SNMP overview

Network Mgmt/Sec.

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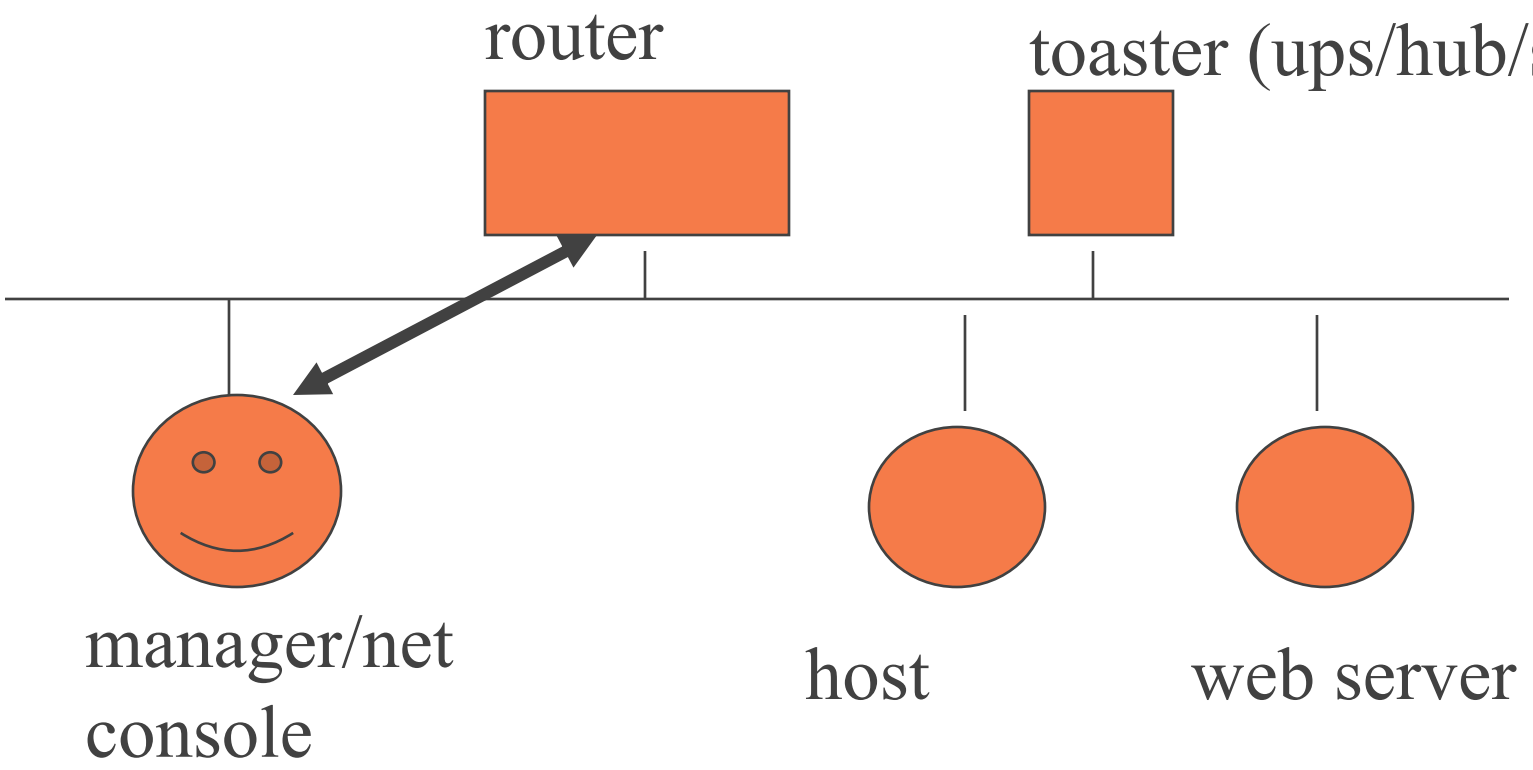
Outline

