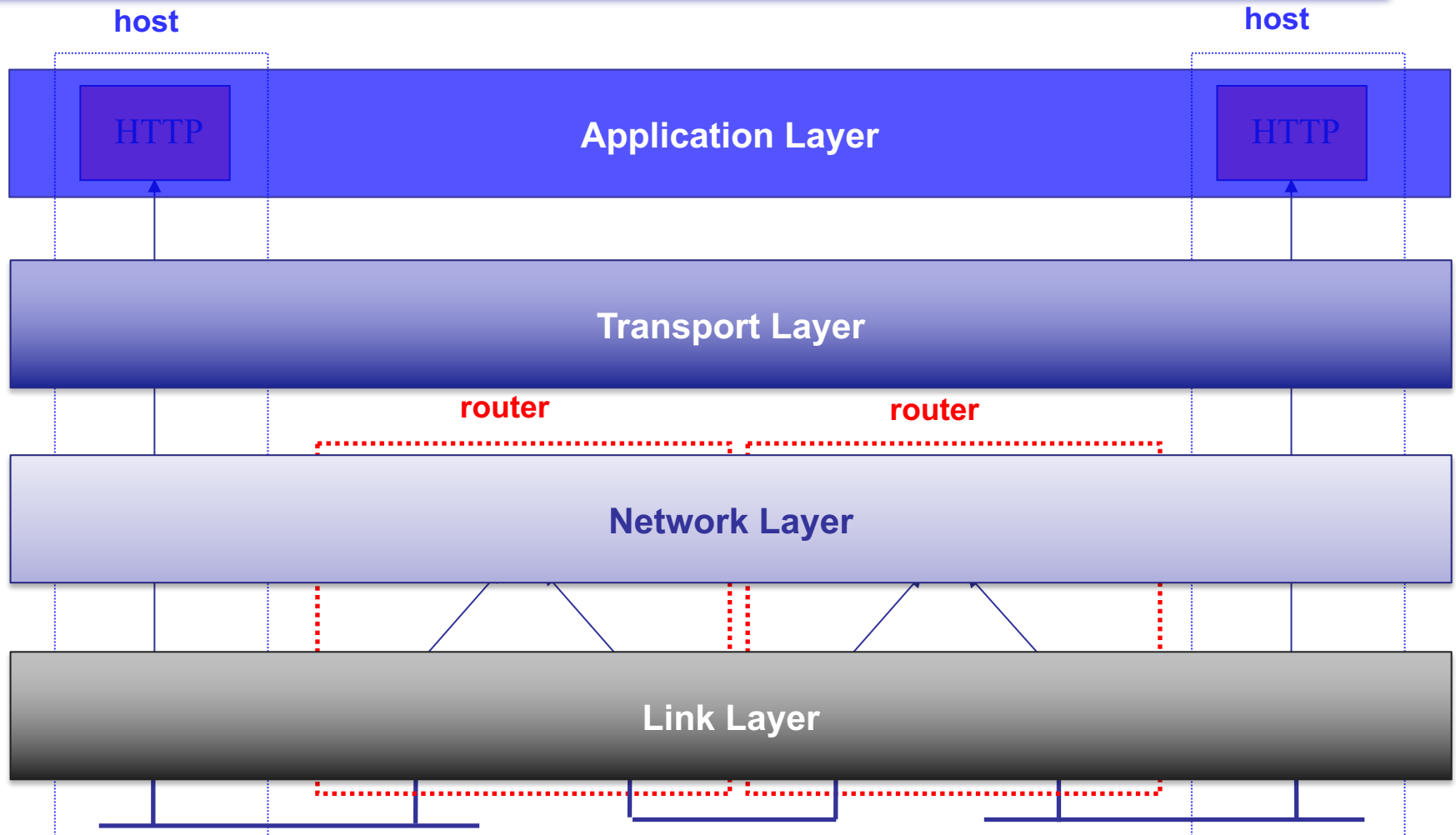
- Main challenge is heterogeneity of link layers:
 - ◆ Addressing
 - » Each network media has a different addressing scheme
 - ◆ Bandwidth
 - » Modems to terabits
 - ◆ Latency
 - » Seconds to nanoseconds
 - ◆ Frame size
 - » Dozens to thousands of bytes
 - ◆ Loss rates
 - » Differ by many orders of magnitude
 - ◆ Service guarantees
 - » “Send and pray” vs reserved bandwidth

