



## Network Monitoring and Management

# Introduction to Networking Monitoring and Management



These materials are licensed under the Creative Commons *Attribution-Noncommercial 3.0 Unported* license (<http://creativecommons.org/licenses/by-nc/3.0/>) as part of the ICANN, ISOC and NSRC Registry Operations Curriculum.

# Part I: Overview

## **Core concepts presented:**

- What is network monitoring
- What is network management
- Getting started
- 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 useful to critical component

# Expectations

A network in operation needs to be monitored in order 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?

30.5 days x 24 hours = 732 hours a month

$(732 - (732 \times .999)) \times 60 = 44$  minutes

only 44 minutes of downtime a month!

## Need to shutdown 1 hour / week?

$(732 - 4) / 732 \times 100 = 99.4 \%$

*Remember to take planned maintenance into account in your calculations, and inform your users/customers if they are included/excluded in the SLA*

## How is availability measured?

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

# Baselining

## What is normal for your network?

If you've never measured or monitored your network you will need to know things like:

- 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 all this?

## **Know when to upgrade**

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

## **Keep an audit trace of changes**

- Record all changes
- Makes it easier to find cause of problems due to upgrades and configuration changes

## **Keep a history of your 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! Makes you look good.
- Monitoring software can generate tickets and automatically notify staff of issues.

## Trends

- All of this information can be used to view trends across your network.
- This 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

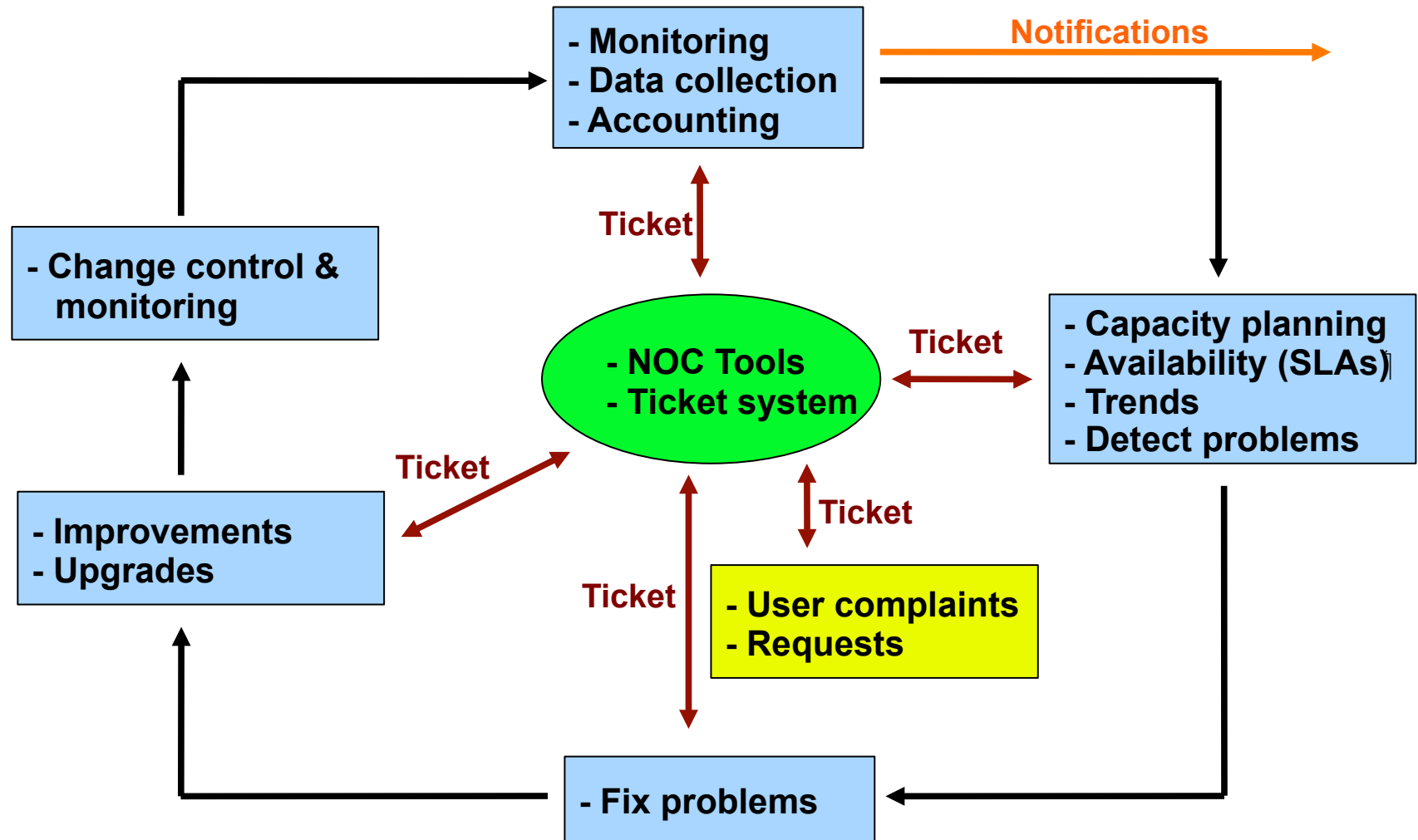
# Consolidating the data

## The Network Operations Center (NOC)

### “Where it all happens”

- Coordination of tasks
- Status of network and services
- Fielding of 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
  - Much more as you'll see.

