Network Monitoring and Management

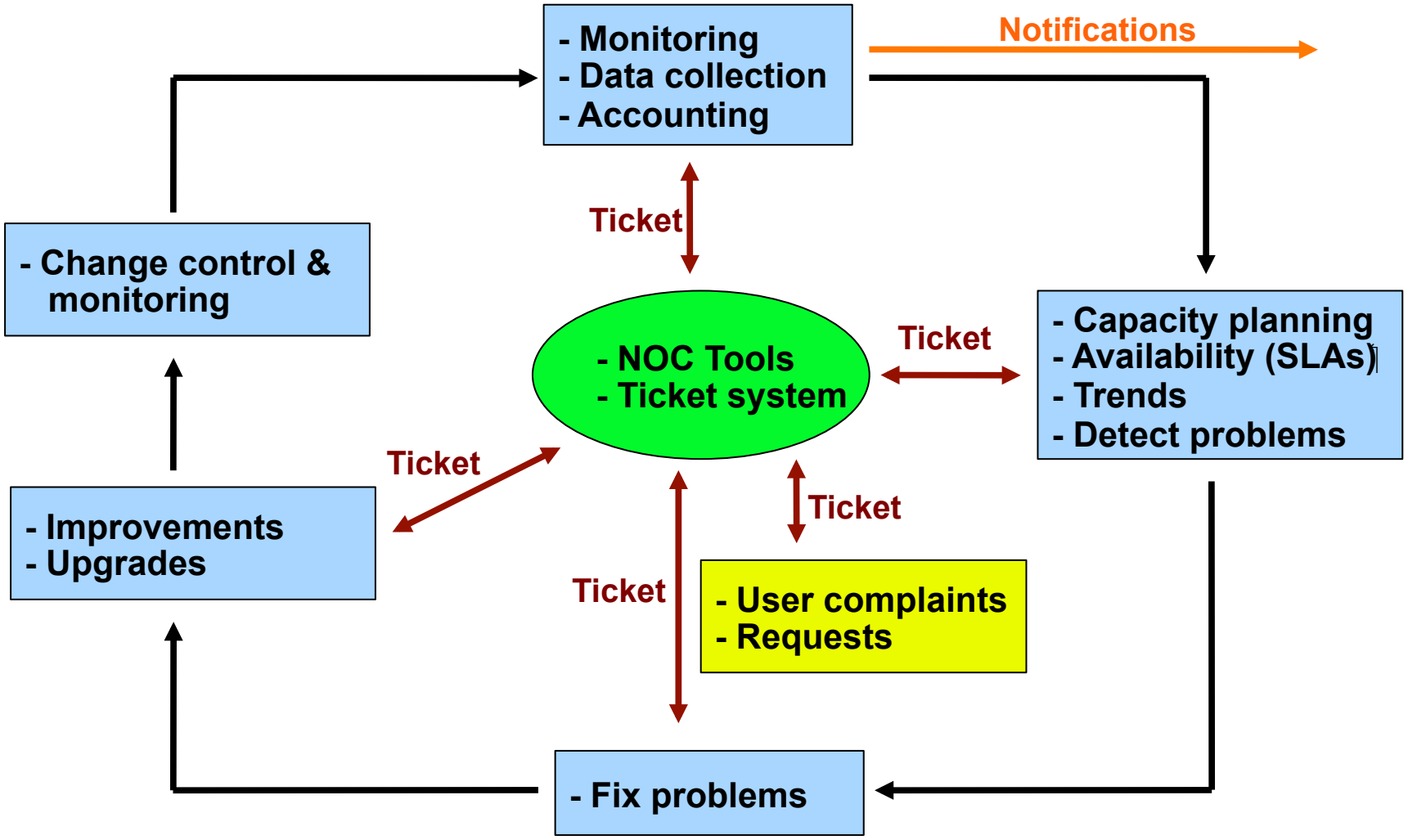
Introduction to Networking Monitoring and Management

Network Management Details

We Monitor

- **Systems & Services**
  - Available, reachable
- **Resource utilisation**
  - Expansion planning, maintain availability
- **Performance**
  - Round-trip-time, throughput
- **Changes and configurations**
  - Documentation, revision control, logging
- **Requests and issues**
  - Ticketing system

The big picture



The “Big Three”?

Availability

- Nagios — Services, servers/routers/switches. Alerting, availability reports

Utilisation

- Cacti — Total traffic, port usage, CPU, RAM, Disk, processes

Reliability

- Smokeping — Packet loss, RTT/latency, service response time

Functional overlap exists between these programs!

Main components of these tools

- Data collection
- Data storage
- Data visualisation
- Configuration
  - e.g. what to monitor and how
- Additional functionality
  - e.g. alerting via E-mail

Data Collection: SNMP

SNMP – Simple Network Management Protocol

- Industry standard, hundreds of tools exist to exploit it
- Present on any decent network equipment
- There are SNMP agents for Unix and Windows servers

