

IP and TCP

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CSE 123b
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Annoucements

- First assignment available
 - HTTP Server: due Apr 21, 5 pm

Internetworking

Motivation

- Goal: efficiently deliver packets between arbitrary hosts in the network
- Key concerns: scalability, performance, robustness
- Key techniques:
 - Hierarchical design
 - Learn enough to do part of the job, hand task off to someone else
 - e.g., one technique for inter-domain routing, another for intra-domain
 - Soft state
 - Learn all the information you need to perform routing
 - State info not for correctness, just performance optimizations

IP: The Internet Protocol

- Service mode: *best effort*
 - No guarantees about reliable, in-order, or error-free delivery
 - Enables IP to “run over anything”

Version	HLen	TOS	Length	
Ident			Flags	Offset
TTL		Protocol	Checksum	
SourceAddr				
DestinationAddr				
Options (variable)			Pad (variable)	
Data...				

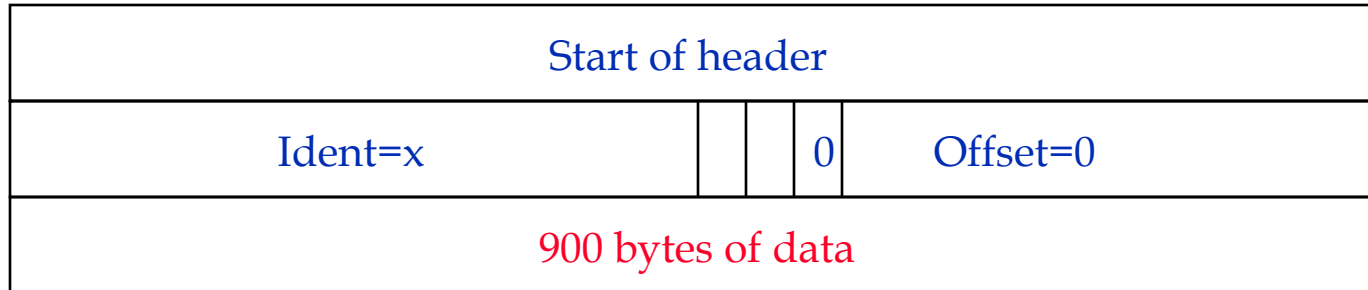
IPv6 Packet Header

Version	TrafficClass	FlowLabel		
PayloadLen		NextHeader	HopLimit	
SourceAddr				
DestinationAddr				

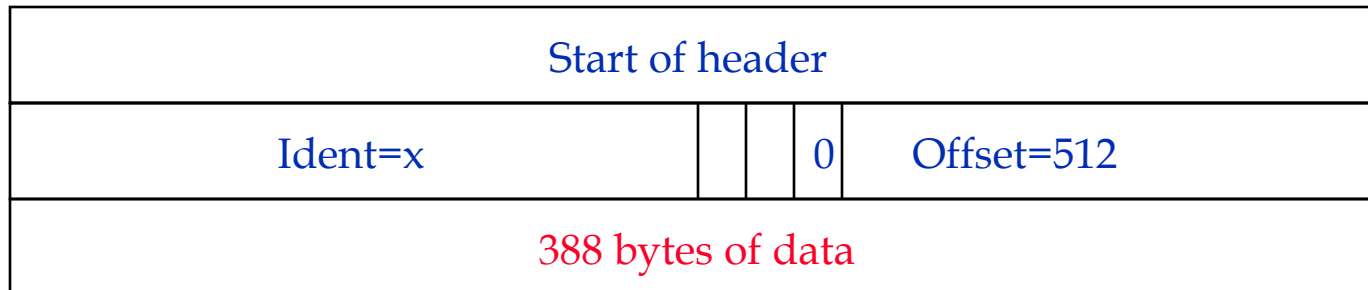
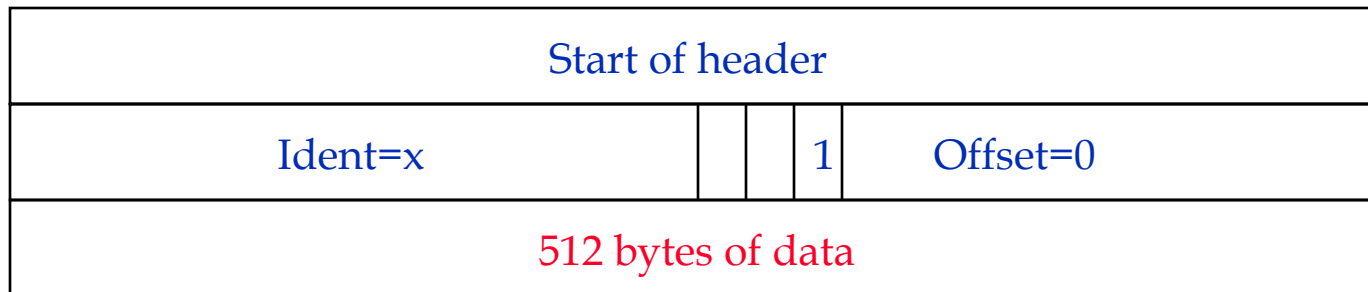
Fragmentation and Reassembly

