Internet Technology

01r. Lecture 1 Review: Key Terms

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Spring 2016

Basic principles & terminology

- The basic principles of data communication were established *long before* computer networking
- Let's review some key terms we covered in the last lecture

Key terms (1)

Broadcast

Send a message that will be received by everyone on the network

Unicast

Send a message to one specific recipient

Synchronization

- Coordinate the delivery of messages.
- E.g., agree to start, stop, or coordinate who transmits

Relay

Repeater: regenerate the message to extend the network farther

Key terms (2)

- Control data vs. message data
 - Control data relates to the messaging protocol
 - synchronization, acknowledgements, flow control, priority, etc.
 - Message data is the actual data that you want to convey to the receiver
- Acknowledgement (also known as positive acknowledgement)
 - A control message sent from the receiver to the sender to indicate that a message has been received successfully
- Negative Acknowledgement
 - A form of error notification
 - A control message sent from the receiver or some network element to the sender to indicate that a message has NOT been delivered successfully

Key terms (3)

Congestion

 The inability of a network element to receive or transmit messages at the desired rate, leading to a buildup or possibly a loss of messages and a deterioration in the quality of service

Flow control

- Modifying the rate at which messages are sent to avoid congestion
- This may includes control messages, such as "slow down"

Key terms (4)

Message encoding

- The techniques used to represent a message.
- Before computers, this referred to, for example, the number of torches to display or positions of a semaphore for a specific message.
- With digital techniques, this refers to the binary symbols used to represent the message and how those binary symbols are transmitted.

Best-effort message delivery

 An attempt to deliver messages reliably. If a message does not make it to the destination, try again: re-transmit

ARPANET

- ARPANET was a precursor to the Internet
- Inter-network a network of networks
 - The devices on the ARPANET (and, later, the Internet) do not have to use the same (or compatible) networking hardware.
 - Routers interconnect the various networks together, creating a larger logical network
- Early key components of the ARPANET
 - IMP Interface Message Processor. This evolved to the router.
 - This provided the hardware to route messages to their destination.
 - NCP Network Control Protocol. This evolved to TCP/IP.
 - This provided the software for addressing, sending, and receiving messages.

Key design principles

Design principles of ARPANET, which became the design principles of the Internet

- 1. The Internet is a network of networks
 - No modification is needed to any underlying physical network to support the Internet
 - Different organizations may use different networking hardware
- 2. Assume unreliable networks
 - The network (collection of networks that a message takes) does not guarantee that a message will arrive at its destination or that messages will arrive in the order they were sent.
 - Software will be responsible for retransmitting lost or corrupt messages and for sequencing the messages in proper order.
- 3. Routers connect the networks that make up the Internet
 - Routers do not have to store information about past packets they've seen
- 4. There is no central control of the network

The network

Two parts: the core & edge

- The edge
 - the devices (computers, TVs, phones) that connect to the network
 - These devices are called nodes, hosts, or end points
- The core
 - The network itself: the wires & radio waves that carry the messages and the routers that relay them toward their destination.

Local area network (LAN)

- The network within a small area (e.g., home, office)
- Compatible networking hardware
 - E.g., all ethernet (Wi-Fi bridges to ethernet and is compatible)
 - No routers needed to send messages from one node to another
- All nodes are peers: anyone can send a message to anyone else
- Generally high speed links with low latency

Local Area Network terms

- A NIC (Network Interface Component) connects a network to a device.
- Media: the communication links of the network
 - Unshielded Twisted Pair (e.g., ethernet), radio (e.g., Wi-Fi), coaxial cable (e.g., cable TV internet service), optical fiber (e.g., FiOS)
- Hubs & switches
 - Central point on a LAN for cables from the various nodes on the LAN
 - Consists of multiple ports. Port = connector for one cable.
 - Hub
 - Takes incoming data from one port and sends it to all other ports
 - Switch
 - Takes incoming data from one port and sends it only to the port where it needs to go. Better than a hub because it does not create extra network traffic for node.
 [Hubs are practically obsolete now; switches are pretty cheap]
- Routers
 - Used to move messages between local area networks

Local Area Network terms

Modem

- Stands for Modulator-Demodulator
- Converts data between different analog formats (e.g., phone lines, cable TV, fiber optic cable)

Access link

- The interface between a LAN and the Internet
- Common access links
 - DSL: digital subscriber line
 - DSL modem: places data packets on frequencies in the 4 kHz 1 MHz range of a phone line
 - Cable TV
 - DOCSIS cable modem: places data packets on one or more 6 MHz wide channels. Each of these channels is the space that a single HDTV channel occupies and gives 38 Mbps of downstream service
 - Fiber to the Home (FTTH)
 - Verizon FiOS

Internet Service Providers

- Internet access is provided by a company called an Internet Service Provider (ISP)
 - There are thousands of ISPs
- ISPs are (roughly) organized into three tiers
 - Tier 1: top-level ISPs
 - Peer with each other
 - Peering = forward & receive traffic with another ISP at no cost
 - Keep a global routing table. For any destination address, a Tier 1 ISP will know which Tier 1 ISP can route the message
 - Tier 2: second level regional
 - May peer with some networks across regions or with competitors within a region
 - Purchases connectivity to the rest of the Internet from Tier 1 & other Tier 2 ISPs
 - Tier 3: third level focus on retail and consumers
 - Purchases internet service from Tier 1 & Tier 2 ISPs

Packet Routing

 A packet going from a source node to a destination will typically pass through many networks (routers), both within an ISP and between ISPs

Sharing a network

- Lots of nodes & applications need to share a network
- Two options:
 - 1. Allow everyone to talk at the same time
 - ...but use different frequency bands
 - FDM: Frequency Division Multiplexing
 - Take turns
 - Two ways of doing this:
 - 1. Give each communication line a fixed time slot (e.g., you can transmit for 15 milliseconds every second)
 - TDM: Time Division Multiplexing
 - 2. Let anyone transmit on variable-size time slots (more time for bigger packets)
 - Packet switching

Circuit switching

- Requires connection setup
 - Connection setup figures out the path from source to destination
 - Each router in the path allocates memory buffers and time to ensure that it can handle the data traffic
 - Once the connection has been acknowledged, data transmission can occur
- Circuit switching offers
 - Guaranteed, fixed, bandwidth
 - Constant latency
- BUT ... it does not use resources efficiently
 - The time slot is there whether you use it or not

Packet switching

- A data stream is broken into chunks called packets
- Each packet contains a destination address
- Routers do need to store state of past packets
 - They figure out a route when they get the packet

- Packet switching can lead to:
 - Variable latency
 - Congestion and possible packet loss
- BUT ... it allows far more efficient use of the network
 - And network capacity is not limited by the number of nodes or applications that need to send data
- The Internet is built around packet switching

