

Internetworking

Outline

- Best Effort Service Model
- Global Addressing Scheme

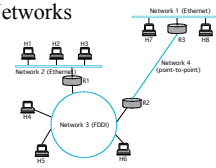
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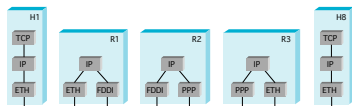
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IP Internet

- Concatenation of Networks



- Protocol Stack



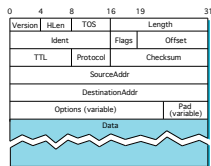
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Service Model

- Connectionless (datagram-based)
- Best-effort delivery (unreliable service)
 - packets are lost
 - packets are delivered out of order
 - duplicate copies of a packet are delivered
 - packets can be delayed for a long time
- Datagram format



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Fragmentation and Reassembly

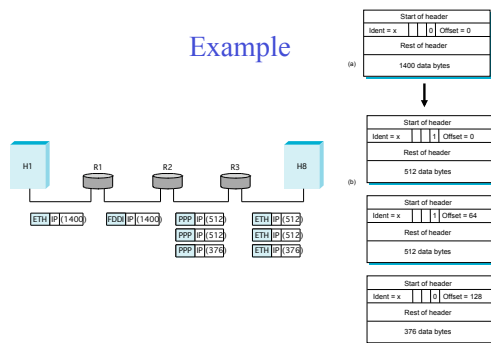
- Each network has some MTU
- Design decisions
 - fragment when necessary (MTU < Datagram)
 - try to avoid fragmentation at source host
 - re-fragmentation is possible
 - fragments are self-contained datagrams
 - use CS-PDU (not cells) for ATM
 - delay reassembly until destination host
 - do not recover from lost fragments

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Example



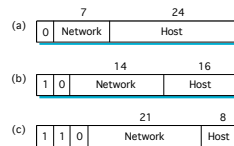
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Global Addresses

- Properties
 - globally unique
 - hierarchical: network + host
- Dot Notation
 - 10.3.2.4
 - 128.96.33.81
 - 192.12.69.77



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Datagram Forwarding

- Strategy
 - every datagram contains destination's address
 - if connected to destination network, then forward to host
 - if not directly connected, then forward to some router
 - forwarding table maps network number into next hop
 - each host has a default router
 - each router maintains a forwarding table

- Example (R2)

Network Number	Next Hop
1	R3
2	R1
3	interface 1
4	interface 0

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Address Translation

- Map IP addresses into physical addresses
 - destination host
 - next hop router
- Techniques
 - encode physical address in host part of IP address
 - table-based
- ARP
 - table of IP to physical address bindings
 - broadcast request if IP address not in table
 - target machine responds with its physical address
 - table entries are discarded if not refreshed

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ARP Details

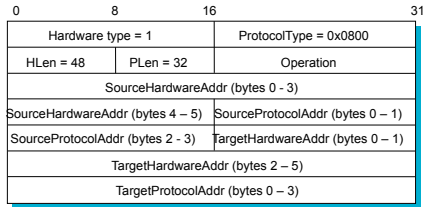
- Request Format
 - HardwareType: type of physical network (e.g., Ethernet)
 - ProtocolType: type of higher layer protocol (e.g., IP)
 - HLEN & PLEN: length of physical and protocol addresses
 - Operation: request or response
 - Source/Target-Physical/Protocol addresses
- Notes
 - table entries timeout in about 15 minutes
 - update table with source when you are the target
 - update table if already have an entry
 - do not refresh table entries upon reference

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ARP Packet Format



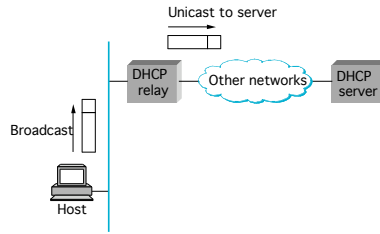
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DHCP

- Dynamic Host Configuration Protocol



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DHCP

Operation	HType	HLen	Hops
Xid			
Secs		Flags	
ciaddr			
yiaddr			
siaddr			
giaddr			
chaddr (16 bytes)			
sname (64 bytes)			
file (128 bytes)			
options			

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Internet Control Message Protocol (ICMP)

- Echo (ping)
- Redirect (from router to source host)
- Destination unreachable (protocol, port, or host)
- TTL exceeded (so datagrams don't cycle forever)
- Checksum failed
- Reassembly failed
- Cannot fragment

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