Cluster Management

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OSG All Hands Meeting, Boston

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About Me

- Fermilab for 10 years
- Head of Fermilab Experiments Facilities (FEF) Department in the Computing Division.
- FEF manages approx 3500 physical Linux systems: farms, workstations, online servers, offline servers, and more!
- FEF is also responsible for the development and support of Scientific Linux. **SL 6 now available!**

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For this talk

- Primarily discuss Free and Open Source Software (FOSS) tools
- Tools in production at Fermilab or ones that we have recently evaluated
- “Cluster” defined as any large group of Linux systems
- Skimming the surface of cluster management

Cluster Management Basics

- Management infrastructure
- Provisioning
- Configuration and software package management
- Monitoring

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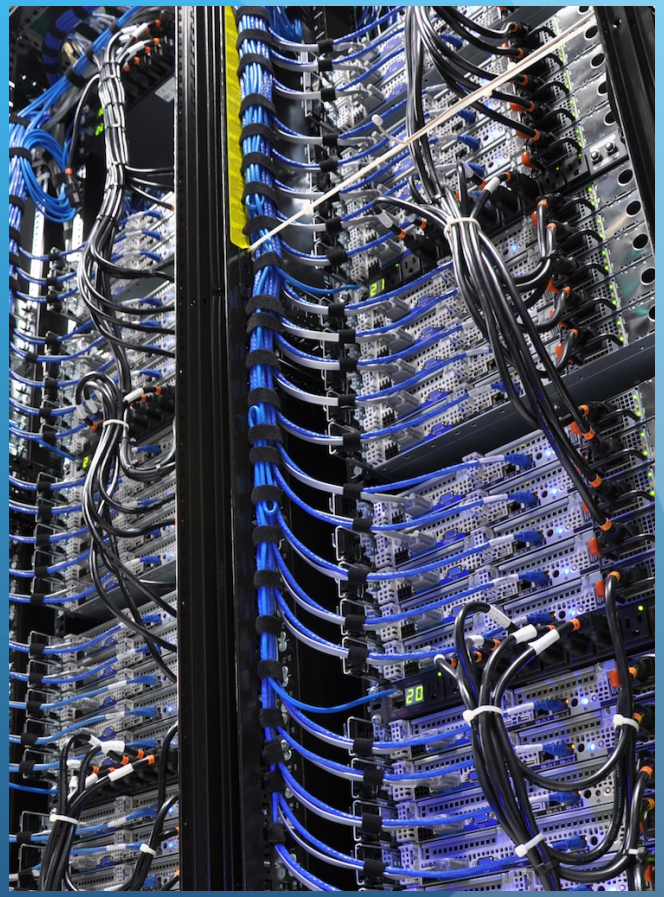
Management Infrastructure

- Remote power-cycling and serial console access
- FEF has standardized on Avocent ACS serial console servers and Avocent PM line of PDU
- Other depts use IPMI or a mix of Avocent and APC products
- All depts have scripts to control and configure remote power-cycling and serial console access



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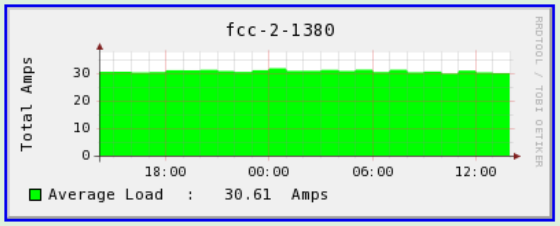
CMS Tier 1 Power Usage Plots



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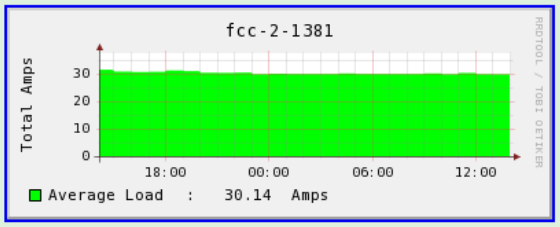
cmssrv03 cmssrv02 cmssrv01 cmssrv95 cmsosgce
cmsosgce2 cmsosgce3 cmsosgce4 cmssrv105 cmssrv14
cmssrv34 cmssrv35



