

Chapter 5

Network Layer:

The Control Plane

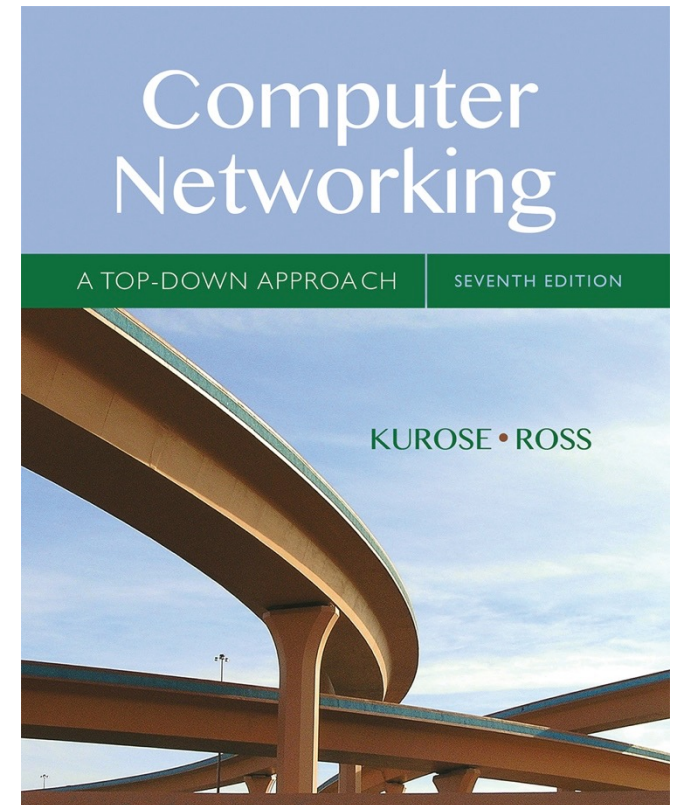
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Computer Networking: A Top Down Approach

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Minor modifications made to original slides by Nathan Bowman

Chapter 5: outline

5.1 introduction

5.2 routing protocols

- link state
- distance vector

5.3 intra-AS routing in the Internet: OSPF

5.4 routing among the ISPs: BGP

5.5 The SDN control plane

5.6 ICMP: The Internet Control Message Protocol

5.7 Network management and SNMP

ICMP: internet control message protocol

- used by hosts & routers to communicate network-level information

- error reporting:
unreachable host, network, port, protocol
- echo request/reply (used by ping)

- network-layer “above” IP:

- ICMP msgs carried in IP datagrams

- **ICMP message:** type, code plus first 8 bytes of IP datagram causing error

<u>Type</u>	<u>Code</u>	<u>description</u>
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

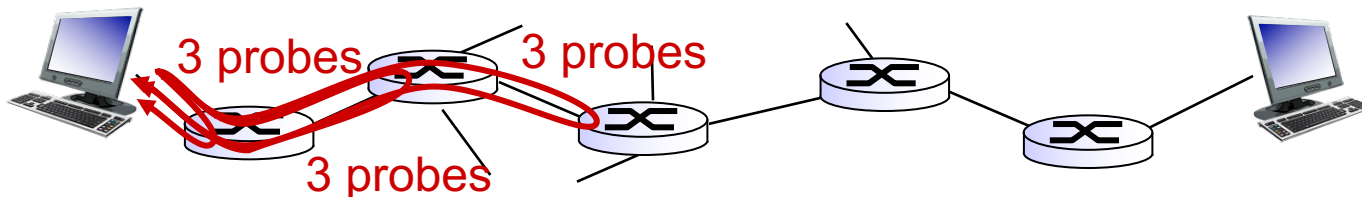
Traceroute and ICMP

- source sends series of UDP segments to destination
 - first set has TTL = 1
 - second set has TTL=2, etc.
 - unlikely port number
- when datagram in n th set arrives to n th router:
 - router discards datagram and sends source ICMP message (type 11, code 0)
 - ICMP message include name of router & IP address

- when ICMP message arrives, source records RTTs

stopping criteria:

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



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What is network management?

