Example Networks

- Internet
- Connection Oriented Networks
  - ATM
- Ethernet
- Wireless LANs

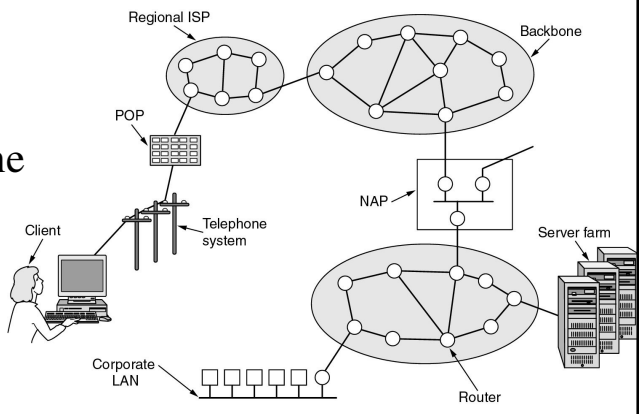
Internet – Applications

- Internetworks: A collection of interconnected networks,
  - Uses gateways to translate between incompatible networks.
- The Internet is a specific worldwide internet.
- Applications based on protocols:
  - HTTP: *HyperText Transfer Protocol*, the underlying protocol used by the World Wide Web,
  - SMTP: *Simple Mail Transfer Protocol*, a protocol for sending e-mail messages between servers,
  - FTP: *File Transfer Protocol*, the protocol used on the Internet for sending files,
  - TELNET: *Telecommunications Network*, provides virtual terminal services for interactive access by terminal servers to host,
  - DNS: *Domain Name System*, an Internet distributed service that translates domain names into IP addresses,
  - NNTP: *Network News Transfer Protocol*, the protocol used to post, distribute, and retrieve USENET messages

APPLICATION LAYER

Internet – Physical Layout

- User
- PC
- Modem
- Telephone
- POP
- ISP
- Internet
- NAP
- Local network
- Server



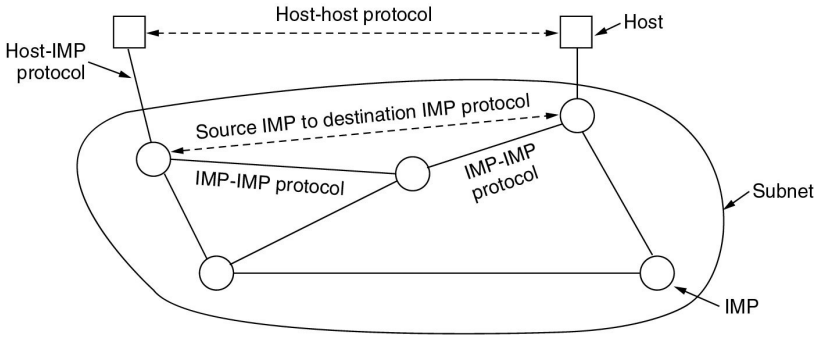
Internet – Messages

- Packaging: Application messages must be packaged up (like putting them in an envelope) and sent off to the recipient.
- Sending
  - Broadcast to many recipients (e.g. e-mail, ?)
  - May want to ensure that messages are received or may not mind if they go astray (e.g. postcard vs. courier).
- Receiving
  - Validity: May need to ensure messages are not corrupt,
  - Order: and that are received in the correct order.
- Network independence: Need to ensure that our communications are independent of the network being used, so that it will not matter if the underlying physical media or network protocols are changed.

TRANSPORT LAYER

Internet – ARPANET

- End to end communication for devices which are not directly connected.
- We go through a Subnet: This is a network of machines which will route a message from A to B. Such routers in ARPANET lingo are referred as IMPs.



Internet – Getting there?

- Routing
  - Learn where to send the messages,
  - Can be based on static routing tables although can lead to congestion and problems if a node in the network goes down,
  - Instead use dynamic routing tables based on system load, path latency, etc.
- Different Networks
  - We must often need to repackage messages due to networks having different message size limitations,
  - We also need to translate messages from network to network which is even more problematic.

NETWORK LAYER

Internet – Transmission ?

- To send a message across a network we must consider:
  - Media: Variety of media (copper, optical fiber, radio waves) for transmission,
  - Encoding: Encode data onto the media, so that a receiver can receive it,
  - Errors: Have to deal with transmission errors (detection/correction)
  - Flow Control:
    - Multiple senders on the same network
    - Slow receivers: Stop them being swamped by fast senders

HOST-TO-NETWORK LAYER

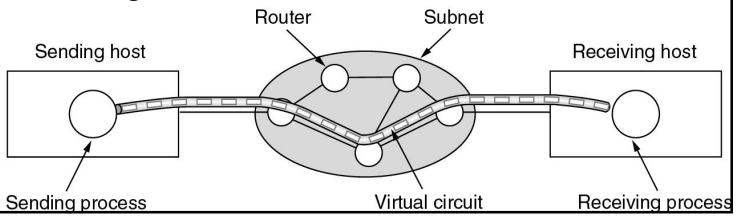
Connection Oriented Networks

- The Internet is a connectionless network designed for fault tolerance in the case of hardware failures
  - Routes all packets independently and can dynamically adjust to changes in configuration.
- Problems for network operators
  - **Q**uality **o**f **S**ervice: Difficult to provide QoS in packet switched networks,
  - Billing: Telecommunication companies charge connection time. No connection, no charge.
- A Connection oriented approach simplifies these issues. We have to
  - Establish connections for the duration of a "call",
  - Reserve bandwidth for the connection – giving guaranteed level of service.

