Enabling Grids for E-science in Europe

Chania, September 18th-19th, 2006

LCG/EGEE Grids & System Administration

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Watch out what you wish for!

Enabling Grids for E-science in Europe

Scope

Enabling Grids for E-science in Europe

- Explain runtime operations and how the workflow will evolve
- Explain new site deployment and upgrade procedures
- Transfer experience gained during HellasGrid I & II phases
- What is GGUS, the egee-see helpdesk and other friends
- Runtime operations include
  - Site problem solving (ROC Support Team)
  - Minor upgrades (Operations Coordination Team)
  - Configuration changes (Operations Coordination Team)
  - Security incidents (Security Coordination Team)

The ROC structure within SEE

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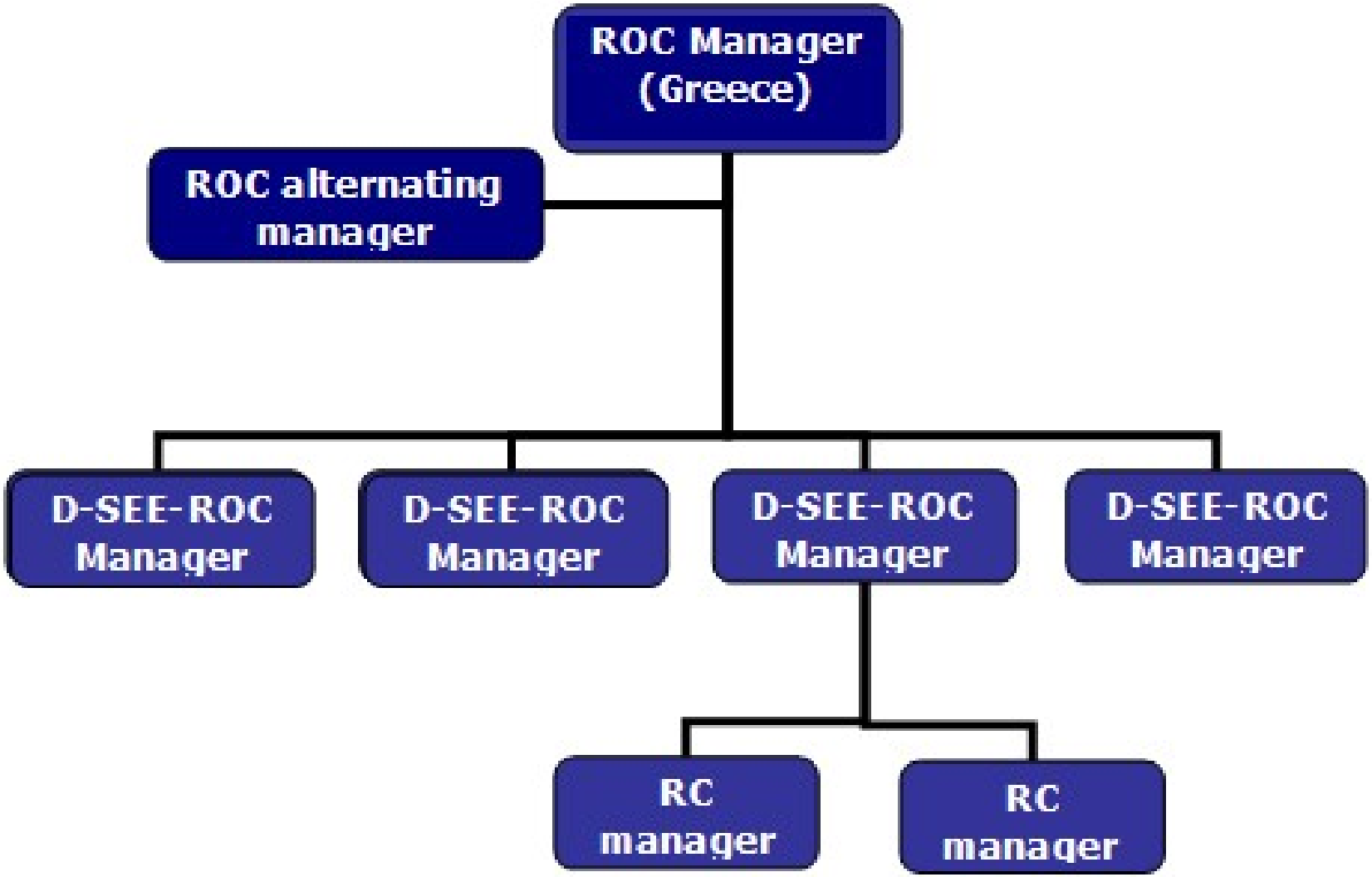
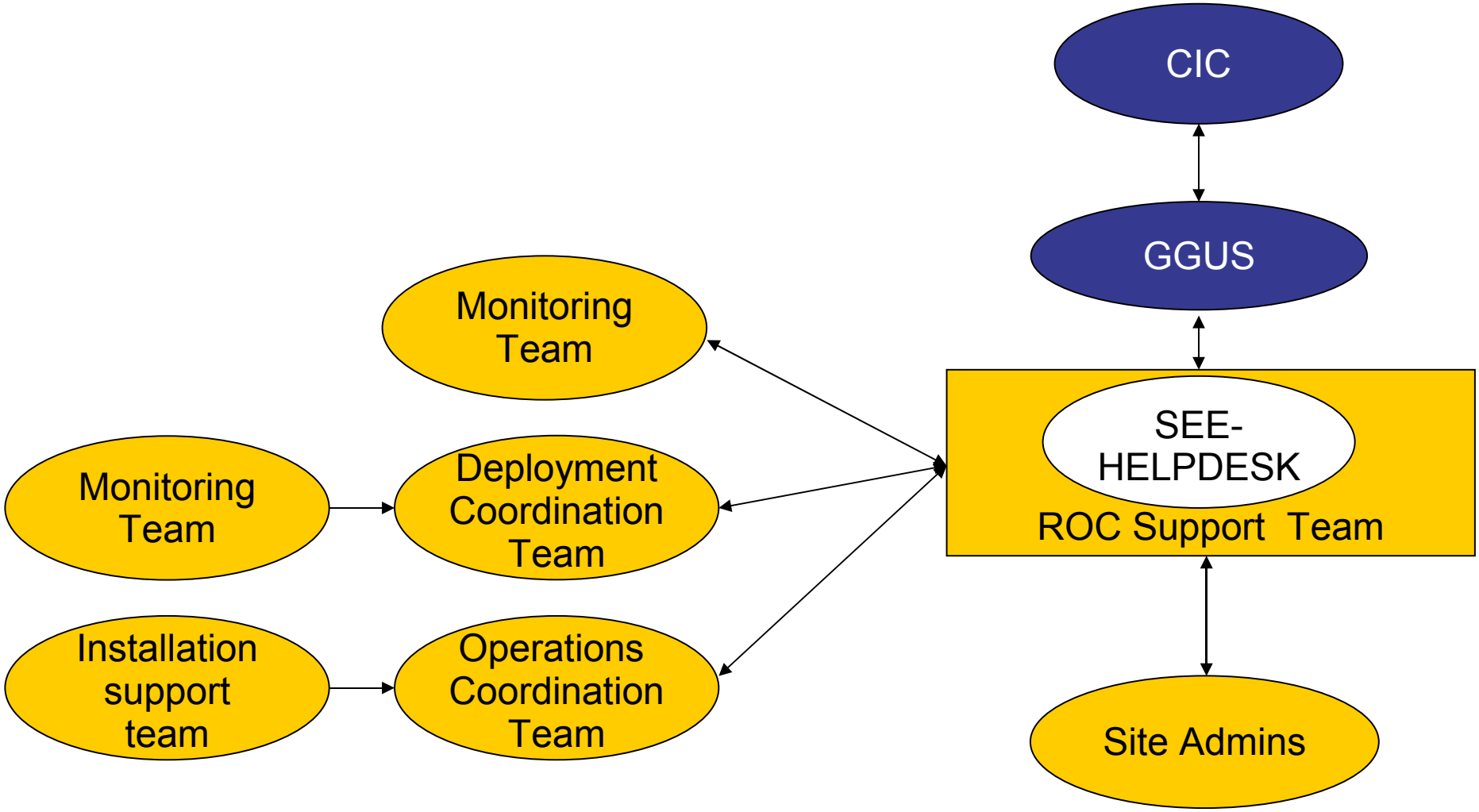