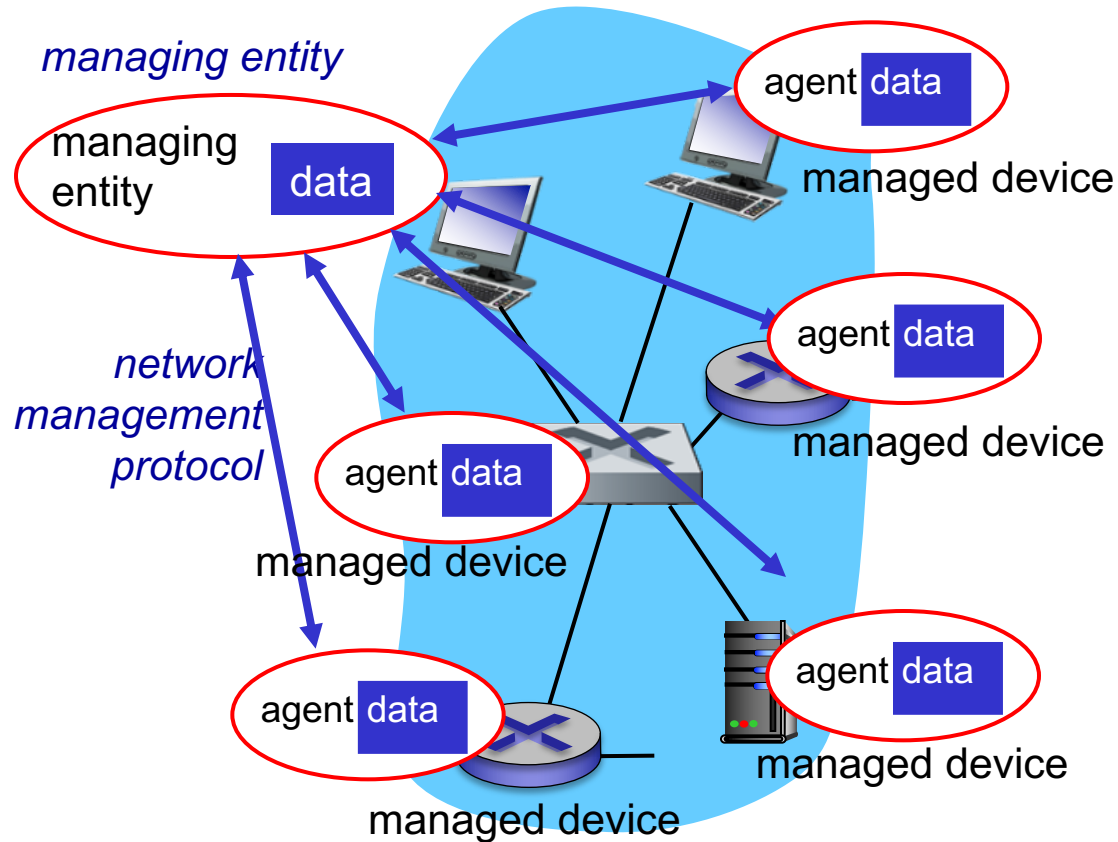
- **autonomous systems (aka “network”)**: 1000s of interacting hardware/software components



"**Network management** includes the deployment, integration and coordination of the hardware, software, and human elements to monitor, test, poll, configure, analyze, evaluate, and control the network and element resources to meet the real-time, operational performance, and Quality of Service requirements at a reasonable cost."

