ECSE-4730: Computer Communications Networks (CCN): Introduction

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Adapted in part from S.Keshav (Cornell), Peterson (Uarizona)

- Syllabus, administratrivia
- Why is networking interesting ?
- Simple network (2 users): issues
- N-user network: issues
- Scalable network of heterogeneous networks: issues
- Laundry list of issues for the course to address

Why is networking interesting ?

- Today's economy
  - manufacturing, distributing, and retailing *atoms*
  - but also
    - publishing
    - banking
    - film making….
  - main 'product' is creation and dissemination of information
  - *part of the 'information economy'*
- Future economy likely to be dominated by information
  - e.g. smart shoes and wireless tags on groceries
- Computers *"manipulate"* information
- Networking creates *"access"* to information

Information

- A representation of knowledge
  - "Information exists only when you learn something that was not ***known*** before"
    - Shannon's theory: allows us to quantify information
- Can represent information in two ways
  - analog (***atoms***)
  - digital (***bits***)
- Digital is better
  - computers manipulate digital information
  - infinitely replicable
  - networks can move bits ***everywhere***, ***cheaply***, and with good ***performance characteristics***

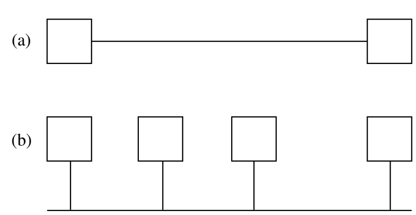
What's a network ?

- #1: A medium which allows information exchange between a population of users or applications
- #2: Defined recursively as two or more nodes connected by a physical link, or by two or more networks connected by one or more nodes.

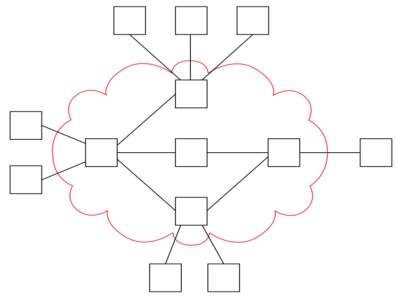
Which one is correct ?

Network provides *connectivity*...

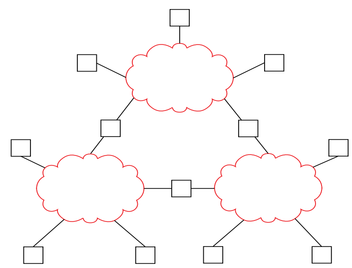
- Building Blocks
  - links: coax cable, optical fiber...
  - nodes: general-purpose workstations...
- Direct Links
  - point-to-point
  - multiple access



- ***Indirect*** Connectivity
  - switched networks



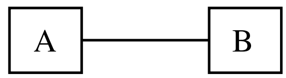
  - inter-networks



So, what is "*connectivity*" ?

- ***Direct or indirect "access" to every other node in the network***
- ***Access*** is not the same as having a pt-pt link
  - What you get is a ***"virtual channel"*** between nodes, which does not necessarily have the same performance characteristics of a physical link.
  - For example, a virtual channel may minimally provide only ***"best-effort connectivity on a packet-by-packet basis"*** whereas a link provides an ***"always-connected, fixed bandwidth, fixed delay and near zero-jitter"*** channel.
- Just connectivity may not be enough for some applications. They might need more services to make the channel look meaningful to them...

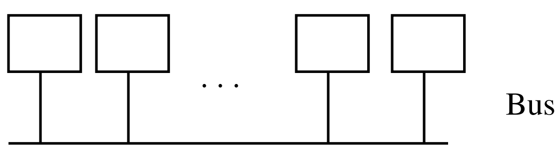
Issues in a point-to-point network ...

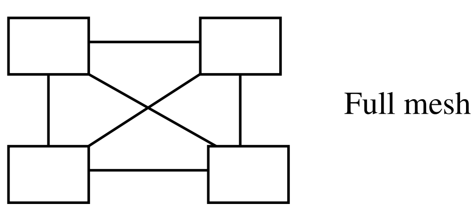


- ***Physical*** layer: coding, modulation etc
- ***Link*** layer: framing, protocol multiplexing, error recovery, flow control…
- No need for protocol flab like addressing, names, routers, hubs etc

Connecting N users: Directly ...

