ICS 451: Today's plan

- Exam Review:
  - TCP: connections, TCB, Nagle Algorithm, retransmissions, congestion control
  - Network-layer forwarding: routing tables
    - static routes, distance-vector, link-state
  - IPv4, IPv6: addresses, netmasks, default routes
  - ICMP, ICMPv6: ping, traceroute
  - ARP, DHCP, IPv6 autoconfig, NAT/firewall, security
  - RIP, OSPF

exam 2 may include material from exam 1

TCP

- connections
- TCB
- Nagle Algorithm
- retransmissions
  - adaptive timer, binary exponential backoff
- congestion control
  - congestion window
  - AIMD
  - slow start

Network-Layer forwarding

- routing tables
- static routes
- dynamic routes:
  - distance-vector
  - link-state

Routing Algorithms

- distance-vector
  - send to my ***neighbors*** my ***distance*** to each destination
  - slower to recover from lost links (∞ is 16)
  - less information sent
- link-state
  - flood to ***everyone*** my ***link-state***, i.e. the information about the routers I can talk to
  - information updated quickly
  - more routing information sent across network

IP

- IPv4, IPv6
- addresses: 32 bits, 128 bits
  - hierarchical, point-of-attachment address
  - routing tables can summarize routes
- netmasks
  - network vs. host part of the address
  - default route (netmask 0.0.0.0 or /0)
  - every network has *n* addresses, where *n* is $2^{32 \text{ - mask-bits}}$ or $2^{128 \text{ - mask-bits}}$

IP details

- headers: source and destination address, TTL or Hop Limit, protocol or next header
- fragmentation, path MTU discovery
- forwarding strictly follows routing table

ICMP

- network debugging: ping
- error reporting: undelivered packets because
  - destination unreachable
  - MTU too small
  - TTL/HopLimit exceeded
  - did not understand packet
- network maintenance (generally deprecated)
  - redirect
  - source quench

ARP/NDP

- given the next-hop IP,

  give me the next-hop MAC address
- broadcast request,
  - unicast reply
  - add to ARP cache whenever a message is seen
- Address Resolution Protocol is for IPv4
- Neighbor Discovery Protocol is for IPv6

DHCP/SLAC

- give me a valid IP address and router info
  - also netmark, DNS servers
- broadcast request, unicast reply
- IPv6 automatically gives us a valid link-local IP address
  - StateLess AutoConfiguration
  - Router Advertisements tell us the routers on this network
- Dynamic Host Configuration Protocol has versions for both IPv4 and Pv6

NAT and firewall

- NAT: reduction in the number of pubic IPs
- firewall: protect unmanaged hosts
- combine well: NAT only allows outgoing connections
  - unless configured otherwise
- NAT table has two local IPs and port numbers
  - one to use for packets inside the network
  - one to use for packets on the Internet

security

- ARP and DHCP/SLAC responses may be sent by an impersonator
  - the MAC address of X is Y (really should be Z)
  - I am a default router on this network
  - use this IP address (which may be wrong or duplicate)

RIP

- distance vector
  - split horizon with poisoned reverse
  - ∞ is 16
  - updates every 30s, routes timeout after 3min
- usually used on smaller, more static, less-managed networks
  - no areas, all routers are equivalent

OSPF

- link state
  - within the local area
    - only summary information sent outside the area
- Backbone area must be connected to all other areas
- Hello packets sent every 10s
- used on larger, more managed and dynamic networks

Assignments:

- Assignment 5: DNS client
- Assignment 6: reliable transmission, Alternating Bit Protocol
  - and beginning of simulation using UDP
- Assignment 7: TCP connections
- Assignment 8: IPv4 routing tables, forwarding
- Assignment 9: IPv6 routing tables, forwarding