Prospective information workflow



Site deployment

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- Involves 3 steps:

1. Site registration, done in coordination with the Deployment Coordination Team (DCT) – 'candidate site'
2. Site installation, done with the guidance and assistance of the Installation Support Team (IST) and the DCT - 'uncertified site'
3. Site certification, in coordination with the CIC-on-duty and the Site Certification Team (SCT) - 'certified site'

Site induction procedure

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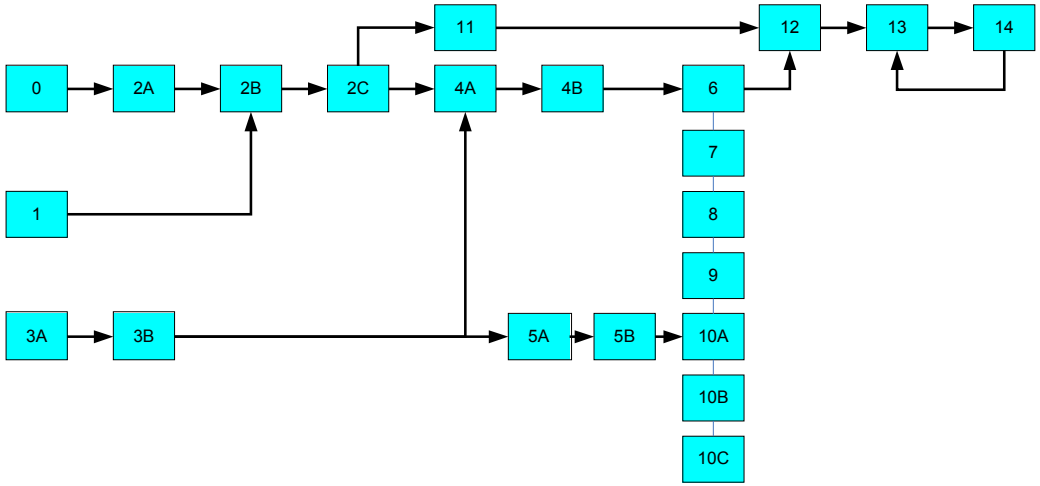
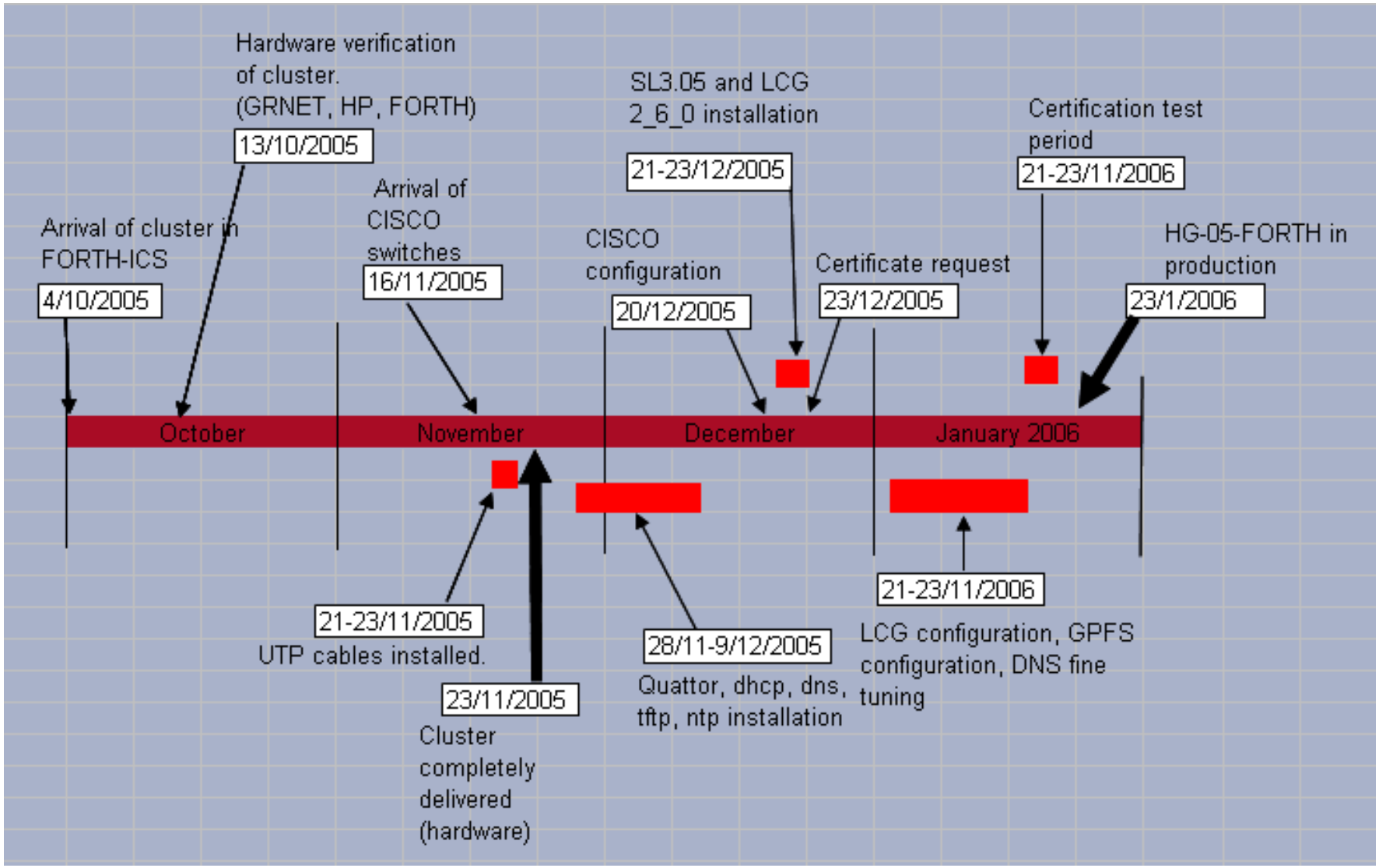
- Follow the 10-step registration procedure, as described here: http://www.egee-see.org/Site_registration.php
- Perform a site installation according to the instructions here: http://lcg.web.cern.ch/LCG/Sites/releases.html
- Follow the 5-step certification sequence: http://www.egee-see.org/Site_certification.php
- Successful Site Functional Tests for five consecutive days, imply the site is stable enough to be considered "Production"
- DCT changes site status in the GOC database to '*certified*'
- From now on the site will submit the relevant weekly reports, also known as RC reports, Friday – Monday 11:00AM(GMT): https://cic.in2p3.fr/index.php?id=rc&subid=rc_report&js_status=2

