Introduction to
Network Monitoring and Management

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Part I: Overview

Core concepts presented:

- What is network monitoring
- What is network management
- Why network management
- The big three
- Attack detection
- Documentation
- Consolidating the data
- The big picture

Network Management Details

We Monitor

- System & Services
  - Available, reachable
- Resources
  - Expansion planning, maintain availability
- Performance
  - Round-trip-time, throughput
- Changes and configurations
  - Documentation, revision control, logging

Network Management Details

We Keep Track Of:

- Statistics
  - For purposes of accounting and metering
- Faults (Intrusion Detection)
  - Detection of issues,
  - Troubleshooting issues and tracking their history
- Ticketing systems are good at this
  - Help Desks are a good place to create, update, troubleshoot and resolve issues between your staff and end-users using a ticketing system.

Expectations

A network needs to be monitored to:

- Deliver projected *SLAs (Service Level Agreements)*
- SLAs depend on policy
  - What does your management expect?
  - What do your users expect?
  - What do your customers expect?
  - What does the rest of the Internet expect?
- What's good enough? 99.999% Uptime?
  - There's no such thing as 100% uptime (as we'll see) →

Uptime Expectations

What does it take to deliver 99.9 % uptime?

only 44 minutes of downtime a month!

Need to shutdown 1 hour / week?

(732 – 4) / 732x 100 = 99.4 %

Take maintenance into account & inform your users and customers if maintenance is included in the SLA.

How is availability measured?

In the core? End-to-end? From the Internet?

Baselining

What is normal for your network?

You need to know:

- Typical load on links (➔ Cacti)
- Level of jitter between endpoints (➔ Smokeping)
- Typical percent usage of resources
- Typical amounts of “noise”:
  - Network scans
  - Dropped data
  - Reported errors or failures

Why Do This?

Know when to upgrade

- Where is your traffic going?
- Is your bandwidth usage too high? Equipment too old?
- Do you need to get a faster line, or more providers?

Keep an audit trace of changes

- Record all changes
- Find problems due to upgrades and configuration changes

Maintain history of network operations

- Using a ticket system lets you keep a history of events.
- Allows you to defend yourself and verify what happened

Why Network Management?

Accounting

- Track usage of resources
- Bill customers according to usage

Know when you have problems

- Stay ahead of your users. It makes you look good!
- Generate tickets & automatically notify staff of issues

Trends

- Monitoring helps you view trends across your network.
- Monitoring is part of baselining, capacity planning and attack detection.

The Big Three

Availability: Nagios

Services, servers, routers, switches

Reliability: Smokeping

- Connection health, rtt, service response time, latency

Performance: Cacti

Total traffic, port usage, CPU, RAM, Disk, processes

Functional overlap exists between these programs!