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cmsstor252 cmsstor253 cmsstor254 cmsstor255
cmsstor256 cmsstor257 cmsstor258 cmsstor259
cmsstor260 cmsdisk252 cmsdisk253 cmsdisk254
cmsdisk255 cmsdisk256 cmsdisk257 cmsdisk258
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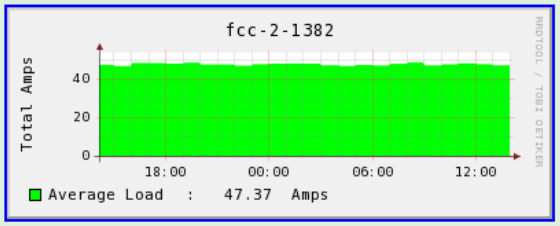

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cmsstor155 cmsstor154 cmsstor153 cmsstor150
cmsstor151 cmsstor149 cmsdisk155 cmsdisk154
cmsdisk153 cmsdisk151 cmsdisk149 cmsdisk150

CMS plots power utilization by querying PDUs using SNMP. This data can be particularly useful to datacenter managers.

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Provisioning Tools

Preparing a system for use; OS installation and initial configuration.

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Provisioning Tools

At Fermilab

- PXE/Kickstart
- Rocks

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FEF's PXE/Kickstart Setup

- FEF uses custom tool built on top of MySQL and Perl DCHP server modules.
- No dhcpd restart required.
- Web front-end for specifying kickstart / node combinations.
- Very flexible
- Kickstart files are created dynamically based on selections from the web GUI
- Planning to eval Cobbler later this year.

Rocks Clusters

- Open source Linux distribution based on CentOS.
- Created in 2000
- Created for easy deployment of large clusters.
- Used by CMS Tier 1 at Fermilab for 2400 machines
- CMS can install ~500 systems in 1 hour.
- Only one OS version per Rocks server may be a deal breaker for some.

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Configuration and Package Management

Tools that help manage system configuration (files, dirs, permissions, etc.) and software packages.

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Configuration and Package Management Tools

Popular open source solutions:

- Cfengine
- Puppet
- Bcfg2

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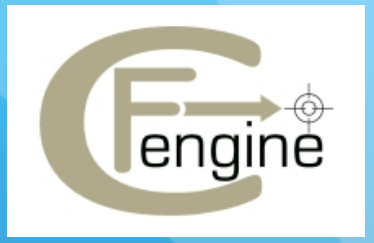
Cfengine



- First version released in 1993
- Still the de facto standard configuration management tool, though Puppet is quickly catching-up
- Written in C
- Fairly easy to understand syntax
- Used by D0 workstation cluster, ClueD0
- FEF used for many years
- Relatively easy to find sysadmins with experience

Puppet

- New generation of configuration management system
- Extensible, declarative language
- Understands dependencies (huge benefit)
- Better reporting than Cfengine
- Auto generation of documentation (think Javadoc)
- FEF avg is 325 actions per node every Puppet run

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FEF Puppet Usage

- Management of all external mounts
- Kerberos files -- keytab files, .k5login, etc
- Package management (RPM sets grouped by cluster)
- NIC bonding configs
- Group quotas
- Grid host certs
- FEF_backup

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Cfengine vs. Puppet (High Level)

	Native File Editing	Dependency Management	Commercial Support	Dependency Graphs	Scalability
Cfengine	✔		✔		✔
Puppet		✔	✔	✔	✔

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Puppet Add User Example

```
User { managehome    => true,
       ensure        => present,
       gid           => users,
       shell         => "/bin/bash",
}

user { “mark”:
    uid => 1000,
}

user { “fred”:
    uid  => 1001,
}

user { “jane”:
    uid => 1002,
}
```

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Cfengine Add User Example

```
"pw[mark]" string => "mark:x:1000:100:Mark Burgess:/home/
mark:/bin/bash”;

"pw[fred]" string => "fred:x:1001:100:Right Said:/home/
fred:/bin/bash";

"pw[jane]" string => "jane:x:1002:100:Jane Doe:/home/
jane:/bin/bash";

"users" slist => getindices("pw");

files:

  "/etc/passwd"

     edit_line => append_users_starting("addusers.pw");

  "/etc/group"

       edit_line => append_user_field("root","4","@
(addusers.users)");

  "/home/$(users)/."

     create => "true",

      perms => mog("755","$(users)","users");
```

