Remote Monitoring (RMON)

Network Manglement

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Outline

- general introduction
  - overview
  - rmon 1 and 2 groups
  - control theory
- rmon 1 groups (some)
- conclusion/summary

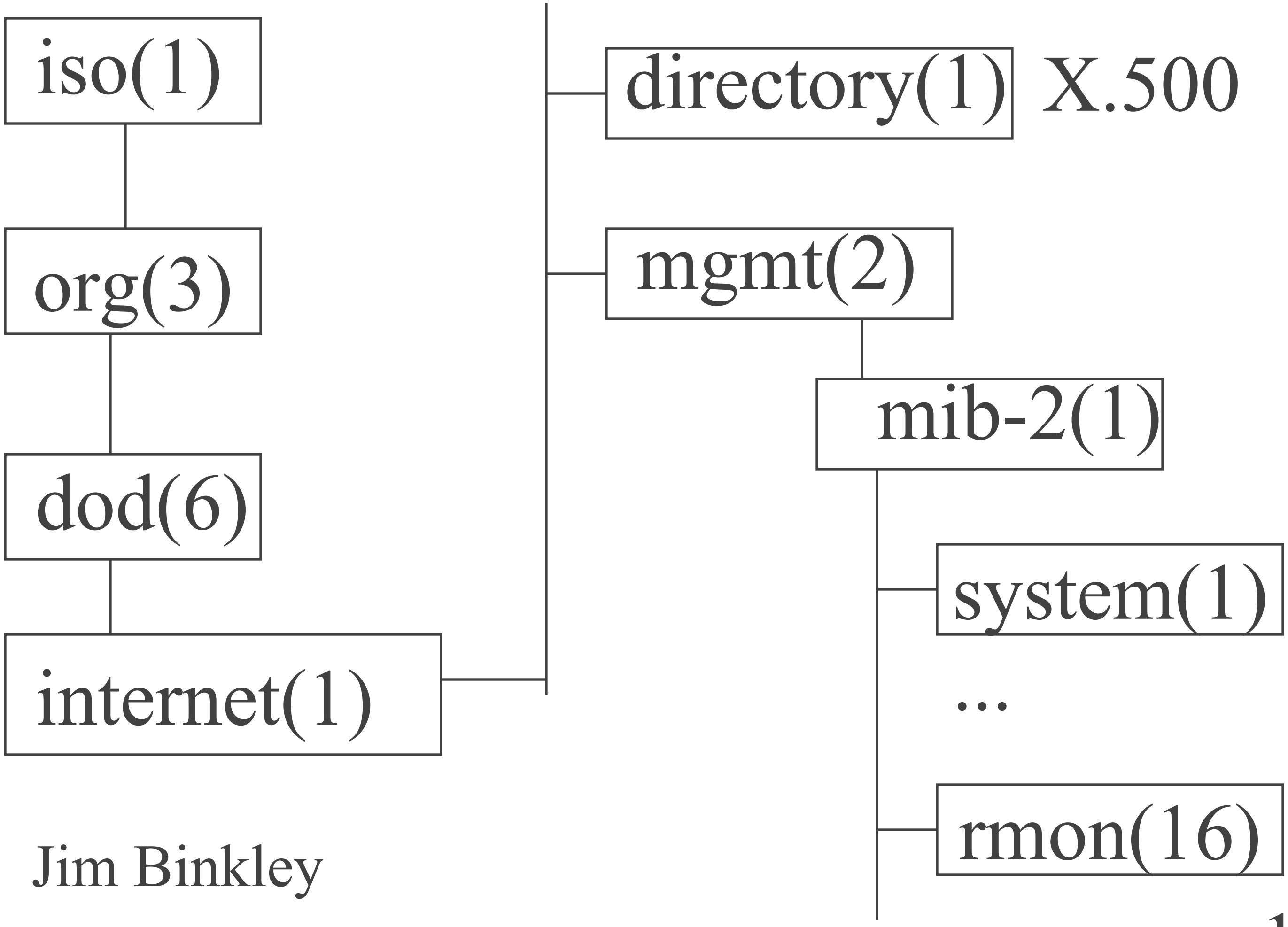
RMON – means what

- remote monitoring
  - aggregate stats for a network
  - aggregate stats for a host
  - for host X talking to host Y
  - layer 1 and layer 2
  - and more
- question: do we have the right information?
- related question: how are networks evolving?
- one more question: is SNMP the right approach?