Query – response based: **GET / SET**

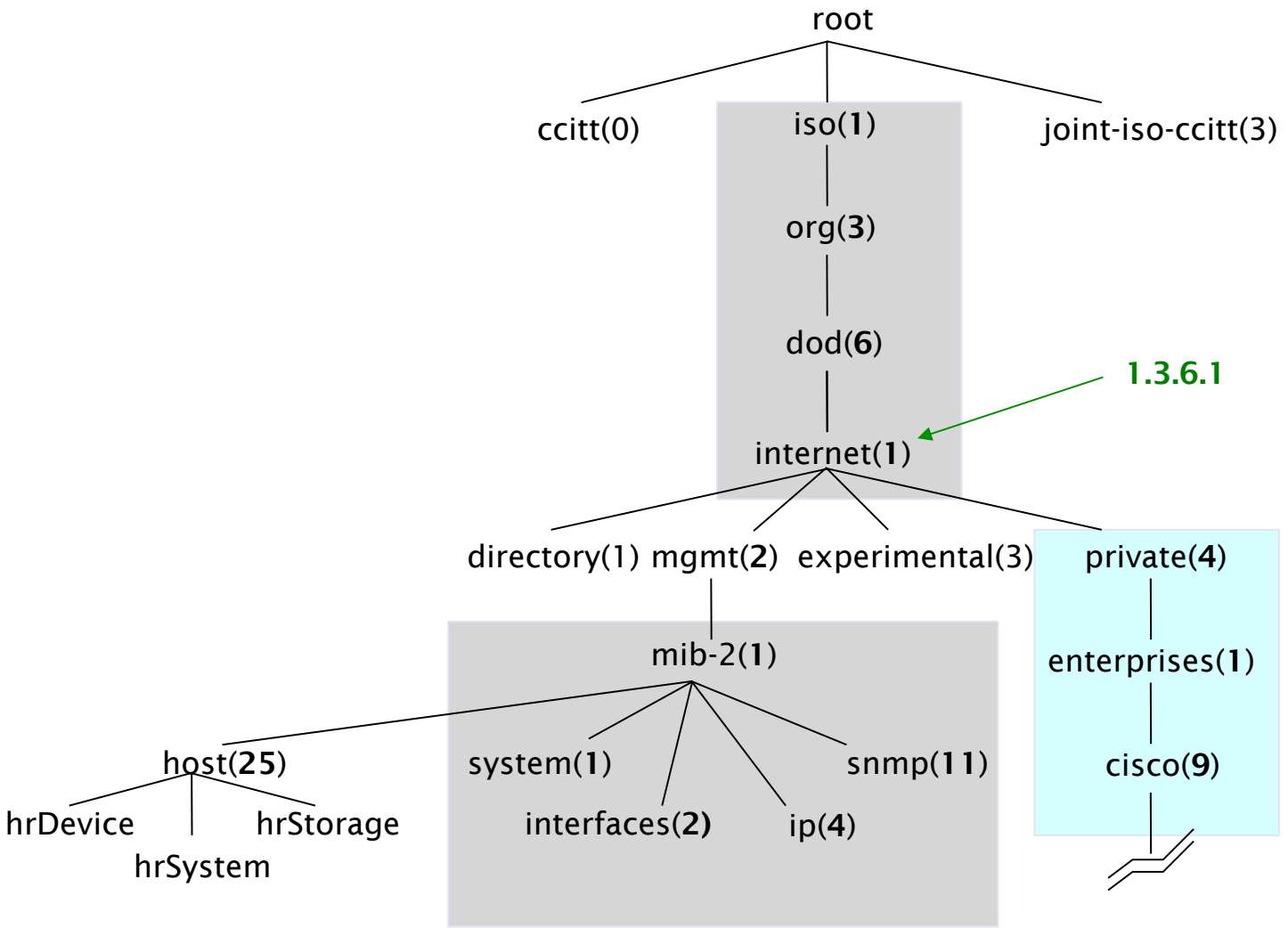
- GET is mostly used for monitoring

Each piece of information is identified by a numeric Object Identifier or ”OID”

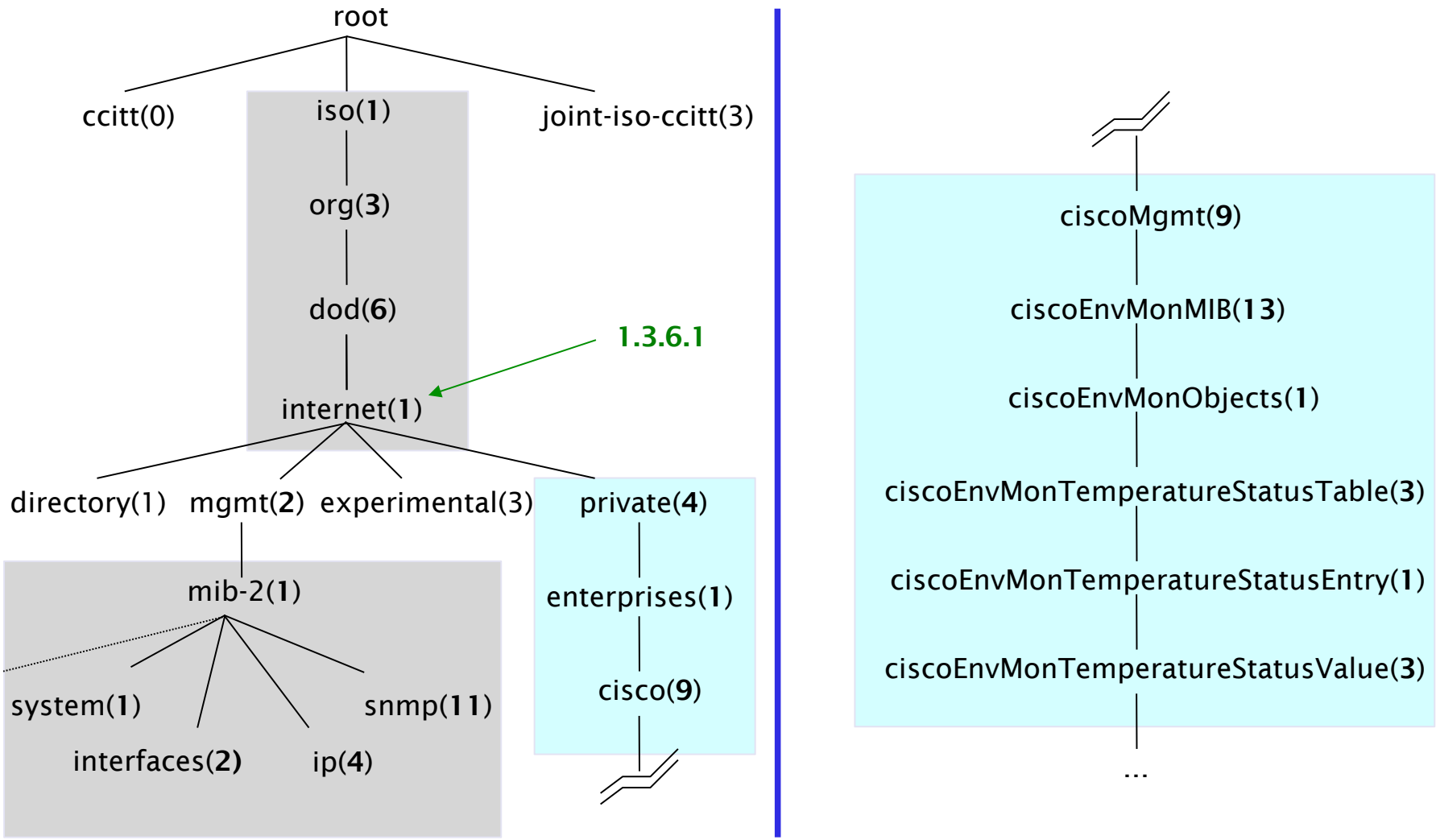
- Forms a unique key within any particular device

A collection of related OIDs is called a MIB (Management Information Base)

The MIB Tree


root
ccitt(0)
iso(1)
joint-iso-ccitt(3)
org(3)
dod(6)
1.3.6.1
internet(1)
directory(1)
mgmt(2)
experimental(3)
private(4)
mib-2(1)
enterprises(1)
host(25)
system(1)
snmp(11)
cisco(9)
hrDevice
hrStorage
interfaces(2)
ip(4)
hrSystem

The MIB Tree


root
ccitt(0)
iso(1)
joint-iso-ccitt(3)
org(3)
dod(6)
1.3.6.1
internet(1)
directory(1)
mgmt(2)
experimental(3)
private(4)
mib-2(1)
enterprises(1)
system(1)
snmp(11)
cisco(9)
interfaces(2)
ip(4)
ciscoMgmt(9)
ciscoEnvMonMIB(13)
ciscoEnvMonObjects(1)
ciscoEnvMonTemperatureStatusTable(3)
ciscoEnvMonTemperatureStatusEntry(1)
ciscoEnvMonTemperatureStatusValue(3)
...