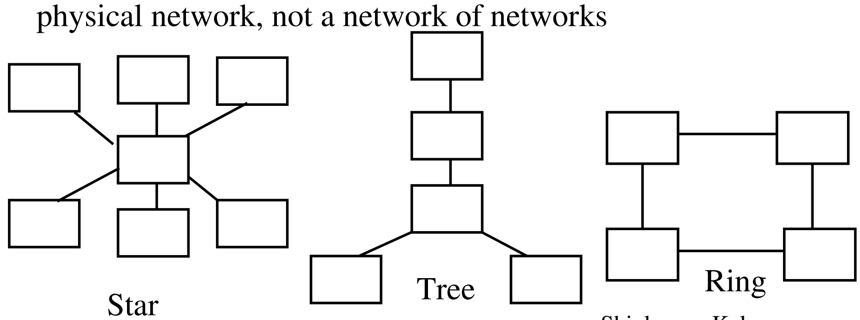
- ***Bus***: broadcast, collisions, media access control
- ***Full mesh***: Cost, simplicity





Connecting N users: Indirectly ...

- Star: One-hop path to any node, reliability, forwarding function
- Tree: Minimal links, multiple hop-paths, distributed load
- Ring: Reliability to link failure, near-minimal links etc
- Hybrid
- All these topologies ("multi-access networks") assume a single physical network, not a network of networks

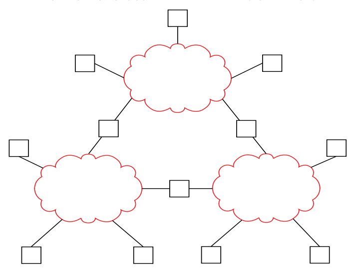


Multi-access networks (contd)

- ***Topology issues***: Cost, reliability, manageability, deployability, scalability, software complexity
- ***Medium Access Protocols***:
  - ALOHA
  - CSMA/CD (Ethernet)
  - Token Ring
  - Wireless
- ***New concepts***: address, forwarding (and forwarding table), bridge, switch, hub, token, medium access control (MAC) protocols

Inter-networks: networks of networks

- Internetworking involves two fundamental problems: ***heterogeneity and scale***
  - ***Concepts***: translation, routing, address & name resolution, address allocation/admin., networking management etc
  - Introduction given in this course.
  - Covered in more detail in "Internet Protocols"



Application networks

- ***Problem: how to run applications over this flaky cloud which can provide "virtual" point-to-point connectivity, without destabilizing it ?***
- Ans: Transport protocols for reliability (TCP), Simple muxing (UDP), multimedia transmission (RTP) etc
- Concepts: more reliability concepts, congestion control
- Introduction in this course.
  - More detail about protocols in “Internet Protocols”
  - Application level issues (API, client/server etc) covered in “Network Programming”

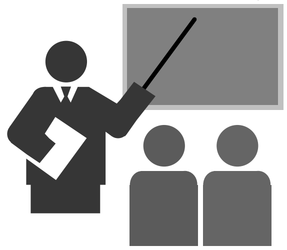
Laundry List of Problems in Networking

- Topologies
- Framing
- Error control
- Flow control
- Multiple access
  - How to share a wire
- Switching, bridging, routing
- Naming, addressing
- Congestion control, traffic management
- Reliability

Perspective

- ***Network users:*** services that their *applications need*, e.g., guarantee that each message it sends will be delivered without error within a certain amount of time
- ***Network designers:*** *cost-effective design* e.g., that network resources are efficiently utilized and fairly allocated to different users
- ***Network providers:*** system that is easy to *administer and manage* e.g., that faults can be easily isolated and it is easy to account for usage

Summary



- Admin junk …
- Networks, connectivity, topologies..
- Laundry list of networking problems which we will learn how to solve in the course...