Internetworking

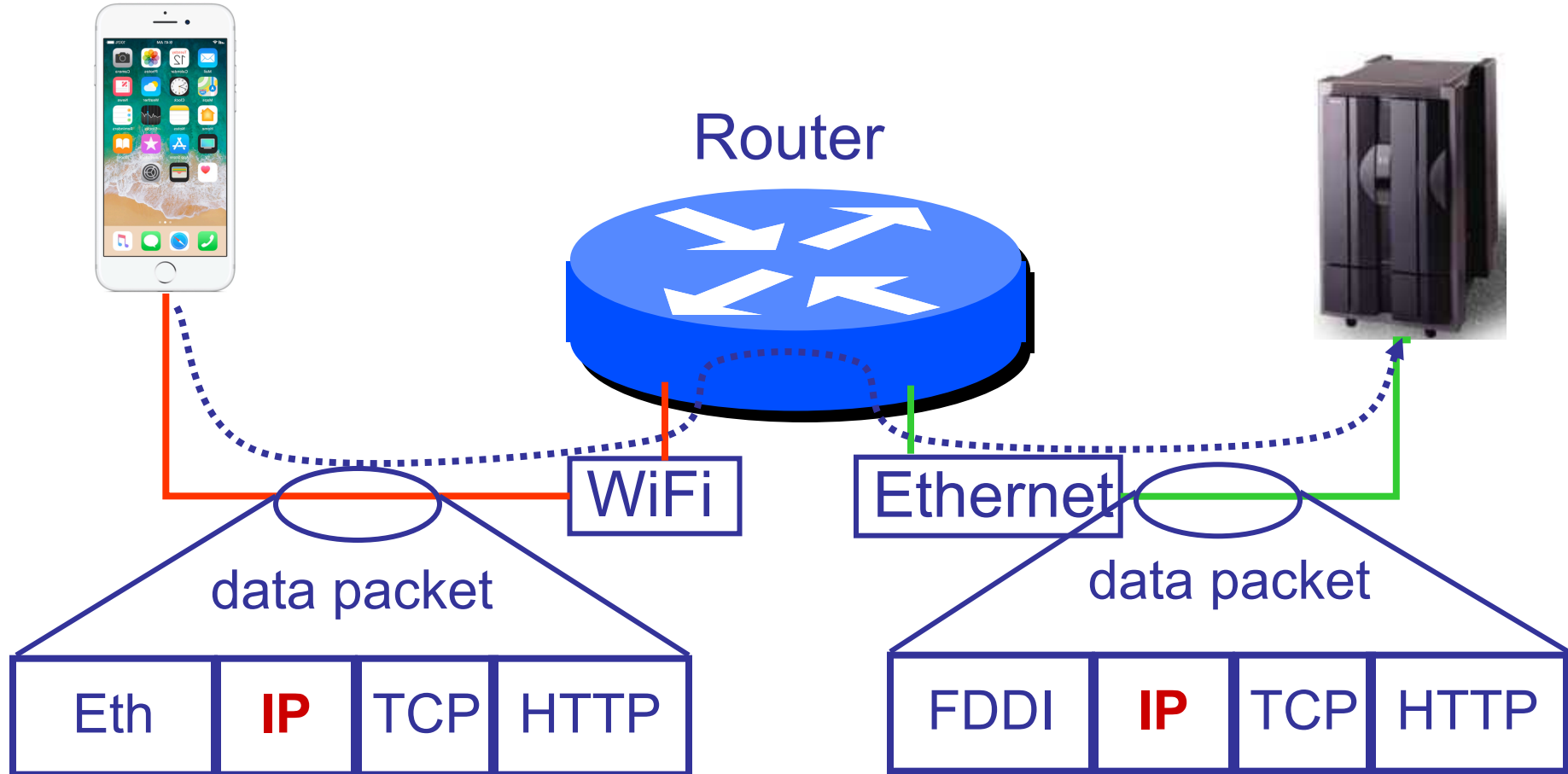


- Cerf & Kahn74,
“*A Protocol for Packet Network Intercommunication*”
 - ◆ Foundation for the modern Internet
- Routers forward packets from source to destination
 - ◆ May cross many separate networks along the way
- All packets use a common Internet Protocol
 - ◆ Any underlying data link protocol
 - ◆ Any higher layer transport protocol

