

Monitoring and Managing the Cloud

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Outline

- Functionality of monitoring and management systems
- Ganglia, Nagios: monitoring systems
- Architecture of monitoring systems
- Eucalyptus, OpenStack, CloudStack: IaaS
- Architecture of management systems

What to monitor and manage in Cloud?

- Computer network (servers, switches, etc)
- Network services (SSH, FTP, HTTP, etc)
- Host resources (processor load, disk usage, system logs, etc)
- Power/Energy (UPS, consumption, etc)
- Software (dependencies, instances, licenses, etc)
- Users (permissions, billing, etc)

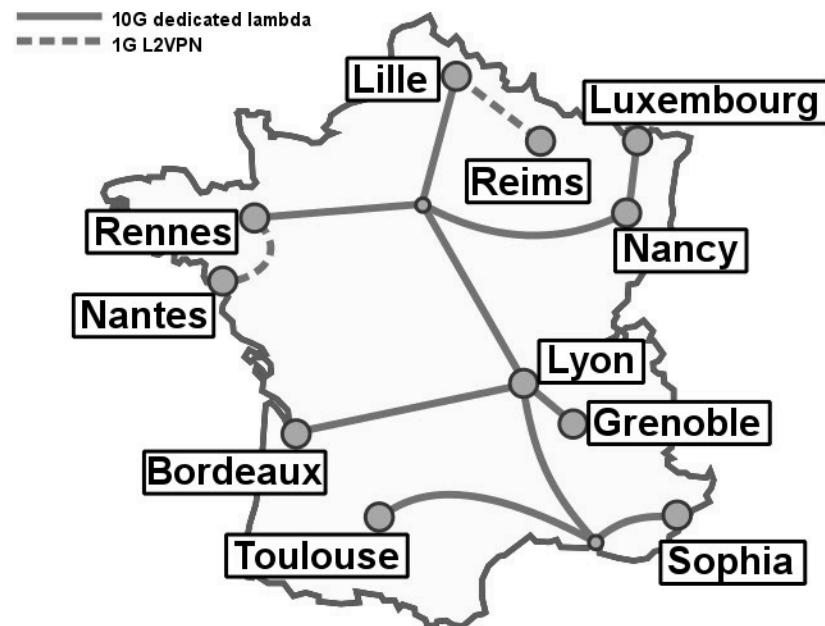
Ganglia: a scalable distributed monitoring tool for HPC systems

- Designed for clusters and grids
- Open-source, written in C, Perl, PHP, Python
- Main components
 - Monitoring daemon on each node
 - Data aggregator on head nodes
 - Web front-end
- Low overhead on nodes
- Multicast communications

<http://en.wikipedia.org/wiki/Multicast>

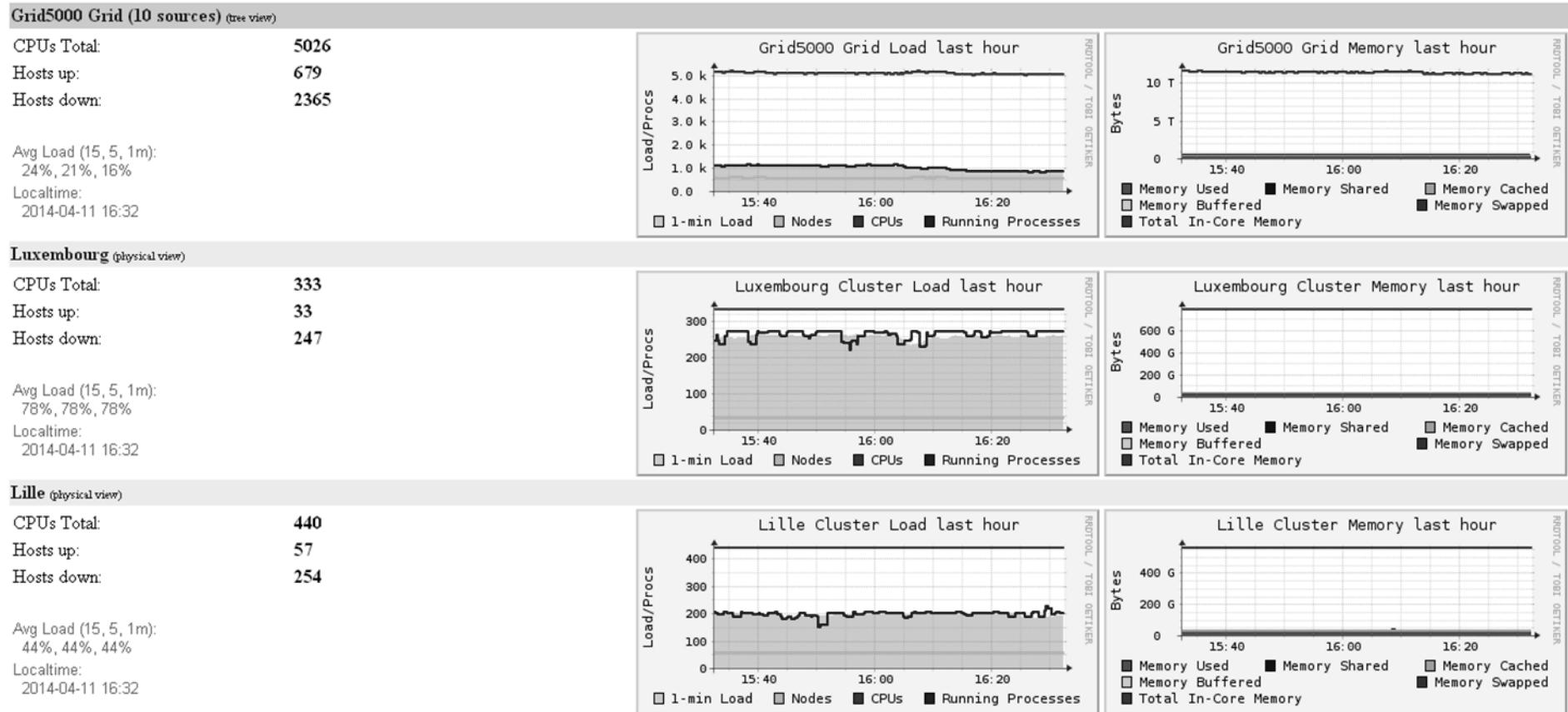
Monitoring systems: a platform for illustration Grid5000