- snmp components
  - architecture/MIBS/naming
  - protocol
  - security
- snmp history and versions
- summary

snmp elements

- client/server - architecture
- database elements (MIB)
  - ASN.1
  - naming
  - it's the contents JIM (too)
- protocol
- security (or lack therein)

e.g., SNMP approach

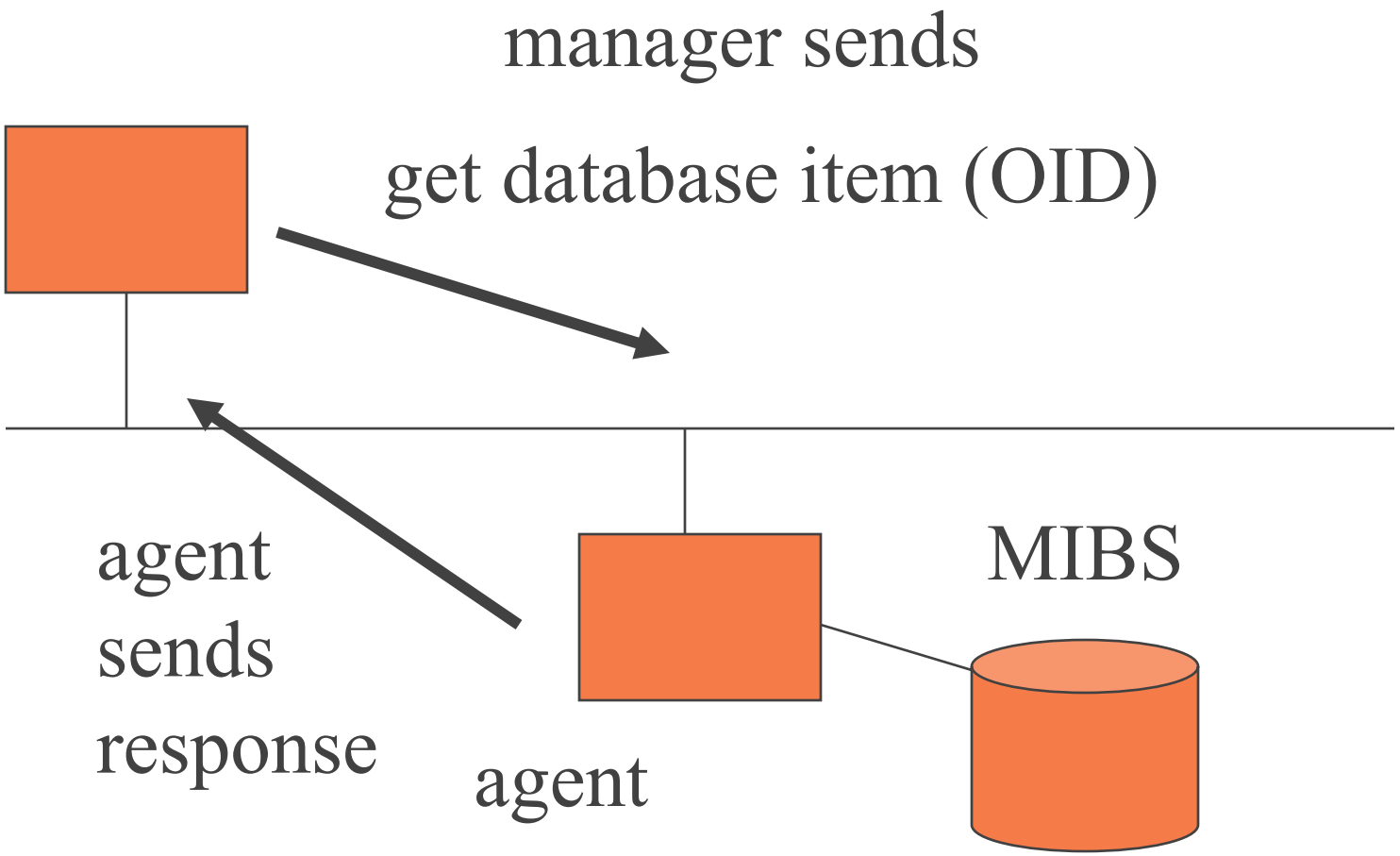


manager polls all nodes (send/response) with SNMP/displays data

architecture

- in general
- **manager** requests individual data items
  - in v2 tables, in v1 table elements 1 at a time
- from **agent**
- **manager** is client/client-server sense
- **agent** consists of MIB database + snmp code to respond to manager, server (serves database)