- Problem: networks have different *maximum transmission units* (MTUs)
 - Ethernet: 1500 bytes, FDDI: 4500 bytes, etc.
 - Communicating hosts may be on networks w/similar MTUs
 - But smaller MTU somewhere in the middle of the network
- To maintain uniform host-to-host communication, IP must fragment and then reassemble packets on end-to-end basis
- Hosts pick MTU of local network
- Fragmentation takes place at routers that forward packets along links with smaller MTU
 - Input on 1500-byte MTU link, output on 500-byte MTU link

- Original 900-byte packet



- Fragmentation to 532-byte MTU network (20 byte header)



IP Address Allocation

- Originally, 4 address classes
 - “A”: 0 | 7 bit network | 24 bit host (1M each)
 - “B”: 10 | 14 bit network | 16 bit host (64K)
 - “C”: 110 | 21 bit network | 8 bit host (255)
 - “D”: 1110 | 28 bit multicast group #
- Assign net # centrally, host # locally
 - UCSD has class B address

IP Address Issues

- We can run out
 - 4B IP addresses; 4B micros in 1997
- We'll run out faster if sparsely allocated
 - Rigid structure causes internal fragmenting
 - E.g., assign a class C address to site with 2 computers
 - Waste 99% of assigned address space
- Need address aggregation to keep tables small
 - 2 million class C networks
 - Entry per network in IP forwarding tables
 - Scalability?

Dynamic Host Configuration Protocol (DHCP)

- IP cannot be configured into hosts when they are produced
 - Depends upon the attached network
 - Difficult for admins to manually configure hosts
- DHCP allows for dynamic assignment of IP addresses
 - Option one: store config info at DHCP server (indexed by unique MAC address)
 - Option two: DHCP server maintains pool of available addrs

Provides *lease* for individual IP addresses
- When host needs config info, broadcast DHCPDISCOVER
 - One host per physical network acts as relay to DHCP server

Introducing New Protocols and Network Address Translation (NAT)

Transitioning to IPv6

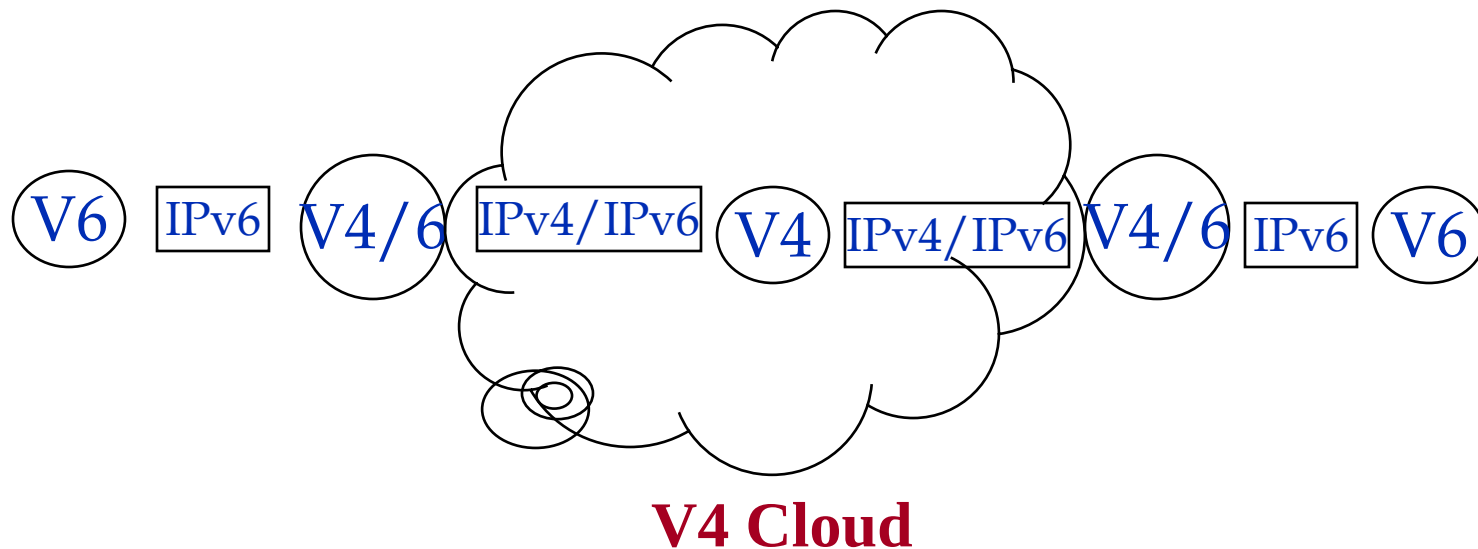
- With the scale of the Internet, cannot have a “flag day” where everyone will flip a switch from IPv4 to IPv6
 - Require a gradual transition scenario
 - Options?