- Highly reconfigurable, controlable and monitorable experimental grid platform (not cloud)
- 10 sites France + 1 site Brazil
- 26 clusters (2 with GPUs)
- 1700 nodes, 7400 cores
- CPU: 1-12 cores, Intel (60%), AMD (40%)
- Network: optical fiber, Myrinet, Infiniband



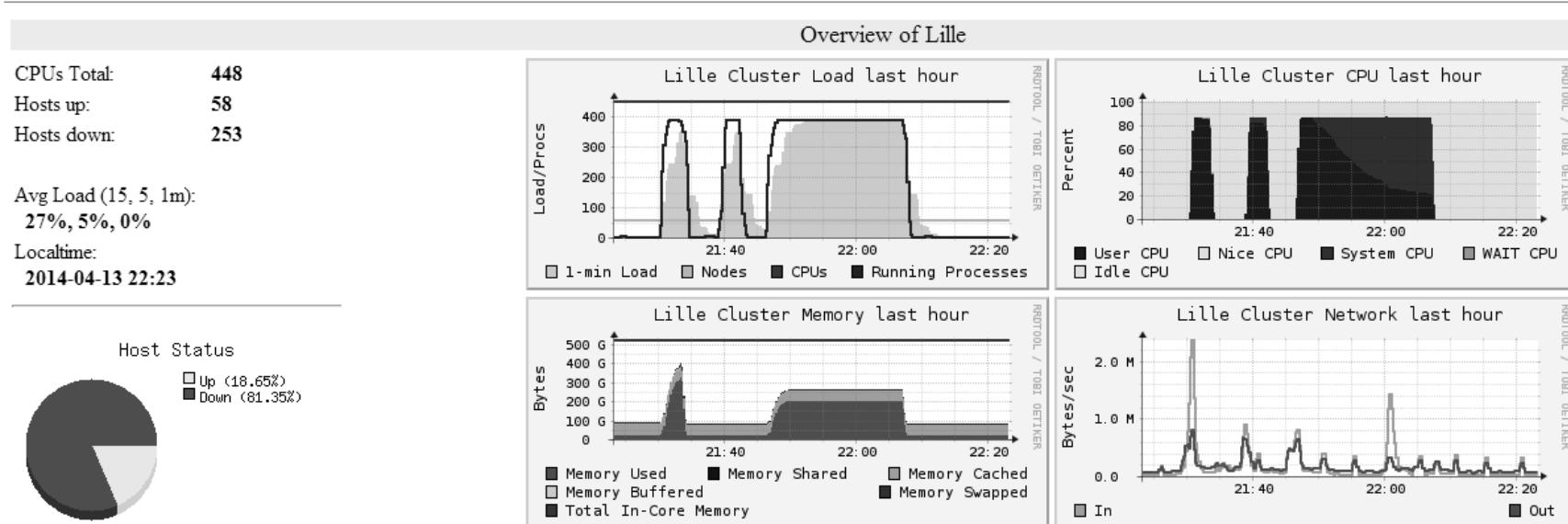
- Grid systems stimulated development of monitoring systems