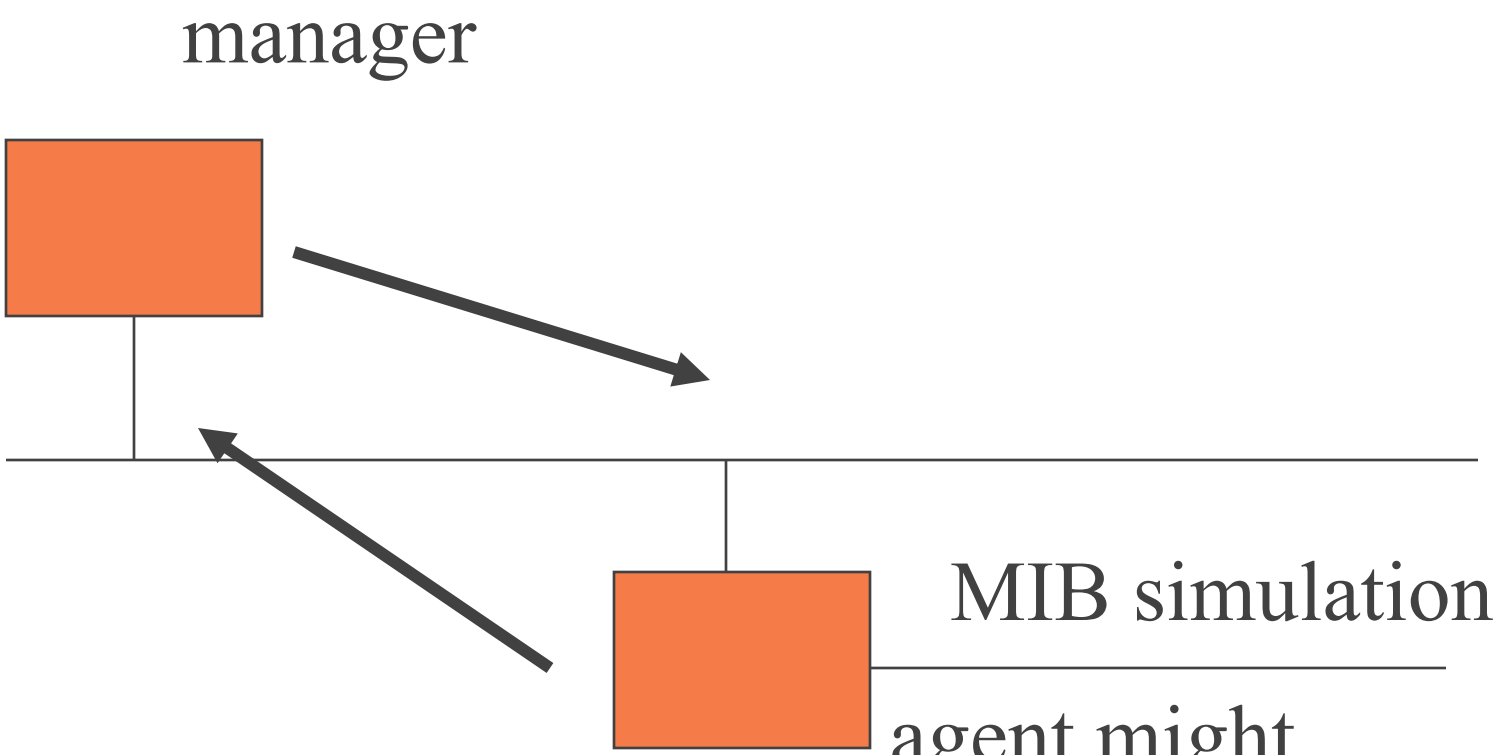
manager/agent



proxy agent possible but rare

- proxy agent
- speaks SNMP to manager
- but “MIB” does not exist
- instead agent might speak another protocol entirely out the other side
  - level of indirection
- proxies for MIB capability
- might use RPC to talk out other end

proxy agent


manager
MIB simulation
agent might
send messages to
emulate MIB values
proxy
agent

database elements

- agent has 1 or more sets of variables
- grouped in MIB
- MIB - management information base
- MIB is in some sense a formal specification
  - in ASCII and a parseable grammar
- basically just variables with naming mechanism plus values
- variables are typed and grouped in data structure