Attack Detection

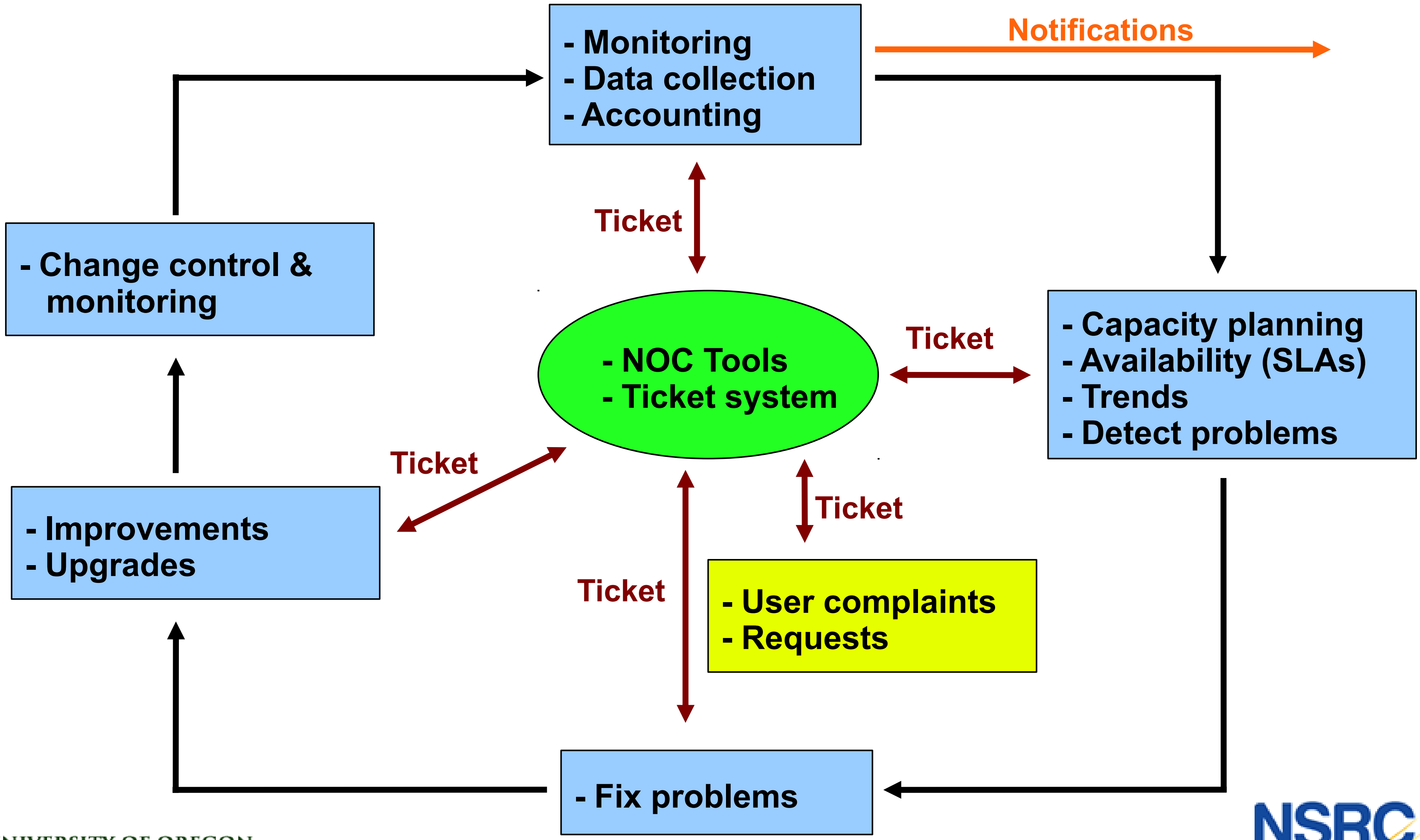
- Trends and automation allow you to know when you are under attack.
- The tools in use can help you to mitigate attacks:
  - Flows across network interfaces
  - Load on specific servers and/or services
  - Multiple service failures

Consolidating The Data

The Network Operations Center (NOC)

- Coordination of tasks
- Status of network and services
- Handle network-related incidents and complaints
- Where the tools reside (”NOC server”)
- Documentation including:
  - Network diagrams
  - database/flat file of each port on each switch
  - Network description

The Big Picture



- Monitoring
- Data collection
- Accounting

- Capacity planning
- Availability (SLAs)
- Trends
- Detect problems

- Fix problems

- Improvements
- Upgrades

- Change control &
  monitoring

- NOC Tools
- Ticket system

- User complaints
- Requests

A Few Open Source Solutions

Performance

- Cricket
- IFPFM
- flowc
- mrtg*
- NetFlow*
- NfSen*
- ntop
- perfSONAR
- pmacct
- RRDtool*
- SmokePing*

Ticketing

- RT*
- Trac*
- Redmine

Change Mgmt

- Mercurial
- Rancid* (routers)
- CVS*
- Subversion*
- git*

Security/NIDS

- Nessus
- OSSEC
- Prelude
- Samhain
- SNORT
- Untangle

Logging

- swatch*
- syslog-ng/rsyslog*
- tenshi*

Net Management

- Big Brother
- Cacti*
- Hyperic
- Munin
- Nagios*
- OpenNMS*
- Observium*
- Sysmon
- Zabbix