OIDs and MIBs

- Navigate tree downwards
- OIDs separated by '.'
  - `1.3.6.1.2.1.1.5`
- Text labels
  - `.iso.org.dod.internet.mgmt.mib-2.system.sysName`
- Usually the end label is unique by itself
  - `.1.3.6.1.2.1.1.5 => sysName`
- MIB files resolve labels to OIDs and vice versa
  - only OIDs are actually sent over the wire

SNMP transport

UDP protocol, port 161

Different versions

- V1 (1988) – RFC1155, RFC1156, RFC1157
  - Original specification
- v2 – RFC1901 ... RFC1908 + RFC2578
  - Extends v1, new data types, better retrieval methods (GETBULK)
  - Used is version v2c (without security model)
- v3 – RFC3411 ... RFC3418 (w/security)

Typically we use SNMPv2 (v2c)

Testing SNMP by hand

Useful for debugging

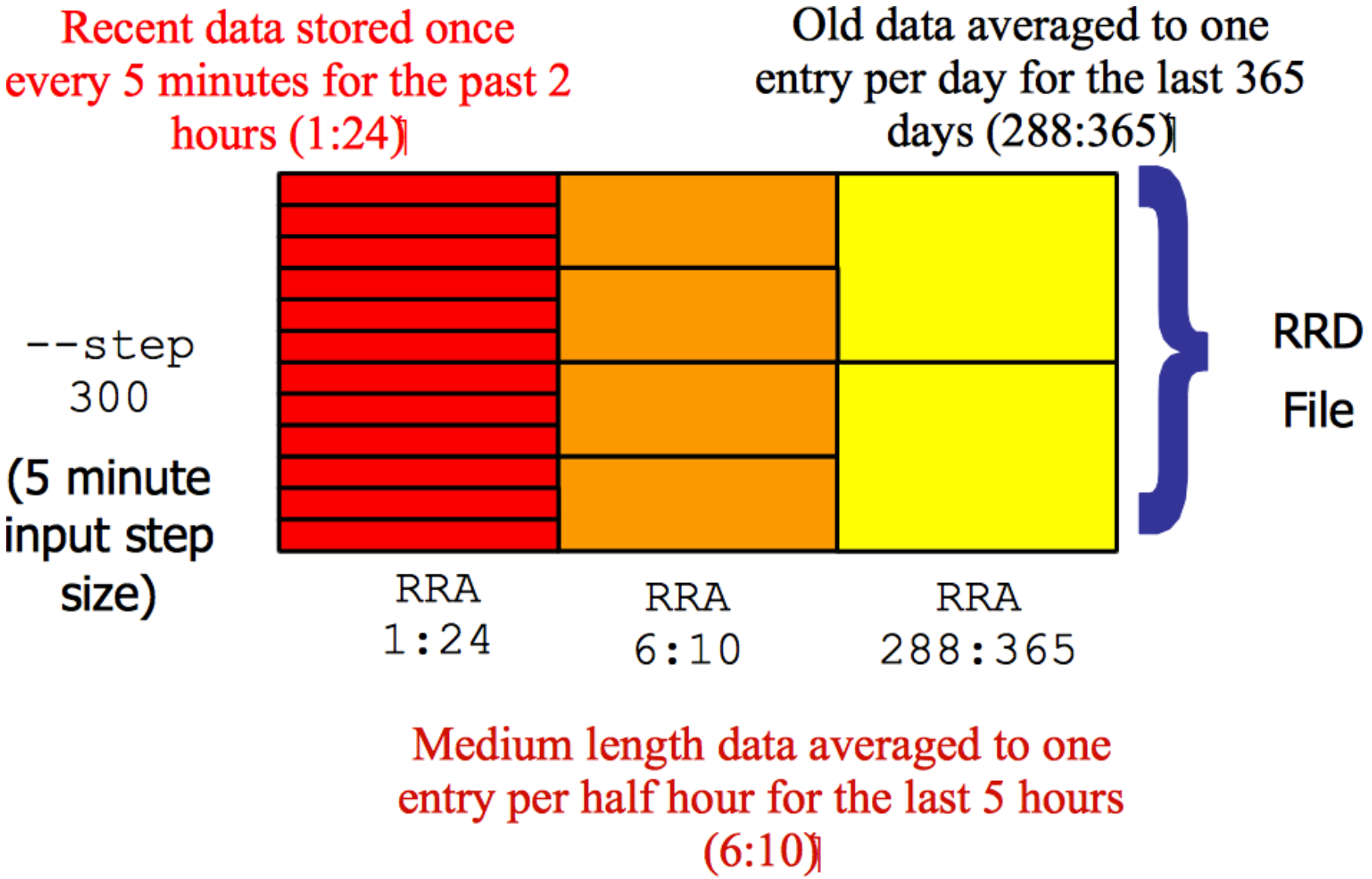
- `snmpstatus -c public -v2c 10.10.0.254`
- `snmpget -c public -v2c 10.10.0.254 sysUptime.0`
- `snmpwalk -c public -v2c 10.10.0.254 ifDescr`

(Note: SNMP won't respond if community string is wrong)

