

Network Layer: ICMP and Network Management

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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

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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

- 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

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Traceroute and ICMP

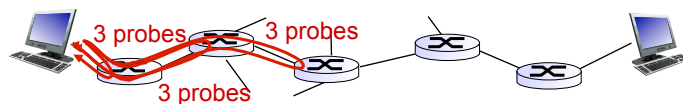
- source sends series of UDP segments to destination
 - first set has TTL = 1
 - second set has TTL=2, etc.
 - unlikely port number

- 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** (a.k.a. “**network**”): 1000s of interacting hardware/software components
- other complex systems requiring monitoring, control:
 - jet airplane
 - nuclear power plant
 - others?

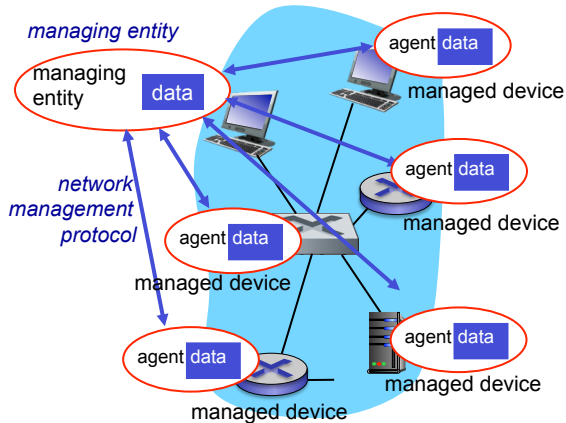


"**Network management** includes the deployment, integration and coordination of the hardware, software, and human elements to monitor, test, poll, configure, analyze, evaluate, and control the network and element resources to meet the real-time, operational performance, and Quality of Service requirements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

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Infrastructure for network management

definitions:

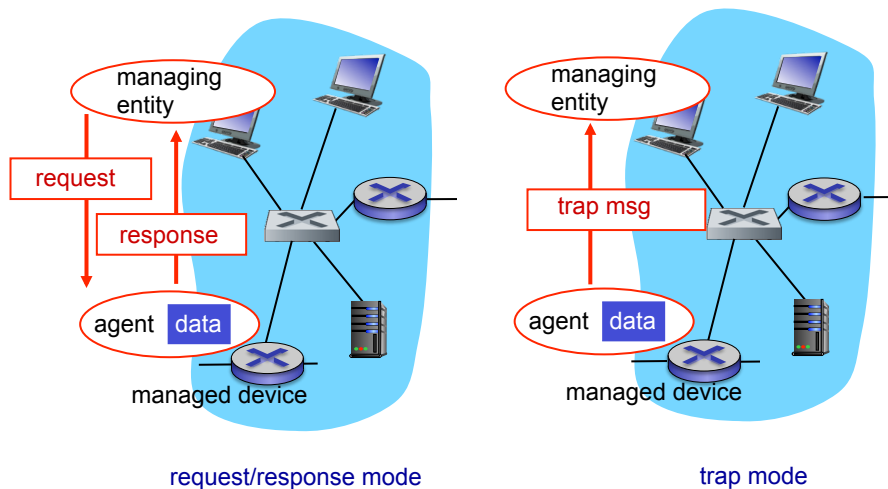


managed devices contain *managed objects* whose data is gathered into a *Management Information Base (MIB)*

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SNMP protocol

Two ways to convey MIB info, commands:



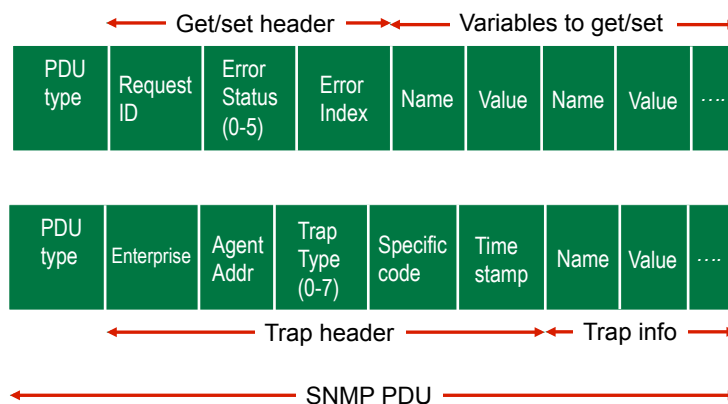
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SNMP protocol: message types

<u>Message type</u>	<u>Function</u>
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

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SNMP protocol: message formats



More on network management: see earlier editions of text, and
http://www.tcpipguide.com/free/t_SNMPVersion2SNMPv2MessageFormats-5.htm

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SNMP PDU Type Values

PDU Type: An integer value that indicates the PDU type:

PDU Type Value	PDU Type
0	<i>GetRequest-PDU</i>
1	<i>GetNextRequest-PDU</i>
2	<i>Response-PDU</i>
3	<i>SetRequest-PDU</i>
4	Obsolete, not used (this was the old <i>Trap-PDU</i> in SNMPv1)
5	<i>GetBulkRequest-PDU</i> (has its own format, see below)
6	<i>InformRequest-PDU</i>
7	<i>Trapv2-PDU</i>
8	<i>Report-PDU</i>

Network Layer

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Chapter 5: summary

we've learned a lot!

- approaches to network control plane
 - per-router control (traditional)
 - logically centralized control (software defined networking)
- traditional routing algorithms
 - implementation in Internet: OSPF, BGP
- SDN controllers
 - implementation in practice: ODL, ONOS
- Internet Control Message Protocol
- network management

next stop: link layer!

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