# The big picture



# 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:

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



# Questions?

?

# Part III: 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

## Three kinds of tools

1. **Diagnostic tools** – used to test connectivity, ascertain that a location is reachable, or a device is up – usually active tools
  2. **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

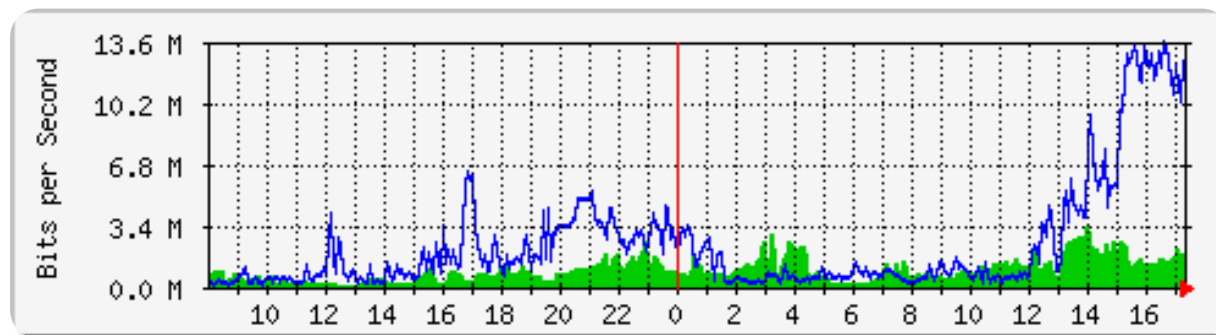
# Network monitoring systems & tools

## 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 snapshots 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 and 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)
- Define dispatch/escalation rules
  - Who handles the problem?
  - Who gets it next if no one is available?

# Ticketing systems

## Why are they important?

- Track all events, failures and issues

## Focal point for helpdesk communication

## Use it to track all communications

- Both internal and external

## Events originating from the outside:

- customer complaints

## Events originating from the inside:

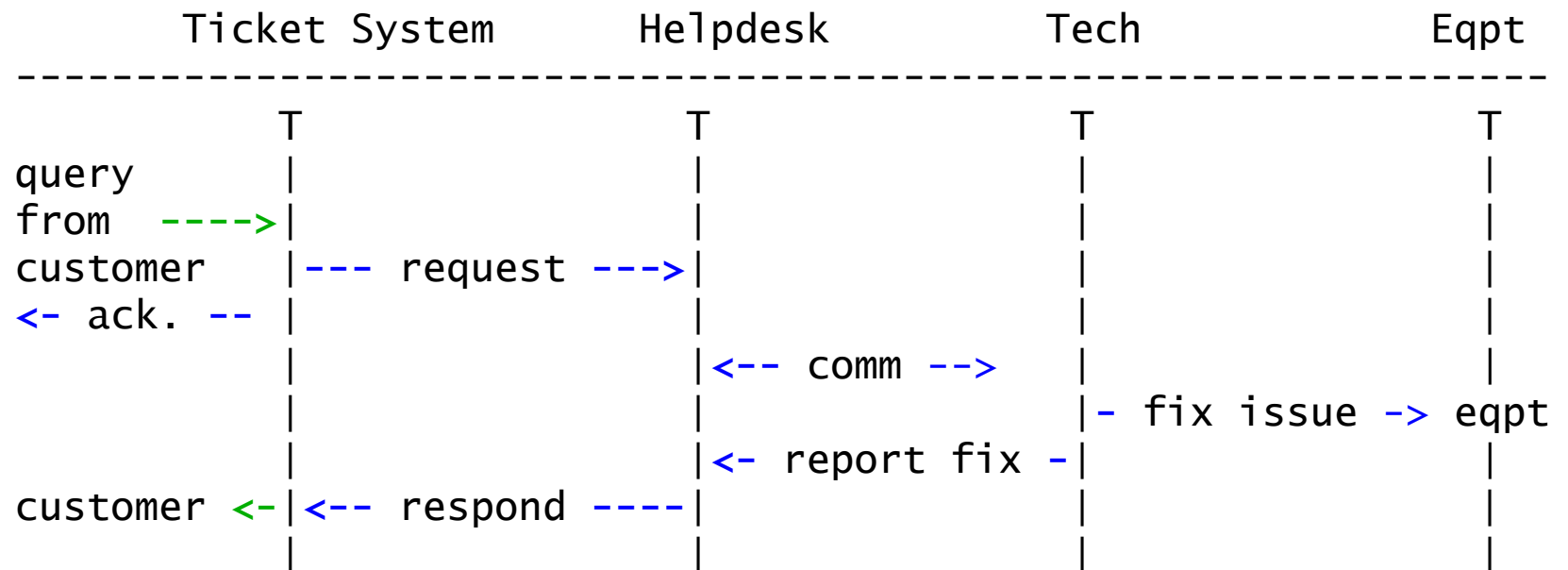
- System outages (direct or indirect)
- Planned maintenances or upgrades – Remember to notify your customers!