bibliography

- rfc1513, 1993 - token-ring extensions
- rfc1757, 1995, MIB 1
- rfc2021, 1997, MIB 2
- rfc2074, 1997, protocol identifiers (directory)
- David Perkin's RMON book
- SNMP, v2, v3, RMON1/2, Stallings

rmon and OID tree



iso(1)

org(3)

dod(6)

internet(1)

directory(1) X.500

mgmt(2)

mib-2(1)

system(1)

...

rmon(16)

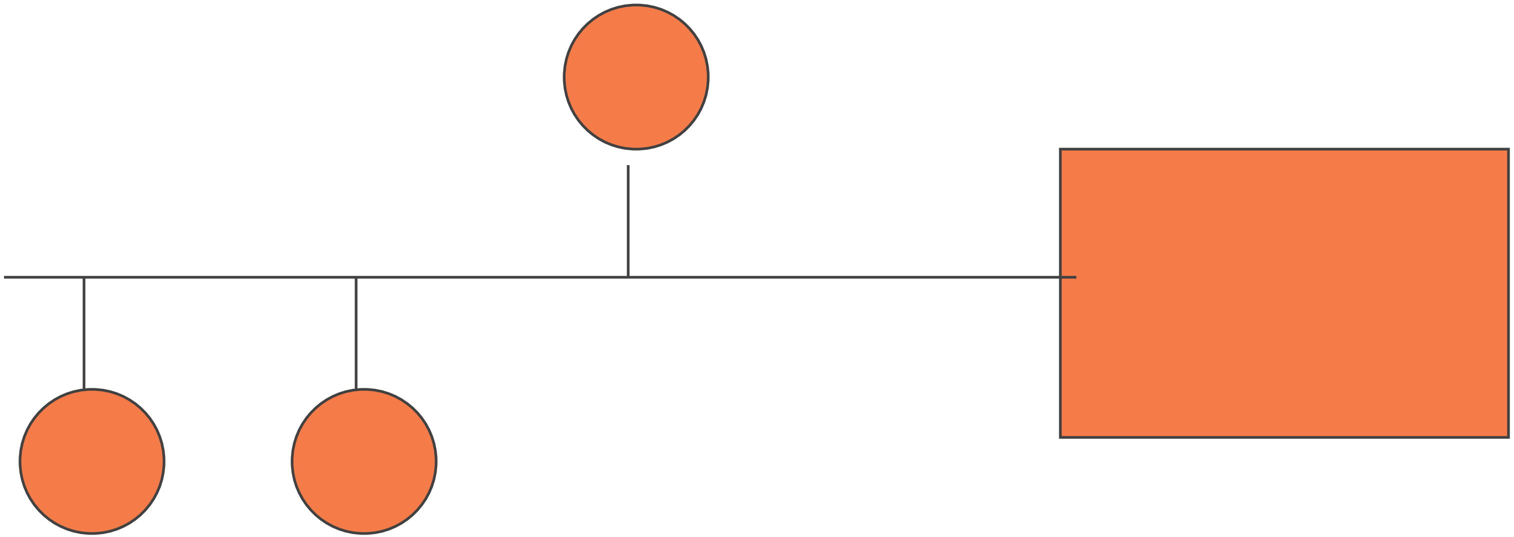
rmon1 & 2

rmon intro

- rmon - remote monitoring
- rmon I - stats at ethernet layer (MAC addresses, but not upstairs)
- rmon II - stats at network and transport layers (IP addresses and tcp/udp ports)