Ganglia: Grid5000 overview

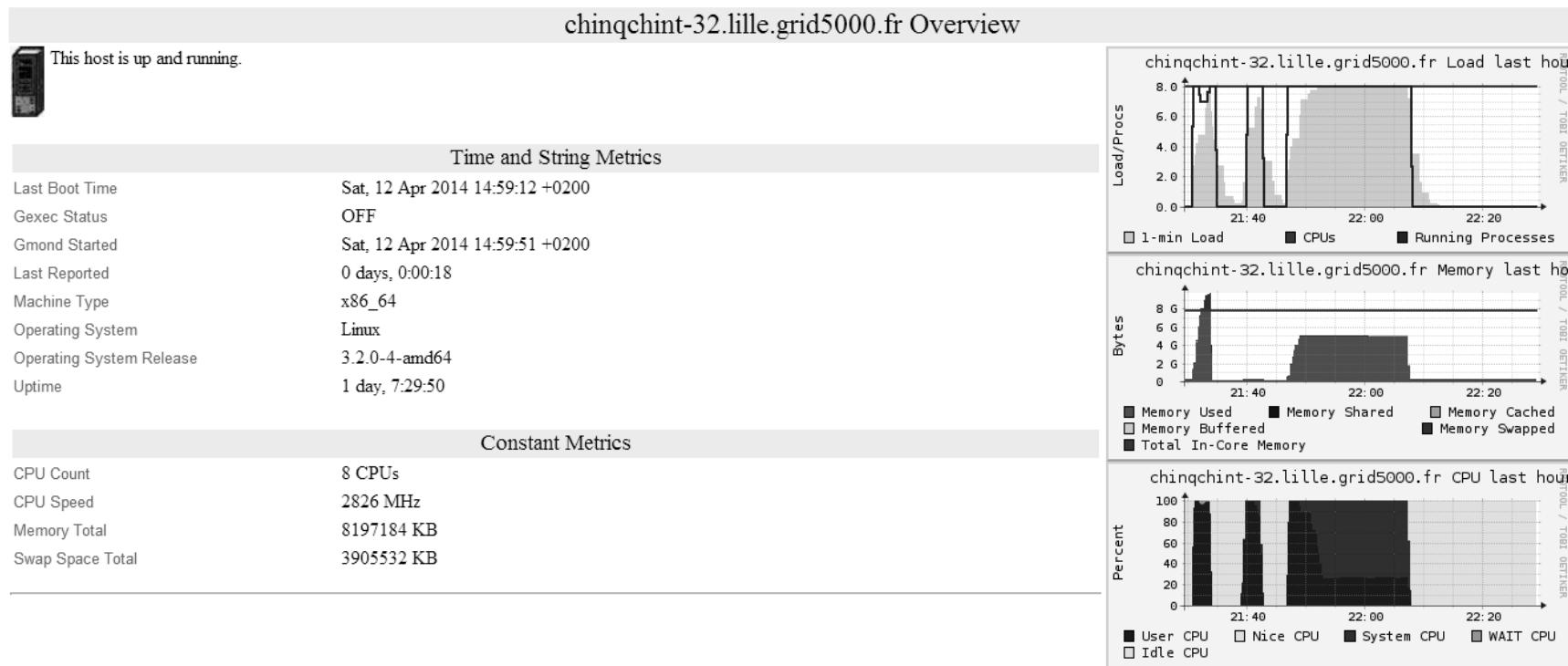


Ganglia: cluster overview

Grid5000 Grid > Lille > [Summary Only]

