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 IPv6
NAT and firewall

- **NAT**: reduction in the number of public 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
  - $\infty$ 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