Introduction to Networks

CSC 348·648

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Spring 2013

Networks Overview

- Interconnected set of computers
  - The *Internet* being the most popular and successful

- To send a *message* through the network...
  - Message broken into smaller pieces (*packets*)
  - A packet contains some data, sender & receiver addresses
  - Sent individually (*good luck, safe journey, don't talk to strangers...*)
- Like sending a document via the mail, one page per envelope

Types of Connectivity

- There are two basic ways to connect computers
  - Broadcast and point-to-point

1. **Broadcast**
   - Single channel (medium of communication) shared by all

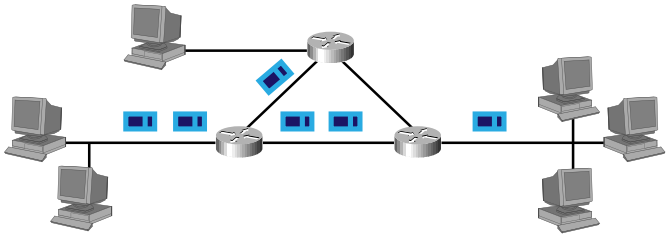
     Examples? Advantages and disadvantages?

2. **Point-to-point**
   - All machines are directly connected

     Examples? Advantages and disadvantages?

More Realistic Connectivity

- The previous two types of networks do not scale
  - Combine broadcast and point-to-point



- This is how most networks operate, **message passing**
  - An inter-connection of *smaller* Local Area Networks (LAN)
  - Communication is more complicated
- Need **protocols** for sending and receiving

Protocols

- Set of rules governing the exchange of data between two entities

  Why are protocols needed in a broadcast network?

  Why are protocols needed in a message passing network?

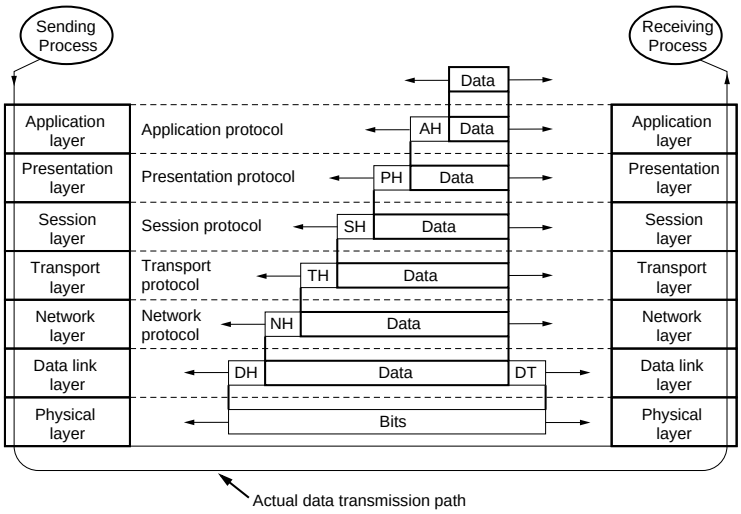
- Many different protocols are needed to address different questions
  - *How do you represent a bit?*
  - *When can you access a channel?*
  - *How should bits be grouped to form a message, packet, or frame?*
  - *How are computers identified?*

OSI

- Open System Interconnection (OSI) model provides organization to the different protocols
  - Model consists of 7 layers
  - Each layer defines a protocol and performs certain tasks
- OSI 7 layers
  1. **Physical** - bit transmission
     - Addresses: *How do you send/represent a bit?*
  2. **Data link** - frame transmission
     - Groups bits into frames (more efficient)
     - Addresses: *Frame structure? Channel access?*

3. **Network** - routing messages (**packet**)
   - Addresses: *How do you forward a packet?*
     Is this layer required for a broadcast network?

4. **Transport** - end-to-end transmission
   - Addresses: *How do you inform the sender to speed-up, slow down, or repeat a data segment?*
5. **Session** - ?
6. **Presentation** - data representation
7. **Application** - provides network service to users



- As a message is sent from machine to machine, it traverses the different layers in order

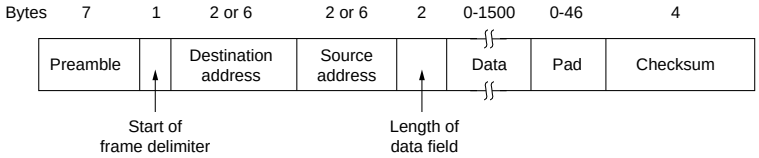
Physical Layer

- Concerned with sending information in the form of electromagnetic signals across a transmission medium
  - Transmission medium includes, copper, fiber, and wireless
- Specifies items such as
  - *How do you represent a bit?*
    Can you give an example?
  - Encoding/decoding techniques
- Not many (if any) security issues at this layer
  - If you want to learn more, take CSC 343 in the Fall