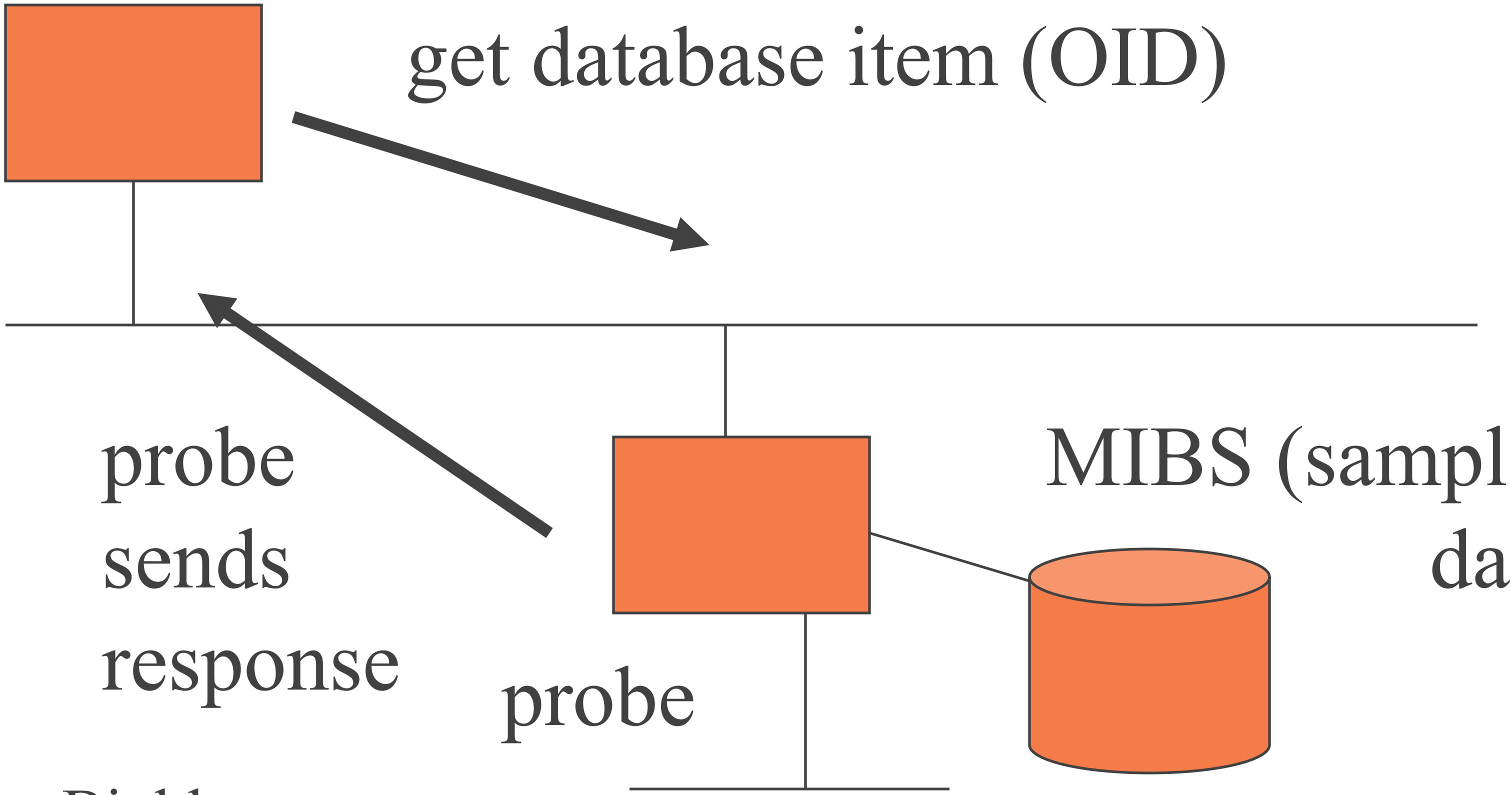
network analysis picture (trad)

analyzer: in promiscous mode



analyzer: can hear A,B, to/from router traffic
on traditional 10BASE shared link

manager/probe



manager sends

get database item (OID)

probe sends response

probe

MIBS (sampled data)

basic idea/s:

- all kinds of stats - but gathered on per link basis as aggregate
  - not by manager from every host on link
- ethernet focus (token-ring support too)
- rmon probe can run SOMEWHAT by itself and gather information
  - however manager needed for more complex functions (may have to suck out data on periodic basis due to lack of space)

rmon 1 functions - overview

- sample stats for all devices on ethernet link
  - ethernet level - e.g., how many collisions
  - basic and history
- derived statistics
  - for each host
  - top N talkers (who sent most bytes?)
  - matrix of conversations SRC x RCV

rmon 1, cont

- threshold events
  - look for N events in elapsed time T
  - if found, send trap to manager
  - e.g., N errors in one minute (too many)
- packet data capture
  - filtering mechanism + capture
  - must work with higher level GUI in manager
  - goal: capture packets of interest/nice decode display

rmon 1 - { mib-2 16 }

- statistics(1) - ethernet stats > interface, roughly equal to dot3 (but global)
- history(2) - snapshots based on stats(1)
- alarm(3) - ability to set threshold, generate alarm on interesting event
- host(4) - per i/f host stats (global interface)
- hostTopN(5) - store/sort by top N hosts
- matrix(6) - X talks to Y (a few stats)

rmon 1, cont.

- filter(7) - filter pkts and capture/or cause event
- capture(8) - traditional packet analyzer
- event(9) - table of events generated by probe
- tokenRing(10) - never mind, but like ethernet stats

rmon2, still { mib-2 16}

- protocolDir(11) - protocols understood by probe
- protocolDist(12) - per protocol stats (bytes/pktcnt)
- addressMap(13) - ip/mac mappings
- nlHost(14) - per host octet/byte counts
- nlMatrix(15) - host X talks to host Y
- alHost(16) - per host application octet/byte counts
- alMatrix(17) - application Z/X to Z/Y
- usrHistory(18) - sampling of any INT OID
- probeConfig(19) - info for manager on probe setup/config

rmon2: notes

- application means “above the network layer”
- both matrix groups have top N functions as well
- note both protocol directory and probe configuration are there to help odds on manager/probe interoperability

do we need a manager?

- mostly ...
- simpler stats in rmon1 could be gathered via net-snmp say but
- higher level functions require complex manager with better than average GUI
  - rmon-2 in general (you want graphical histograms)
  - packet capture facilities in probe are lower-level and need higher level manager sw function

examples:

- commercial (just one example, others exist)
  - cisco traffic director on workstation (manager)
  - cisco netscout probe on link
  - cisco mini-rmon in some switches
- freeware versions ?!
  - BTNG (it’s dead Jim)
  - there aren’t any. is this a surprise?
  - ourmon …(not SNMP-based)

software complexity notes:

- higher-level functions (e.g., rmon2 or rmon1 data packet capture)
  - require copious memory/CPU
  - 100mbit ethernet link ... lots of data
- easy to ask too much of system
- probably best to not assume that manager A will interoperate with probe B