MIB, more

- the language for encoding MIB variables is called
- **ASN.1 - Abstract Syntax Notation**
- "Pascal-like" data description language
- basic and structured types
- variables consist of (name, value) and a type (e.g., *displayString*)
- types usually ints, strings, addresses, arrays

MIB, more

- simple example of MIB values might include
- system MIB vars as (type,name,value):
  - DisplayString sysDescr (“cisco 2924”)
  - TimeTicks sysUpTime (“up since yesterday”)
  - DisplayString sysContact (“Charlie S.”)
  - INTEGER sysServices (“internet layer (router)”)

MIB does not mean “Men In Black”

- can include more complex values including
- tables (2-dimensional scalars)
  - ip routing table
  - arp table
  - list of interfaces with associated ip addresses, netmasks
  - tcp connections that are open

a MIB by any other name

- the miracle is the naming mechanism
  - a **COMPLEX** miracle ...
- borrowed from ISO/OSI protocol suite
- applies both to SNMP PDU and data
  - in ISO ASN.1 was used to describe all packet elements too, e.g., CLNP
- attributes include:
  - **lexicographical ordering**; i.e., if you know the predecessor, you can always get the next value
  - and you always know a predecessor therefore

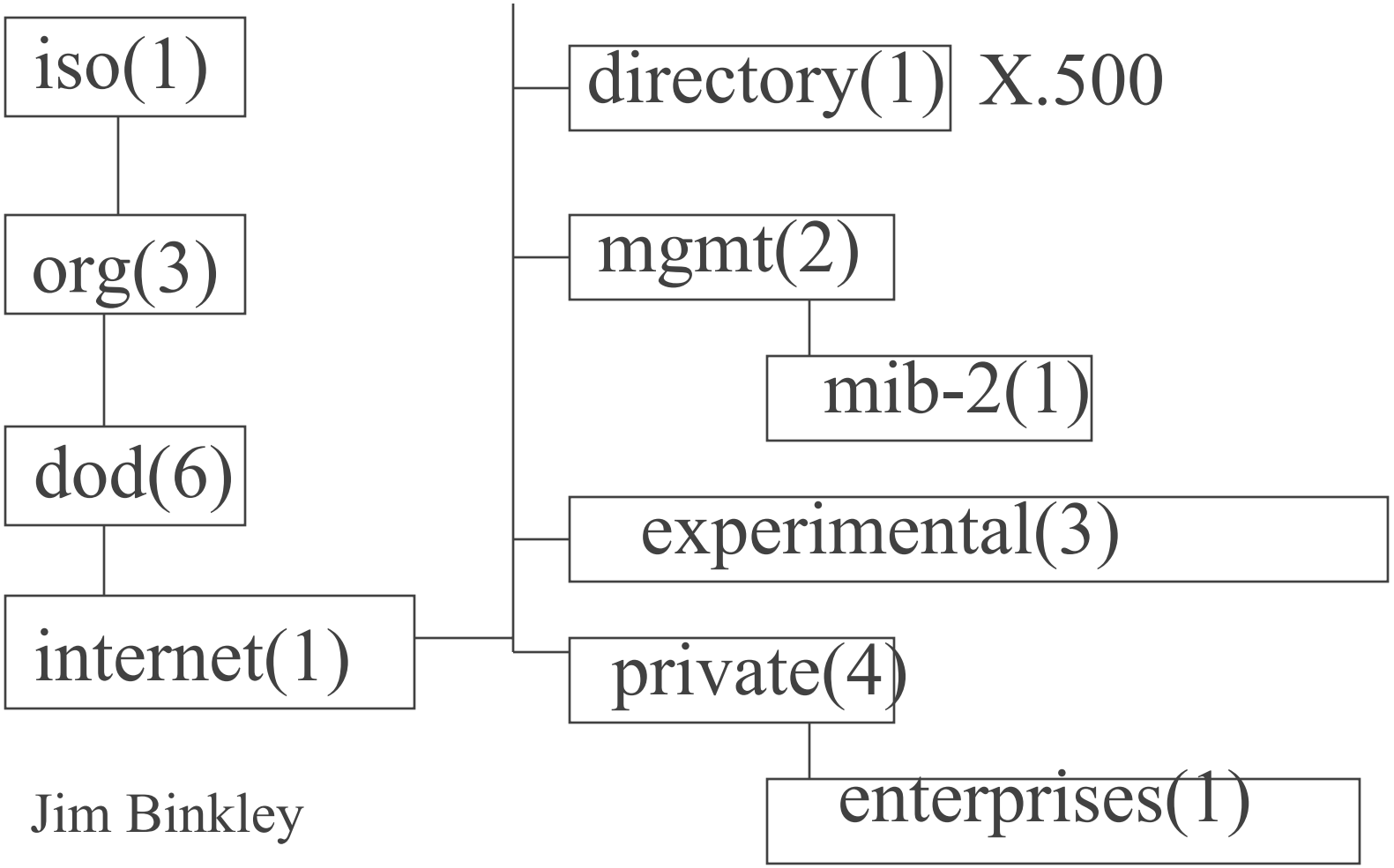
magical MIB marvels

- any manager can always find any or all of a MIB
- without a priori knowing its elements, or table size (how big it is)
- **you can walk all of it a priori**
- this is due to the basic **tree structure** of all MIB data

a MIB data item

- is called or named by its associated
- **Object Identifier** or *OID*
- fundamental base type
- universal prefix is:
- internet OBJECT IDENTIFIER::= { iso(1), org(3), dod(6), internet(1)}
- 1.3.6.1 (iso.org.dod.internet)
- note associated string labels (but the numbers are used in the protocol)