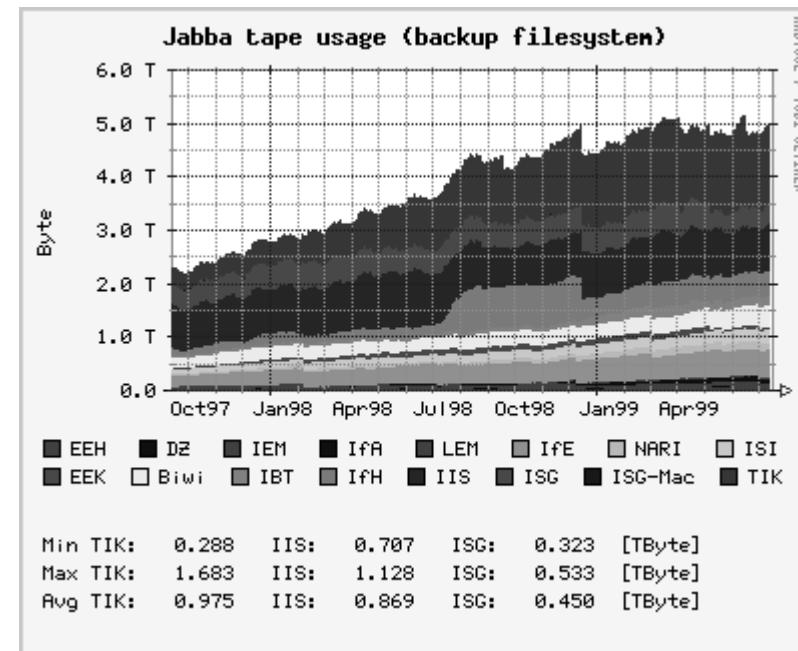


Ganglia: node overview



RRDtool: handling time series

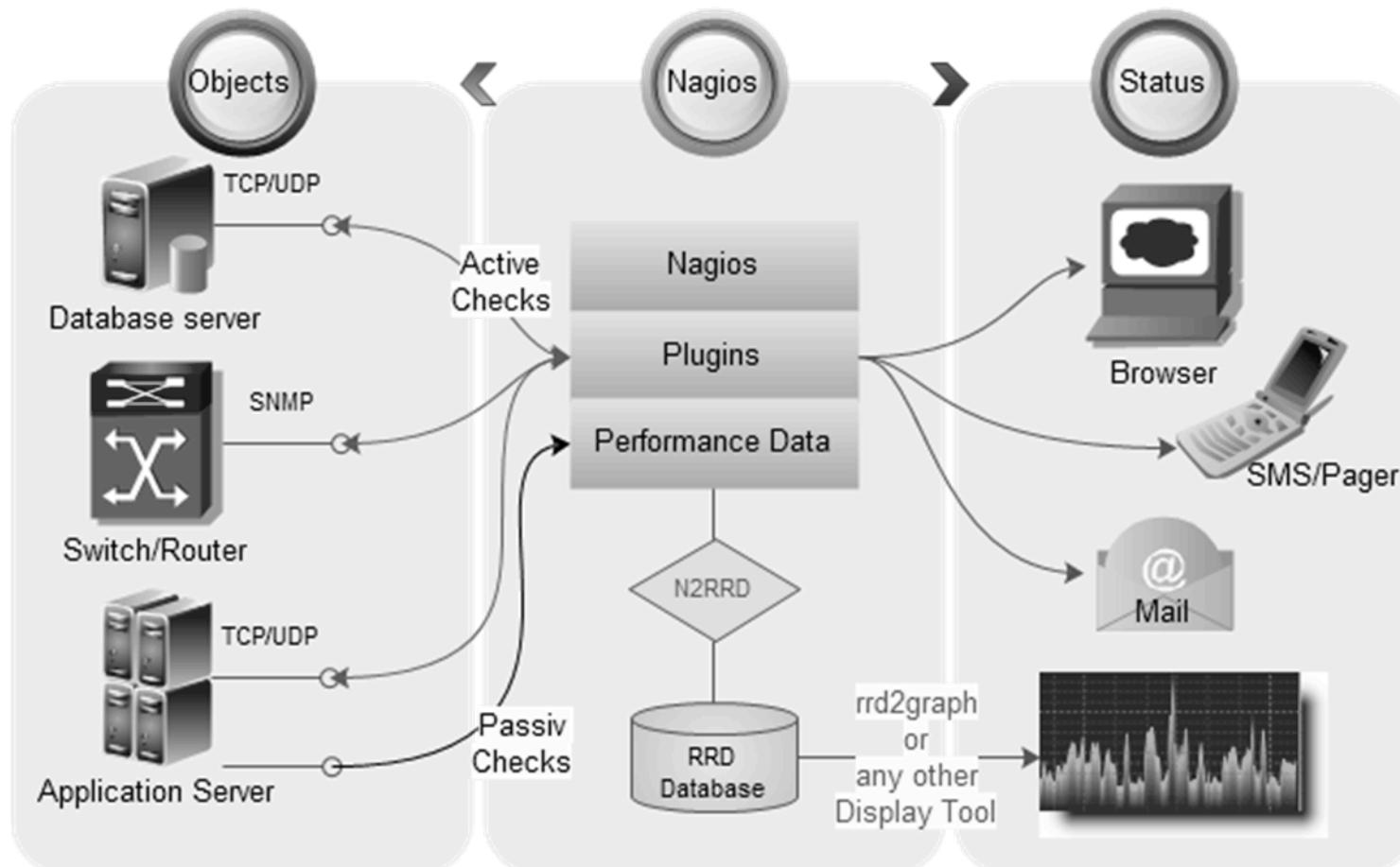
- Used in Ganglia, now in many other monitoring systems
- Functionality:
 - Round-robin database: efficient constant-time storage of time series
http://en.wikipedia.org/wiki/Circular_buffer
 - Extracting time series in a graphical format



Nagios: a platform for system monitoring

- Remote access: various interfaces
- Log storage, graphs and reports
- Extensible (custom monitoring in Shell, C++, Python, etc)
- Used in grid (Grid5000) and cloud (OpenStack) solutions

Nagios: a platform for system monitoring



Nagios architecture

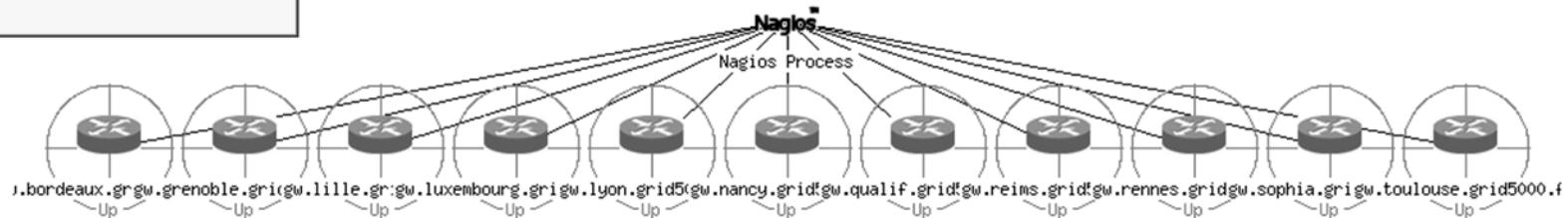
- Nagios process = data reaping + notification
 - Can be run as a service (rcX.d, soft runlevel)
- Web interface
 - External web server (Apache)
 - Bunch of cgi scripts (part of Nagios)
- Configuration
 - Simple text files
 - Or a postgres database
- Logs (local files)
- Named pipe (unix domain socket) to enable nagios to receive commands (from cgi, passive asynchronous events)

Nagios service check

- **Service**
 - Service delivered by a software
 - Percentage of free space on a partition
 - Bandwidth usage on a network interface ...
- **Service check**
 - Provides state information on a service
 - Returns a value: OK, WARNING, CRITICAL (exit status 0, 1, 2), UNKNOWN (exit status 3, due to time out or plugin runtime trouble) to reflect the Nagios view about this service
 - Can be local (OS calls) or remote (ICMP, NRPE, SNMP ...)
 - Is implemented by a plugin (external command/script)

Nagios: Grid5000 network

RENATER4	
Name:	gw.bordeaux.grid5000.fr
Alias:	gw.bordeaux.grid5000.fr
Address:	gw.bordeaux.grid5000.fr
State:	Up
Status Information:	PING OK - Packet loss = 0%, RTA = 21.51 ms
State Duration:	2d 7h 28m 51s
Last Status Check:	2014-04-11 15:15:04
Last State Change:	2014-04-09 07:50:44
Parent Host(s):	None (This is a root host)
Immediate Child Hosts:	0
Services:	
- 1 ok	



Nagios: host groups

Current Network Status

Last Updated: Fri Jan 11 11:49:36 CST 2008
Updated every 90 seconds
Nagios® 3.0rc1 - www.nagios.org
Logged in as nagiosadmin

[View Service Status Detail For All Host Groups](#)
[View Host Status Detail For All Host Groups](#)
[View Status Summary For All Host Groups](#)
[View Status Grid For All Host Groups](#)