The complexities of a full site setup



0) UI account setup (Isabella or local)
1) An academic sends a fax to Hellasgrid CA, mentioning sysadmin's name
2A) User certificate is created by sysadmin(s), for himself
2B) Accept user certificate against CA, within a week's time!
2C) convert user certificate to pkcs12, add to browser and mail client
3A) Decide for IP, NTP and DNS configuration (addresses, names, servers)
3B) Verify NTP, DNS (forward and reverse) with host, www.dnsstuff.com etc
4A) Host certificates are created by sysadmin(s), (for CE, SE, MON ...)
4B) Accept host certificates against CA, within a week's time!
5A) Istall SL30x to your systems
5B) Setup Java, NTP, lcg-yaim
6) Configure CE
7) Configure SE
8) Configure WNs
9) Configure MON 9B) & send its IP address to RGMA DB
10) Configure UI and/or 10B) BDII 10C) RB
11) Add site to GOCdb & inform ROC manager, update GOCdb
12) Ask Isabella's team for SFTs
13) Identify any erroneous entries with SFTs
14) Perform corrective actions for errors found in 13)

A real installation: HG-05-FORTH



Site registration procedure

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- Resource admin at candidate site obtains a certificate from Certification Authority (CA) eg. http://ca.hellasgrid.gr or http://ca.egee-see.org
- Site manager contacts the ROC Deployment Coordination Team (DCT)

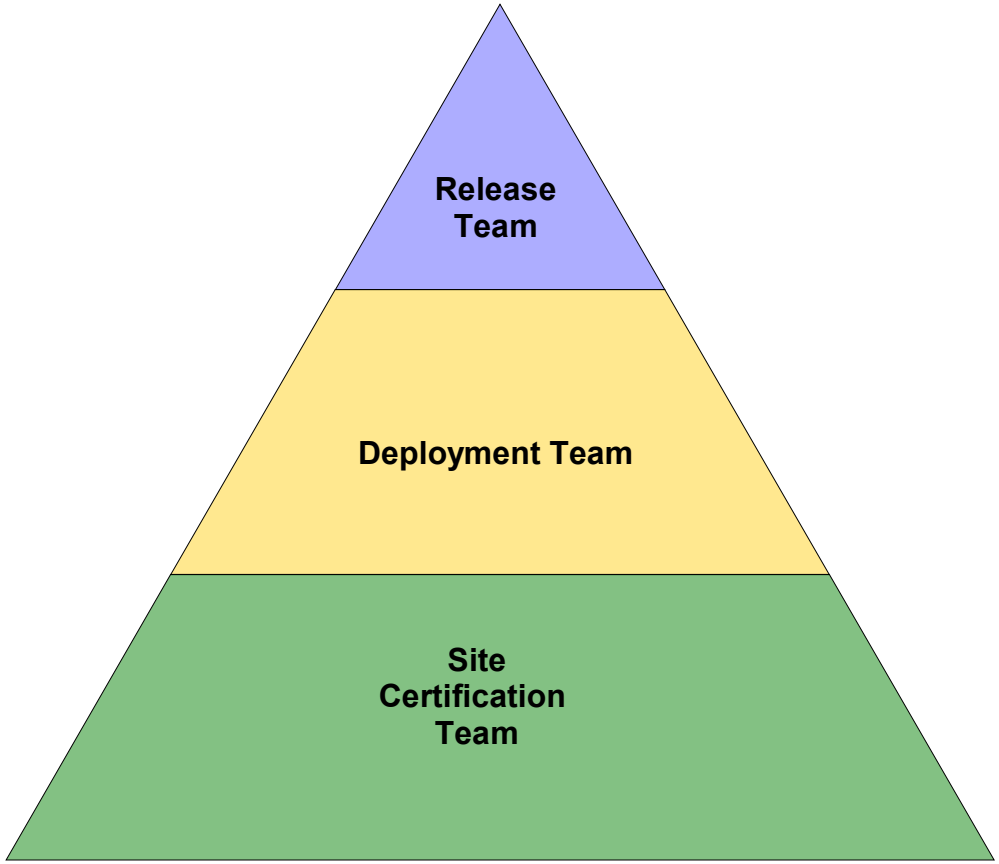
  Providing:

  2. Statement of acceptance of policy documents. http://www.egee-see.org/aup
  3. Site contact information
  4. HW details in the Infrastructure.xls
  5. Statement of agreement with LCG/EGEE Security Incident Response procedures https://edms.cern.ch/file/428035/LAST_RELEASED/LCG_Incident_Response.pdf
- DCT validates the information and creates the new site's record in the GOC database; site status is *'**candidate**'*.
- Site to register with the helpdesk https://helpdesk.egee-see.org/
- Resource Admin at the site enters the remaining information in the GOC database, and then requests validation by the DCT
- The DCT validates the information and changes the site status to *'**uncertified**'*