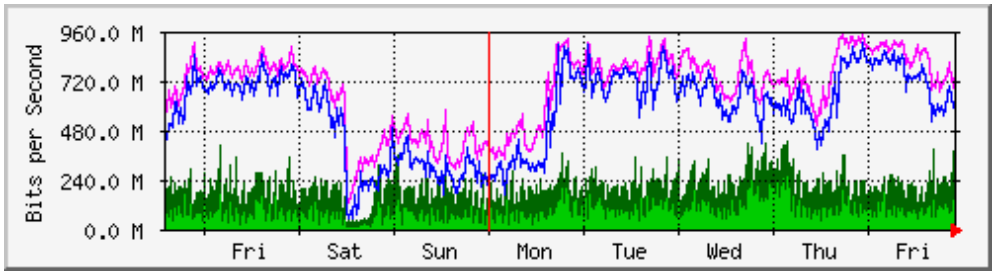
Storage and visualisation: rrdtool

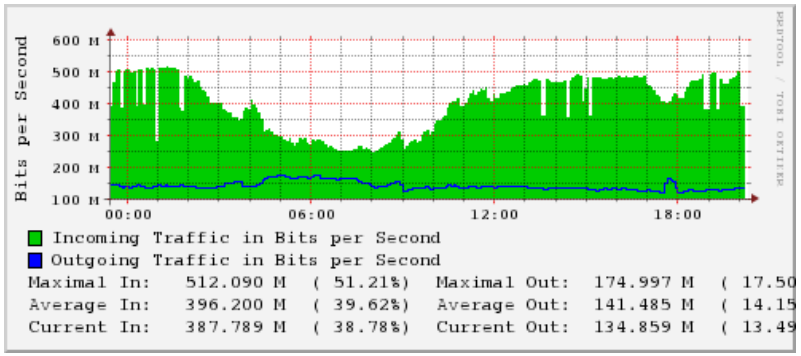
- Has become the de-facto method of storing time-sequence data
- Data written in a “round-robin” file
- rrd files are of *fixed size*
- As newer data is entered, older data is *consolidated* to make space
  - so older data has lower resolution
- Hugely flexible API for generating graphs

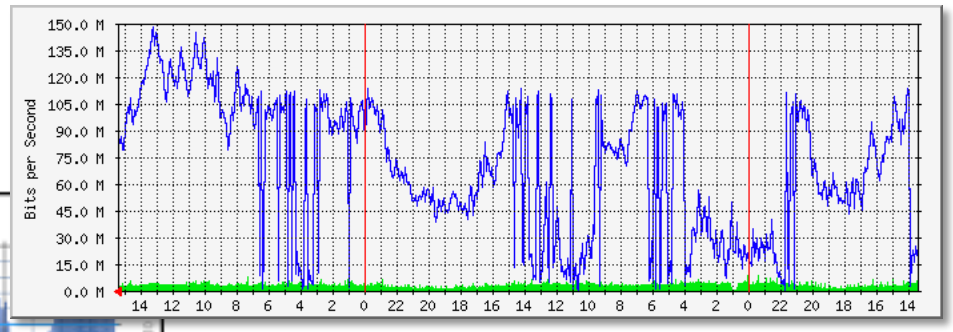
Example RRD file

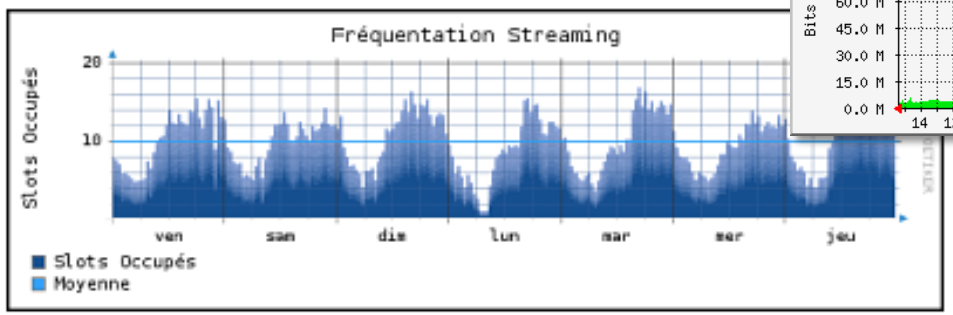


What it looks like...









1. Nagios

- Periodically tests hosts and services for availability
- Sends alerts and/or triggers event handlers
- Logs history, generates SLA reports

Nagios architecture

- Data collection: “Nagios Plugins”
  - Small, self-contained applications which make a single connection to test a service then quit
  - Return OK, Warning, Critical or Unknown
  - Many plugins supplied, even more available
  - Easy to write your own
- Data storage: plain text files
- Data visualisation: CGI web interface
- Configuration: plain text files

Pre-installed plugins in Ubuntu

/usr/lib/nagios/plugins

check_apt	check_file_age	check_jabber	check_nntp	check_procs	check_swap
check_bgpstate	check_flexlm	check_ldap	check_nntps	check_radius	check_tcp
check_breeze	check_ftp	check_ldaps	check_nt	check_real	check_time
check_by_ssh	check_host	check_linux_raid	check_ntp	check_rpc	check_udp
check_clamd	check_hpjd	check_load	check_ntp_peer	check_rta_multi	check_ups
check_cluster	check_http	check_log	check_ntp_time	check_sensors	check_users
check_dhcp	check_icmp	check_mailq	check_nwstat	check_simap	check_wave
check_dig	check_ide_smart	check_mrtg	check_oracle	check_smtp	negate
check_disk	check_ifoperstatus	check_mrtgtraf	check_overcr	check_snmp	urlize
check_disk_smb	check_ifstatus	check_mysql	check_pgsql	check_spop	utils.pm
check_dns	check_imap	check_mysql_query	check_ping	check_ssh	utils.sh
check_dummy	check_ircd	check_nagios	check_pop	check_ssmtp	

/etc/nagios-plugins/config

apt.cfg	disk-smb.cfg	ftp.cfg	ldap.cfg	mysql.cfg	ntp.cfg	radius.cfg	ssh.cfg
breeze.cfg	dns.cfg	hppjd.cfg	load.cfg	netware.cfg	pgsql.cfg	real.cfg	tcp_udp.cfg
dhcp.cfg	dummy.cfg	http.cfg	mail.cfg	news.cfg	ping.cfg	rpc-nfs.cfg	telnet.cfg
disk.cfg	flexlm.cfg	ifstatus.cfg	mrtg.cfg	nt.cfg	procs.cfg	snmp.cfg	users.cfg

Nagios core state machine

- Nagios schedules the checks to run evenly over the monitoring interval (e.g. 5 minutes)
- When a plugin returns Warning or Critical, Nagios enters a “soft” error state
- After a certain number of re-checks, enters a “hard” error state. At this point an alert is sent
- Repeated state changes enter “flapping” state which suppresses further notifications
- Designed to limit the day-to-day noise