Documentation

- IPplan
- Netdisco
- Netdot*
- Rack Table

Protocols/Utilities

- SNMP*, Perl, ping

Questions

Part II: Details

Some details on the core concepts:

- Diagnostic tools
- Monitoring tools
- Performance tools
- Active and passive tools
- SNMP
- Ticket systems
- Configuration and change management

Network Monitoring Systems & Tools

- **Diagnostic tools** – used to test connectivity, ascertain that a location is reachable, or a device is up – usually active tools
- **Monitoring tools** – tools running in the background (”daemons” or services), which collect events, but can also initiate their own probes (using diagnostic tools), and recording the output, in a scheduled fashion.
- **Performance tools** – tell us how our network is handling traffic flow.

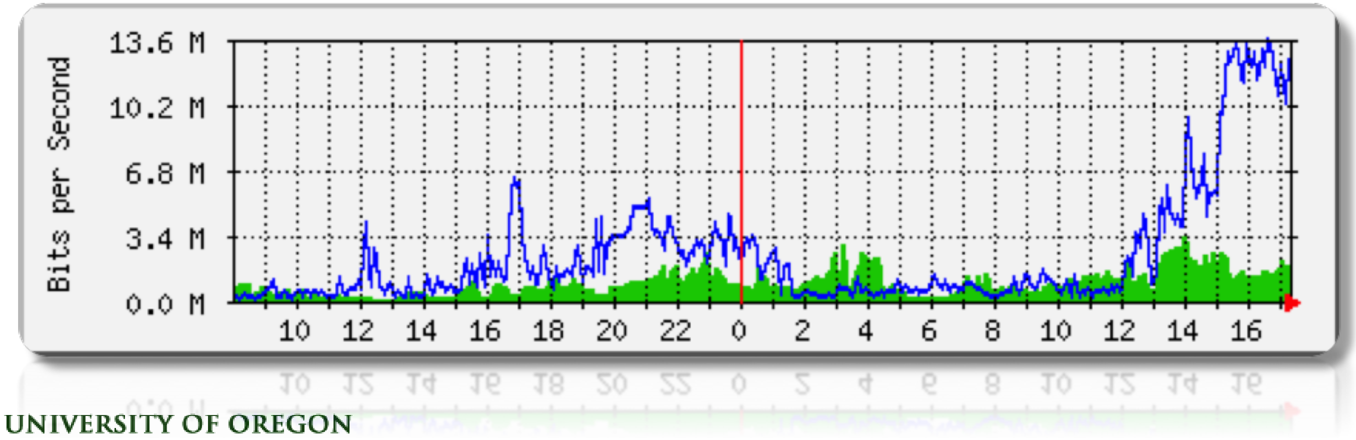
Network Monitoring Systems & Tools

3. Performance Tools

Key is to look at each router interface (probably don't need to look at switch ports).

Two common tools:

- Netflow/NfSen: http://nfsen.sourceforge.net/
- MRTG: http://oss.oetiker.ch/mrtg/



MRTG = "Multi Router Traffic Grapher"

Network Monitoring Systems & Tools

Active tools

- Ping – test connectivity to a host
- Traceroute – show path to a host
- MTR – combination of ping + traceroute
- SNMP collectors (polling)

Passive tools

- log monitoring, SNMP trap receivers, NetFlow

Automated tools

- SmokePing – record and graph latency to a set of hosts, using ICMP (Ping) or other protocols
- MRTG/RRD – record and graph bandwidth usage on a switch port or network link, at regular intervals

Network Monitoring Systems & Tools

Network & Service Monitoring tools

- Nagios – server and service monitor
  - Can monitor pretty much anything
  - HTTP, SMTP, DNS, Disk space, CPU usage, ...
  - Easy to write new plugins (extensions)
- Basic scripting skills are required to develop simple monitoring jobs – Perl, Shell scripts, php, etc...
- Many good Open Source tools
  - Zabbix, ZenOSS, Hyperic, OpenNMS ...

Use them to monitor reachability and latency in your network

- Parent-child dependency mechanisms are very useful!

Network Monitoring Systems & Tools

Monitor your critical Network Services

- DNS/Web/Email
- Radius/LDAP/SQL
- SSH to routers

How will you be notified?