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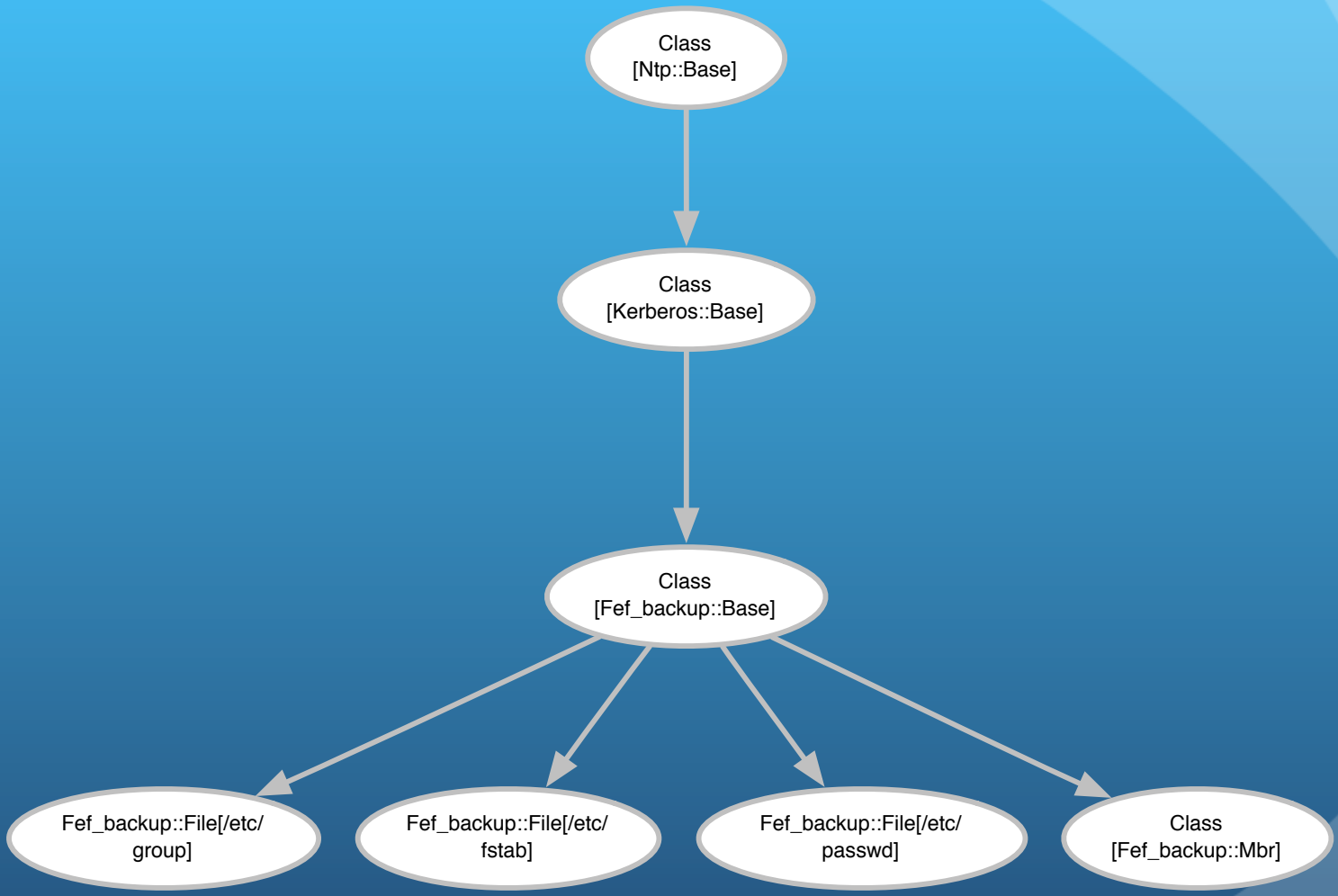
Example Puppet Dependency Graph