Hosts and services

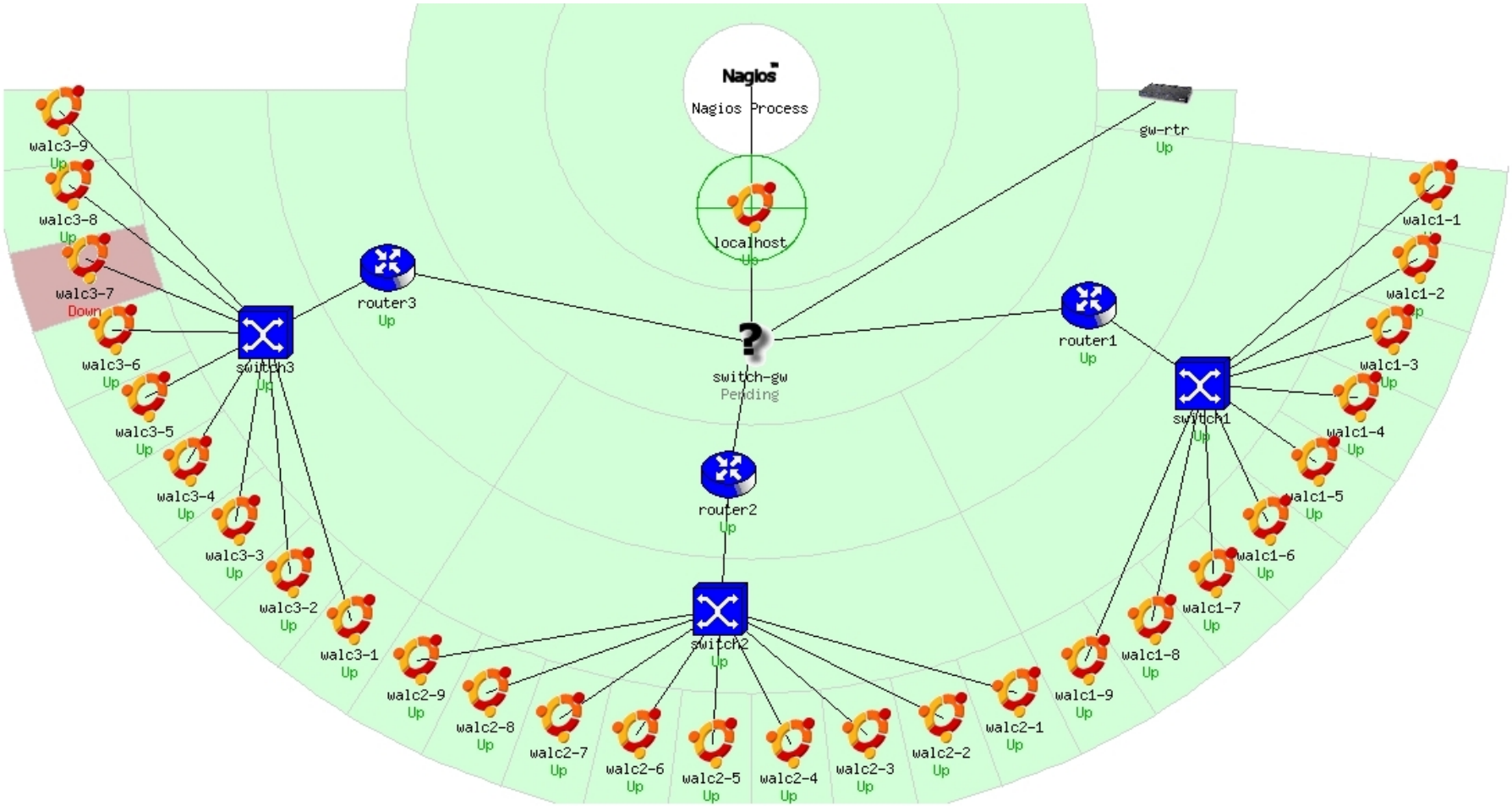
- Generally we are interested in checking *services*
- Services run on *hosts*
- Nagios checks both hosts and services
- If a host fails, it's smart enough to send you one notification for the host, rather than separate notifications for each service on that host

The concept of “parents”

Hosts can have parents:

- The parent of a PC connected to a switch would be the switch.
- Allows us to specify the dependencies between devices.
- Avoids sending alarms when parent does not respond.
- A node can have multiple parents (dual homed).

Network viewpoint



Nagios demonstration

2. Cacti

- A tool to monitor, store and present network and system/server statistics
- Designed around RRDTool with a special emphasis on the graphical interface
- Almost all of Cacti's functionality can be configured via the Web.
- Acts as portal: let customers see their own graphs

Cacti architecture

1. Cacti is written as a group of PHP scripts.
2. The key script is “poller.php”, which runs every 5 minutes (by default). Data can be collected using SNMP or via PHP scripts.
3. Cacti uses RRDtool to store data on disk and create graphs for each device. You can configure them from within the Cacti web interface.
4. User configuration data is stored in a MySQL database
5. Configuration of what types of data to collect and how to graph them is stored in template files (XML)
6. Cacti Plugin Architecture allows Cacti functionality to be extended

Adding graphs to Cacti

1. Add a **Device** with the right **Data sources**
2. Create **Graphs** for that device
3. Add the graphs to **Graph Trees**

Simple when you've done it a few times

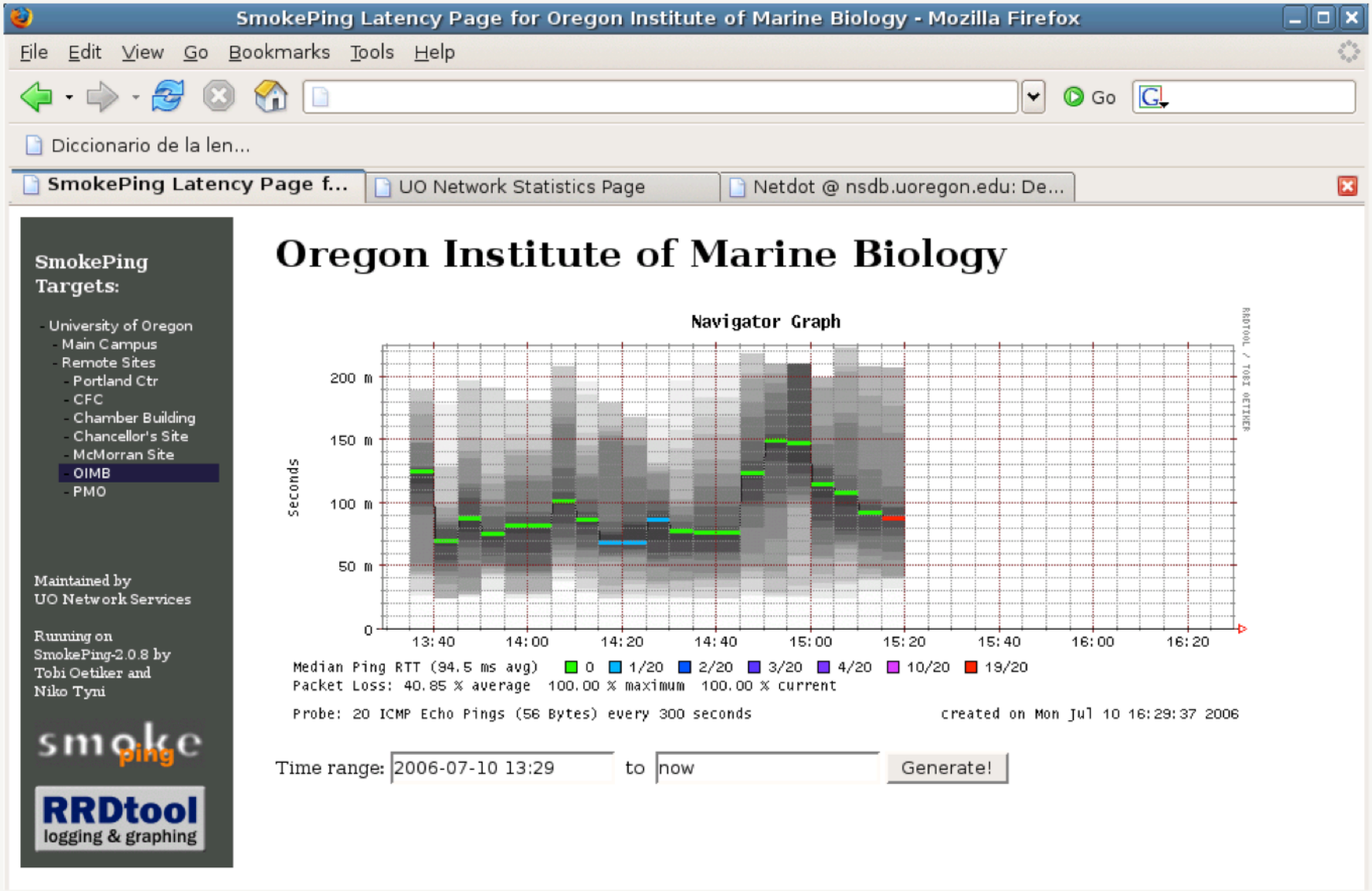
Tedious if you have lots of devices to add