Host Status Totals

Up	Down	Unreachable	Pending
17	0	0	0

Service Status Totals

Ok	Warning	Unknown	Critical	Pending
169	4	0	2	0

[All Problems](#) [All Types](#)

0	17
---	----

[All Problems](#) [All Types](#)

6	175
---	-----

Service Overview For All Host Groups

Environmental Probes (environmental-probes)

Host	Status	Services	Actions
em01b	UP	2 OK	
tempraxe1	UP	3 OK 2 WARNING	

Fedora Core 8 Production Servers (fc8-production-servers)

Host	Status	Services	Actions
dev1	UP	33 OK 1 WARNING 1 CRITICAL	
filer	UP	42 OK	
task	UP	37 OK 1 CRITICAL	

Printers (printers)

Host	Status	Services	Actions
hpl2605dn	UP	2 OK	
hpl5mp	UP	2 OK	

Production Linux Servers (production-linux-servers)

Host	Status	Services	Actions
dev1	UP	33 OK 1 WARNING 1 CRITICAL	
filer	UP	42 OK	
lanman	UP	3 OK	
task	UP	37 OK 1 CRITICAL	

Production Websites (production-websites)

Host	Status	Services	Actions
ayamon.com	UP	6 OK	
nagios.com	UP	6 OK	
nagios.org	UP	6 OK	
nagioscommunity.org	UP	6 OK	

Switches (switches)

Host	Status	Services	Actions
linksys-srw224p	UP	1 OK	

Windows Desktop (Windows desktop)

Nagios: services

Current Network Status

Last Updated: Fri Jan 11 11:48:27 CST 2008
Updated every 90 seconds
Nagios® 3.0rc1 - www.nagios.org
Logged in as nagiosadmin

[View History For all hosts](#)
[View Notifications For All Hosts](#)
[View Host Status Detail For All Hosts](#)

Up	Down	Unreachable	Pending
17	0	0	0

Ok	Warning	Unknown	Critical	Pending
169	4	0	2	0

All Problems	All Types
0	17

All Problems	All Types
6	175

Service Status Details For All Hosts

Host ↑↓	Service ↑↓	Status ↑↓	Last Check ↑↓	Duration ↑↓	Attempt ↑↓	Status Information
ayamon.com	DNS	OK	01-11-2008 11:45:08	2d 1h 48m 21s	1/3	DNS OK: 0.017 seconds response time. ayamon.com returns 208.64.136.202
	FTP	OK	01-11-2008 11:44:11	0d 0h 14m 16s	1/3	FTP OK - 10.261 second response time on port 21 [220 ProFTPD 1.3.0 Server (4Admin(tm) FTP Server) [208.64.136.202]]
	HTTP	OK	01-11-2008 11:48:06	0d 23h 0m 21s	1/3	HTTP OK HTTP/1.1 200 OK - 10363 bytes in 0.433 seconds
	IMAP	OK	01-11-2008 11:46:36	2d 1h 46m 51s	1/3	IMAP OK - 0.202 second response time on port 143 [* OK [CAPABILITY IMAP4rev1 UIDPLUS CHILDREN NAMESPACE THREAD=ORDEREDSUBJECT THREAD=REFERENCES SORT QUOTA IDLE ACL ACL2=UNION STARTTLS] Courier-IMAP ready. Copyright 1998-2004 Double Precision, Inc. See COPYING for distribution information.]
	PING	OK	01-11-2008 11:46:34	0d 1h 42m 21s	1/3	OK - 208.64.136.202: rta 97.770ms, lost 0%
	SMTP	OK	01-11-2008 11:44:37	1d 18h 58m 51s	1/3	SMTP OK - 0.401 sec. response time
dev1	/Disk Usage	OK	01-11-2008 11:47:35	1d 23h 42m 21s	1/3	DISK OK - free space: / 6497 MB (60% inode=88%):
	//dev1/html	OK	01-11-2008 11:48:08	1d 23h 40m 46s	1/3	Disk ok - 6.34G (57%) free on \DEV1\HTML
	/boot Disk Usage	OK	01-11-2008 11:48:02	1d 23h 41m 21s	1/3	DISK OK - free space: /boot 223 MB (91% inode=99%):
	/dev/ada S.M.A.R.T.	OK	01-11-2008 11:47:36	1d 23h 40m 51s	1/3	Id= 1, Status=11 {PreFailure , OnLine }, Value=200, Threshold= 51, Passed
	/home Disk Usage	OK	01-11-2008 11:48:09	1d 23h 40m 19s	1/3	DISK OK - free space: /home 2437 MB (84% inode=93%):
	/store Disk Usage	OK	01-11-2008 11:45:23	1d 23h 44m 19s	1/3	DISK OK - free space: /store 683 MB (28% inode=99%):
	/tmp Disk Usage	OK	01-11-2008 11:45:23	1d 23h 44m 19s	1/3	DISK OK - free space: /tmp 1109 MB (97% inode=99%):
	Backups: Home Dirs	OK	01-11-2008 11:44:40	1d 23h 43m 49s	1/3	/store/backups/homedirs/root.tar.gz is OK (0d 5h 41m 40s old, 184094422 bytes)
	Backups: Mondo Rescue	OK	01-11-2008 11:45:08	1d 23h 43m 19s	1/3	/store/backups/mondo/monorescue-1.iso is OK (4d 8h 22m 2s old, 730595328 bytes)
	Backups: MySQL	CRITICAL	01-11-2008 11:47:18	2d 1h 45m 50s	3/3	CRITICAL: mysql_2008-01-02_07h00m.Wednesday.sql.gz is too old (9d 4h 47m 16s old)
Backups:	OK	01-11-2008 11:46:08	1d 23h 42m 20s	1/3	/store/backups/system/etc.tar.gz is OK (0d 8h 45m 52s)	

Nagios: logs

Contact Notifications
Last Updated: Fri Jan 11 12:03:00 CST 2008
Nagios® 3.0rc1 - www.nagios.org
Logged in as nagiosadmin

All Contacts

Latest Archive Log File Navigation
Fri Jan 11 00:00:00 CST 2008 to Present..