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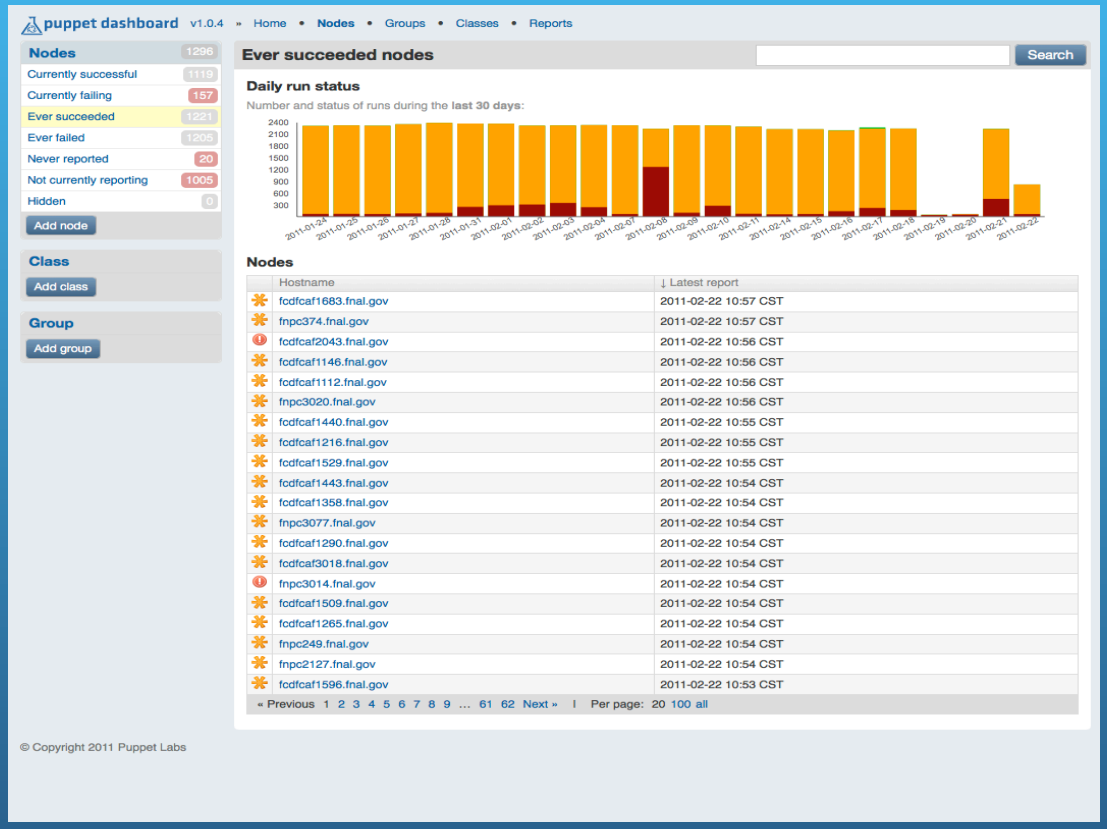
Puppet Dashboard



Puppet dashboard is a web interface for quickly viewing puppet run status and the state of individual system configurations.

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Bcfg2

- BCFG2 is an xml-based configuration management system
- Developed by Argonne National Lab
- Being used by CMS Tier 1 at Fermilab for 2 years to manage a limited number of configuration items. Not RPMS
- Developers are very responsive; provide support via mailing list and IRC
- Complex file manipulation can be tricky
- Does simple pre/post dependencies