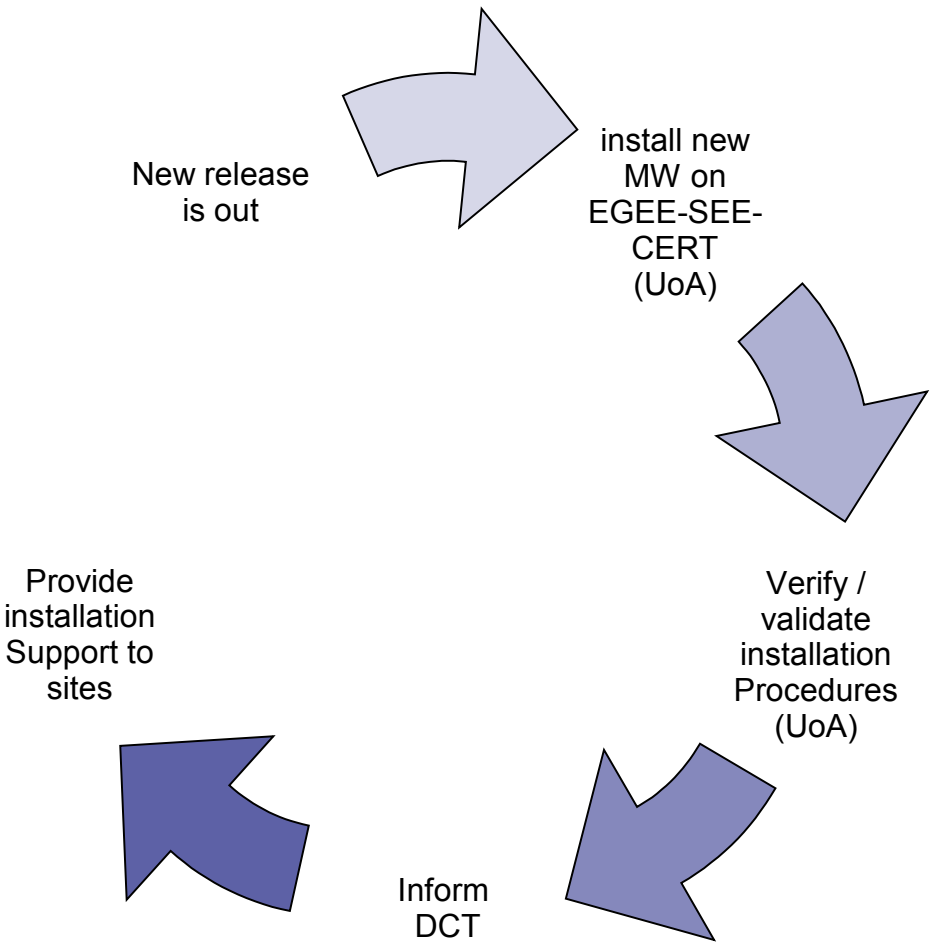
Site installation

- Done with the guidance and assistance of the IST and the DCT
  - Installation support through egee-see helpdesk
- Using the Installation Guidelines at
  - http://lcg.web.cern.ch/LCG/Sites/releases.html
- Supported OS: SL 305, SLC306, RHEL3 or similar

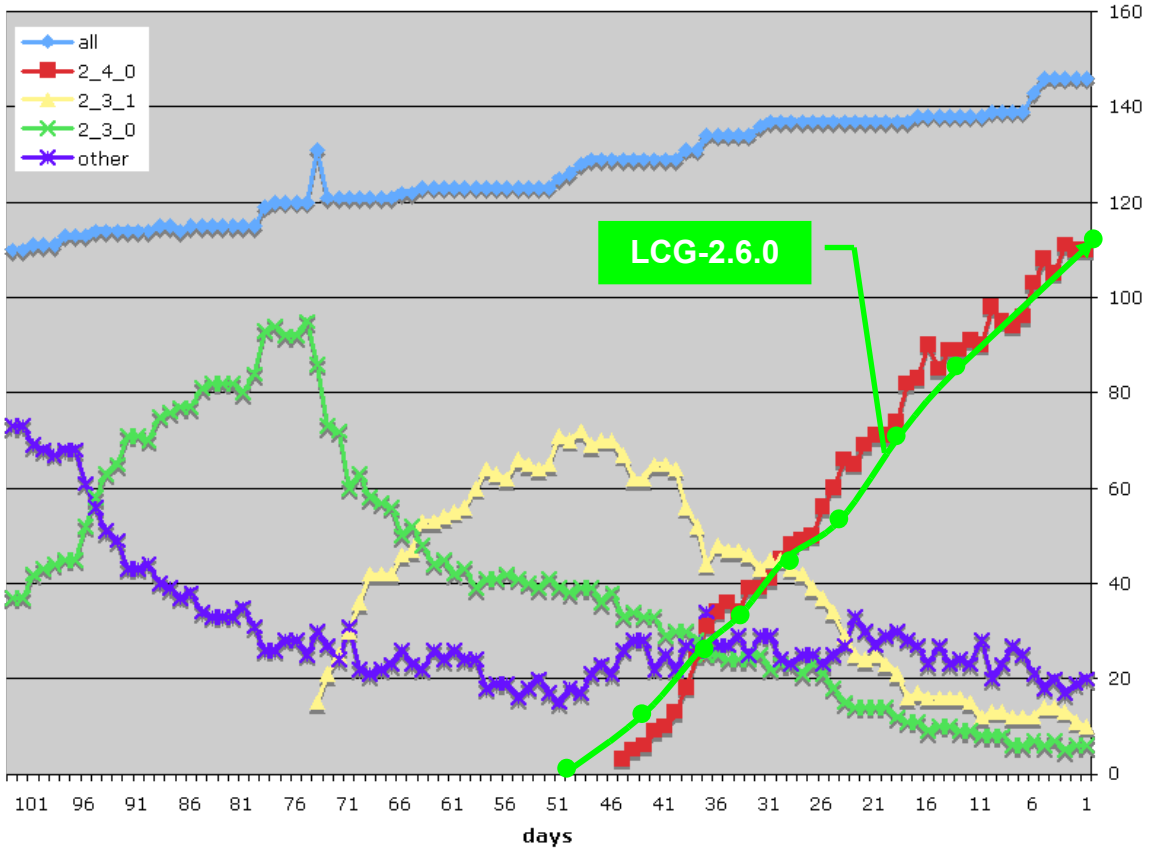
Site deployment/upgrade workflow



Deployment/upgrade workflow (Release Team)



Upgrade cases of the LCG Testbed



- **Time to upgrade ~constant (~2.5 sites/day)**
- **Takes a long time, O(#sites), to upgrade entire infrastructure**
- **Better now than it was – site functional tests and operational oversight**
- **Need to move away from the need to do full upgrades more than 1-2 times / year**
  - But need to be able to deploy updates, new tools, security patches, etc.