File: /usr/local/nagios/var/nagios.log

Host	Service	Type	Time	Contact	Notification Command	Information
filer	Yum Updates	OK	01-11-2008 11:45:06	nagiosadmin	notify-service-by-email	YUM OK: O/S is up to date.
filer	Memory Usage	OK	01-11-2008 11:42:56	nagiosadmin	notify-service-by-email	OK - 308 / 756 MB (40%) Free Memory, Used: 448 MB, Shared: 0 MB, Buffers: 59 MB, Cached: 274 MB
nero	Physical Memory Usage	WARNING	01-11-2008 11:39:06	nagiosadmin	notify-service-by-email	WARNING: physical memory: Total: 0.999G - Used: 663M (64%) - Free: 360M (36%) > warning
ayamon.com	FTP	OK	01-11-2008 11:34:31	nagiosadmin	notify-service-by-email	FTP OK - 10.753 second response time on port 21 [220 ProFTPD 1.3.0 Server (4Admin(lm) FTP Server) [208.64.138.202]]
filer	Memory Usage	WARNING	01-11-2008 11:32:51	nagiosadmin	notify-service-by-email	WARNING - 8 / 756 MB (1%) Free Memory, Used: 748 MB, Shared: 0 MB, Buffers: 46 MB, Cached: 434 MB
ayamon.com	FTP	CRITICAL	01-11-2008 11:24:14	nagiosadmin	notify-service-by-email	No data received from host
filer	Memory Usage	OK	01-11-2008 11:23:54	nagiosadmin	notify-service-by-email	OK - 276 / 756 MB (36%) Free Memory, Used: 480 MB, Shared: 0 MB, Buffers: 62 MB, Cached: 176 MB
temptraxe1	Probe 2	WARNING	01-11-2008 11:18:13	nagiosadmin	notify-service-by-email	Temp Warning: Attic = 39.8 F
temptraxe1	Probe 1	WARNING	01-11-2008 11:13:53	nagiosadmin	notify-service-by-email	Temp Warning: Furnace Room = 80.7 F
task	Backups: MySQL	CRITICAL	01-11-2008 11:12:03	nagiosadmin	notify-service-by-email	CRITICAL: mysql_2008-01-02_07h00m.Wednesday.sql.gz is too old (9d 4h 11m 58s old)
dev1	Backups: MySQL	CRITICAL	01-11-2008 11:11:43	nagiosadmin	notify-service-by-email	CRITICAL: mysql_2008-01-02_07h00m.Wednesday.sql.gz is too old (9d 4h 11m 37s old)
dev1	Memory Usage	WARNING	01-11-2008 11:10:43	nagiosadmin	notify-service-by-email	WARNING - 93 / 1010 MB (8%) Free Memory, Used: 917 MB, Shared: 0 MB, Buffers: 136 MB, Cached: 640 MB
filer	Yum Updates	CRITICAL	01-11-2008 11:09:33	nagiosadmin	notify-service-by-email	CHECK_NRPE: Socket timeout after 10 seconds.
nero	Physical Memory Usage	WARNING	01-11-2008 10:34:06	nagiosadmin	notify-service-by-email	WARNING: physical memory: Total: 0.999G - Used: 675M (66%) - Free: 348M (34%) > warning
filer	Memory Usage	WARNING	01-11-2008 10:28:57	nagiosadmin	notify-service-by-email	WARNING - 73 / 756 MB (9%) Free Memory, Used: 683 MB, Shared: 0 MB, Buffers: 101 MB, Cached: 471 MB
temptraxe1	Probe 4	OK	01-11-2008 10:18:07	nagiosadmin	notify-service-by-email	Temp Ok: Probe 4 = 23.6 F
temptraxe1	Probe 2	WARNING	01-11-2008 10:18:07	nagiosadmin	notify-service-by-email	Temp Warning: Attic = 38.7 F
temptraxe1	Probe 3	OK	01-11-2008 10:13:37	nagiosadmin	notify-service-by-email	Temp Ok: Port 3 = 72.8 F
temptraxe1	Probe 1	WARNING	01-11-2008 10:13:37	nagiosadmin	notify-service-by-email	Temp Warning: Furnace Room = 81.4 F
temptraxe1	Probe 2	CRITICAL	01-11-2008 10:13:07	nagiosadmin	notify-service-by-email	(Return code of 127 is out of bounds - plugin may be missing)