TCP/IP Protocol Stack



IP Networking



Routers



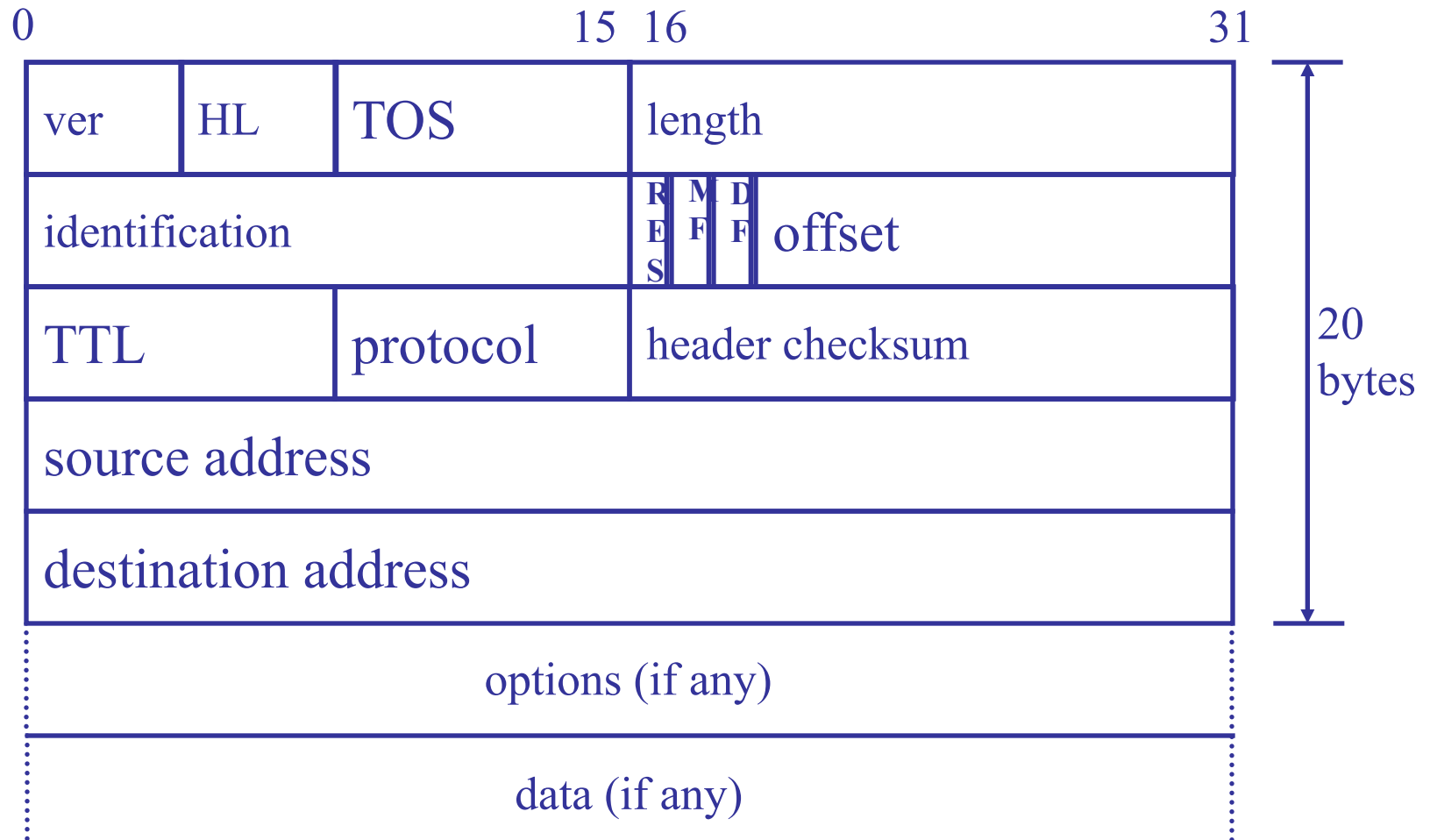
- A router is a store-and-forward device
 - ◆ Routers are connected to multiple networks
 - ◆ On each network, looks just like another host
 - ◆ A lot like a switch, but supports multiple datalink layers and makes decisions at the network layer
- Must be explicitly addressed by incoming frames (L2)
 - ◆ Not at all like a switch, which is transparent
 - ◆ Removes link-layer header, parses IP header (L3)
- Looks up next hop, forwards on appropriate network
 - ◆ Each router need only get one step closer to destination