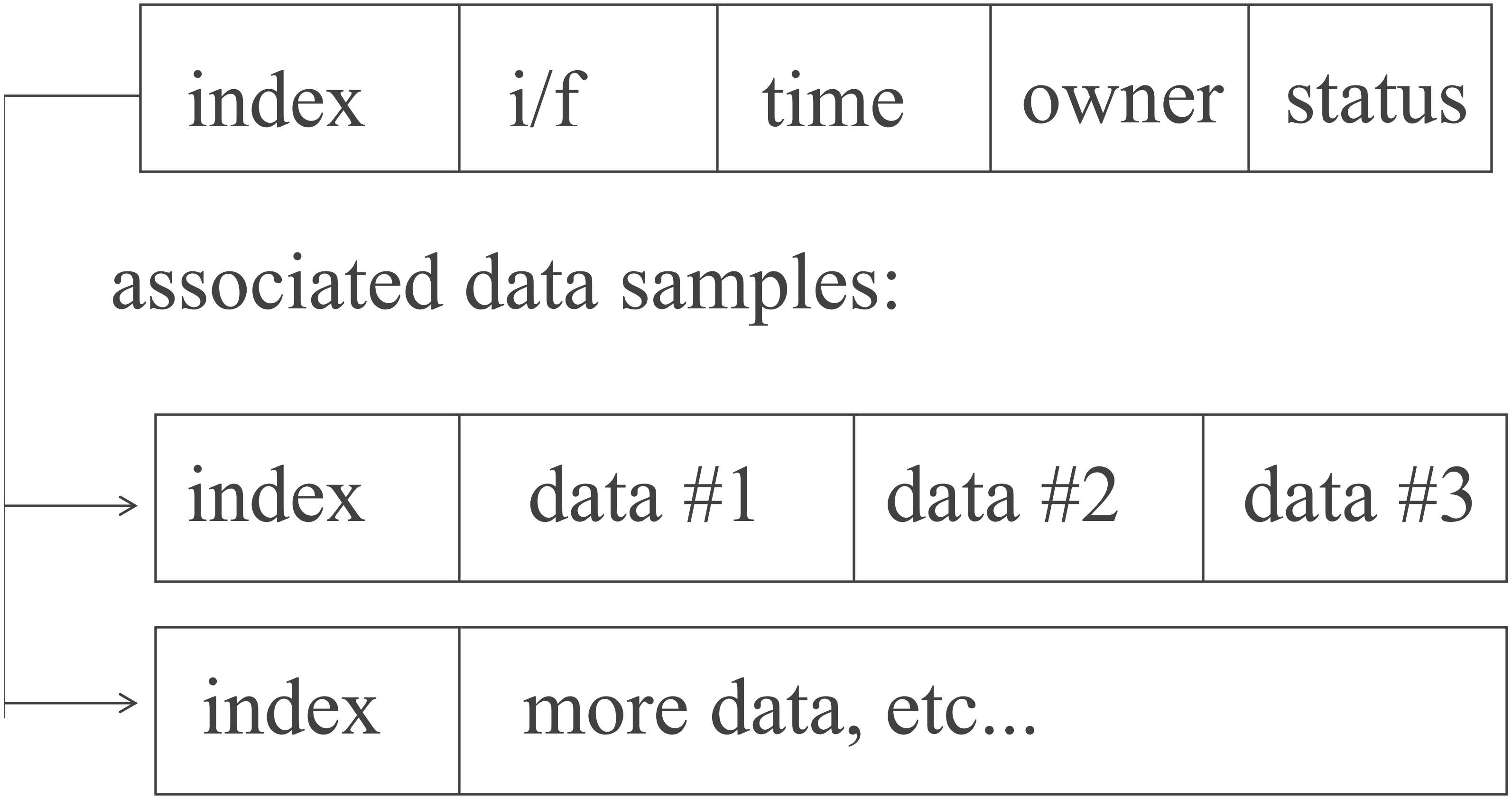
possible rmon uses

- what kind of questions might you ask?
  - how much IP vs IPX traffic?
  - how much traffic is web/news/ftp, whatever?
  - how utilized (full) is the pipe?
  - who talks to server X?
  - we have a problem with DHCP, we need to capture the packets and look?
  - global ethernet errors on this link are what?

rmon control theory

- in general rmon groups (except for stats group) consists of control rows and per control row data rows
- e.g., one interface might have a control row that specifies HOW to sample data on a delta T time basis (every 30 secs make a snapshot)
- one or more data rows will be built up and stored in the probe, associated with that control row
- note control row per i/f and possible to have more than one (different sample times)

control rows(tables)/data rows(tables)



abstract control row:

index	i/f	time	owner	status

associated data samples:

index	data #1	data #2	data #3

index	more data, etc...

notes:

- index mechanism must exist to tie together control and data rows
- in snmpv2, one may have index that is not in table (an array of structures say with an integer index and no such int in table) (true of RMON2 groups)
- view mechanism exists in RMON to allow additional time-based table thus
  - manager need only suck out NEW samples plus efficient access as index is creation time
- manager must sometimes insert/enable control row (this is what status field is for)

notes, cont:

- memory needs can be quite large
- in some cases, samples will wrap
- control tables limit # of buckets (number of sample sizes)
- manager may need to show up and suck out data in a timely fashion

statistics {rmon 1}

- etherStatsTable/etherStatsEntry
- etherStatsIndex
- etherStatsDataSource - which i/f
- etherStatsDropEvents
- etherStatsOctets - byte count, includes bad pkts
- etherStatsPkts, includes bad pkts
- etherStatsBroadcastPkts
- etherStatsMulticastPkts
- etherStatsCRCAlignErrors
- etherStatsUndersizePkts (runts)

stats, cont

- etherStatsOversizePkts (giants)
- etherStatsFragments
- etherStatsJabbers - giants with problems (e.g., CRC errs)
- etherStatsCollisions - estimate of # of collisions
- etherStatsPkts64Octets
- etherStatsPkts65to127Octets
- etherStatsPkts128to255Octets
- etherStatsPkts256to511Octets
- etherStatsPkts512to1023Octets
- etherStatsPkts1024to1518Octets

stats, cont.