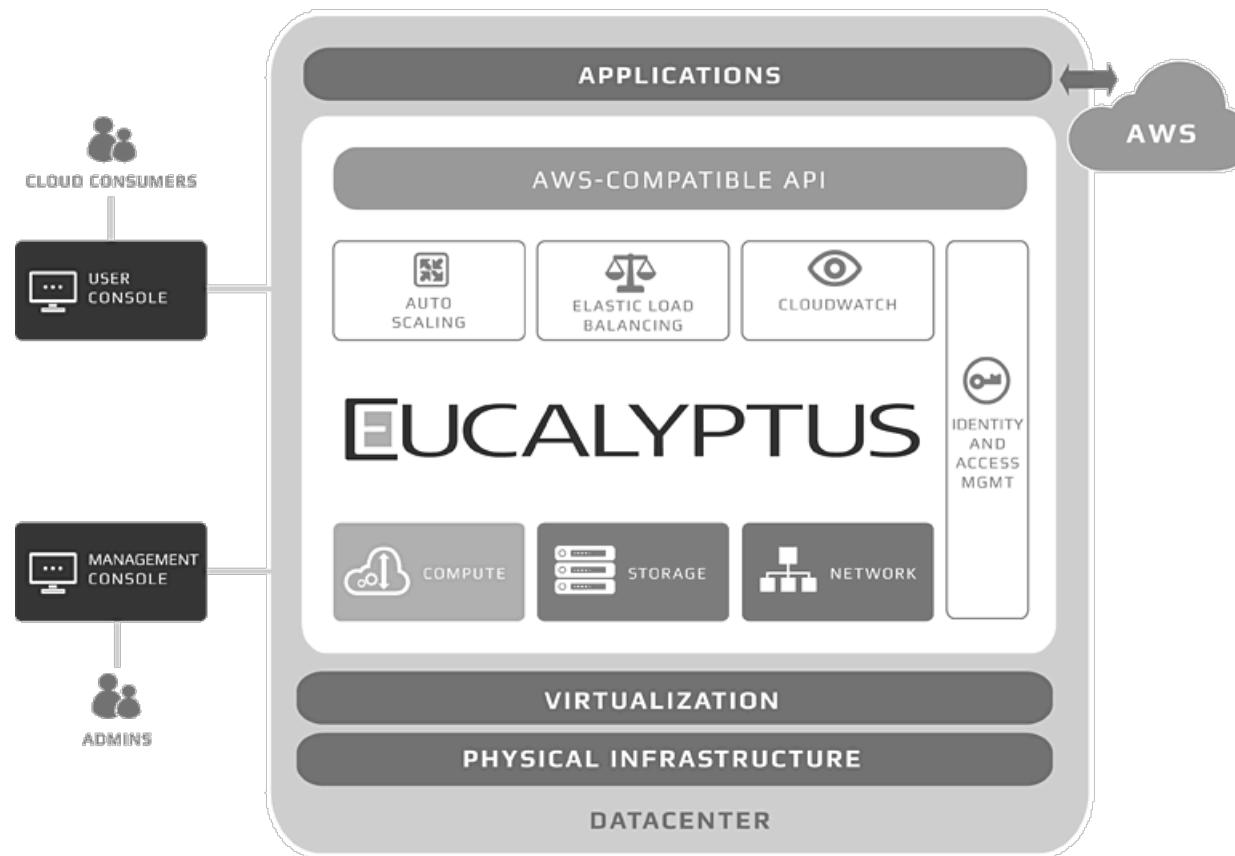
Architecture of monitoring systems

- Core (core functionality, complex configuration, API)
- Monitoring daemons for different types of objects (low overhead)
- Performance data module (storage, visualization of time series)
- Extensions (monitoring new types of objects, supporting new clients, advanced data analysis)

Eucalyptus: IaaS solution

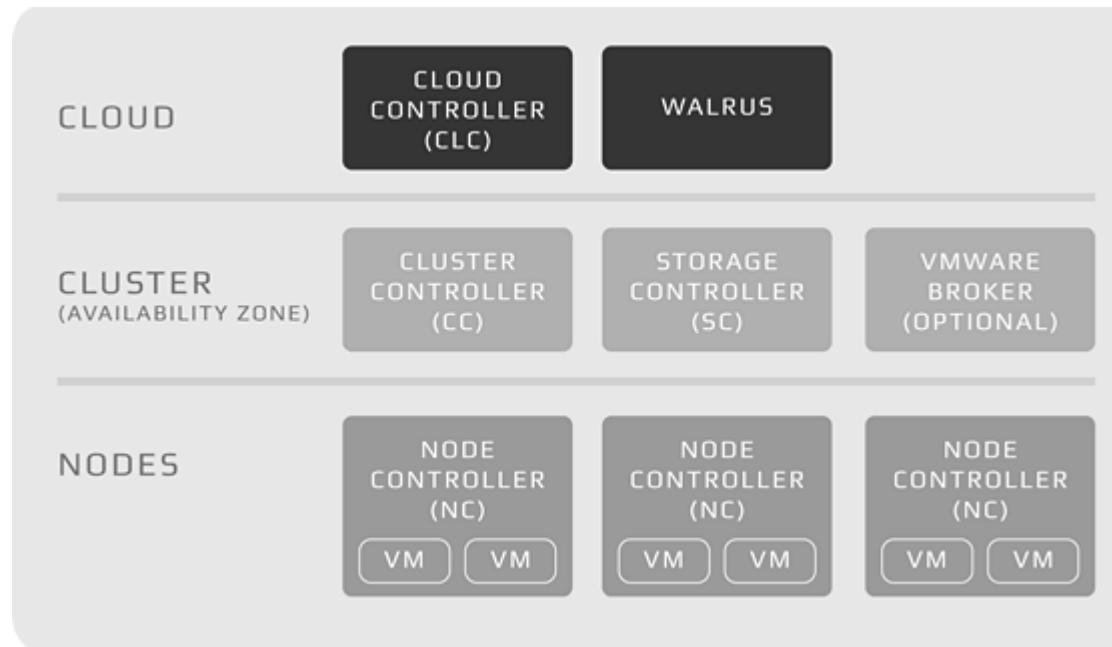
- Elastic Utility Computing Architecture Linking Your Programs To Useful Systems
- Open-source software for building AWS-compatible private and hybrid clouds
- Distributed system with monitoring and management components
 - Linux distribution agnostic
 - Ubuntu, RHEL, CentOS, SLES, openSUSE, Debian
 - Hypervisor agnostic
 - Xen, KVM, VMware