IP Philosophy



- Impose few demands on network
 - ◆ Make few assumptions about what network can do
 - ◆ No QoS, no reliability, no ordering, no large packets
 - ◆ No persistent state about communications; no connections
- Manage heterogeneity at hosts (not in network)
 - ◆ Adapt to underlying network heterogeneity
 - ◆ Re-order packets, detect errors, retransmit lost messages...
 - ◆ Persistent network state only kept in hosts (fate-sharing)
- Service model: **best effort**, a.k.a. *send and pray*

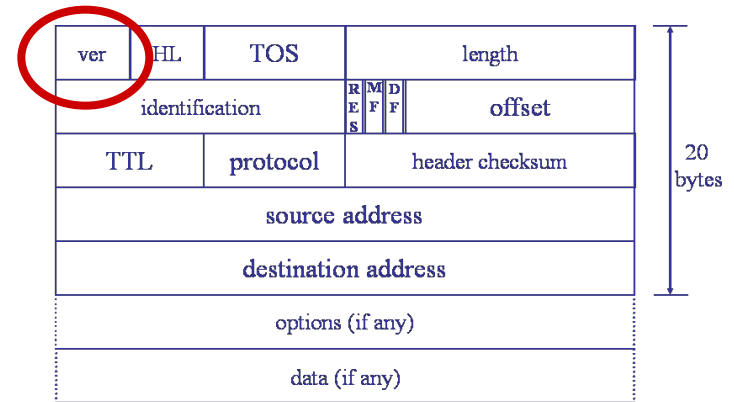
IP Packet Header





Version field

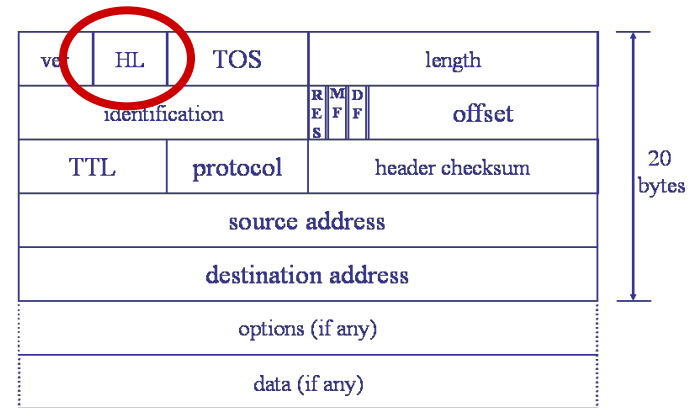
- Which version of IP is this?
 - ◆ Plan for change
 - ◆ Very important!
- Current versions
 - ◆ 4: most of Internet today
 - ◆ 6: new protocol with larger addresses
 - ◆ What happened to 5?
Standards body politics.





Header length

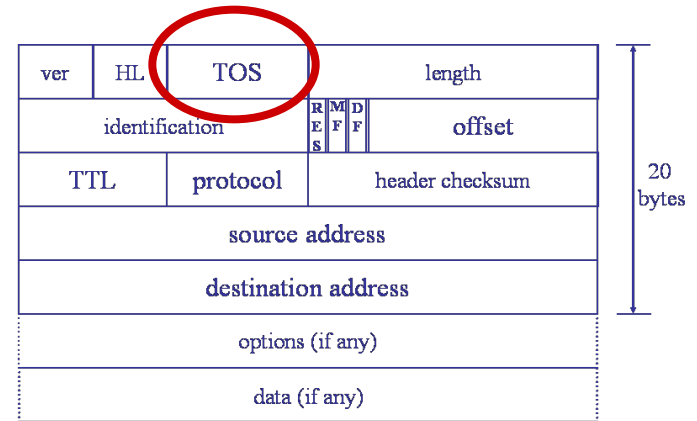
- How big is IP header?
 - ◆ Counted in 32-bit words
 - ◆ Variable length
 - » Options
 - ◆ Engineering consequences of variable length...
- Most IP packet headers are 20 bytes long



Type-of-Service



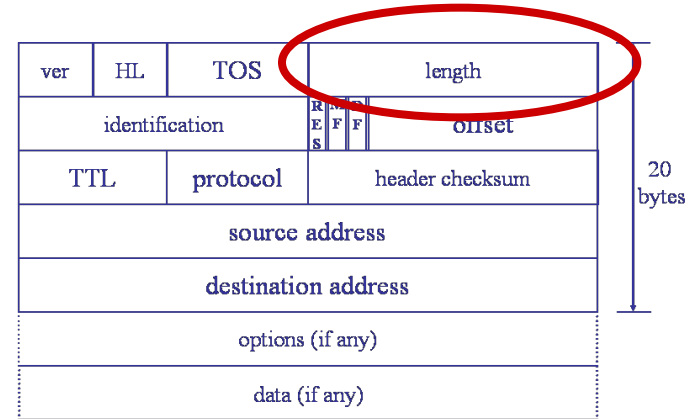
- How should this packet be treated?
 - ◆ Care/don't care for delay, throughput, reliability, cost
 - ◆ How to interpret, how to apply on underlying net?
 - ◆ Largely unused until 2000 (hijacked for new purposes, ECN & Diffserv)