top part of OID tree



important SNMP variables live in:

- 1. **MIB-2** subtree
- prefix: **1.3.6.1.2.1**
  - 1.3.6.1.2.1.1.1 (system.sysDescr}
- 2. **private/enterprises** subtree
  - for proprietary MIB values
  - e.g., Cisco Mibs quite extensive
  - **1.3.6.1.4.1** (enterprises is last prefix)

so remember these two:

- **MIB-2: 1.3.6.1.2.1**
  - **{iso.org.dod.internet.mgmt.mib-2}**
- **enterprise: 1.3.6.1.4.1**
  - **{iso.org.dod.internet.private.enterprises}**

system.sysDescr

1 .3. 6. 1. 2. 1. 1. 1

iso.org.dod.internet.mgmt.mib2.system.sysDescr

sw note: depending on manager, possible that rooted OID starts with 1 or .1. read the documentation.

MIB-2(1) subtree

system (1)
interfaces(2)
at(3)
ip(4)
icmp(5)
tcp(6)
udp(7)
egp(8)
transmission(10) { specific link types }
snmp(11)
and more (bridge/ethernet stats, repeaters/UPS)

some enterprise MIB values

- from Cisco-land
- environmental mib can contain temperatures!
- router may provide load average
- big switch may have traffic meter (how much is backplane utilized)
- CDP values and VLAN values in MIBS
- although not totally related, Cisco has so-called community-based VLAN indexing
  - allows per VLAN bridge/STP information

protocol

- on top of UDP
- manager “probes” agent (sends request),
  - gets back result (send/receive)
- SNMP v1 defines 5 message types
  - **get**, and **get-next** (reads)
  - **set** (write)
  - **response** (ACK if set, or value if get)
  - **trap**

traps

- asynchronously sent by agent to manager
- most important type is linkDown - interface crashed (e.g., router interface)
- common to have linkDown caught by some manager as part of trap/event analysis
  - HPOV can do this, or net-snmp trapd can be setup to do this
  - send page to network manager (human being)

