ICS 351: Today's plan

- Performance
- Peer-to-Peer Networking
Performance

- Ultimately, performance is given by how long it takes a user to complete an action.
- Performance is measured as both latency and throughput:
  - Latency is the time to send 1 bit (or one packet).
  - Throughput is how many bits can be sent in a given time.
- \( n \) round-trips sending \( m \) bits might take time:
  \[ n \times \text{latency} + \left( \frac{m}{\text{throughput}} \right) \]
- In practice, it gets more complicated:
  - Bits might be sent in both directions.
  - Operations don't always take the same amount of time.
  - Both throughput and latency vary.
Latency

- latency is measured in seconds:
  - one-way (useful, but hard to measure)
  - round-trip (also useful, and easy to measure)
- usually measured by sending the smallest possible transmission unit
- latency matters when there are lots of round-trips
  - web transfers (less so with HTTP/2)
  - remote login
- latency matters when things must happen in real time
  - telephony, gaming, trading, remote control, telemedicine
Throughput

- throughput is measured in bits/second or Bytes/second
  - network equipment generally rated in bits/second
  - network downloads generally list Bytes/second
  - in this class and in much (but not all) of the world:
    - b/s stands for bits/second
    - B/s stands for Bytes/second

- throughput matters when lots of data must be sent
- ttcp, netperf, and iperf measure and report throughput
Considerations

- at each level in the network, it is usually cheaper to provide less performance than more
  - i.e. more profitable to serve more people given the same infrastructure
- HTTP headers consume multiple hundred bytes, as opposed to about 40-60 bytes for TCP/IP headers
- but until HTTP/2, nobody was concerned enough to try to compress them
  - so the inefficiency must be negligible compared to the available throughput
A more advance performance test

- send two successive pings as fast as possible
- at the slowest link in the path, the second will be delayed in proportion to the size of the first
- this allows us to estimate the speed of the bottleneck link
- bwping performs this test
Peer-to-peer Networking

- In this class, it has been clear that a PC can perform as a router, and vice-versa
- Why not use our PCs as routers?
- For many purposes this is adequate
Content-Addressable Networking

- if we are not restricted to forwarding to IP addresses, there is less need for hierarchical control
- in fact, we can have content-addressable networks
- perhaps, to increase the incentive, every node that has content and makes it available might get priority for obtaining other content
- the decentralization and lack of control are one of the attractions for many of the users
Managing Peer-to-peer Networks

- management of a network requires some authorities that cooperate
- in a peer-to-peer network, both the management and the authority are made as small as possible
- because there is no hierarchical assignment of addresses, each peer can decide what content to provide, i.e. what "address" to use
- this minimizes management
Connecting Peer-to-peer Networks

- the network is connected by having one peer exchange addresses about other peers
- then, if the original peer stops collaborating, the other peers can be used to connect to the network
- the expectation is that some useful data exchange will take place, not necessarily that there will be continuous end-to-end connectivity with all parties involved
Examples of Peer-to-Peer

- BitTorrent
- Distributed Hash Tables
- Freenet
- AllNet
  - maybe: Skype
Peer-to-peer vs. Client-Server

- A server is a program that provides a service.
- Typically, a server is found at a given address and port number, and is maintained by an individual or an organization.
- Clients may be anonymous or unidentified.
- Peer-to-peer (P2P) often brings to the infrastructure the anonymity of clients.
- Can imagine authenticated P2P networks, set up for reliability rather than anonymity.
Peer-to-peer vs. Client-Server II

- for a very different example, routing is a peer-to-peer process
  - routers identified by IP address or ID
- the ultimate appeal of peer-to-peer for some networking people is a self-organizing, self-managing scalable network
- peer-to-peer networks seem to be widely accepted
  - though less well-known than client-server