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Bcfg2 Reporting System

Node	State	Good	Bad	Modified	Extra	Last Run	Server
cms-sleepgw.fnal.gov	clean	7	0	0	798	2011-03-03 06:55	cmssrv01.fnal.gov
cms-xen20.fnal.gov	dirty	4	1	2	821	2011-02-28 06:30	cmssrv01.fnal.gov
cms-xen39.fnal.gov	clean	9	0	0	664	2011-03-02 08:35	cmssrv01.fnal.gov
cms-xen40.fnal.gov	clean	9	0	0	638	2011-03-03 05:03	cmssrv01.fnal.gov
cms-xen41.fnal.gov	clean	9	0	0	552	2011-03-03 05:06	cmssrv01.fnal.gov
cmscbn.fnal.gov	clean	7	0	0	803	2010-12-14 04:23	cmssrv01.fnal.gov
cmscode01.fnal.gov	clean	7	0	0	871	2011-03-03 04:36	cmssrv01.fnal.gov
cmscode02.fnal.gov	clean	7	0	0	826	2011-03-03 04:26	cmssrv01.fnal.gov
cmscode03.fnal.gov	clean	7	0	0	824	2011-03-02 05:35	cmssrv01.fnal.gov
cmsdcdr1.fnal.gov	clean	10	0	0	886	2011-03-03 04:02	cmssrv01.fnal.gov
cmsdcdr2.fnal.gov	clean	10	0	0	888	2011-03-02 04:32	cmssrv01.fnal.gov
cmsdcmon1.fnal.gov	clean	12	0	0	898	2011-03-02 06:50	cmssrv01.fnal.gov
cmsfilemover.fnal.gov	clean	7	0	0	957	2011-03-03 07:22	cmssrv01.fnal.gov
cmsfnal01.fnal.gov	clean	11	0	0	936	2011-03-03 06:48	cmssrv01.fnal.gov
cmsfnal02.fnal.gov	clean	11	0	0	936	2011-03-03 05:06	cmssrv01.fnal.gov
cmsfnal03.fnal.gov	clean	11	0	0	977	2011-03-03 06:23	cmssrv01.fnal.gov
cmsfts1.fnal.gov	dirty	2	5	0	1023	2010-12-14 05:11	cmssrv01.fnal.gov
cmsfts2.fnal.gov	clean	7	0	0	1018	2010-12-11 04:32	cmssrv01.fnal.gov
cmsfts3.fnal.gov	clean	7	0	0	792	2011-03-01 04:57	cmssrv01.fnal.gov
cmslmds.fnal.gov	clean	7	0	0	872	2011-03-03 06:00	cmssrv01.fnal.gov

Node status and last run times are viewable from the Bcfg2 web interface.

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Monitoring

Tools to help monitor system state and performance.

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Monitoring

In use at Fermilab:

- Zabbix
- Nagios
- Ganglia
- Many custom solutions using MRTG, RRDtool, etc

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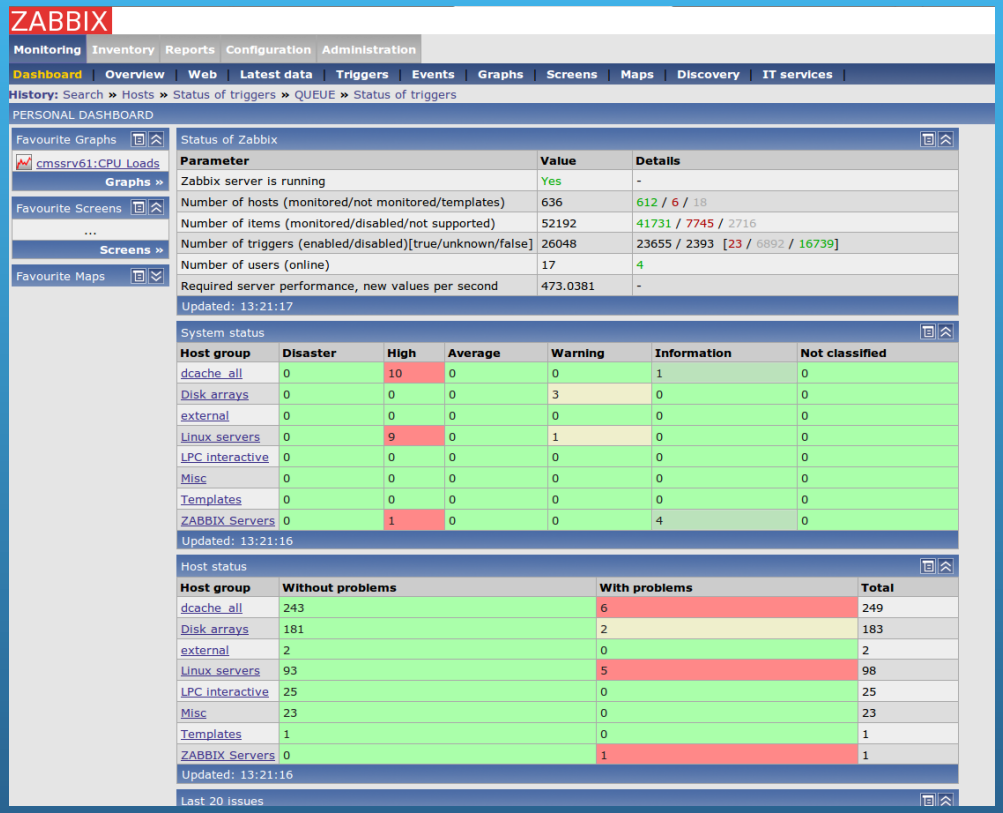
Zabbix

