Notes
CSC317 Computer Networks

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13 October 2016

- distinction between forwarding and routing
  - forwarding: packet transfer (from input link to output link) in a single router
  - routing: packets movements through all routers in network
- topics
  - Internet Protocol (IP)
  - IPv4 datagram format
  - Network Address Translation (NAT)
  - datagram fragmentation
  - Internet Control Message Protocol (ICMP)
  - IPv6
- 2 principal classes of routing algorithms
  - link-state
  - distance-vector
- hierarchical routing algorithms
  - intra-autonomous: RIP, OSPF, IS-IS
  - inter-autonomous: BGP
- routers do not run application or transport layer protocols (except for control)
- routers run network (and link) layer protocols
- analogy to a trip by automobile (Pennsylvania to Florida)
  - forwarding: getting through a single intersection
  - routing: plan to get from home to vacation destination

- our authors use words forwarding and routing differently than other authors
- centralized and distributed routing algorithms
- interaction between forwarding and routing
  - routing protocol produces messages
  - messages used to configure forwarding tables
- packet switches—most general term
  - routers, switches, hubs
  - router—forward using addresses in network-layer datagram
  - link-layer switch—forward using addresses in link-layer frame
- organization/construction of a router
  - input ports
  - output ports
  - switching fabric
  - routing processor
- structure of IPv4 datagram
  - version (4 bits)
  - header length (4 bits) (most IP datagrams have no options)
  - type of service (8 bits)
  - datagram length (16 bits) (maximum is 65,535 but usually < 1500 bytes)
  - *
  - identifier (16 bits) (for fragmentation)
  - flags (3 bits) (for fragmentation)
  - fragmentation offset (13 bits) (for fragmentation)
  - *
  - time-to-live (8 bits) (prevent endless circulation, decremented each time datagram is processed by a router)
  - upper-layer protocol (8 bits) (e.g., 6 for TCP, 17 for UDP) (analogous to port number in transport protocol—binds lower level to higher level)
  - header checksum (16 bits)
  - *
  - source IP address (32 bits)

  - *
  - destination IP address (32 bits)

- why checksums in network and transport layers?
  - only IP header is checksummed at network layer
  - TCP/UDP checksum computed over the whole segment
  - IP can carry data not passed to TCP/UDP
  - TCP/UDP can run through ATM (non-IP) network

- TCP segment in IP datagram: $20 + 20 = 40$ bytes of headers

- decisions in the design of routers
  - size of buffer
  - packet scheduling

- routing algorithms
  - classifications
    - global vs. decentralized
    - static vs. dynamic
    - load-sensitive vs. load-insensitive
  - link-state
    - inputs: network topology, all link costs
    - each node broadcasts link-state packets to all other nodes
    - e.g., Dijkstra's algorithm (similar to Prim's)
  - distance-vector
    - iterative
    - asynchronous
    - distributed
    - self-terminating

- intra-autonomous system routing and inter-autonomous systems routing
  - autonomous system
    - routers owned/administered by same organization
    - e.g., ISP or company network
  - intra-autonomous — within a single autonomous system
  - inter-autonomous — among several or many autonomous systems

- names of routing algorithms
  - RIP: Routing Information Protocol (intra-AS)
  - OSPF: Open Shortest Path First (intra-AS)
  - IS-IS: closely related to OSPF (not discussed further)
  - BGP: Border Gateway Protocol (inter-AS)