Internetworking

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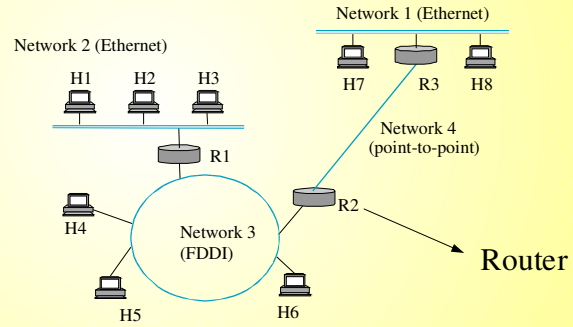
Simple Internetworking



Problems to address:

- Heterogeneity
- Scale

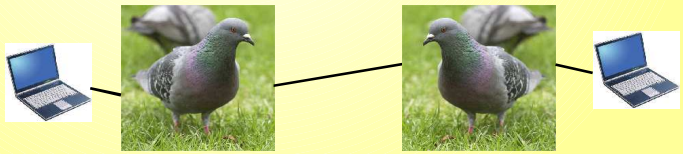
Solution:
Internet Protocol (IP)

Service Model

- Underlying networks can
  - Lose packets
  - Reorder packets
  - Deliver same packet more than once
  - Can delay packets arbitrarily
- Connectionless Datagram service (Best Effort)
  - No state maintained in the network
  - Packet switching core
  - No guarantees to data delivery

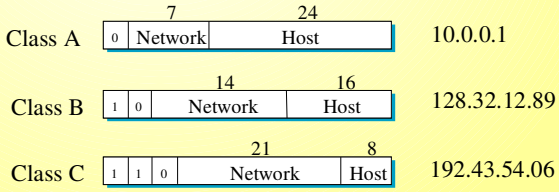
Advantages of Best-effort service

- Reconfigurable after a failure without concern for state
- Provides basic building block from which a variety of services can be implemented
- Minimum network service assumption helps in heterogeneous network integration
- IP can “run over anything”
  - Pigeon powered Internet: 1hr. 42 minutes to transfer 64 bytes



Addressing

- Globally unique
- Hierarchical (32 bit binary number):
  - Consists of two parts: network and host
  - Network part: Identifies the network of the host
  - Host part: Identifies the host within the network
- IP address space divided into 5 classes (A,B,C,D,E)



Datagram Forwarding

- Host
  - Computers that execute application programs on behalf of users
  - Examples: Personal computers, workstations, batch systems etc
- Routers
  - Building blocks that interconnect networks
  - Receive datagrams from hosts and routers on one network
  - Forward datagrams to hosts or routers on other networks

Datagram Forwarding Cont..

- Forwarding algorithms employed by hosts different from those of gateways
  - Number of hosts far exceed gateways
  - Algorithms change with time
  - Resource constraints

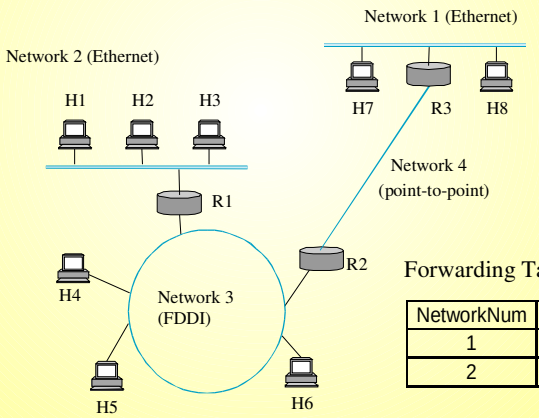
Host Forwarding

- On receipt of a packet
  - If (NetworkNum of destination = NetworkNum of my interface) then deliver packet to destination on that interface
  - else deliver packet to default router
- A host maintains a cache of recently used routes
- If cache lookup fails, use default router

Router Forwarding

- When a packet arrives at a router A,
  - If (NetworkNum of destination = NetworkNum of one of my interfaces) then deliver packet to destination on that interface
  - else chooses another router B, such that
    - B is closer to the destination address
    - B is directly reachable from G
- B is next hop for the packet
- Process of selecting next hop host or router is called ROUTING

Example

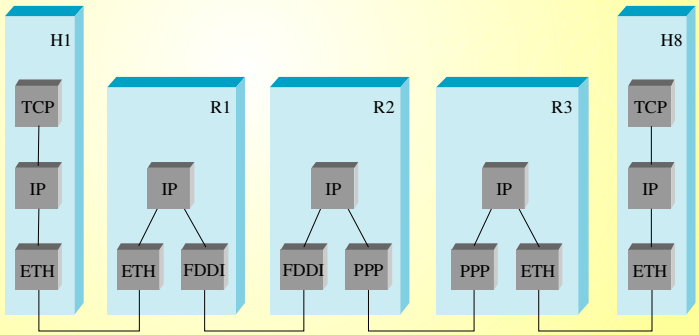


Forwarding Table of R2

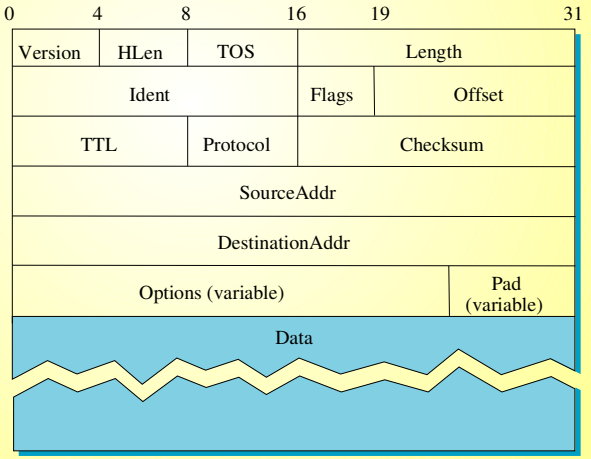
NetworkNum	NextHop
1	R3
2	R1

Scalability: Router tables list only set of network numbers

Protocol Stack



IP Packet Format



Address Resolution Protocol (ARP)

- Translates IP addresses to link-level addresses
- Each host maintains a table of address pairs
  - Manual configuration is tedious
  - Dynamical learning of tables achieved by ARP
- ARP relies on broadcast
  - Broadcast request if mapping missing
  - Destination machines responds with the mapping
  - Table entries are discarded is not refreshed

Summary

- Problem: How to build huge networks by interconnecting smaller networks
- Challenges: Heterogeneity and Scale
- Solution: Internet Protocol (IP)
  - Connectionless datagram service
  - Hierarchical addressing
- ARP mechanism to translate IP to link-level addresses