- Being used by CMS Tier 1 to monitor approx 2.4K nodes; performs 100K checks.
- Does status and performance monitoring.
- Relatively new compared to Nagios.
- Most configuration is done via the web interface.
- Easy to add custom checks and alerts.

Zabbix Dashboard



Zabbix provides a polished web interface that displays finely grained status and performance information.

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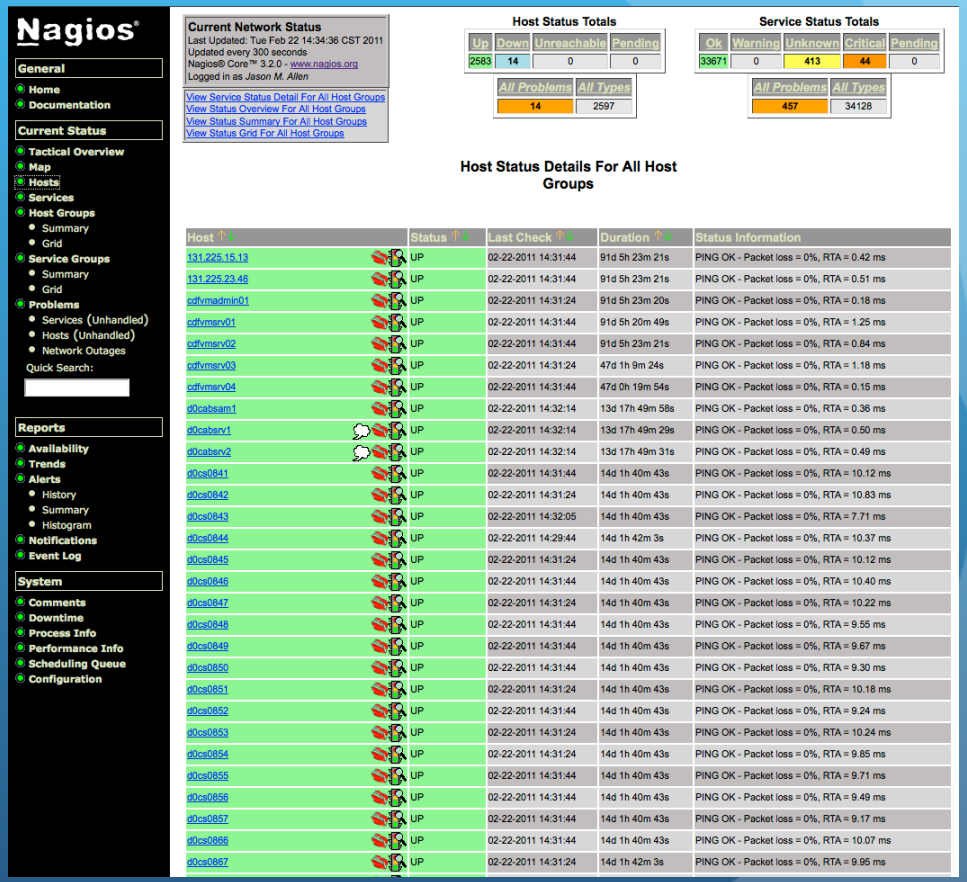
Nagios

- Used by FEF; 3.5K nodes, approx 30K checks on one server
- Around for many years.
- Create a new check by dropping shell script on node (check_mk plugin)
- Nagios support built-in to Puppet.
- Web interface can be slow and feels dated.

Nagios Web Interface

The Nagios web interface is functional but feels dated. Performance is an issue when monitoring many hosts.