Data Link

- Provide reliable and efficient communication between two machines physically connected via a channel
- Data link layer specifies
  - How bits are grouped together into **frames**
  - Line discipline, when can you access (MAC)
  - Error detection (possibly correction)
  - Flow control between two adjacent machines
- Frames typically consist of
  - Start and stop characters indicates beginning and end of frame
  - **Data**
  - Error correction/detection (parity bit)

- Sequence number
- **Address** (MAC address) uniquely identifies a machine



- Addresses
  - Every machine should have a unique data link address
  - Also called MAC or hardware address
  - Different from IP address (which is one layer above)
- We have described the format of a frame
  - Need a protocol indicating how/when to transmit frames
  - **Medium Access Control** (MAC)

Medium Access Control

- Medium Access Control (MAC)
  - Method for controlling access (**transmission rules**)
  - Answers the question: *Who sends next?*
    What is the protocol to ask a question in a classroom?
- MAC categories
  - Contention - no permission to send required
    Can you give an example?
  - Round-robin - send when you have permission
    Can you give an example?
  - Reservation - request before sending

CSMA/CD

- Carrier Sense Multiple Access Collision Detection (CSMA/CD)
  - Contention based MAC
  - Used in **Ethernet** Local Area Networks (LAN)

    What type of network topology is required?

- Transmission rules
  1. Medium idle transmit
  2. Medium busy, listen until idle then transmit
  3. If collision, transmit jamming signal
  4. After jamming, wait random amount of time then go to step 1

  Is this how you interact in a classroom? What is its performance?

IEEE 802 Standards

- IEEE has produced several LAN standards called the 802 series

  Why are standards needed?

- 802.x standards defines
  - Physical layer and data link layer
  - Examples include 802.3 (Ethernet) and 802.11x (wireless)
- For example 802.3 (Ethernet) defines
  - Cabling type - category 5
  - Signal encoding - differential manchester
  - Frame structure - what the bits represent
  - Line discipline - CSMA/CD

Network Devices

Classify the devices based on the OSI *layers* they implement

- Hub
  - Connects several Ethernet-enabled computers together
  - Each computer connects directly to the hub
  - Hub **repeats** what is sent on one wire to all other wires

    What layer(s) is/are implemented by a hub? What is the difference between a hub and a switch?

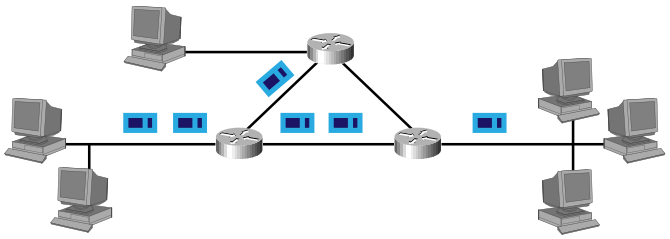
- Network Interface Card (NIC)
  - Ethernet card is an example
  - Connects a computer to a LAN
  - Sends bits over wire and follows medium protocol

    What layer(s) is/are implemented by a NIC?

Network Layer

- Concerned with delivering packets from source to destination

  Isn't this the same as the data link layer?



- Messages are forwarded from machine to machine until destination
  - Messages (**packets** or **datagrams**) are **routed**
  - Network layer describes how packets are routed
  - Network layer also provides congestion control
- Transport protocols also have addresses

- **Routers** implement layers 1, 2, and 3
  - Receive packets and forward to *next* machine
  - Identifying the *next* is important
  - Routing decisions could be based on metrics, tables, or flooding
- Internet Protocol (IP) is the most prevalent network protocol

Transport Layer

- Provides reliable transmission of data across the network
  - Concerned with end-to-end transmission of data
  - Items include loss and Quality of Service (QoS)
    Is this not a concern of the network layer?
- Example transport layer protocols
  - User Datagram Protocol (UDP)
  - Transmission Control Protocol (TCP)
- Transport protocols also have addresses

Application Layer

- Applications built to use the network
- Examples include
  - `http`
  - FTP
  - telnet
- Many security exploits are at the application layer
  - Buffer overflows