# EE 565 – Computer-Communication Networks I

- · Course details (available on web)
  - Monday & Wednesdays 10:30-12:20
     Missed classes due to holidays (1/21 & 2/18) will be made up on Fridays (probably 1/25 & 2/22)
  - Tentatively: 4 HW, 1 project, 2 mini-projects, 1 midterm, 1 final (details on web)
  - Discussion board available on web
    - Please post questions to discussion board before emailing me!
       Others may answer before I am able.

### EE 565 Overview

· Goal:

 Understand fundamental concepts, problems, and issues of networking (not a survey of protocols and standards)

#### · Prerequisite:

- Comfortable with probabilistic concepts and computations at the level of EE 505
- Willing and able to expand to the level of EE 508



## Network Components & Structure

#### · Components of a Network:

- Node: represents a user, device, etc.
- Link: physical connection between two (or more) nodes
- Network topology: collection of nodes and links
- Required functionality/structure
  - Addressing and routing
  - Resource sharing
  - Error handling (detection, request for resend, etc.)
  - Buffering info (queueing)
  - Regulation of traffic flow to avoid congestion
  - Enforcement of rules/policies



# Network Topology & Scale

#### Network terminology

- Personal area network (PAN) cm to 1 m
- Local area network (LAN) 10s to 1000s of m
- Tend to have regular structure (star, bus), 10 Mbps 10 Gbps
   Metro area network (MAN) 10s of km
- Typically ≥ 1-50 Mbps
- Wide area network (WAN) 100s-1000s of km
- · Tend to have irregular structure (mesh), speeds in kbps to Mpbs

#### **Evaluation Metrics**

- What quantities do we care about?
  - How much data per unit time can a link carry?Bandwidth
  - How much data per unit time can be sent between users?
    Throughput (capacity)
  - How long does it take?
  - Delay (end-to-end, round trip, one hop, etc.)
    What if there are transmission errors?
  - Error detection & correction
    Additional delay due to request and retransmit

- ???



## Delay

- **Processing delay**: Time required to inspect a new packet and figure out what to do with it.
- Queueing delay: Time spent in a packet buffer before being sent.
- Transmission delay: Time required to put the bits in the packet onto the link. Packet of *L* bits onto link of bandwidth *W* bits/second takes *L/R* seconds.
- **Propagation delay**: Time taken for each bit to traverse the medium from A to B.
- Round-trip time (RTT): Time for (small) packet to go from A to B and back to A



# Switching in Data Networks

- Switching: How are resources allocated for each connection
- Three main techniques
- Circuit switching
- Message switching
- Packet switching







# Simplifying Network Design by Layering

- Layering
  - Networks are complex, with multiple communication media, applications, hosts, routes, etc. To make network design easier, functionality is organized into layers.
  - Each layer performs a service to other layers, and does not need to know how other layers' services are implemented, leading to design transparency.
  - What should each layer do?