Infrastructure for network management

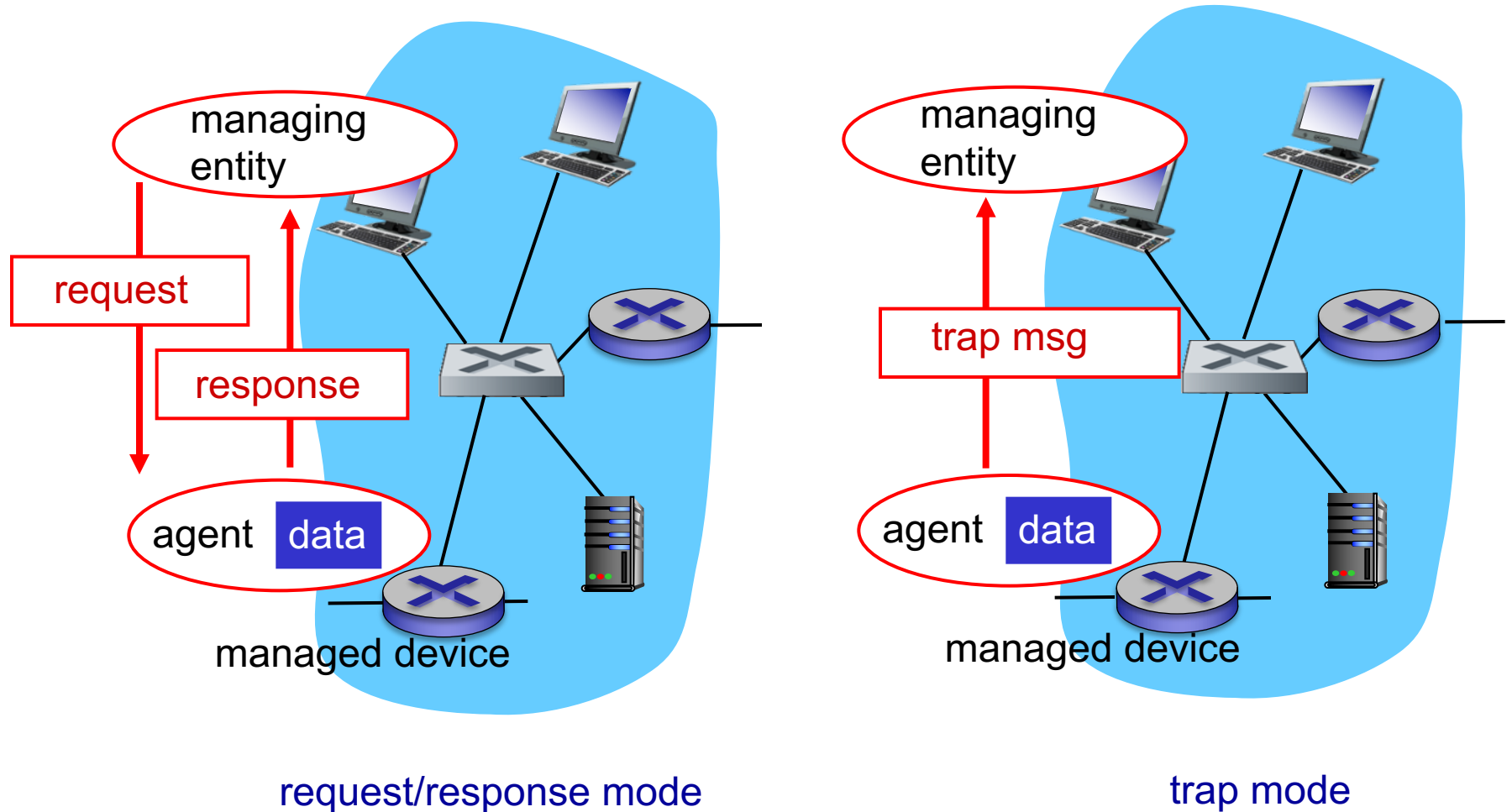
definitions:



managed devices
contain *managed objects* whose data is gathered into a **Management Information Base (MIB)**

SNMP protocol

Two ways to convey MIB info, commands:



SNMP protocol: message types

Message type

Function

GetRequest
GetNextRequest
GetBulkRequest

manager-to-agent: “get me data”
(data instance, next data in list, block of data)

InformRequest

manager-to-manager: here's MIB value

SetRequest

manager-to-agent: set MIB value

Response

Agent-to-manager: value, response to Request

Trap

Agent-to-manager: inform manager of exceptional event

SNMP protocol: message formats

