Network Layer

Lecturer: Ling Luo

Semester 2, 2021

Network Layer

Connecting different n (internetworking)

Framing, error and flow control, MAC

Different transmission media, signals, modulation …

Outline

- Network layer in the Internet
- Types of services
- Internetworking
  - Tunneling
  - Fragmentation
  - Path MTU discovery
- Internet Protocol
  - Addressing
  - Subnetting
- Routing algorithms

Network Layer in the Internet (1)

4G

SONET ADSL

Network Layer in the Internet (2)

- Internet is a collection of many networks that is interconnected by IP
- Provides a **best-effort** service to **route datagrams** from source host to destination host
- These hosts
  - On the same network
  - On different networks

Network Layer in the Internet (3)

Network Layer in the Internet (4)

Store-and-Forward Packet Switching

- Hosts generate packets and inject into the network
- **Router routes packets through the network**
  - Routers treat packets as messages, receive/store them and then forward them based on how the message is addressed

equipment

Services Provided to the Transport Layer

- Design goals:
  - Services should be **independent of router technologi**
  - Transport l d from the number, type and topolo rs
  - Network addressing should use a uniform numbering plan (network identifier)

Types of Services

- **Connectionless**: Packets are injected into subnet **individually** and routed **independently** to the destination
  - Flow and erro yers
  - Internet: mov nreliable subnet; QoS is not easily implemente
- **Connection-oriented**: P velling to the destination following the **same route**
  - Telecommunication: guarantee reliability; QoS is important

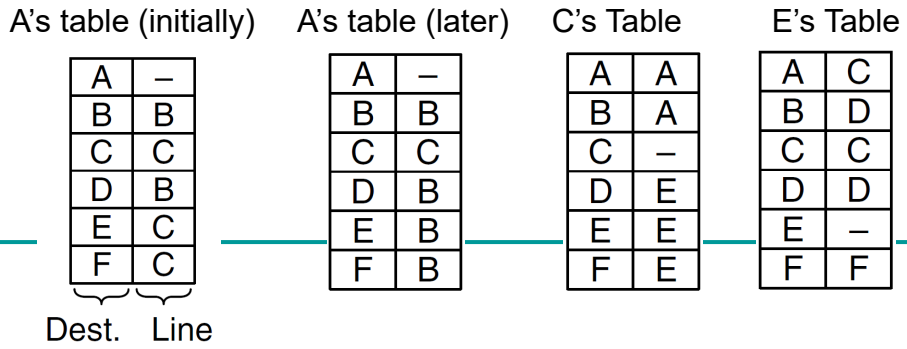
Routing within a Datagram Subnet

- **Connectionless - post office model**: packets are routed individually based on destination addresses in them
  - Packets can take different paths
  - e.g., P1 sends a long message to P2

ISP's equipment

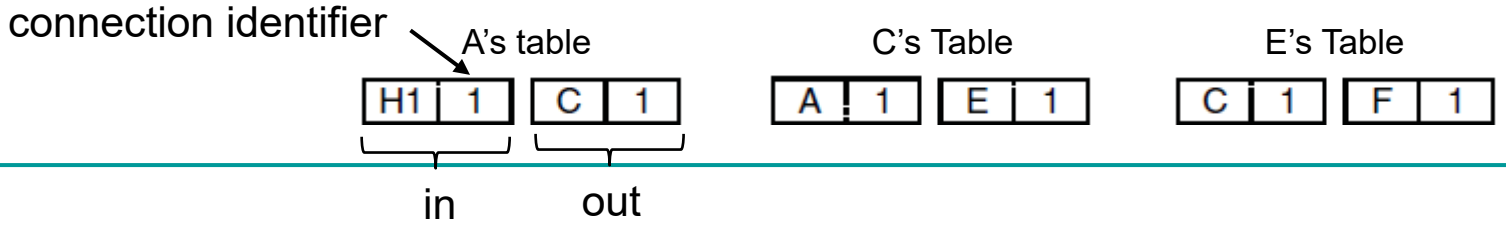
Routing table (can be fixed or change over time)

Routing algorithm – manages the routing table



Routing within a Virtual-Circuit Subnet

- **Connection-oriented - telephone network model:** packets are routed through virtual circuits based on connection id in them.
  - Packets take the same path to avoid having to choose a new path for every packet
  - e.g., MultiProtocol Label Switching Network



Datagram vs. Virtual-Circuit Subnets

Issue	Datagram network	Virtual-circuit network
Circuit setup	Not needed	Required
Addressing	Each packet contains the full source and destination address	Each packet contains a short VC number

Compromises in VC and Datagram Subnets (1)

- Setup time vs. address parsing time
  - VC: requires setup time and resources, but packet transmission is very fast after that
  - Datagram: more complicated lookup procedure
- Memory of route
  - VC: requires e
  - Datagram: requires large tables ible destination route
- Bandwidth
  - VC: saves potential overhead in full addressing of each packet and computation of path. Still needs them during setup
  - Datagram: full destination address in every packet

Compromises in VC and Datagram Subnets (2)

- QoS and congestion avoidance
  - VC: easier to provide QoS, able to reserve CPU, bandwidth and buffer in advance
- Longevity
  - VC: can be set pning uses e.g. Permanent VC
- Vulnerability
  - VC: particularly vulnerable to hardware/software crashes, all VC's aborted and no traffic until they are rebuilt
  - Datagram: can use an alternative route

Different Networks

- Service offered: connectionless vs. connection-oriented
- Packet size: different max
- Addressing: different sizes, flat or hierarchical
- Quality of servi
- Reliability: diff
- Security: privacy rules, encry
- Parameters: different timeouts

Outline

- Network layer in the Internet
- Types of services
- Internetworking
  - Tunneling
  - Fragmentation
  - Path MTU discovery
- Internet Protocol
  - Addressing
  - Subnetting
- Routing algorithms

Internetworking

- Internetworking joins multiple, different networks into a single larger network
- Issues when connecting networks:
  - Different net ls
  - Different mo oices
  - Different technologies at b re and software levels

How Different Networks are Connected

- Internetworking based on a common network layer – IP

Common protocol (IP) carried all the way

Tunneling

- Tunneling is a special case used when the source and destination are on the same network, but there is a different network in between.
- Source pack in packets, travelling through connec ork

Tunneling IPv6 Packets through IPv4