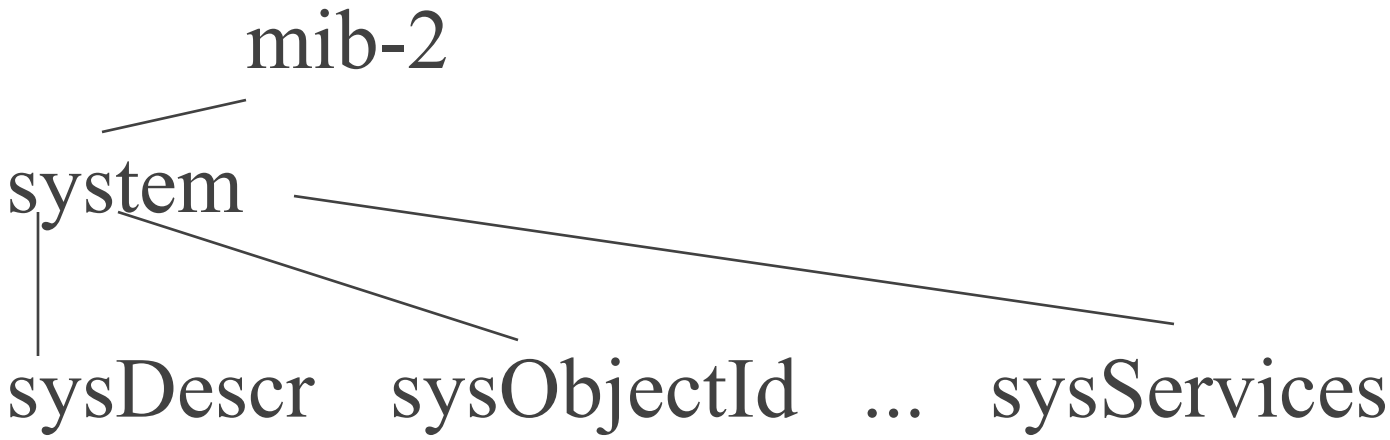
SNMPv1 trap types include:

- coldStart(0) - unexpected restart(crash)
- warmStart(1) - soft reboot
- linkDown(2) - if down, the most imprint!
- linkUp(3) - the opposite of linkDown
- (snmp) authenticationFailure(4)
- egpNeighborLoss(5)
- enterpriseSpecific(6) - proprietary with sub-code
  - » Cisco has lots of these

get and get-next

- get specifies a single variable by name; e.g.,
- system.sysDescr
  - get at ip X, OID=1.3.6.1.2.1.1.1
  - response returns value “cisco 5505”
- get-next specifies OID, but value returned is next lexicographic OID and its value
- **thus get-next can be used to query the entire tree**, get tables, heal the sick, etc.

the amazing get-next



get-next sysDescr, and you get sysObjectId
get-next sysObjectId and get sysUpTime
get-next sysServices and get what?

security (bwaa-ha-ha)

- starting point: security is poor
- SNMPv1 relies on “passwords in the clear”
  like telnet/ftp/pop, etc.
- OID objects have attributes, include
  - readonly
  - read/write
  - write-only (never mind)
  - not implemented (at least be honest)

in practice,

- SNMPv1 agent has a set of community strings (passwords applied to a set of agents)
- these must be supplied with get/set requests, etc (traps too) from manager/agent
- traps are the other way of course, agent to manager
- SET of 1 or more strings for readonly/read-write request
- if PDU/packet community string matches, value returned