Cacti Demonstration

3. Smokeping

- Based on RRDTool (the same author)
- Measures ICMP round-trip time
- Measures service response time, e.g. HTTP request, DNS request
- Can run slave servers at different points around your network (or around the world)

The “Smoke” and the “Pings”



How to Read Smokeping Graphs

- Smokeping sends multiples tests (pings), makes note of RTT, orders these and selects the median.
- The different values of RTT are shown graphically as lighter and darker shades of grey (the “smoke”). This conveys the idea of variable round trip times or *jitter*.
- The number of lost packets (if any) changes the color of the horizontal line across the graph.

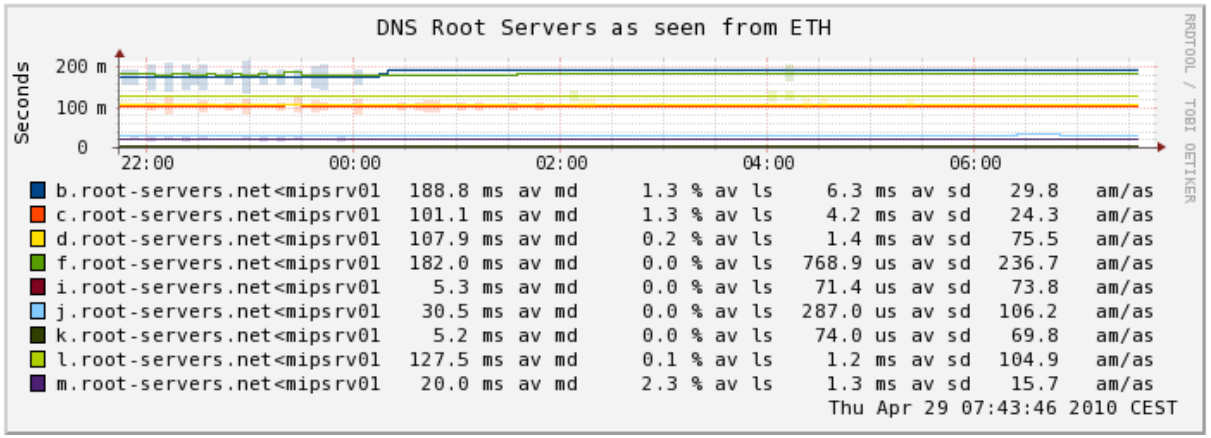
MultiHost Graphing

Combine multiple data sources into one graph with the same Y-axis scale

http://oss.oetiker.ch/smokeping/doc/smokeping_examples.en.html

Sample configuration

```
+++MultihostRouters
menu = MutihostRouters
title = Combined Router Results
host = /Local/Routers/gw /Local/Routers/rtr1
       /Local/Routers/rtr2
```



Smokeping demonstration

{net.} NETwork DOcumentation Tool

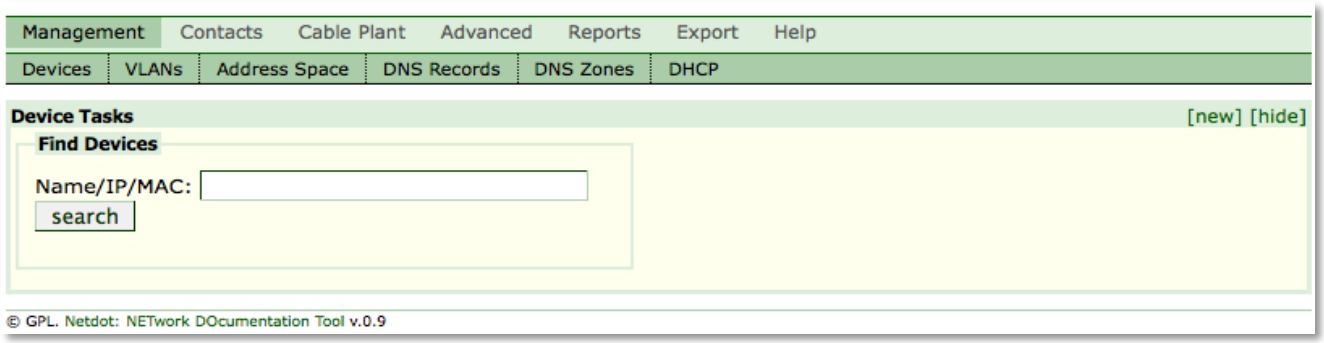
Core functionality includes:

- Discovery of network interfaces via SNMP
- Layer 2 topology discovery and graphics using:
  - CDP/LLDP
  - Spanning Tree protocol
  - Switches forwarding tables
  - Router point-to-point subnets
- VLANs
- IPv4 and IPv6 address management (IPAM)
  - Address space visualization
  - DNS and DHCP configuration managment
  - IP and Mac address correlation from ARP tables