Vicious circle of problem solving

Problem detection

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- Done mostly by CIC-on-duty, but also ROC
- 1. Problem usually spotted using one of:
  - **GIIS Monitor**: http://goc.grid.sinica.edu.tw/gstat/
  - **Site Functional Tests**: https://lcg-sft.cern.ch/sft/lastreport.cgi
  - **Grid ICE**: http://gridice2.cnaf.infn.it:50080/gridice/site/site.php
  - **GOC Database**: https://goc.grid-support.ac.uk/gridsite/db
  - **GOC Site Map**: http://goc02.grid-support.ac.uk/googlemaps/lcg.html
  - **GOC Live Job Monitor**: http://gridportal.hep.ph.ic.ac.uk/rtm/
- 2. CICs open a Ticket at Savannah and/or GGUS (https://savannah.cern.ch/projects/lcg2sites) and sends an e-mail to site Administrators and the ROC **support team** grid-support@egee-see.org.
- Site admins should look at:
  - A) the GIIS Monitor and
  - B) the Site Functional Tests and start working on a problem ASAP

Monitoring tools: GIIS Monitor

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- GIIS Monitor (http://goc.grid.sinica.edu.tw/gstat/)

No	Site Reports	GIIS Host	bnode	cernse	gperf	sanity	serv	version	totalCPU	freeCPU	runJob	waitJob	seAvail TB	seUsed TB	maxCPU	avgCPU	DI	gice	
1	BG-INRNE	ce1.inrne.bas.bg	ok	ok	ok	ok	ok	GLITE-3_0_2	26	8	18	0	0.90	0.00	27	24	OK	ok	
2	BG01-IPP	ce002.ipp.acad.bg	.	.	ok	warn	ok	na	18	9	9	154	0.90	0.10	18	15	OK	OK	info
3	BG02-IM	ce001.imbm.bas.bg	.	.	ok	ok	ok	GLITE-3_0_2	3	2	1	0	0.02	0.03	3	2	OK	ok	
4	BG04-ACAD	ce02.grid.acad.bg	.	.	ok	ok	ok	GLITE-3_0_2	80	60	20	0	0.04	0.01	80	78	OK	ok	
5	BG05-SUGrid	ce001.grid.uni-sofia.bg	.	.	ok	ok	ok	GLITE-3_0_0	14	8	6	8	0.03	0.04	14	4	OK	ok	
6	CY-01-KIMON	ce101.grid.ucy.ac.cy	ok	ok	ok	ok	ok	GLITE-3_0_1	70	51	19	0	0.19	0.01	72	69	OK	ok	
7	GR-01-AUTH	node001.grid.auth.gr	.	.	ok	ok	ok	GLITE-3_0_0	14	11	3	9	0.17	0.03	14	12	OK	.	
8	GR-03-HEPNTUA	ce.hep.ntua.gr	.	.	ok	ok	ok	GLITE-3_0_2	22	18	10	0	0.78	0.06	49	23	OK	ok	
9	GR-04-FORTH-ICS	grid001.ics.forth.gr	.	.	ok	note	ok	GLITE-3_0_0	5	2	3	36	0.00	0.01	5	4	OK	ok	
10	GR-05-DEMOKRITOS	ikaros4.inp.demokritos.gr	.	.	ok	ok	ok	GLITE-3_0_0	24	18	0	0	1.68	0.00	44	40	SD	.	
11	GR-06-IASA	ce02.marie.hellasgrid.gr	.	.	ok	ok	ok	GLITE-3_0_1	20	2	18	1	0.17	0.00	20	17	OK	info	
12	HG-01-GRNET	ce01.isabella.grnet.gr	ok	ok	ok	ok	ok	GLITE-3_0_2	64	1	63	7	3.32	1.46	64	63	OK	ok	
13	HG-02-IASA	ce01.marie.hellasgrid.gr	.	.	ok	ok	ok	GLITE-3_0_1	118	40	78	0	2.68	0.17	118	117	OK	info	
14	HG-04-CTI-CEID	ce01.kallisto.hellasgrid.gr	.	.	ok	ok	ok	GLITE-3_0_0	120	30	93	0	2.47	0.15	120	116	OK	ok	
15	HG-05-FORTH	ce01.ariagni.hellasgrid.gr	.	.	ok	ok	ok	GLITE-3_0_0	116	2	116	9	2.69	0.22	120	99	OK	ok	
16	HG-06-EKT	ce01.athena.hellasgrid.gr	ok	ok	ok	ok	ok	GLITE-3_0_2	226	1	225	17	9.37	0.00	228	207	OK	OK	ok
17	LCG-IL-OU	grid01.cslab.openu.ac.il	.	.	ok	ok	ok	GLITE-3_0_0	10	1	9	27	0.11	0.01	10	9	OK	ok	
18	TAU-LCG2	lcfgng.cs.tau.ac.il	.	.	ok	ok	ok	GLITE-3_0_1	19	2	30	33	0.08	0.01	22	11	OK	.	
19	TECHNION-LCG2	ds-lcg-ce01.cs.technion.ac.il	.	.	ok	ok	ok	GLITE-3_0_2	13	9	0	0	0.09	0	18	3	JL	.	
20	WEIZMANN-LCG2	wipp-ce.weizmann.ac.il	ok	ok	ok	ok	ok	GLITE-3_0_1	50	20	26	8	0.09	0.06	50	48	OK	ok	
21	MK-01-UKIM_II	grid-ce.ii.edu.mk	.	.	ok	ok	ok	GLITE-3_0_0	12	9	3	0	0.21	0.00	12	11	OK	ok	
22	NIHAM	alice003.nipne.ro	.	.	ok	ok	ok	GLITE-3_0_1	2	2	0	0	0.04	0.00	2	1	OK	ok	
23	RO-01-ICI	testbed001.grid.ici.ro	.	.	ok	ok	ok	GLITE-3_0_1	20	16	2	0	0.40	0.01	20	19	OK	.	
24	RO-02-NIPNE	tbat01.nipne.ro	.	.	ok	ok	ok	GLITE-3_0_1	102	86	16	0	0.36	0.05	102	101	OK	ok	
25	TR-01-ULAKBIM	ce.ulakbim.gov.tr	ok	ok	ok	ok	ok	GLITE-3_0_2	85	54	12	10	2.36	0.69	108	95	JS	JS	ok
26	AEGIS01-PHY-SCL	ce.phy.bg.ac.yu	ok	ok	ok	ok	ok	GLITE-3_0_2	101	1	100	200	0.05	0.08	101	97	OK	OK	ok
							sites	countries	totalCPU	freeCPU	runJob	waitJob	seAvail TB	seUsed TB	maxCPU	avgCPU			
		Total					26	8	1354	463	880	519	29.32	3.33	1441	1285			

Monitoring tools: SFTs

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- Site Functional Tests (https://lcg-sft.cern.ch/sft/lastreport.cgi)