Length



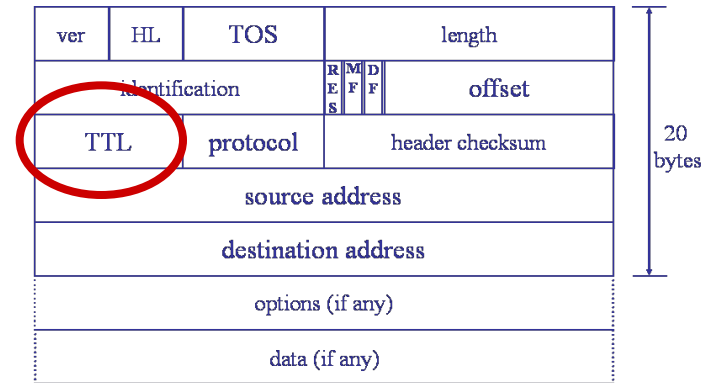
- How long is whole packet in bytes?
 - ◆ Includes header
 - ◆ Limits total packet to 64K
 - ◆ Redundant?





TTL (Time-to-Live)

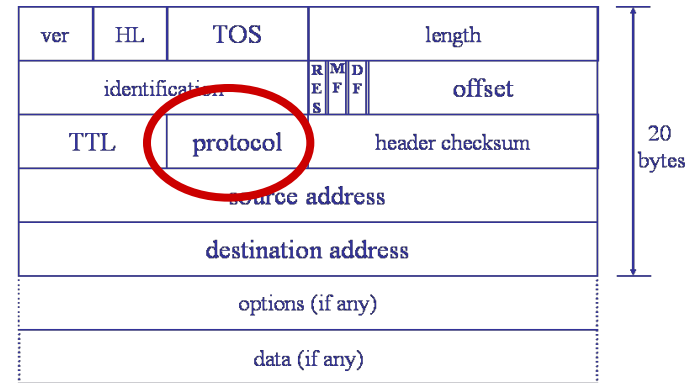
- How many more routers can this packet pass through?
 - ◆ Designed to limit packet from looping forever
- Each router decrements TTL field
- If TTL is 0 then router discards packet



Protocol



- Which transport protocol is the data using?
 - ◆ i.e. how should a host interpret the data
- TCP = 6
- UDP = 17

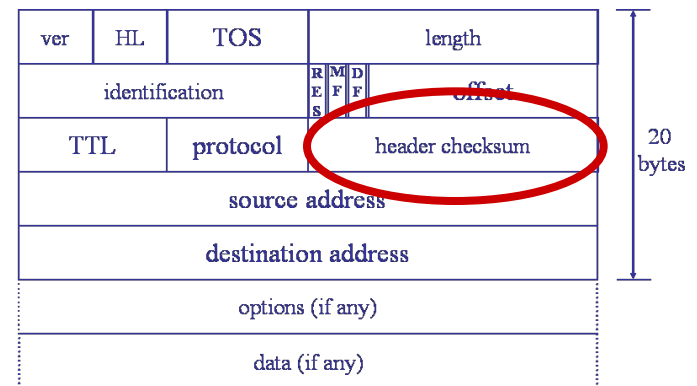


IP Checksum



- Header contains simple checksum
 - ◆ Validates content of header *only*

- Recalculated at each hop
 - ◆ Routers need to update TTL
 - ◆ Hence straightforward to modify



- Ensures *correct* destination receives packet



So what *does* IP do?

- Addressing
- Fragmentation
 - ◆ E.g. FDDI's maximum packet is 4500 bytes while Ethernet is 1500 bytes, how to manage this?
- *Some* error detection
- Routers only forward packets to next hop
 - ◆ They do not:
 - » Detect packet loss, packet duplication
 - » Reassemble or retransmit packets
- Today we'll talk about fragmentation



For Next Time

- Read 3.2.5 in P&D
- Homework 1 due TODAY
- Homework 2 out on Monday
- Project 1 due in 1.5 weeks!