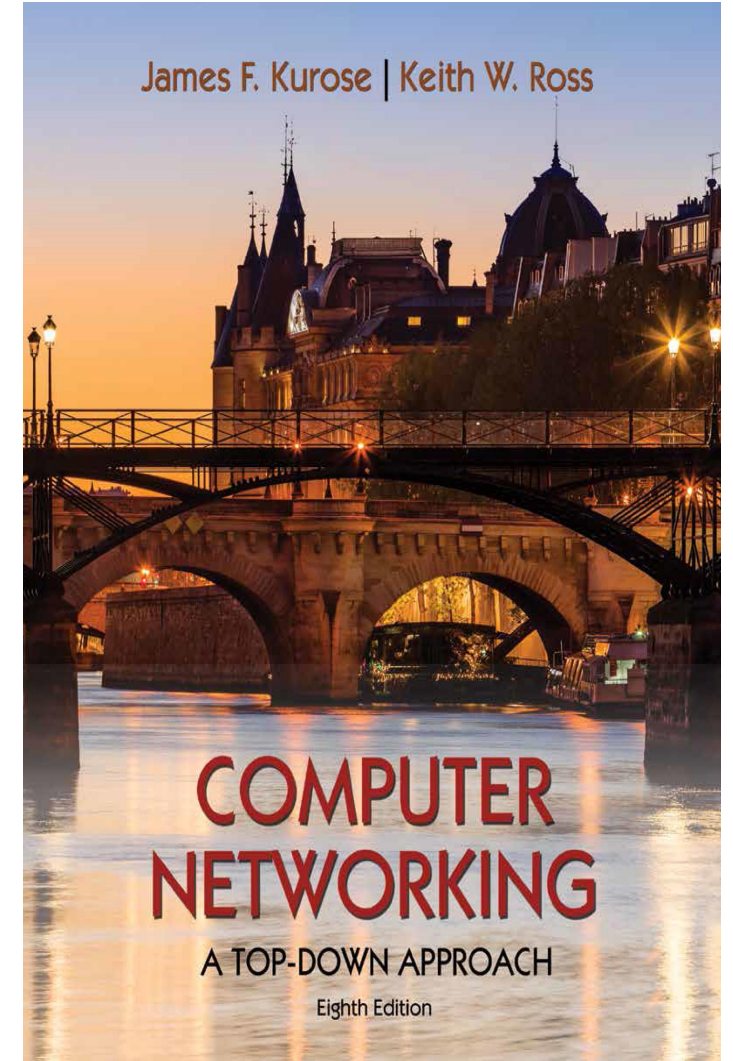


Network Layer: Control Plane

- introduction
- routing algorithms
 - link state
 - distance vector
- intra-ISP routing: OSPF
- routing among ISPs: BGP
- SDN control plane
- Internet Control Message Protocol
- Network management, configuration

Computer Networks

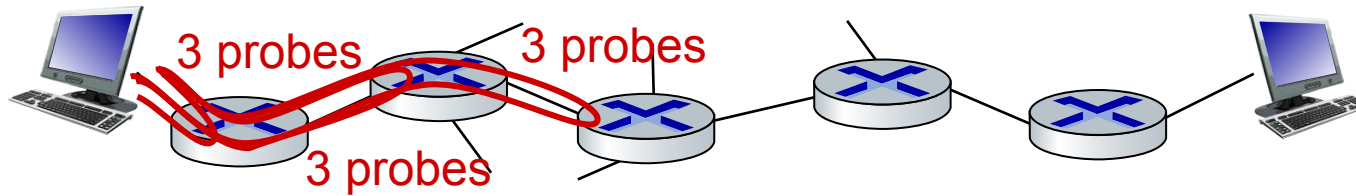


ICMP: internet control message protocol

- used by hosts and routers to communicate network-level information
 - error reporting: unreachable host, network, port, protocol
 - echo request/reply (used by ping)
- network-layer “above” IP:
 - ICMP messages carried in IP datagrams, protocol number: 1
- *ICMP message*: type, code plus header and first 8 bytes of IP datagram causing error

Type	Code	description
0	0	echo reply (ping)
3	0	dest. network unreachable
3	1	dest host unreachable
3	2	dest protocol unreachable
3	3	dest port unreachable
3	6	dest network unknown
3	7	dest host unknown
4	0	source quench (congestion control - not used)
8	0	echo request (ping)
9	0	route advertisement
10	0	router discovery
11	0	TTL expired
12	0	bad IP header

Traceroute and ICMP



- source sends sets of UDP segments to destination
 - 1st set has TTL =1, 2nd set has TTL=2, etc.
- datagram in n th set arrives to n th router:
 - router discards datagram and sends source ICMP message (type 11, code 0)
 - IP address of router where TTL expired is source IP address of datagram containing this ICMP message

stopping criteria:

- UDP segment eventually arrives at destination host
 - destination returns ICMP “port unreachable” message (type 3, code 3)
 - source stops
-
- when ICMP message arrives at source: record RTTs