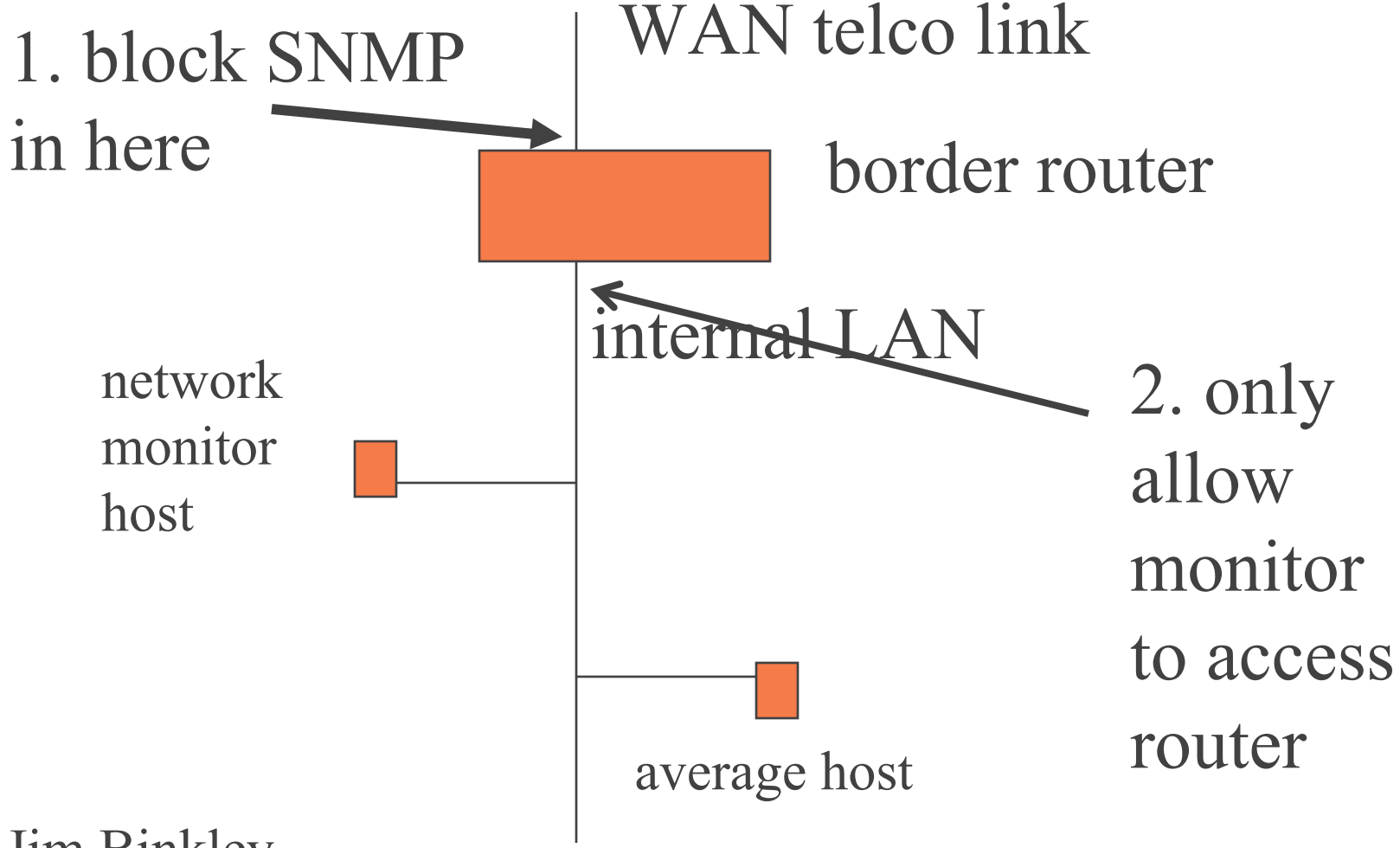
universal community strings

- readonly - *public* (common default)
- readwrite - *private* (default)
- usually applies to ENTIRE SET OF MIBS at agent
- authentication-only service in SNMPv1, i.e., no privacy (no encryption)

security constraints

- typically imposed by border router access-lists
- may block all but given ip address from talking to it
- assume can’t send snmp requests from WAN/Internet into site (make that so)

picture of possible SNMP security setup



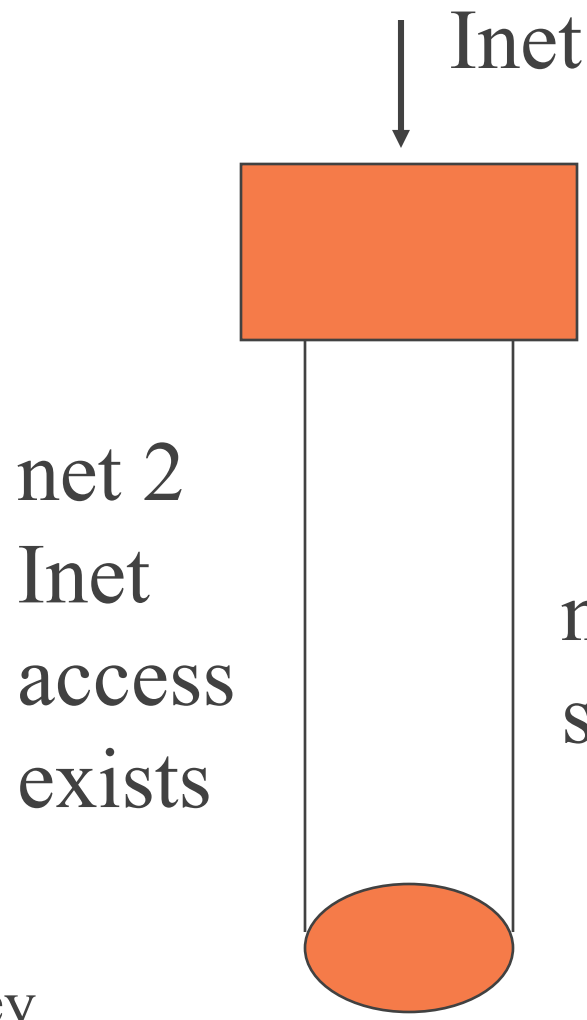
common-practice (v1 continued)