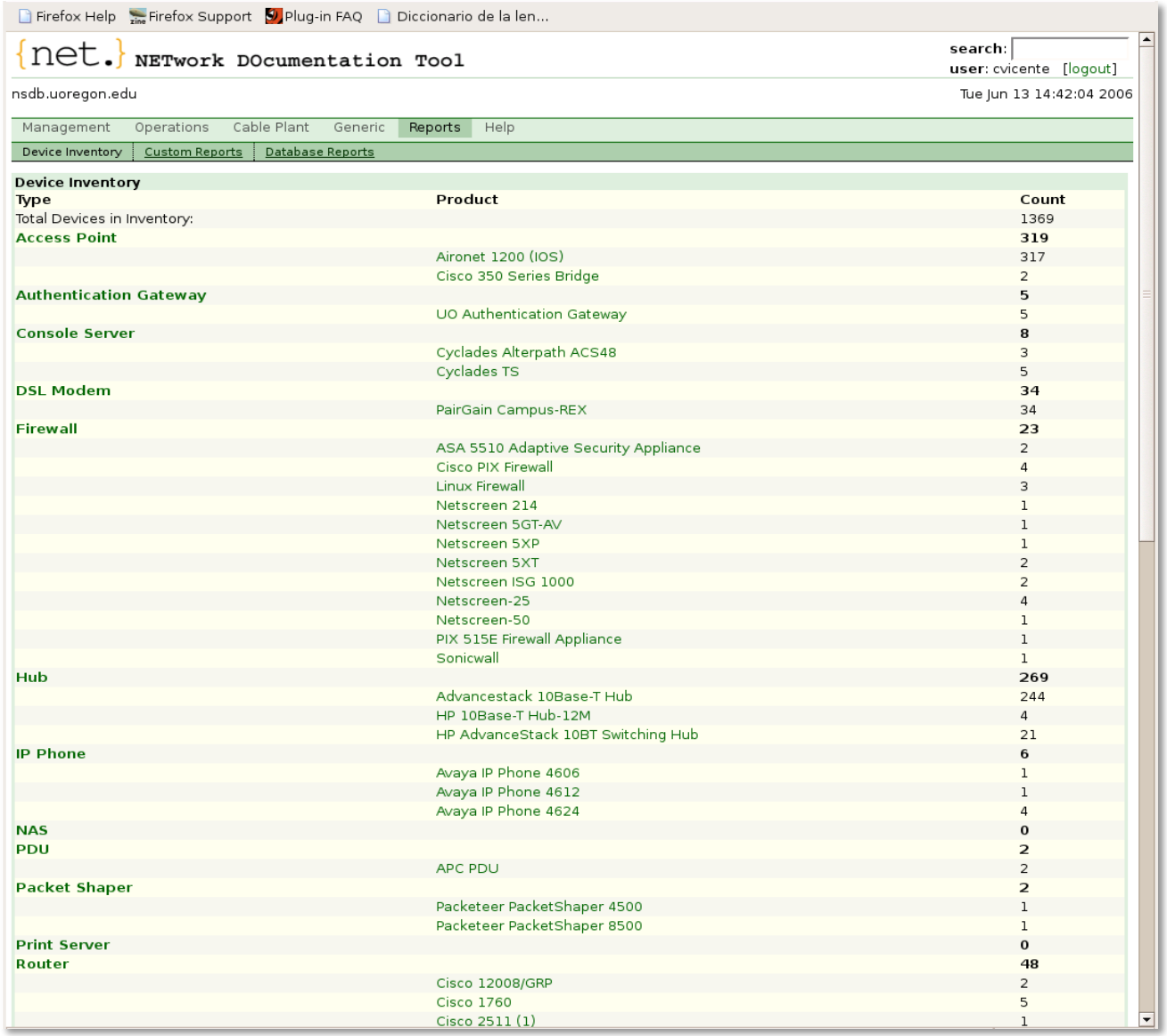
{net.} NETwork DOcumentation Tool

Functionality cont.

- Cable plants (sites, fibre, copper, closes, circuits)
- Contacts (departments, providers, vendors, etc.)
- Export of data for various tools (Nagios, Sysmon, RANCID, Cacti, etc.)
  - For example, automate Cacti configuration
- User access-level: admin, operator, user
- Reports
- Ability to draw pretty pictures of your network.



Inventory and Devices



Device Inventory

Type	Product	Count
Total Devices in Inventory:		1369
Access Point		**319**
	Aironet 1200 (IOS)	317
	Cisco 350 Series Bridge	2
Authentication Gateway		**5**
	UO Authentication Gateway	5
Console Server		**8**
	Cyclades Alterpath ACS48	3
	Cyclades TS	5
DSL Modem		**34**
	PairGain Campus-REX	34
Firewall		**23**
	ASA 5510 Adaptive Security Appliance	2
	Cisco PIX Firewall	4
	Linux Firewall	3
	Netscreen 214	1
	Netscreen 5GT-AV	1
	Netscreen 5XP	1
	Netscreen 5XT	2
	Netscreen ISG 1000	2
	Netscreen-25	4
	Netscreen-50	1
	PIX 515E Firewall Appliance	1
	Sonicwall	1
Hub		**269**
	Advancestack 10Base-T Hub	244
	HP 10Base-T Hub-12M	4
	HP AdvanceStack 10BT Switching Hub	21
IP Phone		**6**
	Avaya IP Phone 4606	1
	Avaya IP Phone 4612	1
	Avaya IP Phone 4624	4
NAS		**0**
PDU		**2**
	APC PDU	2
Packet Shaper		**2**
	Packeteer PacketShaper 4500	1
	Packeteer PacketShaper 8500	1
Print Server		**0**
Router		**48**
	Cisco 12008/GRP	2
	Cisco 1760	5
	Cisco 2511 (1)	1

Topology example

Netdot can draw the topology of a network or a segment of a network dynamically.

