Overview of Ideas

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Contents

1 Last time

- Hack the network, don't have to compromise machines to compromise machines
- Example: request for 1.1.1.2 1.1.1.1/16 means you can access the first 16 bits (two digits of IP), from discussion on subnet masks
- AS1 $\rightarrow$ AS2 $\rightarrow$ AS3 (AS = autonomous system)
- Add an AS4 to network, add subnet range to route to AS4 (man in the middle attack) (this is difficult to do)

2 Chapter 1 Overview

Goals

- Understand terminology
- Go into detail, more depth on topics

2.1 What is the internet?

- Nuts and bolts view
  - Networks connected to one another
  - Global ISPs (Sprint) and local ISPs (Comcast)
  - Hosts: (end systemms), PCs, phones, etc
  - Network apps: apps that use the internet
  - Communication links
  - Fiber, copper, radio, satellite
  - Transmission rate: bandwidth
- Service view
  - Infrastructure that provides services to applications
  - Provides programming interface to applications
- Packet switching: allows more users on a network
- Internet of things
- Problem: not enough IP addresses (solution: IPv4 -¿ IPv6)
- Protocols (IP, TCP, HTTP)
- Internet standards
  - RFC: request for comments
  - IETF: internet engineering task force

2.2 Protocol: strategy for doing information exchange

- Human protocols ("Whats the time", "I have a question")
- Network protocols: Define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt
- Aside: debate about DHCP protocol from previous class (lots of redundancies), a lot of protocols have handshakes, not too efficient

2.3 Network edge

- Hosts (PCs, phones), servers in data centers
- Access networks, physical media: wired/wireless communication links
- Network core: network of networks, interconnected routers
- How to connect end systems to edge router: different strategies for residential/institutional, mobile
- Issues: bandwidth? Shared or dedicated?

2.4 Access network: DSL

- DSLAM: directly takes signal modulated from modem, multiplexes between networking core, ISP, telephone network
- Voice and data transmitted at different frequencies to DSLAM
- Allows for different upload/download speeds by design
- POTS: Plain old telephone system (DSLAM can mux to this)
- CC: cross connect pox, provides a digital fallback
- "If you wanted to be an anarchist, you could blow up these boxes. But that might not be the best thing to do" - Graham

2.5 Using existing infrastructure

- Sound over TV network (first video we watched)
- Cable network
  - Use cable as a bus
  - Frequency division multiple access
  - HFC: hybrid fiber coax
  - Neighborhood shares coax cable, muxed into CMTS
- Circuit switching (media access control)
  - Frequency division
  - Time division
- Verizon fios
  - Fiber optic links from Central Office to home
  - Optical Link lin terminator, Optical network terminator (modem dealing with optical stuff at your house)
  - Passive splitters vs Active splitters (Not powered vs powered)
- Institutional
  - Connected directly to network
  - Ethernet switches
- Physical media
  - Bit: propagates between transmitter/receiver pairs
  - Guided/unguided media
  - Why coax? Insulated, can run them outside
  - Fiber optic: low error rate, high transmission rate

2.6 Network core

- packet switching: hosts break aplication layer messages into packets
- Alternative: central switch which makes connections manually (doesn't scale)

2.7 Good exam questions

- Packet switching: store and forward
- Divide size of packet by speed
- Loss in routers: queueing
- How to choose which link to forward packet to
- Forwarding table that looks at packet header to make a decision
- Routing algorithms (Distance vector algorithm)
- Link state (advantages: add or remove routers easily, distributed)

2.8 How to connect a network of networks

- Global ISP? Not decentralized
- Solution: several regional/global ISPs
  - Downside: Have to pay them
  - Have an agreement between ISPs so transmitting between them is free
  - Internet Exchange Points (IXP) connect regional ISPs
- If you're a large content provider like Netflix, you want a Content Distribution Network (CDN) for each regional network
- Point of Presence (POP): where global ISPs connect to regional ISPs

2.9 Delay, loss, and throughput in networks

- Four sources of packet delay

$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

1. d_{proc}: delay in processing in a node (e.g., error correction, forwarding)
2. d_{queue}: delay in queuing (depends on congestion level of router)

3. d_{trans}: delay in transmission

$$d_{trans} = \frac{\text{Packet length (bits)}}{\text{Link bandwidth (bps)}}$$

4. d_{prop}: propagation delay (the physics)

$$d_{prop} = \frac{\text{Length of physical link}}{\text{Propogation speed}}$$

- Caravan analogy (good exam question, see slides): There are two toll booths, takes time to process cars at each toll booth, how long before cars get to the second toll booth? (Car is a bit, caravan is a packet, toll booth is a node)
- Queuing delay (revisited): packets are held while others are being processed
  - R: link bandwidth (bits per second)
  - L: packet length (bits)
  - a: average packet arrival rate
  - Avg. queueing delay small: $\frac{L \cdot a}{R} \approx 0$
  - Avg. queueing delay large: $\frac{L \cdot a}{R} \approx 1$
  - More data arriving than can be serviced: $\frac{L \cdot a}{R} > 1$
- Traceroute: program that measures delay along nodes in a network connection (does this by setting the Hops field of IP packets)