Lecture 19: Network Layer – Control Plane III

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Contents of Chapter 5

- Introduction
- Routing algorithms
- Intra-AS routing in the Internet: OSPF
- Routing among the ISPs: BGP
- The SDN control plane **(skipped)**
- **ICMP: The internet control message protocol**
- **Network management and SNMP**

Message Exchanges

- **OSPF**
  - Carried directly over IP (transport layer) with an upper-layer protocol of 89
- **BGP**
  - Semi-permanent TCP connections using port 179

ICMP

- **The internet control message protocol (ICMP)**
  - Used by hosts and routers to communicate network-layer information to each other
  - Error reporting, echo request/reply, etc.
  - Carried as IP payload just as TCP or UDP segments
    - Transport layer control protocol

ICMP

ICMP message types

ICMP Type	Code	Description
0	0	echo reply (to ping)
3	0	destination network unreachable
3	1	destination host unreachable
3	2	destination protocol unreachable
3	3	destination port unreachable
3	6	destination network unknown
3	7	destination host unknown
4	0	source quench (congestion control)
8	0	echo request
9	0	router advertisement
10	0	router discovery
11	0	TTL expired
12	0	IP header bad

ICMP

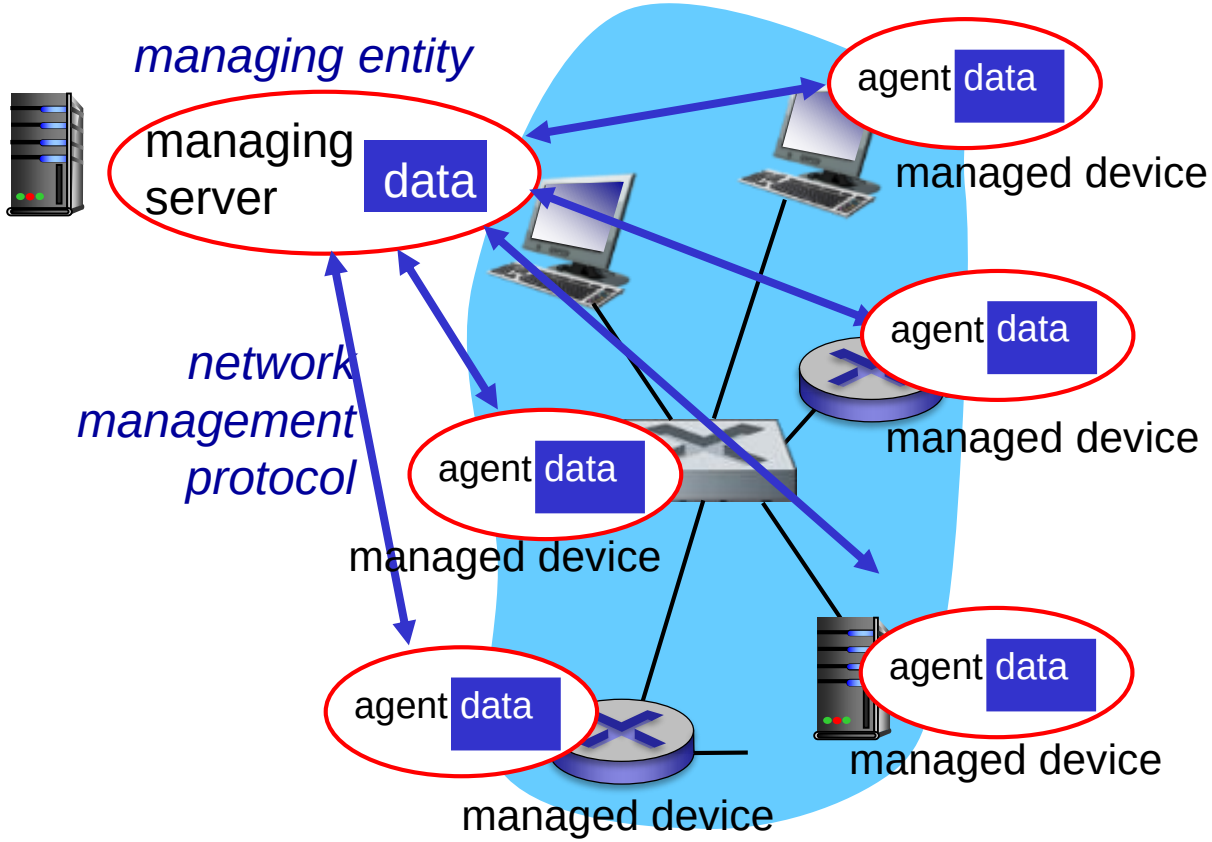
- **Type 9 (router advertisement)**
  - This message is used by routers to let hosts know of their existence and capabilities.
- **Type 10 (router solicitation)**
  - This message is used by hosts to request Router Advertisement messages from any listening routers.

ICMP

Traceroute program

- Source sends a series of ordinary IP datagrams to the destination.
  - UDP segments with an unlikely UDP port number
  - A TTL is increased by one for each datagram, e.g., 1, 2, 3, and so on.
  - Source starts a timer for each of the datagrams.
- When the *n*th datagram arrives at the *n*th router,
  - The router discards the datagram and sends an ICMP warning message to the source (type 11 code 0).
  - The ICMP message includes the name and IP address of the router.
- When the datagram eventually arrives at the destination host,
  - The host sends a port unreachable ICMP message (type 3 code 3)

Network Management Framework



SNMP

- **The simple network management protocol (SNMP)**
  - Used to convey network-management control and information messages between a managing server and an agent
  - Application-layer protocol
  - Manager-to-agent: Send a request to query or modify MIB object values
    - MIB: Management information base
  - Agent-to-manager: Send an unsolicited message to notify a managing server of an exceptional situation

SNMP

SNMPv2 PDU types

SNMPv2 PDU Type	Sender-receiver	Description
GetRequest	manager-to-agent	get value of one or more MIB object instances
GetNextRequest	manager-to-agent	get value of next MIB object instance in list or table
GetBulkRequest	manager-to-agent	get values in large block of data, for example, values in a large table
InformRequest	manager-to-manager	inform remote managing entity of MIB values remote to its access
SetRequest	manager-to-agent	set value of one or more MIB object instances
Response	agent-to-manager or manager-to-manager	generated in response to GetRequest, GetNextRequest, GetBulkRequest, SetRequest PDU, or InformRequest
SNMPv2-Trap	agent-to-manager	inform manager of an exceptional event