Eucalyptus: architecture



- Management console: monitoring and managing cloud resources

Eucalyptus: architecture



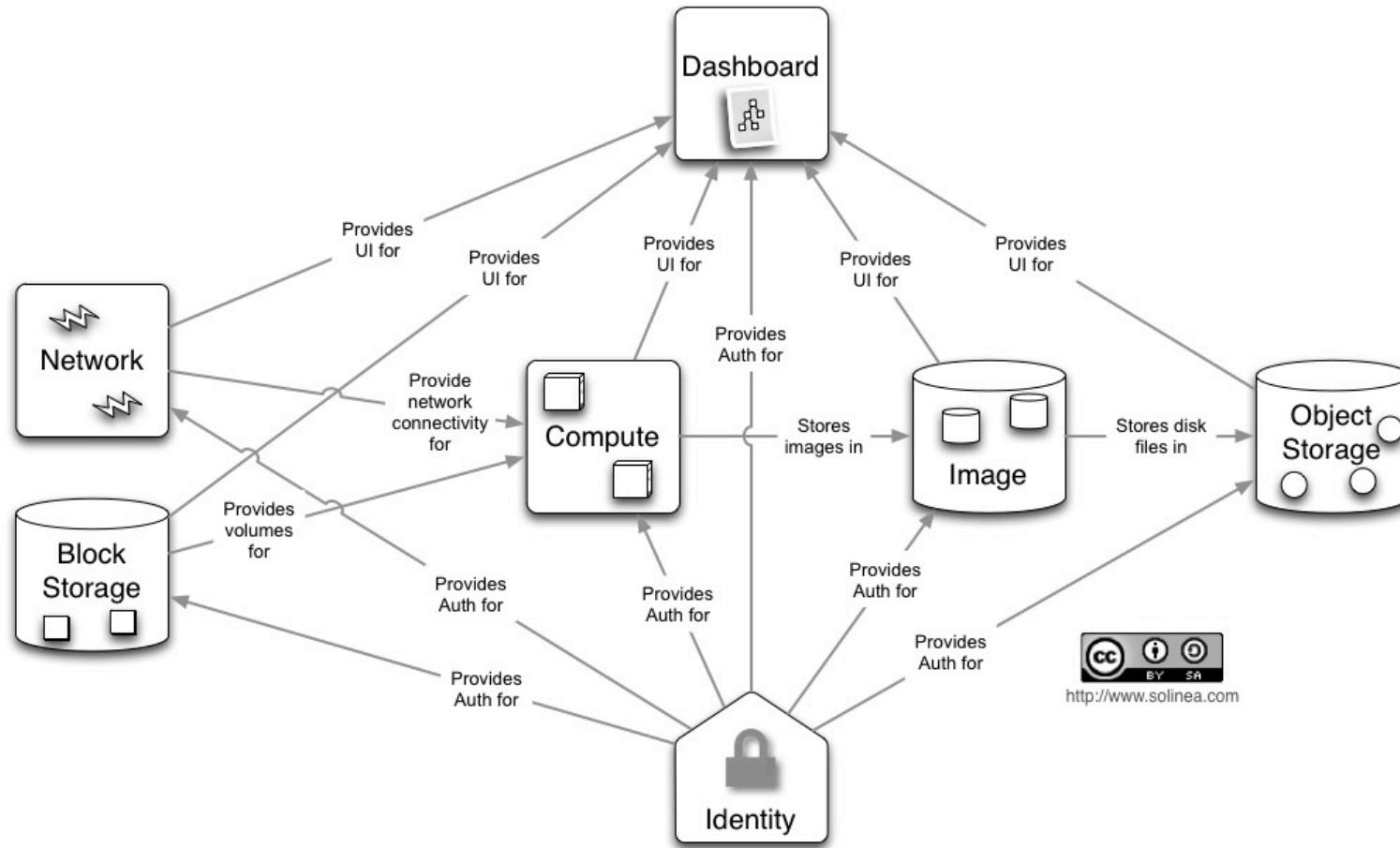
Eucalyptus: architecture

- **Cloud controller:** entry point to cloud, exposing and managing all resources to different groups of users
- **Walrus:** cloud storage service (like AWS S3), managing the images and persistent data of virtual machines
- **Cluster controller:** manages VMs execution in a cluster
- **Node controller:** hosts VMs on a node
- **Storage controller:** blocked-accessed network storage (like AWS EBS)

OpenStack: IaaS solution

- Open-source cloud computing platform for public and private clouds
- Compatible with Amazon EC2, S3
- Cloud services expose interfaces to manage network, storage, nodes, users

OpenStack: architecture



OpenStack: architecture

- Dashboard ("Horizon") provides a web front end to the other OpenStack services
- Compute ("Nova") stores and retrieves virtual disks ("images") and associated metadata in Image ("Glance")
- Network ("Quantum") provides virtual networking for Compute.
- Block Storage ("Cinder") provides storage volumes for Compute.
- Image ("Glance") can store the actual virtual disk files in the Object Store("Swift")
- All the services authenticate with Identity ("Keystone")

Architecture of management systems

- Control panel: controls cloud services and provides GUI to different groups of users
- Cloud service: exposes interface to manage a certain type of resources
- Cloud storage: manages VM images and persistent data