Test summary

	SD	JL	JS	CT	OK	total
dteam			1		5	6

Colours definition

SD	Scheduled downtime	#a3a3a3
JL	Job list match failed	#aab3ff
JS	Job submission failed	#f4876b
CT	Critical tests failed	#f9d48e
NT	Non-critical tests failed	#f2f98e
OK	OK	#b2f98e

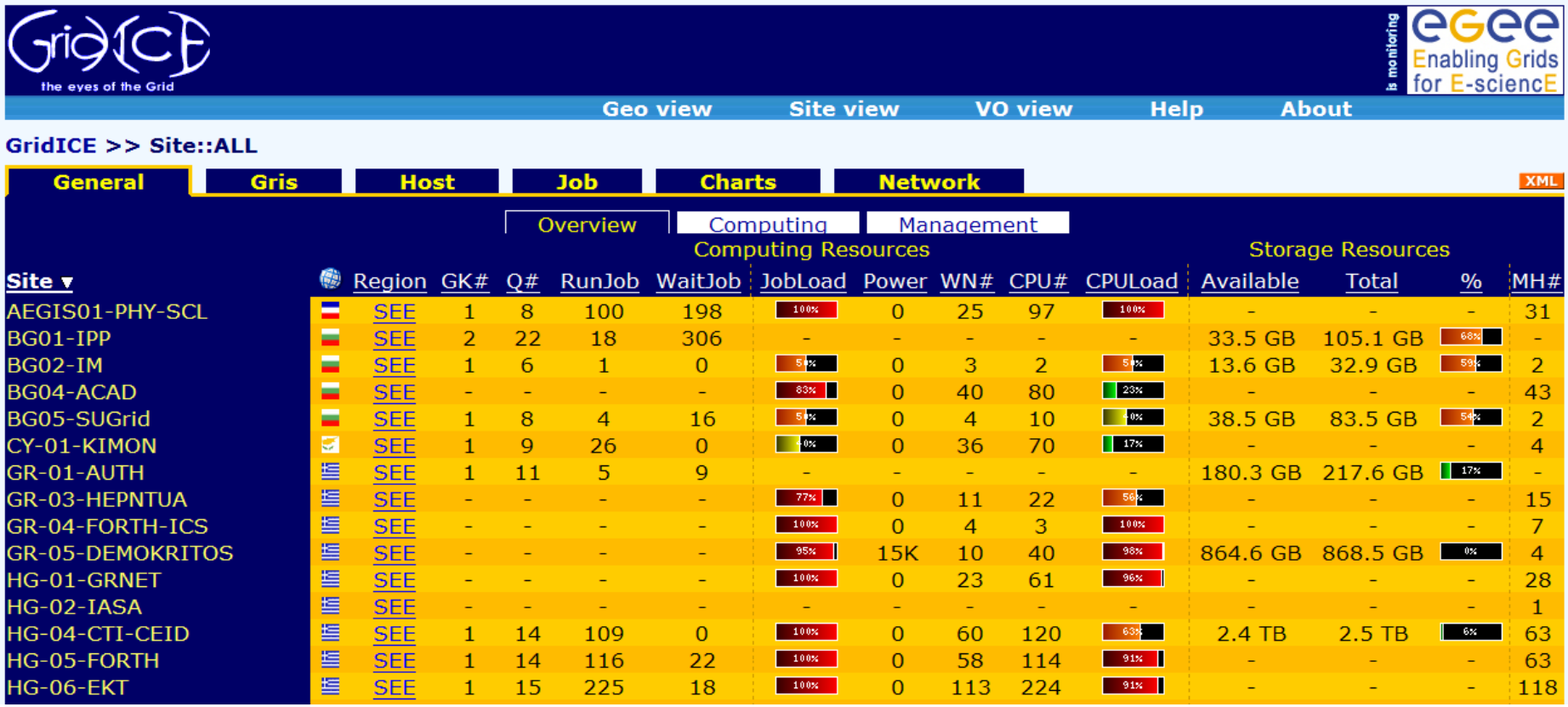
Test abbreviations

csh	CSH test
rgmasc	R-GMA Secure Connector
swdir	VO software directory
rgma	R-GMA
wn	WN host name
ver	Software Version (WN)
ca	CA certs version
rm	Replica Management
votag	VO Tag management
js	Job submission
bi	BrokerInfo
apel	Apel test

	St.	Region	Site Name	Site CE	VO dteam												
					St.	js	wn	ver	ca	rgma	bi	csh	rm	votag	swdir	rgmasc	apel
1.	OK	SouthEasternEurope	BG01-IPP	ce001.grid.bas.bg	OK	O	I	2 7 0	O	O	O	O	O	O	O	O	O
2.	JS	SouthEasternEurope	EGEE-SEE-CERT	ce01.gridctb.uoa.gr	JS	X	??	??	??	??	??	??	??	??	??	??	??
3.	OK	SouthEasternEurope	GR-01-AUTH	node001.grid.auth.gr	OK	O	I	2 7 0	O	O	O	O	O	O	O	O	O
4.	OK	SouthEasternEurope	HG-01-GRNET	ce01.isabella.grnet.gr	OK	O	I	2 7 0	O	O	O	O	O	O	O	O	O
5.	OK	SouthEasternEurope	HG-02-IASA	ce01.marie.hellasgrid.gr	OK	O	I	2 7 0	O	O	O	O	O	W	O	O	O
6.	OK	SouthEasternEurope	NIHAM	alice003.nipne.ro	OK	O	I	2 7 0	O	O	O	O	O	W	O	O	O

Monitoring tools: GridICE

- Grid ICE (http://gridice2.cnaf.infn.it:50080/gridice/site/site.php)



