CSC 525:
Computer Networks

The Final Exam

- Friday 12/10, 1:00 – 3:00 PM, GS 701.
  - Focus on papers and lecture slides covered in the 2nd half of semester.
  - Closed books, closed notes.
  - One letter-sized (8.5x11) cheat sheet, double-sided, any font size.
  - and a simple calculator.
- Same type of questions as in the midterm exam
  - Design principles
  - Protocol operations
  - Comparison and evaluation
- This review just highlights points that I think are important. By no means it is a complete list.

Overview

- IP Multicast:
  - IGMP, DVMRP, MOSPF, CBT/PIM.
- TCP Congestion Control:
  - TCP Reno, BBR
- Overlays
  - DNS, RON, Application Multicast, DHT, Bittorrent
- Local area networks
  - Ethernet, Seattle, Portland
- Others
  - SDN, IPv6, CDN, NDN, LEO satellite networks
- Focus on basic concepts and key protocol mechanisms.

IP Multicast

- The basic service model and design.
- IGMP: how it works, especially how it uses multicast to reduce duplicate query/reply packets.
- Routing: DVMRP, MOSPF, CBT/PIM
  - Tradeoff between source tree vs. shared group tree
  - How the protocols work.
  - Pros and cons of each protocol.

TCP

- Basic mechanism for reliable transmission
  - Retransmission timer, window size, RTT estimate, ...
  - How TCP estimates timeout values.
- TCP Reno
  - i.e., Tahoe + fast retransmission + fast recovery
  - How congestion window size and threshold re adjusted, understand the pseudo code, be able to execute it over an example.
- BBR
  - Fully utilize bandwidth without causing large delay.
  - How it measures delay and bandwidth, and use them to control sending rate.

DNS

- Understand the overall system and its various components.
- Lookup process
  - How does it work?
  - Recursive vs. Iterated
  - Caching, replication.
- Resource records
  - Four major types
- Configuration errors
  - Understand the error scenarios.

Overlay Multicast

- How does it compare with IP multicast?
- The main challenge in application layer multicast: how to build efficient overlay for multicast delivery?
- Narada
  - Maintain the complete virtual graph among all the members, reduce it to a well-connected mesh, and run DVMRP on top of the mesh.
- The main part is construct and manage the mesh
  - Join, leave, repair partition
  - Add links based on "utility"
  - Drop links based on "consensus cost"

Resilient Overlay Network

- Goal
  - Quickly route around failed or congested links
  - For small communities only
- The basic idea
  - Frequently measure all inter-node overlay links
  - Estimate link and path performance
  - Exchange the performance information
  - Route along app-specific best paths
- Main results
  - Respond quickly
  - Improve latency and throughput
  - One-hop indirection is enough in most cases.

Distributed Hashing Table

- What is a DHT? The basic functions.
- Chord
  - A one-dimensional id space
  - An item is stored at the node with next highest id.
  - A node keeps track of
    - Successor (for lookup)
    - Predecessor (for ring maintenance)
    - Finger table (to speed up lookup)
  - Lookup process
  - Join Process
- Properties
  - Routing table size O(logN)
  - Lookup steps O(logN)

Bittorrent

- The basic idea, terminology, and the process of running a torrent.
- Rarest-first in choosing pieces to download.
- Choke/unchoke algorithm to choose peers.
- Clustering, sharing incentives, and upload utilization.
  - Understand the concepts and metrics.

Comparison

- Compare different overlay networks we covered:
  - DNS for name lookup, overlay multicast, RON for unicast, DHT for searching, Bittorrent for file distribution.
  - What overlay topology does each protocol maintain, how do they maintain the overlay, and how it fits the application goals.

Ethernet, Seattle, PortLand

- What are the problems?
  - Ethernet's self-learning switching vs. IP-based routing, pros and cons.
  - Need scalable solutions for large enterprise or datacenter networks.
- How SEATTLE works
  - Switches run a link-state routing protocol among themselves.
  - Hosts register with the attached Switch.
  - Switches run a one-hop DHT to map the destination host to one of the switches.
  - Optimizing the path by caching mapping results.
- How PortLand works
  - Assume FatTree topology, use virtual MAC to denote the position of a server in the topology.
  - Use a central manager for the mapping from physical MAC to virtual MAC, track server/switch status, facilitate failure recovery.

IPv6

- How NAT allows multiple hosts share a single public IP address.
  - Pros and cons.
- The different measurement metrics used in the paper to quantify the deployment of IPv6.

HTTP and CDN

- Basic HTTP mechanisms
  - Request and reply, proxy, persistent connection with pipelining, caching.
- The concept of Content Distribution Networks.

Software-Defined Networks

- The basic concepts of SDN
  - What problems it tries to solve, and how.

- Understand how SDN enables Google to use links at > 90% average utilization.

Named Data Networking

- The idea of NDN
  - Interest and Data packets carry application-level names that identify the data wanted by apps.
  - Network is not limited to any particular address to retrieve the data from.
  - requires Data to be signed by the producer.
- NDN's basic operation
  - Hierarchical name, one Interest for one Data at packet level, Interest is routed based on its name, and Data returns on the same path as Interest's.
- NDN's node model.

Satellite Networks

- Why the recent push for LEO constellations?
  - Benefits and challenges.
- StarLink constellation
  - The placement of satellites and orbital planes
  - The inter-satellite links
  - Source routing