ATM

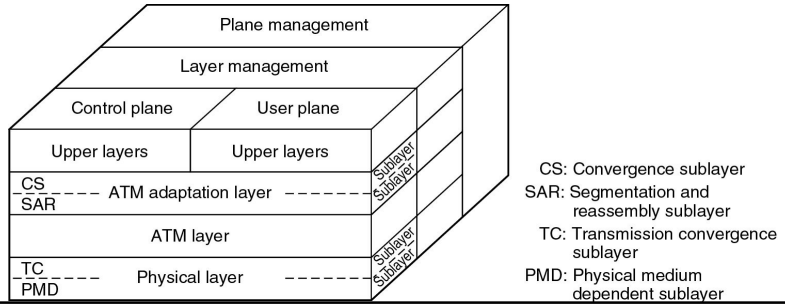
- Asynchronous Transfer Mode
- Intended as a solution to all problems
- Uses: Didn't succeed, but used extensively inside the telephone system
- Cell based

- Routers establish connections: called virtual circuit
  - Can be permanent with any required resources reserved,
  - No Ordering issues as cells arrive in the order sent.



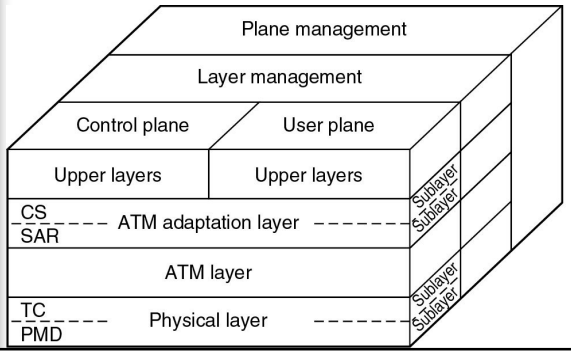
ATM Reference Model (1)

- Different reference model to OSI & TCP/IP
  - Physical layer: deals with the physical medium (voltages, bit timing)
  - ATM layer: deals with cells and their transportation (e.g. establishing virtual circuits, flow control, etc.)
  - AAL layer: ATM Adaptation Layer, allows users to send packets larger than cells.



ATM Reference Model (2)

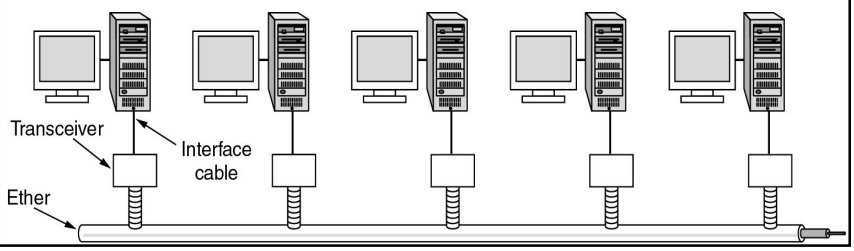
- User plane: deals with data transport, flow control, error correction and other user functions,
- Control plane: deals with connection management,
- Layer & Plane Management: relate to resource management and interlayer coordination.



CS: Convergence sublayer
SAR: Segmentation and reassembly sublayer
TC: Transmission convergence sublayer
PMD: Physical medium dependent sublayer

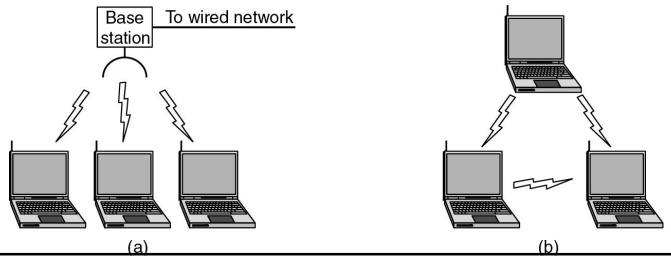
Ethernet

- Most popular LAN (Local Area Network)
- Coaxial Cable up to 2.5 km long
  - Repeaters every 500 meters
  - 256 machines could be connected via transceivers.
- Sharing the medium: stations would sense the line to ensure nothing was being transmitted.
- Simultaneous transmission: Yet, the possibility of simultaneous transmissions was still there.

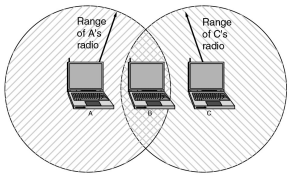


Wireless LANs (1)

- 802.11: IEEE standard for Wireless LANs
- Two Modes provided
  a) With a Base station
     – All comms go through access points,
  b) Without a base station
     – All comms go directly between devices in an ad hoc fashion.



Wireless LANs (2)



- Challenges
  – Frequency band: Need a band that could be used worldwide,
  – Range: Radio signals have a finite range,
  – Privacy: Need to ensure users privacy,
  – Safety: Human safety could be an issue with radio waves,
  – Bandwidth: Ensuring enough bandwidth is available to make this economically viable,
  – Listen doesn't work: Cannot sense the medium - results in the hidden terminal problem,
  – Multipath fading: Radio waves are reflected off solid objects,
  – Mobile software: Most software isn't designed to be mobile,
  – Handoff: A device moving from one base station to another, requires a handoff process.

Wireless LANs (3)

- New standards
  - 802.11a: uses a wider frequency band to achieve speeds of up to 54 Mbps,
  - 802.11b: uses a different modulation technique, but the original frequency band to achieve 11Mbps,
  - 802.11g: uses same frequency band as 802.11b but different modulation (same as 802.11a) to achieve high data rates.