# 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:



# Ticketing systems: examples

## **rt (request tracker)**

- Heavily used worldwide.
- A classic ticketing system that can be customized to your location.
- Somewhat difficult to install and configure.
- Handles large-scale operations.

## **trac**

- A hybrid system that includes a wiki and project management features.
- Ticketing system is 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 (NIDS)

These are systems that observe all of your network traffic and report when it sees specific kinds of problems, such as:

- hosts that are infected or are acting as spamming sources.

## A few tools:

- **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/>



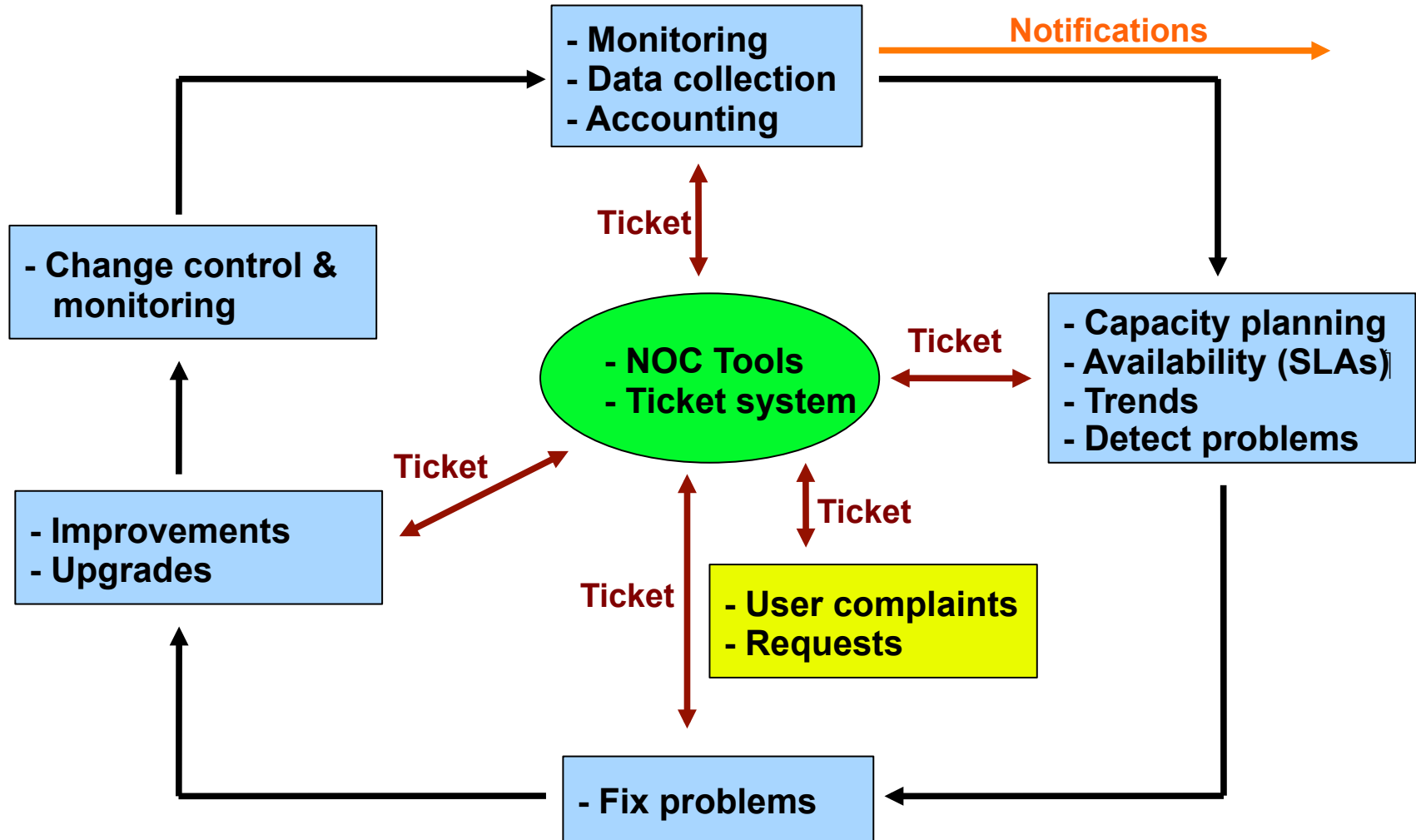
# Configuration mgmt & monitoring

- 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 mgmt & 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



# Questions

?