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Misc Cluster Management Tools and Techniques

Other things you might find interesting

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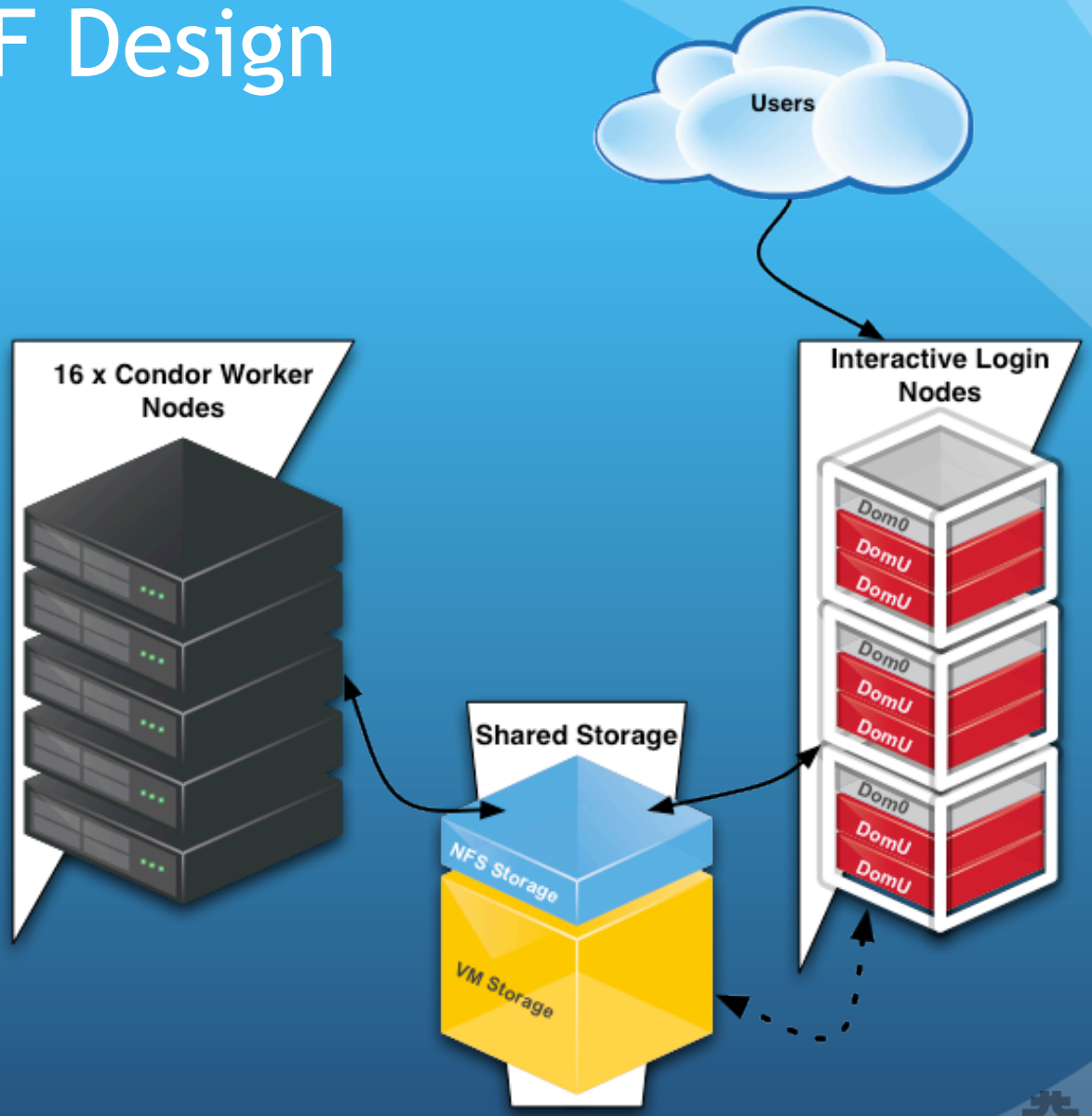
GPCF

- General Purpose Computing Facility
- Oracle VM cluster + batch cluster
- Quick provisioning for smaller or new experiments.
- Computing resources in days instead of weeks/months.
- Small batch cluster serves as training wheels for the Grid.