IP Space: Addresses and Blocks

- Hierarchical (*drill-down)* and graphical representation
- Support for IPv4 and IPv6
- Classification in:
  - Block
    - Container
    - Subnet
    - Reserved
  - Address
    - Static
    - Dynamic
    - Reserved

Visualization of IP space

Netdot demonstration

Netflow

- Find out who is using your bandwidth and for what
- You need a router which can export Netflow data; or a switch with a mirror port (and a PC to generate the flow records)
- Tools like nfsen can collect, store, and help you visualise the data

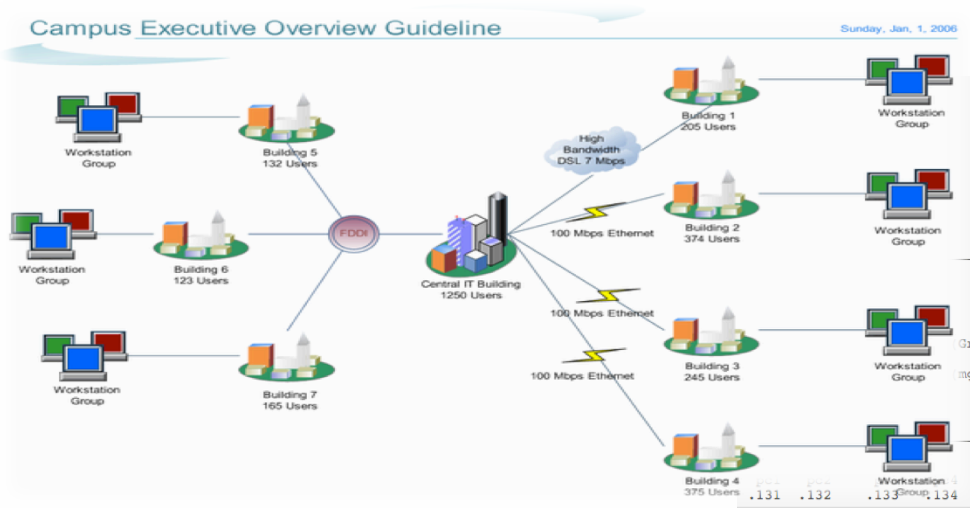
Other essential tools

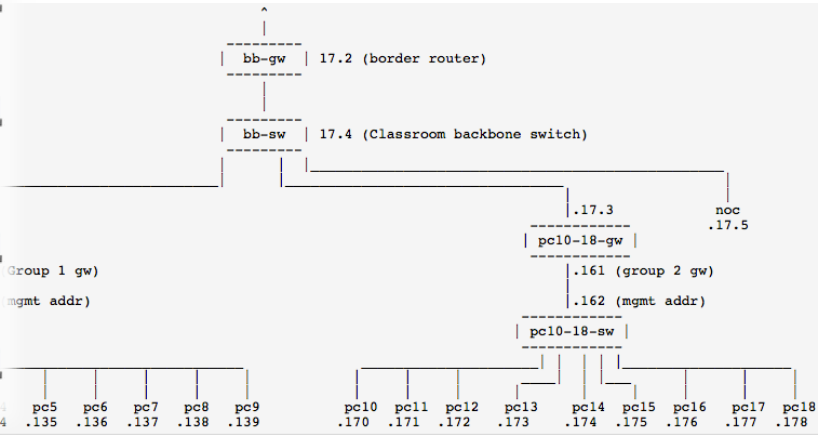
- Rancid: archive your router and switch configurations
- Syslogd, swatch/tenshi: centralise your logs, alert on unusual messages
- RT: ticketing system
- A wiki: documentation which you keep up to date continually

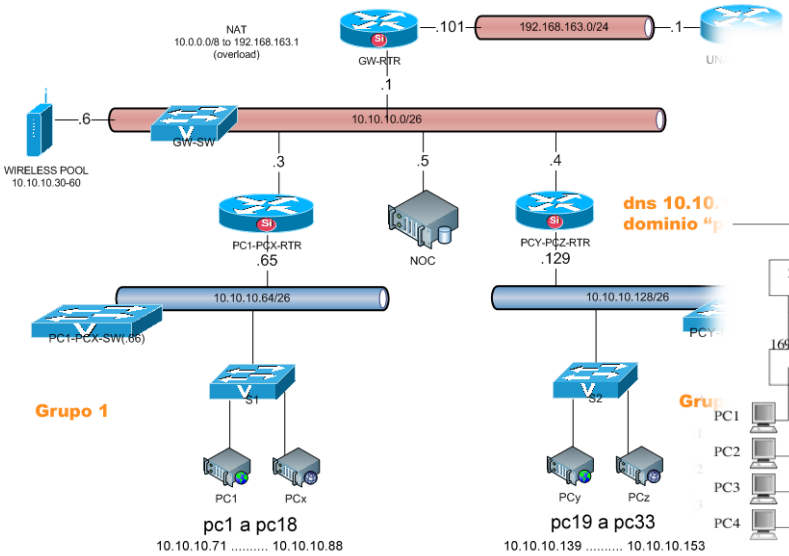
Choosing equipment

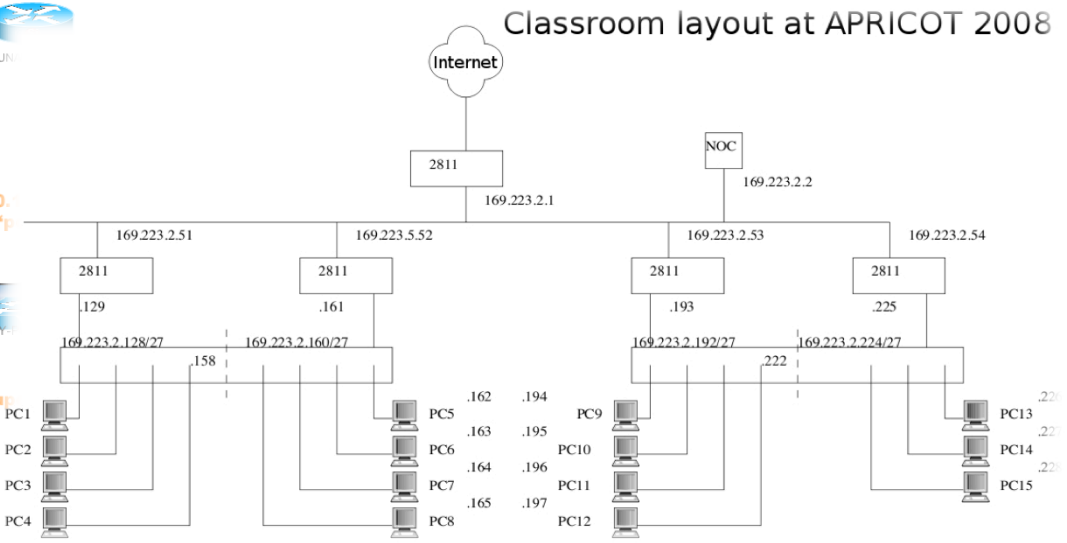
- Keep management in mind when selecting equipment – e.g. it must have SNMP
- Configure the management features
  - Enable SNMP
  - Enable SSH, disable Telnet
  - Synchronise time using NTP
  - Set strong passwords
- Try to get rid of unmanaged switches - or at least keep them at the very edge of your network (and only one layer deep)

Documentation: Diagrams









Questions?

?