CPSC441

Basic Networking Concepts

LANs, WANs, and Multiplexing

- There are different types of networks.
- LAN: Local Area Network
  - Limited geographic coverage (e.g. lab, building)
  - Home Network, Ethernet LAN, Wifi
- MAN: Metropolitan Area Network
  - Size of a "city" (1-10km or so)
- WAN: Wide Area Network
  - Large geographic coverage (country, planet)
  - CANARIE, cellular networks, Internet
- These technologies differ in capacity, distance & cost.

Some concepts in Computer Networks are borrowed from other areas such as:

- Telephone network: (POTS, i.e., Plain Old Telephone System)
  - Phone calls, trunk lines, toll offices, circuit-switching
- Postal System: (Internet packet-switching)
  - Letters/parcels, addresses, mail carriers, post office
- Highway network:
  - Cars/buses, streets/highways, rush hour, collisions
- Broadcast TV:
  - Channels, stations, TVs, streaming (live/stored)

- Two different philosophies guiding the design, operation, and evolution of communication networks
  - the telco view (telecommunications networks to support voice telephony and other types of services, such as fax, dialup modems, etc.)
  - the "data networking" view (the Internet)
- Both approaches share similar goals & challenges such as scale, geography, heterogeneity, but they have different underlying assumptions.

Telco Networks

- Over 100 years old, circuit-switched, designed for transmission of human voice. Basically, a twisted pair of copper wires used for residential access. (cheap, adequate bandwidth, easy handling)
- Aggregation of multiple calls at toll office for multiplexing demultiplexing using TDM
- Low bandwidth required per call (64kbps)
- Fixed —11—
- Call routing & circuit allocation decided once per call at arrival time.
- End-to-end path allocation, with dedicated circuit (reserved bandwidth) per active call.
- All bits travel same path; stay in same order
- Call state information crucial in network switches.
- Busy signal if no path possible (blocking <= 2%)

- Billing model based on time used (minutes)
- Single class of service; high reliability (99.99%)
- Additional services faxes, modems, mobility.

The Internet

- About 50 yo, packet-switched network.
- Designed for data transmission.
- Variable size packets permitted
- Wide range of access technologies
- Wide range of user and application behaviour.
- Bursty, variable bandwidth required by apps.
- Aggregation of traffic at routers/switches.
- Transmission links shared on stat mux basis.
- Connection-less network layer protocol (IP).
- "Best effort" datagram delivery model
- Packet routing decided on a per packet basis.
- No end-to-end path allocation; no reserved bandwidth per active call.
- Packets can travel any path; packets can be delayed, lost, duplicated, re-ordered.
- Minimal state info in network switches
- Single class of service.
- Billing model? (hours? packets? bytes? bandwidth?)

Time Division Multiplexing (TDM)

- Static channel allocation mechanism
- Divider a fixed resource among N concurrent users.
- Done in the time domain (turn taking, time slots)
- Give each user all of the channel part of the time.
- Examples:
  - Classroom scheduling; traffic lights; daily TV programs
  - T1 digital transmission standard (1.5Mbps)
- Very efficient if N is fixed and all N users are active
- Very inefficient for bursty and unpredictable traffic.

Frequency Division Multiplexing

- Static Channel Allocation Mechanism
- Divides a fixed resource among N concurrent users
- Done in the frequency domain (i.e., Hertz) (Hz)
- Give each user part of the channel all of the time.
- Examples:
  - Radio Stations, TV channels, WiFi channels
  - CRTC regulation of wireless/cellular technologies
- Very efficient if N is fixed and all N users are active.
- Very inefficient for bursty and unpredictable traffic.

Statistical Multiplexing (Stat Mux)

- Flexible (dynamic) channel allocation mechanism.
- Shares a fixed resource among N concurrent users.
- Done dynamically on packet-by-packet basis.
- Give each user the channel when they need it.
- Hope they don't all need it at exactly same time!
- Examples:
  - Cars on city streets; letters sent via Canada Post.
  - Internet packets on ISP link.
- Very efficient for bursty and unpredictable traffic, even if N is unknown or highly dynamic.

- Several key concepts that underly many of the computer networks that we will talk about:
  - Network edge: end system devices, access links, LAN
  - Network core: aggregation, switching, multiplexing, WAN
- An internetwork is a network of networks
- Protocols are the glue for putting these together.