GPCF Design



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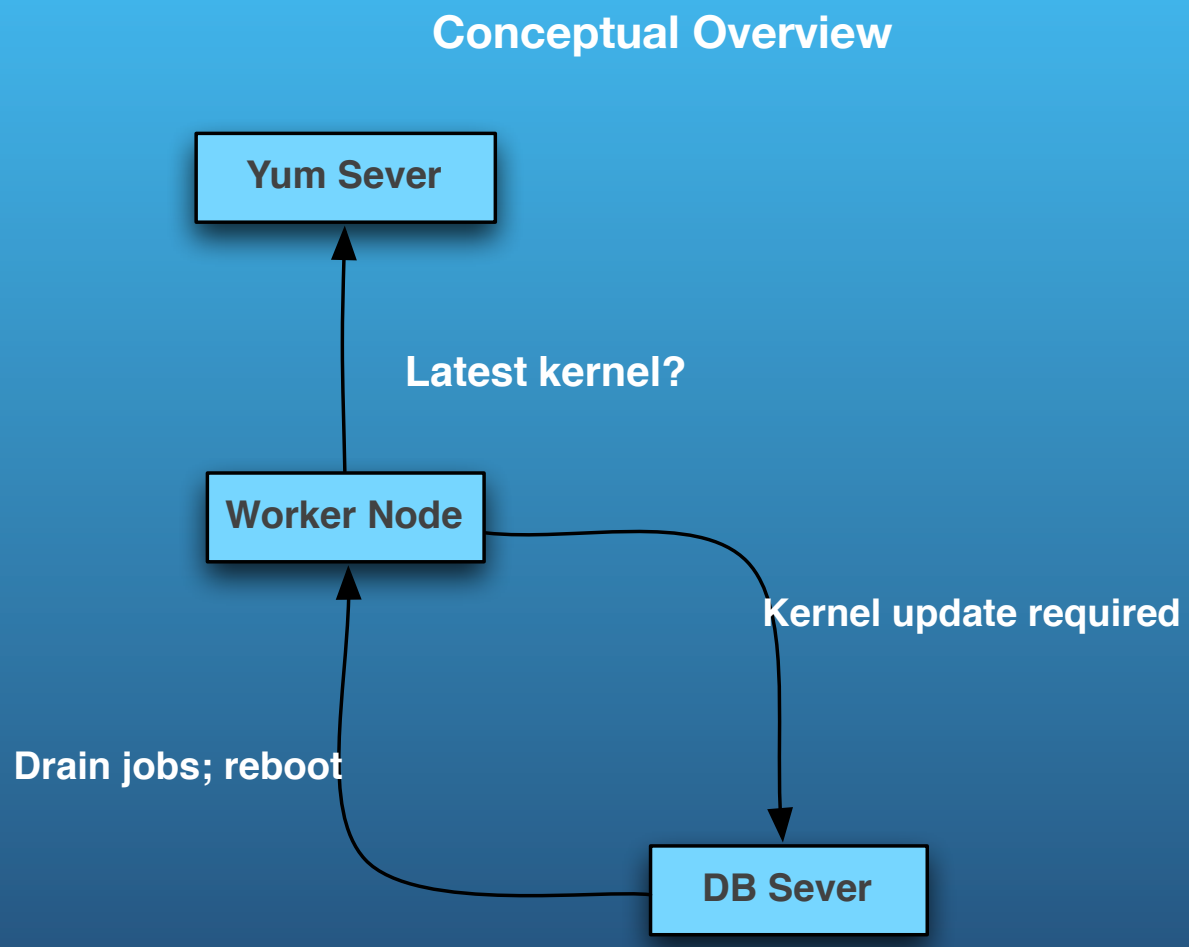
CDF Grid Rolling Upgrades

- Fermi security policy states that software patches to be applied within 60 days of release.
- Systems must be every rebooted every 2-3 months to load new Linux kernel.
- Tool automatically drains and reboots 50 nodes at a time.
- 1K node cluster is updated in appox 2 weeks.

Rolling Upgrades



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Resources

Comparison of Puppet/Cfengine/Bcfg2
https://cd-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=3967

Evaluation and feature comparison of the Nagios and Zabbix monitoring systems

http://cd-docdb.fnal.gov/cgi-bin/ShowDocument?docid=3277

Download Scientific Linux 6

http://scientificlinux.org/

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