Transitioning to IPv6

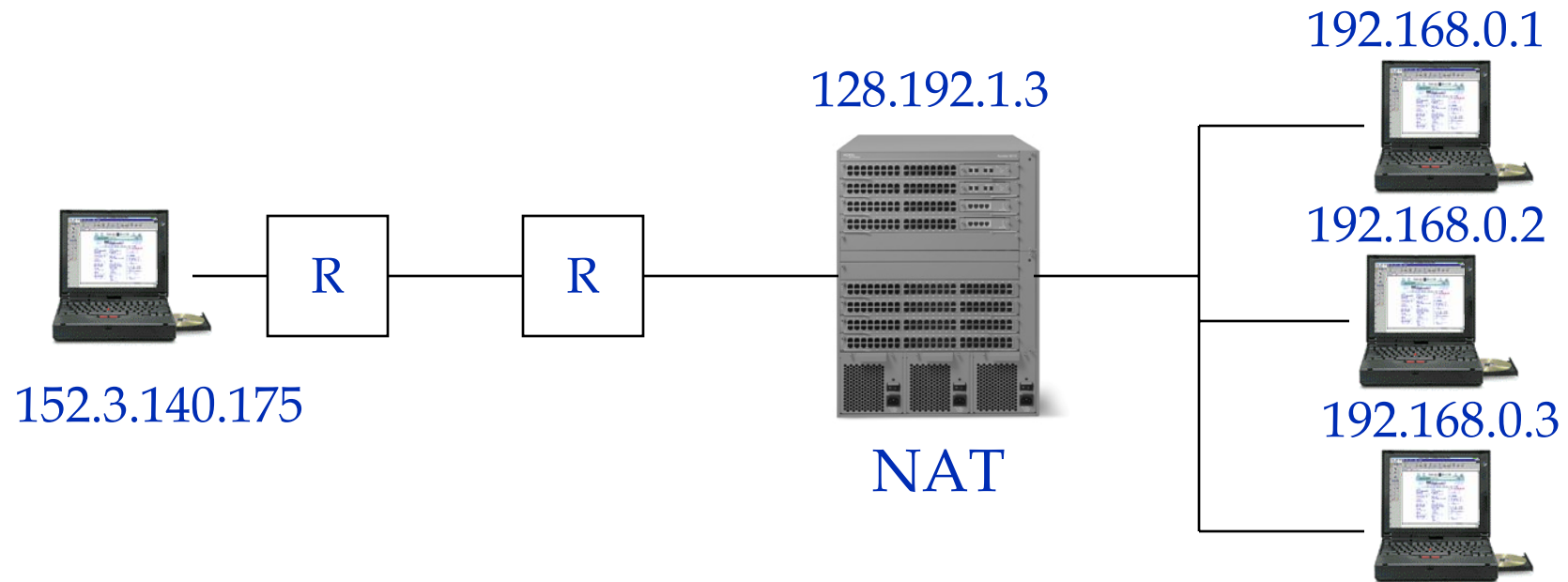
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 - Require a gradual transition scenario
- Options:
 - Dual stack operation
 - Tunneling
 - Network address translation

Tunneling

- Modify packet format
 - Tunnel IPV6 packets over IPV4 network
 - Encapsulate IPV6 Packet within new IPV4 packet
 - Similar technique used for MBONE



Network Address Translation



NAT State

Source IP Addr	Source Port	Destination Addr	Destination Port
66.23.42.1	8112	192.168.0.1	4232
...	...	192.168.0.3	12432
...	...	192.168.0.1	8912

- Maintain table to rewrite destination addr/port of *incoming* packet to specified values based on matching source ip addr and port

Network Address Translation

- Allows multiple machines to be assigned same IPV4 addr
- NAT separates internal from external hosts
 - Hosts only need internally unique address
- NAT translates each packet
 - Multiplex small set of externally unique addresses among active connections
 - internal IP -> dynamically allocated ext. IP
- What if NAT crashes?
- Interaction with security?
- Interaction with higher-level applications?