- by very wary of snmp “writes” - may disallow them entirely
- do not allow any snmp from outside world-in
- worry about “interior lines”, make sure manager is close to agents so that promiscuous mode sniffing cannot occur
  - with some routers/switches can start to use ssh
- **you NEVER know what might be in a MIB and settable** (catch fire on command)
  - could be buggy too

snmp writes may be unavoidable

- some tools may assume snmp writes ok
- cisco ciscoview, rmon probe config
- if you want to use these tools, must design network for secure access
- if hacker could break into probe, can use built-in sniffer
- hacker could manipulate vlans in switches (too awful to think about)

network snmp write design



SNMP-short history

- late 80's, early 90's presumed by IETF that ISO would win out in protocol stack race
- thus SNMP was viewed as temporary compromise
- but was oddly based on ISO mechanisms (ASN.1 ...) (not necessarily a bad thing)
- ISO didn't happen and SNMP crushed its ISO competition

SNMP versions

- v1 - widely implemented
  - many new RFCS added for mib-2 new variables sets associated with new network entities
  - RMON added for more instrumentation (especially on ethernet)
  - RMON-2 added as RMON-1 ethernet only, RMON-2 added network/transport-layer stats

v2 (aka v2c)

- v2 was supposed to add better security
- and some optimizations
- security modifications were good, and ahead of their time BUT
- IETF wg couldn't agree, security ideas were not standardized
- all that remained of v2 practically was
  - **get-bulk** (get a table in one go)
  - **64 bit integers** used for some counters

v3

- focus is on security (crypto wrappers)
  - and finer grain access control to MIBS
- packets may be authenticated and/or encrypted
- view as authentication wrapper on v2/v1 pkt
- simple session-key (change of key) exists
- big ticket item: **writes may be made secure**
- one may still disallow snmp across net
  - basic security policy: just say no …

rmon

- remote monitoring (more real-time)
  - includes real-time promiscuous based ethernet sampling/threshold mgmt/packet sniffing/topn
- rmon I (layer 2)
  - ethernet/link-layer stats only
  - e.g., top N talkers src/dest
- rmon II (layer 3/4)
  - includes IP addr/tcp&&udp port stats

rmon statement:

- hint to jim: say something about rmon probes/expense/functionality
- functionality:
  - layer 2 stats collected over short time snapshots
  - layer 3 stats the same
  - host 1 by host 2 traffic flow information
  - thresholds - event on too much/too little X
  - promiscuous mode sniffing

summary

- snmp consists of
  - grammar (ASN) for defining data
  - variables (MIBS) associated with device
    - » standard, optional, and enterprise-specific
    - » depends on the device though (hub/printer/router)
  - UDP-based L7 protocol including get-next, and trap
  - naming convention (OID/tree) that allows
    - » lexicographic walk - you may but do not need to know variables names ahead of time (or number)
- security bad in v1, v3 to “fix”, v2c may be norm

more summary

- **manager** is client in client-server sense
- **agent** (or proxy) is server (where the MIBS are)
- manager **polls** (usually periodically as with HPOV, MRTG, or by hand as with ucd-snmp snmpwalk or HPOV mib browser) agents
  - displays data

some common tools

- HPOV
  - ip map and built-in mib browser
- MRTG/rrdtool/Cricket and friends
  - periodic graphing of snmp elements
- ucd-snmp, now net-snmp (command shell utilities)
  - snmpget, snmpset, snmpwalk
  - note HPOV supplied version similar but different in terms of command-line options