Electronics and
Computer Science
University of Southampton

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Data Communications and Networks

Connecting Heterogeneous Networks

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Objectives

- To look at connecting multiple networks of (very) different types
  - The Internet Protocol (IP)
  - Routing Issues

- (Peterson & Davie, Section 4.1, 4.2, 4.3.5)

Review

- In previous lectures we looked at
  - Ethernet Networks
  - Connecting multiple Ethernet (and Ethernet-like) networks using bridges and switches
  - Limitations
    - Globally unique addressing required
    - Network addressing of same type
    - Scalability

Internetworking

- What if we want to connect networks of different types?
  - Different addressing schemes
  - Different packet sizes
  - Different quality of service
- Most common protocol is IP
  - Internet Protocol
  - Devised by Kahn & Cerf

IP Service Model

- IP defines a simple service model
  - "Best effort" packet delivery
  - Connectionless (datagram) packets
  - This is "lowest common denominator"
- IP also provides an addressing scheme
  - IPv4, 32 bits (IPv6 later)
  - Split into a network part and host part
  - Globally unique (to the internet)

IP Packet Size

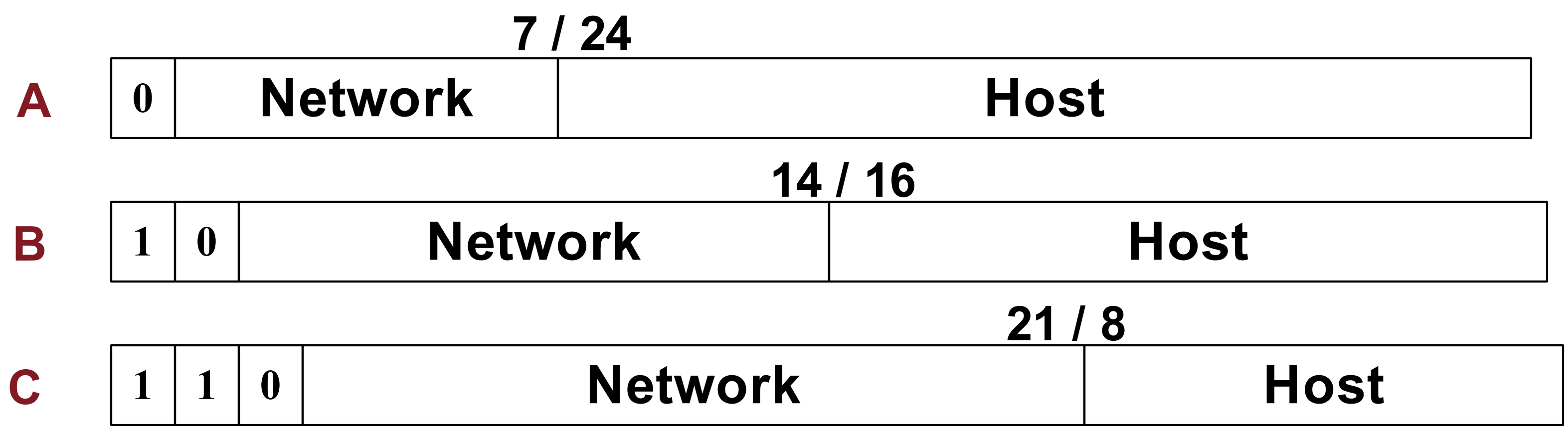
- Networks support different packet sizes
- How big should a packet be?
  - We do not know over which other network types the packet will go over
- Choose maximum size to be that of the network to which host is connected
- Problem can arise at router
  - Needs to send over network with smaller maximum packet size

IP Fragmentation

- IP has a mechanism to allow a router to fragment one packet into several smaller ones (for onward transmission)
  - Uses an "ident" number, byte offset and continuation marker (all in IP header)
- Note packets remain as fragments (not reassembled if larger packets available)
  - Expensive in processing, avoid if possible

IP Addressing

- 32 Bit address, split into a Network part and a Host part
- 3 versions, distinguished by initial bits



Address Assignment

- Can assign address to host manually
  – Error prone & tedious
- Dynamic Host Configuration Protocol
  – At power up, host broadcasts to server
  – DHCP server assigns address from a “pool” (or fixed, based on MAC address)
  – Addresses are “leased” for a time, in case of failure
    - Must be renewed before expiry

IP Header Format

0	4	8	16	19	31
Version	**HLen**	**TOS**	**Length**		
Ident			**Flags**	**Offset**	
TTL		**Prot.**	**Checksum**		
Source Address					
Destination Address					
Options (variable length)				**Pad** (variable)	
Data … (variable length)					

Routing to the Network

- Hosts / Routers need a mapping of network numbers to network interfaces
  - Same network number, must be local
  - Other “known” networks mapped to appropriate interface
  - Normally a “default” route for unknown network numbers
- Routers forward packets based on network numbers

Routing to the Host

- Once at the destination, how do we find mapping between Host number and link level (e.g. MAC) address?
- Address Resolution Protocol (ARP)
  – Broadcast request to all nodes, containing host number
  – Target host only replies with its own MAC address
  – (All) hosts can use this information to update their own ARP mappings

Routing Algorithms

- Spanning Tree does not scale well
- Other methods (RIP / OSPF etc.)
  - Better scalability & authentication
  - Take account of “cost” of links
  - Can handle multiple routes
  - Handle failures / congestion
  - Are dynamic & distributed
  - And complicated (esp. for mobile)

IP Version 6

- Designed to resolve address shortage (IPv4, 32 bits, < 4 billion addresses)
- Increases addresses to 128 bits
- Supports autoconfiguration
  - By embedding link level address
- Supports advanced routing
  - For mobiles, broadcast and multicast
- Migration path from IPv4

Summary

- TBD