0. Welcome to networking
- How networks work is a big part of systems
- Network = source of failure for many systems. Why?
- Today: intro to network / history of Internet. Look for common themes that you'll see over and over.
- Don't worry about details of specific protocols today; we'll delve into those later on.

1. General networks
- Model networks as graphs. Endpoints on outskirts, switches in the middle. Edge = direct connection between two nodes (perhaps a wire, perhaps not)
- Problems:
  - Addressing
  - Naming
  - Routing
  - Transport
- For small networks:
  - Naming/addressing: Just assign each node a unique name
  - Routing: How do nodes figure out how to get data to other nodes?
  - Transport: Lots of questions here. One problem to think about is reliability: what do we do when a packet gets dropped?
- In 6.033, we care mostly about the Internet. The Internet is not a "normal" network

2. The Internet, Pre-1993
- Launch of Sputnik => creation of ARPA (now DARPA)
  - Using hosts.txt, distance-vector, sliding-window, etc.
- 1978: Decide to make the Internet flexible. Encourages a layered model. A common model:

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[     Application     ] - things generating the traffic
[     Transport      ] - reliable (maybe) delivery, sharing
[ Network - IP       ] - addressing/routing
[         Link        ] - point-to-point links
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- Ideally, layering lets us swap out protocols.
- ~1983: TCP, provides reliable transport. Now apps don't have to reimplement reliable delivery.
3. Growth => Change
   - 1982: DNS. More scalable naming. Also enabled growth through distributed management.

4. Growth => Problems
   - Mid 80s: Congestion collapse. So many packets in network, but none were useful. TCP added a congestion control mechanism (more on this next week).
   - Why add it to TCP, not as a separate layer? It was already hard to add a new layer, even in the 80s.
   - Early 90s: Policy routing. Internet was beginning to be commercialized, parts of it didn't want to provide transit to commercial transit. Policy routing (BGP) is a means to do this.
   - Notice: commercialization is causing problems.
   - Addressing. Assign addresses in chunks of different sizes. "Class B" chunks -- 65K -- are typically "just right", and we ran out of those. The protocol CIDR was developed to divide these up.
     - Most interesting thing about CIDR: that it was possible to make this change at all. Changing addressing => changing switches. Happened because all switches were made by Cisco and forwarding was done in software.

5. The Internet, post-1993
     (http://www0.cs.ucl.ac.uk/staff/M.Handley/papers/only-just-works.pdf)

6. Problems we deal with today
   - DDoS: send a lot of traffic to one machine to consume its resources. Hard to prevent. Internet wasn't designed with accountability in mind.
   - Security: Internet was not designed for security. DNS, BGP, etc., have no secure infrastructure
   - Mobility: No one ever imagined this
   - Address Space Depletion: IPv4 -> IPv6
   - Congestion control: should probably change given the changes we've seen in the Internet (more about this later)

7. So what's new on the Internet?
   - Lots. P2P, wireless, mobile, streaming, cloud computing, datacenter networks, security threats/defenses..
   - Almost everything happens on the Internet today! Crazy.
   - We expect to see continued changes: massive growth, software-defined networks, sensors, robots, embedded devices, privacy, censorship

8. Recurring themes
   - Layering and hierarchy (particularly hierarchy as a means of
addressing scale)

- Scalability: If enforcing modularity was the theme of the first part of 6.033, scalability is the theme of the second part.
- Performance/efficiency: As the Internet grew, performance requirements informed its (re-)design.
- Diversity of Applications: As the Internet grew, more and more applications used it. These applications have different demands: some care about throughput, some care about latency, some care about both, some need reliability, some don't, etc. We have to build a network that works for all of them.
- Money: Because people pay to use the Internet, designing protocols can sometimes be trickier than it "should" be.
- End-to-end argument: what part of the network should implement what features (endpoints, switches, etc.)?