Don't forget log management!

- Every network device (and UNIX and Windows servers as well) can report system events using syslog
- You **MUST collect** and **monitor** your logs!
- Not doing so is one of the most common mistakes when doing network monitoring

Network Management Protocols

SNMP – Simple Network Management Protocol

- Industry standard, hundreds of tools exist to exploit it
- Present on any decent network equipment
  - Network throughput, errors, CPU load, temperature, ...
- UNIX and Windows implement this as well
  - Disk space, running processes, ...

SSH and telnet

- It is also possible to use scripting to automate monitoring of hosts and services

SNMP Tools

Net SNMP tool set

- http://net-snmp.sourceforge.net/

Very simple to build simple tools

- One that builds snapshots of which IP is used by which Ethernet address
- Another that builds shapshots of which Ethernet addresses exist on which port on which switch.
- Query remote RAID array for state.
- Query server, switches and routers for temperatures.
- Etc…

Statistics and Accounting Tools

Traffic accounting and analysis

- What is your network used for, and how much
- Useful for Quality of Service, detecting abuses, and billing (metering)
- Dedicated protocol: NetFlow
- Identify traffic ”flows”: protocol, source, destination, bytes
- Different tools exist to process the information
  - Flowtools, flowc
  - NFSen
  - Many more: http://www.networkuptime.com/tools/netflow/

Fault & Problem Management

Is the problem transient?

- Overload, temporary resource shortage

Is the problem permanent?

- Equipment failure, link down

How do you detect an error?

- Monitoring!
- Customer complaints

A ticket system is essential!

- Open ticket to track an event (planned or failure)
  - ➔ Who handles the problem? (Dispatch)
  - ➔ Who gets it next if no one is available? (Escalation)

Ticketing Systems

Why are they important?

- Track all events, failures and issues

Use it to track all communications

- Both internal and external

Events originating from the outside

- customer complaints

Events originating from the inside

- System outages (direct or indirect)
- Planned maintenances or upgrades
- – Remember to notify your customers!

Ticketing Systems

- Use ticket system to follow each case, including internal communication between technicians
- Each case is assigned a case number
- Each case goes through a similar life cycle:
  - New
  - Open
  - ...
  - Resolved
  - Closed

Ticketing Systems

Workflow:

```
   Ticket System      Helpdesk         Tech            Eqpt
----------------------------------------------------------------
           T                T               T                T
query      |                |               |                |
from  ---->|                |               |                |
customer   |--- request --->|               |                |
<- ack. -- |                |               |                |
           |                |<-- comm -->   |                |
           |                |               |- fix issue -> eqpt
           |                |<- report fix -|                |
customer <-|<-- respond ----|               |                |
           |                |               |                |
```

Ticketing Systems: Examples

rt (request tracker)

- Heavily used worldwide
- Ccan be customized to your location
- Somewhat difficult to install and configure
- Handles large-scale operations

trac

- Iincludes a wiki and project management features.
- Ticketing system not as robust as rt, but works well.
- Often used for ”trac”king group projects.

redmine

- Like trac, but more robust. Harder to install

Network Intrusion Detection Systems

Systems that observe network traffic & report when specific kinds of problems are seen, like infected or spamming computers.

- **SNORT** - a commonly used open source tool: http://www.snort.org/
- **Prelude –** Security Information Management System https://dev.prelude-technologies.com/
- **Samhain –** Centralized HIDS http://la-samhna.de/samhain/
- **Nessus** - scan for vulnerabilities: http://www.nessus.org/download/

