Final Exam Review

COS 461 - Precept 11

Exam Format

- Similar to midterm – take-home exam on Gradescope
- Open-notes, open course resources. Cannot use third-party internet resources
- Timed exam you may take at any time from May 10 to May 17
- Exam is cumulative, but emphasizes material covered after the midterm (Lecture 11 onwards)
- All material covered in lectures, assignments, and precepts is fair game
- Today: High-level discussion of topics covered since midterm
    - Please ask questions!

Interdomain Routing

- Border Gateway Protocol (BGP): Application-layer protocol that enables autonomous systems (ASes) to coordinate routing traffic.
- eBGP versus iBGP
- BGP bootstrapped using finite state machine
- Peering versus customer-provider relationship
- Rules influencing routing decisions: Next-hop, local preference, MED, etc.

Application Layer and the Web

- Domain Name System (DNS): Hierarchical network service that resolves Domain Name → IP address mappings
  - Lots of caching here to make efficient
- Multicast and Anycast: Load balancing requests across multiple servers in a large system
  - But tricky to deploy
- Content distribution networks: Third-party networks of datacenters that store cached web content to reduce end user lookup time

Application Layer and the Web

- Hypertext Transfer Protocol (HTTP): Primary web application-layer protocol
  - Your browser makes lots of these requests
  - Operates over TCP
- HTTP Versions:
  - 1.1 (Persistent TCP connection)
  - 2.0 (Pipelining requests)
  - 3.0 (Move transport layer functionality to userspace and uses UDP)
- Request types: GET, POST, PUT, …
- HTTP caching and limitations
- Proxies
  - You worked with HTTP Requests and Responses in Assignment 4

Wireless

- Tricky to share a wireless link
- Resource-sharing protocols:
  - Unslotted/Slotted ALOHA
  - MACA: RTS/CTS, Binary exponential backoff (BEB)
  - MACAW: Fairer random backoff, ACKs, RRTSes, Carrier-sense
  - IEEE 802.11: Standard for WiFi communication. Adopts parts of MACAW and Ethernet
- Routing
  - DSDV: Distance-vector routing with route sequence numbers. Avoids Count-to-infinity problem
  - DSR: No periodic route advertisements; nodes specifically ask for routes by flooding with route requests (RREQ).
- 5G Cellular Networks
  - Similar network stack to traditional internet, but no network layer
  - Several specific design points to address rapid attenuation of millimeter waves

SDN and Datacenters

- Software-defined networking (SDN)
  - Network hardware vendors issue general-purpose compute hardware
  - Network designers program hardware to perform specific IP-layer tasks
  - Developer programs control plane; rules applied in data plane
- Data Centers
  - Large facilities with many servers
  - Cloud computing models: IaaS, PaaS, FaaS
  - Virtualization versus Containerization
  - North/South versus East/West traffic
  - Network topology: Virtual versus physical switching, L2 versus L3 coordination

Network Security

- Basic Security Properties
  - Confidentiality, Integrity, Authenticity, Availability, Non-repudiation, Access Control
- Security at many network layers (e.g. IPSec at L3, TLS at L4)
- Symmetric versus asymmetric encryption and tradeoffs
- End-to-end encryption
  - OpenPGP, Secure email
- HTTP Security
  - TLS and Certificates
- DNS Security: Hijacking, Cache poisoning
- BGP Session Security, Hijacking, Bogus paths, S-BGP and challenges