GridICE — the eyes of the Grid

is monitoring Enabling Grids for E-sciencE

Geo view | Site view | VO view | Help | About

GridICE >> Site::ALL

General | Gris | Host | Job | Charts | Network | XML

Overview | Computing | Management

Site	Region	GK#	Q#	RunJob	WaitJob	JobLoad	Power	WN#	CPU#	CPULoad	Storage Resources Available	Storage Resources Total	Storage Resources %	MH#
AEGIS01-PHY-SCL	SEE	1	8	100	198	100%	0	25	97	100%	-	-	-	31
BG01-IPP	SEE	2	22	18	306	-	-	-	-	-	33.5 GB	105.1 GB	68%	-
BG02-IM	SEE	1	6	1	0	5%	0	3	2	5%	13.6 GB	32.9 GB	5%	2
BG04-ACAD	SEE	-	-	-	-	83%	0	40	80	23%	-	-	-	43
BG05-SUGrid	SEE	1	8	4	16	5%	0	4	10	40%	38.5 GB	83.5 GB	5%	2
CY-01-KIMON	SEE	1	9	26	0	40%	0	36	70	17%	-	-	-	4
GR-01-AUTH	SEE	1	11	5	9	-	-	-	-	-	180.3 GB	217.6 GB	17%	-
GR-03-HEPNTUA	SEE	-	-	-	-	77%	0	11	22	50%	-	-	-	15
GR-04-FORTH-ICS	SEE	-	-	-	-	100%	0	4	3	100%	-	-	-	7
GR-05-DEMOKRITOS	SEE	-	-	-	-	95%	15K	10	40	98%	864.6 GB	868.5 GB	0%	4
HG-01-GRNET	SEE	-	-	-	-	100%	0	23	61	96%	-	-	-	28
HG-02-IASA	SEE	-	-	-	-	-	-	-	-	-	-	-	-	1
HG-04-CTI-CEID	SEE	1	14	109	0	100%	0	60	120	63%	2.4 TB	2.5 TB	6%	63
HG-05-FORTH	SEE	1	14	116	22	100%	0	58	114	91%	-	-	-	63
HG-06-EKT	SEE	1	15	225	18	100%	0	113	224	91%	-	-	-	118

- There can also exist local mon. instances (eg: http://mon.egee-see.org)

Diagnosis

- Read the description of the task / problem
  - mail received usually from the CIC-on-duty or ROC: helpdesk.egee-see.org
- Look (yes!) at the “Sites functional tests” for more details
- Get assistance / guidance from
  - Knowledge databases with information about the typical problems
    - http://goc.grid.sinica.edu.tw/gocwiki/SiteProblemsFollowUpFaq
    - http://grid-it.cnaf.infn.it/index.php?knowledgebase
    - http://www.gridpp.ac.uk/tb-support/faq/index.html
  - The pools of expertise that reside in
    - **LCG-ROLLOUT@LISTSERV.RL.AC.UK**
    - egee-sa1-tech@grnet.gr

Problem solving

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- Try to **reproduce** the problem and **identify** its cause
- Try to **solve** the problem
- If needed request assistance from egee-sa1-tech@grnet.gr and/or the CIC-on-duty
- If problem is solved
  - Report to **Savannah/GGUS** that it is solved, explain briefly what caused it
  - CIC-on-duty or the ROC support team updates the ticket to “Site OK”
  - Your site will be in quarantine for 3 working days
- Else
  - Report to **Savannah/GGUS** and grid-support@egee-see.org the reason why the problem is not solved.
  - Keep on trying … ☺

Where to get information from

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- ICCS team Grid Certification Guide (you should be familiar!)
  http://www.egee-see.org/content/modules/downloads/Certification_v2.pdf
- HOW TO TEST AN LCG2 SITE (LCG2-Site-Testing.pdf)
  http://grid-deployment.web.cern.ch/grid-deployment/documentation/LCG2-Site-Testing.pdf
- DESY's Test Guide (find examples and debug commands)
  http://grid.desy.de/tests/
- GridPP: FAQ for LCG Site Administrators
  http://www.gridpp.ac.uk/tb-support/faq/
- GOCwiki: Grid Administration FAQs and Troubleshooting
  http://goc.grid.sinica.edu.tw/gocwiki
- Information System Troubleshooting (GRISs, GIISs, BDIIs)
  http://lfield.home.cern.ch/lfield/trouble.html (if you have to debug the MDS)

The SEE-VO

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- Operational since March 2005
- Purpose:
  act as catch-all VO for new applications of Regional Users
- How to enroll : Get a certificate and go to
  https://www.grid.auth.gr/services/voms/SEE/request.php
- Evaluation committee for new user/applications (SEE-EGAAP). Formal evaluation procedure will be established based on EGAAP existing policies but with relaxed requirements.