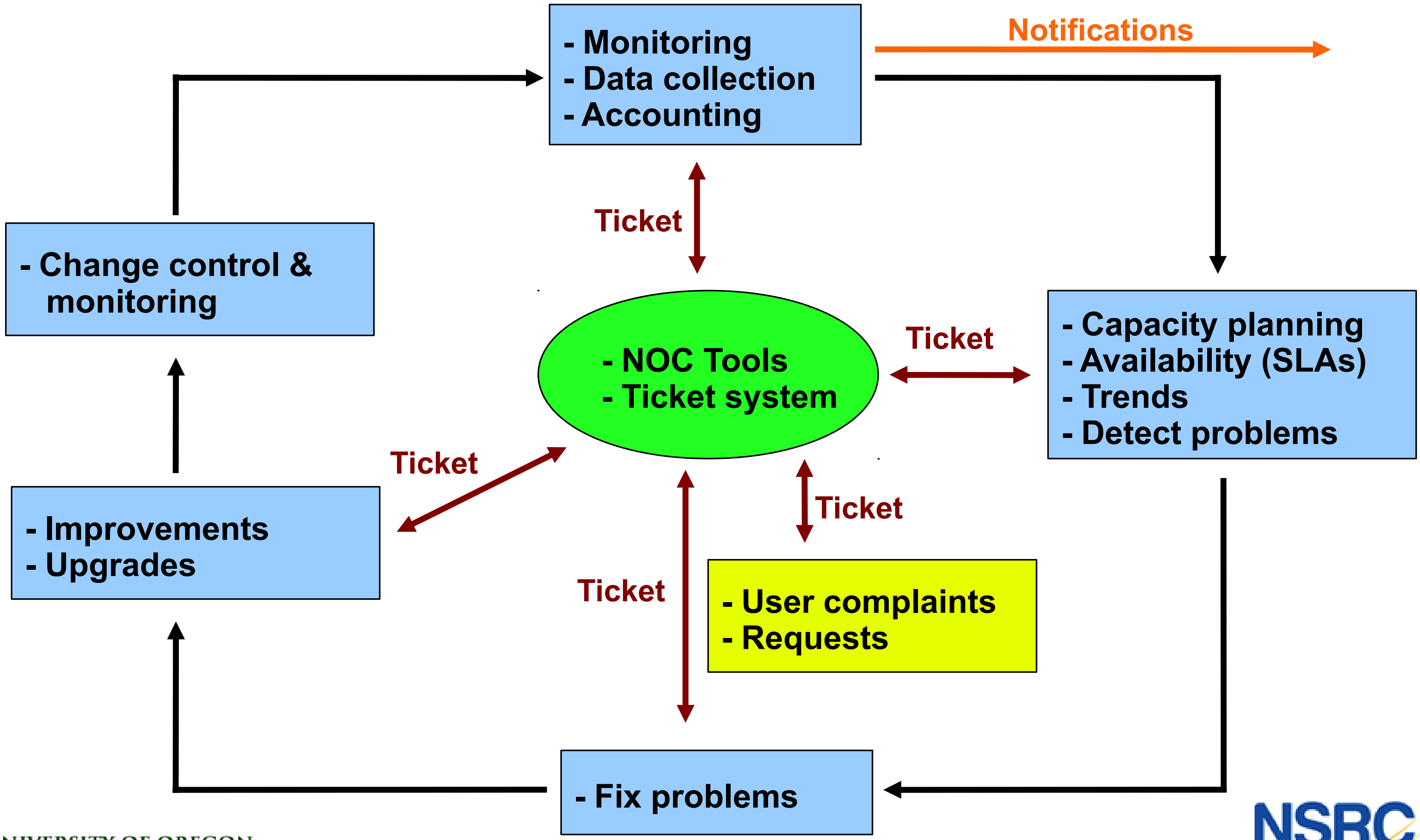
Configuration Management & Monitoring

- Record changes to equipment configuration using *revision control* (also for configuration files)
- Inventory management (equipment, IPs, interfaces)
- Use versioning control
  - As simple as: ”`cp named.conf named.conf.20070827-01`”
- For plain configuration files:
  - **CVS, Subversion (SVN)**
  - **Mercurial**
- For routers:
  - **RANCID**

Configuration Management & Monitoring

- Traditionally, used for source code (programs)
- Works well for any text-based configuration files
  - Also for binary files, but less easy to see differences
- For network equipment:
  - **RANCID** (Automatic Cisco configuration retrieval and archiving, also for other equipment types)
- Built-in to Project Management Software like:
  - **Trac**
  - **Redmine**
  - And, many other wiki products. Excellent for documenting your network.

The Big Picture Revisited



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Notifications

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