- etherStatsOwner
- etherStatsStatus

statistics, notes:

- simplest rmon group
- note histogram mechanism for counts
- one entry per interface on probe
- no separate control table
- similar to dot3 in some ways, but dot3 is per interface, not per network
  - can approximate by adding values together in hub or switch (?)

history { rmon 2 }

- historyControlTable (1)
  - historyControlEntry (1)
    - » row entries
- etherHistoryTable (2)
  - etherHistoryEntry (1)
    - » row entries

history { rmon 2 }

- historyControlTable/historyControlEntry
- historyControlIndex - 1-1 with values in data table
- historyControlDataSource - which interface
- historycontrolBucketsRequested - request for data slots
- historyControlBucketsGranted - how many did you get
- historyControlInterval - per bucket sample time, seconds
- historyControlOwner
- historyControlStatus

notes:

- each row when enabled causes sampling to begin on a certain interface
  - gathering of “buckets” (samples) in associated data table
- note you can have more than one sample time on same interface (short period and long period, 1 minute, 1 hour)
- samples are stored during Interval, and then new entry is created
- once bucketsGranted is used up, the buckets will wrap and start rewriting the oldest buckets (circular buffer scheme)

history data table

- etherHistoryTable/etherHistoryEntry
- etherHistoryIndex - matches control table
- etherHistorySampleIndex - unique per sample
- etherHistoryIntervalStart - sysUpTime at start of sample
- etherHistoryDropEvents
- etherHistoryOctets
- etherHistoryPkts
- etherHistoryBroadcastPkts
- etherHistoryMulticastPkts
- etherHistoryCRCAlignErrors

history data table, cont.

- etherHistoryUndersizePkts
- etherHistoryOversizePkts
- etherHistoryFragments
- etherHistoryJabbers
- etherHistoryCollisions
- etherHistoryUtilization - function of etherStatsOctets and etherStatsPkts

utilization

- this is fairly common in packet capture systems
- roughly over time T, how full was the pipe?
- utilization = packet overhead + bytes sent * 100%

  ----

  interval * bits possible on link
- on 10BASE, bits possible would be 10**7
- packet overhead due to preamble & interframe gap
- packet overhead = packets * (96+64)
- bytes sent = octets * 8

utilization question/s:

- how long should the period be?
- how should this be interpreted with switches
  - interswitch (or switch to router)
  - servers
  - hosts
  - in light of full-duplex wires?
    - which should show NO collisions ...

hosts { rmon 4 }

- hostControlTable
  - hostControlEntry
    - » control rows
- hostTable
  - hostEntry
    - » data rows
- hostTimeTable
  - hostTimeEntry
    - » data rows

host control table

- hostControlTable/hostControlEntry
  - hostcontrolIndex
  - hostcontrolDataSource
  - hostControlTableSize
  - hostcontrolLastDeleteTime - last time data deleted
  - hostControlOwner
  - hostControlStatus

hostTable (data, not time sorted)

- hostTable/hostEntry
  - hostAddress - mac address
  - hostCreationOrder 1..N, relative creation order
  - hostIndex
  - hostInPkts
  - hostOutPkts - packet count
  - hostInOctets - byte count
  - hostOutOctets
  - hostOutErrors
  - hostOutBroadcastPkts && hostOutMulticastPkts

time table

- hostTimeTable/hostTimeEntry
  - hostTimeAddress
  - hostTimeCreationOrder
  - hostTimeIndex
  - hostTimeInPkts
  - hostTimeOutPkts
  - hostTimeInOctets
  - hostTimeOutOctets (same as data table ... here on out)

notes:

- one entry per host (mac) per interface
- basically counts of bytes/packets in/out
- time table is view (same data underneath) and is simply indexed by creation order
  - data table indexed by mac address

hostTopN { rmon 5 }

- hostTopNControlTable
  - hostTopNControlEntry
    - rows
- hostTopNTable
  - hostTopNEntry
    - rows

host control table

- hostTopNControlTable/hostTopNControlEntry
  - hostTopNControlIndex
  - hostTopNHostIndex
  - hostTopNRateBase - one of seven variables (next slide)
  - hostTopNTimeRemaining - time left in sample period
  - hostTopNDuration - absolute time of sample period
  - hostTopNRequestedSize
  - hostTopNGrantedSize
  - hostTopNStartTime - when sample time started
  - owner/status

rateBase - possible variables

- hostTopNInPkts
- hostTopNOutPkts
- hostTopNInOctets
- hostTopNOutOctets
- hostTopNOutErrors
- hostTopNOutBroadcastPkts
- hostTopNOutMulticastPkts

data table

- hostTopNTable/hostTopNEntry
  - hostTopNReport - matches hostTopNControlIndex (which report)
  - hostTopNIndex - per host in report
  - hostTopNAddress - host mac address
  - hostTopNRate - amount of change in selected variable for this report period
    - » variable selected in hostTopNRateBase

matrix group (in brief)

- basically source by dest mac
  - count of pkts/octets (pkt count/byte count)

alarm { rmon 3 }

- alarmTable/alarmEntry
  - alarmIndex
  - alarmInterval - data sample period
  - alarmVariable - OID of variable being sampled
  - alarmSampleType - absolute or delta (previous sample)
  - alarmValue - value during last sample period
  - alarmStartupAlarm - rising/falling or both
  - alarmRisingThreshold
  - alarmFallingThreshold

alarm { rmon 3 }

- alarmTable/alarmEntry
  - ... cont ....
  - alarmRisingEventIndex
  - alarmFallingEventIndex
  - alarmOwner
  - alarmStatus

how this works (overview)

- if value (counter/gauge) crosses rising threshold (and rising specified)
  - then generate alarm
- if value crosses falling threshold (and falling specified)
  - then generate alarm
- delta threshold sampled once per period
- use to look for too many errors during period X (or your idea here ...)

event group (summary)

- can generate
  - traps sent to monitor
  - events stored in local event table (log history of events)
- both packet capture and alarm group can cause events stored here

conclusion - summary of capabilities

- remember that measurement may have two poles, relative to length of time samples:
  - 1. baseline of data over time
  - 2. measurement of what is going on NOW
- snmp focus generally on set of objects at one node - rmon focus on wire itself
- over-generalization, but rmon helps you focus on NOW and the general LINK

and the problem is: **SWITCHES**

- switches, of course and the "death of promiscuous mode"
- instead of link focus, we can have all ports on switch focus, or vlan X on switch focus, or ports 1,2,3 on switch focus
- however we won't be able to see all traffic on a broadcast domain
- rmon too expensive for cheaper switches at this time
- have to focus on key backbone switches

bigger cisco switches

- have mini-rmon; e.g., ethernet stats/rmon1
- SPAN function to allow you to hookup external sniffer/rmon probe and suck down packets
  - aka port mirroring (ports/vlan, etc)
  - NOT inter-switch

keep in mind:

- rmon has LARGE # of function points
- other tools exist that may have rmon-like feature sets (but not all of it)
- e.g., packet capture freebies
  - tcpdump, snoop, etherfind (latter 2 on sun)
  - trafshow, arpwatch (show traffic of various kinds in some kind of real-time display)

some general tools in this area

- Cisco netflow
  - aggregate flow stats, UDP-based collection
- HPOV event generation
- ntop – open-source tool
  - like ourmon in some ways but details differ
- ourmon – open-source tool
  - network mgmt/anomaly detection

what is the real problem?

- **too much data not enough analysis**
  - – I don’t want all the flows
  - – networks are evolving
    - » p2p/skype/irc/games etc.
    - » meaning protocols are not IETF-based
  - – security problems are evolving too
    - » today TCP worms rule
    - » agobot/phatbot/rxbot – black hats have tools