Network Service and Applications

EECS 489 Computer Networks
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Overview

• Taxonomy of Communication Networks
• Services and Applications
Communication networks can be classified based on the way in which the nodes exchange information:
Broadcast vs. Switched Communication Networks

- **Broadcast communication networks**
  - Information transmitted by any node is received by every other node in the network
    - Examples: usually in LANs (Ethernet, Wavelan)
  - Problem: coordinate the access of all nodes to the shared communication medium (Multiple Access Problem)

- **Switched communication networks**
  - Information is transmitted to a sub-set of designated nodes
    - Examples: WANs (Telephony Network, Internet)
  - Problem: how to forward information to intended node(s)
    - This is done by special nodes (e.g., routers, switches) running routing protocols
Communication networks can be classified based on the way in which the nodes exchange information:

- **Switched Communication Network**
  - **Circuit-Switched Communication Network**
  - **Packet-Switched Communication Network**
  - **Datagram Network**
  - **Virtual Circuit Network**

- **Broadcast Communication Network**
Circuit Switching

- Three phases
  1. circuit establishment
  2. data transfer
  3. circuit termination
- If circuit not available: “Busy signal”
- Examples
  - Telephone networks
  - ISDN (Integrated Services Digital Networks)
Timing in Circuit Switching

- Circuit Establishment
- Data Transmission
- Circuit Termination

Host 1 → Node 1 → Node 2 → Host 2

- Propagation delay between Host 1 and Node 1
- Propagation delay between Host 2 and Node 1

DATA

Processing delay at Node 1
Circuit Switching

- A node (switch) in a circuit switching network
Circuit Switching: Multiplexing/Demultiplexing

- Time divided in frames and frames divided in slots
- Relative slot position inside a frame determines which conversation the data belongs to
  - E.g., slot 0 belongs to red conversation
- Needs synchronization between sender and receiver
- In case of non-permanent conversations
  - Needs to dynamically bind a slot to a conversation
  - How to do this?
- If a conversation does not use its circuit the capacity is lost!
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- **Broadcast Communication Network**
Packet Switching

- Data is sent as formatted bit-sequences (Packets)
- Packets have the following structure:
  - Header and Trailer carry control information (e.g., destination address, check sum)
  - Each packet traverses the network from node to node along some path (Routing)
  - At each node the entire packet is received, stored briefly, and then forwarded to the next node (Store-and-Forward Networks)
  - Typically no capacity is allocated for packets
Packet Switching

- A node in a packet switching network
Packet Switching: Multiplexing/Demultiplexing

- Data from any conversation can be transmitted at any given time
  - A single conversation can use the entire link capacity if it is alone

- How to tell them apart?
  - Use meta-data (header) to describe data
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- **Broadcast Communication Network**
Datagram Packet Switching

- Each packet is independently switched
  - Each packet header contains destination address
- No resources are pre-allocated (reserved) in advance
- Example: IP networks
Timing of Datagram Packet Switching

transmission time of Packet 1 at Host 1

propagation delay between Host 1 and Node 2

processing delay of Packet 1 at Node 2
Datagram Packet Switching
Communication networks can be classified based on the way in which the nodes exchange information:

- **Communication Network**
  - **Switched Communication Network**
  - **Packet-Switched Communication Network**
    - **Datagram Network**
    - **Virtual Circuit Network**
  - **Broadcast Communication Network**
Virtual-Circuit Packet Switching

- Hybrid of circuit switching and packet switching
  - Data is transmitted as packets
  - All packets from one packet stream are sent along a pre-established path (=virtual circuit)

- Guarantees in-sequence delivery of packets
- However, packets from different virtual circuits may be interleaved
- Example: ATM networks
Virtual-Circuit Packet Switching

- Communication with virtual circuits takes place in three phases
  1. VC establishment
  2. data transfer
  3. VC disconnect
- Note: packet headers don’t need to contain the full destination address of the packet
Timing of Virtual-Circuit Packet Switching

VC establishment

Packet 1
Packet 2
Packet 3

Data transfer

Packet 1
Packet 2
Packet 3

VC termination

Packet 1
Packet 2
Packet 3

propagation delay between Host 1 and Node 1
Datagram Packet Switching
Most important advantage of packet-switching over circuit switching: Ability to exploit statistical multiplexing:
- Efficient bandwidth usage; ratio between peak and average rate is 3:1 for audio, and 15:1 for data traffic

However, packet-switching needs to deal with congestion:
- More complex routers
- Harder to provide good network services (e.g., delay and bandwidth guarantees)

In practice they are combined:
- IP over SONET, IP over Frame Relay
Overview

• Taxonomy of Communication Networks
  ➢ Services and Applications
The Internet Protocol (IP)

- Problem:
  - many different network technologies
  - e.g., Ethernet, Token Ring, ATM, Frame Relay, etc.
  - How can you hook them together?
    - \( n \times n \) translations?

- IP was invented to glue them together
  - \( n \) translations
  - minimal requirements (datagram)

- The Internet uses IP
Addressing

- Every Internet host has an IP address
  - e.g., 67.114.133.15
- Packets include destination address
  - network is responsible for routing packet to address
- Host-view:
IP-centric View
Physical View

- A big mess!

- Every “link” could be a whole network of ATM, frame relay, ethernet, DSL, etc.

- Beauty of IP: you can ignore these different network technologies

- In many networks, IP is used only at the edge
Back to IP
Routing

- Routers have “routing tables”
  - tables mapping each destination with an outgoing link
  - requires that routing table is highly compressible!
  - implications for address assignment, mobility, etc.

- Routing decisions made packet-by-packet
  - routers keep no connection state

- Question: Why have the network do routing?
  - Why not the hosts?
  - Compare delivery-by-hand to FedEx
Internet Service

• “Best-Effort” service
  - No guarantees about packet delivery
  - Hosts are responsible for coping with:
    • loss
    • delay

Why this service model?
  - why not guarantee no loss and low delay?
Domain Name Service (DNS)

- Humans/applications use machine names
  - e.g., www.cs.berkeley.edu

- Network (IP) uses IP addresses
  - e.g., 67.114.112.23

- DNS translates between the two
  - among other things
  - unsung hero of the Internet