Hierarchical National Infrastructure

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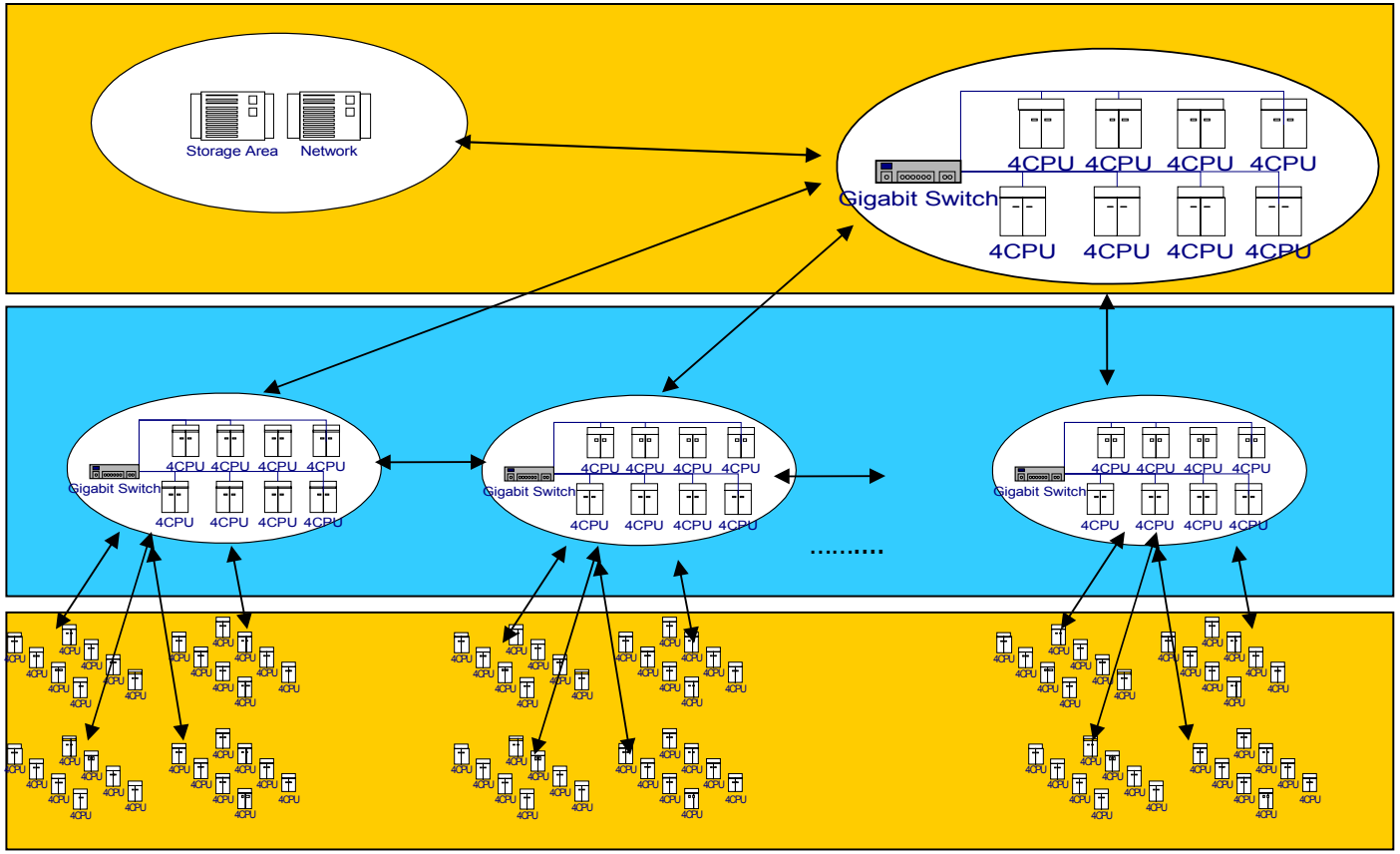
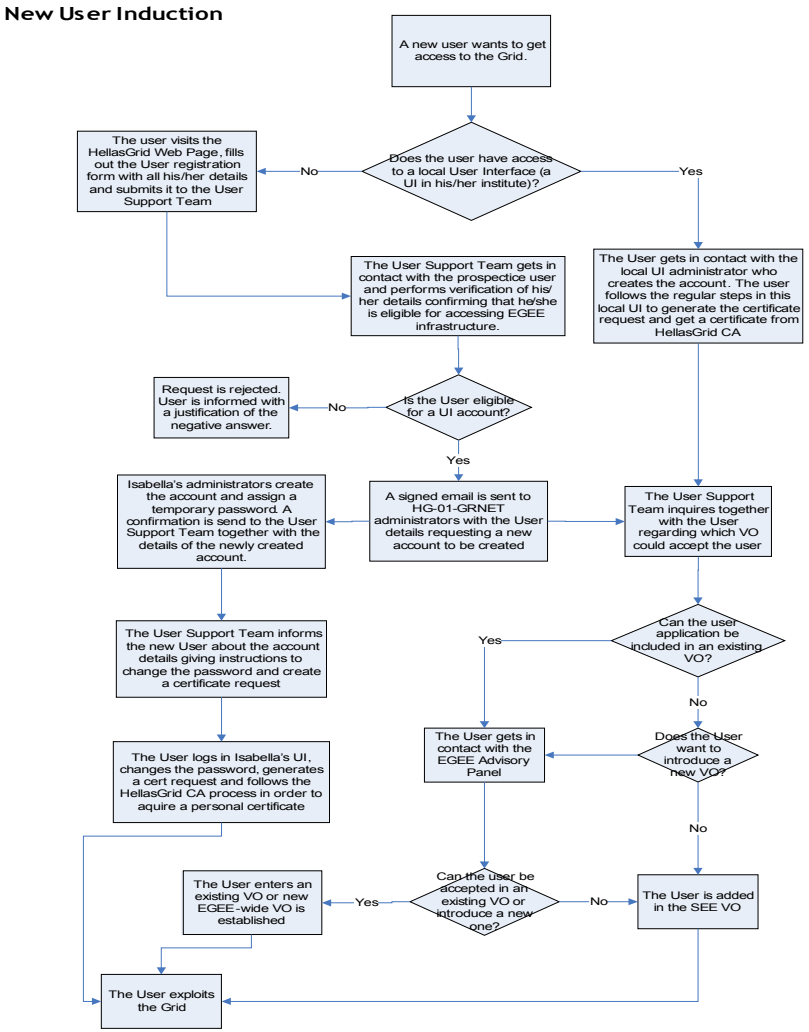
Tier 0 –
Central GRNET node
(64 CPUs-10TB SAN)

Tier 1 –
5 peripheral nodes:
Athens (2), Patras,
Thessaloniki, Creta

Tier 2 – Integration of other infrastructure (sch.gr, Laboratories)

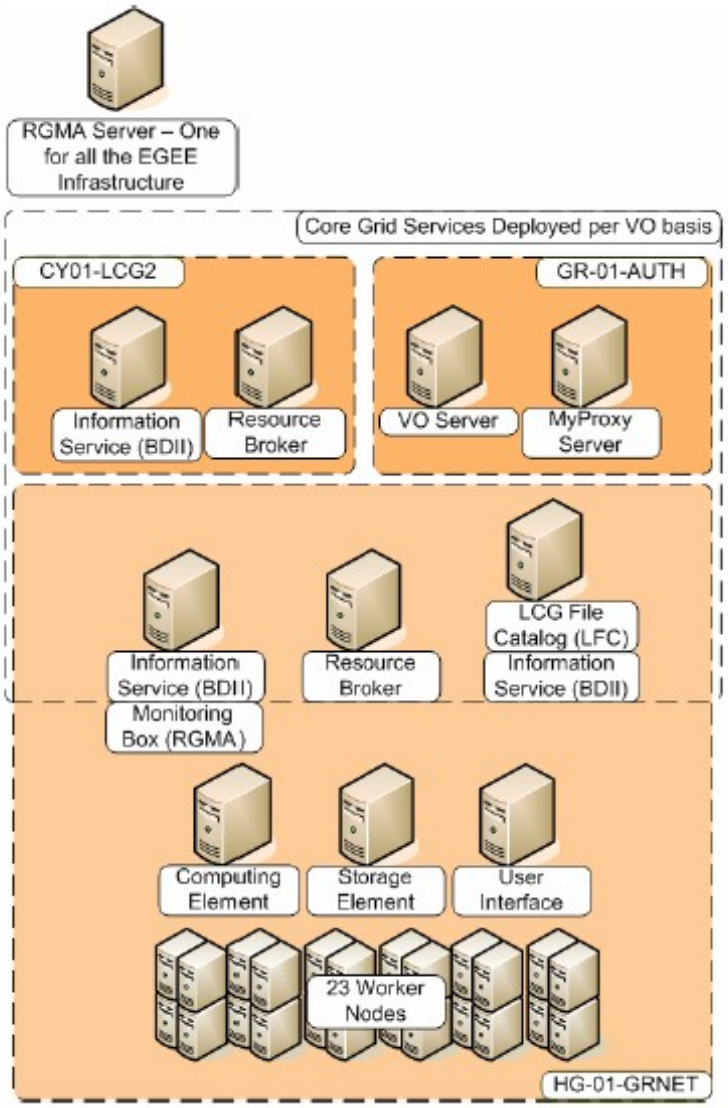


Policies and Procedures



- Policies exist for nearly any grid related activity, such as:
  - Adding a site (ROC-related)
  - Having a user get a certificate
  - Adding a user to a VO (AUP)
  - Adding a system administrator
  - Handling a security incident
  - …more we don't know…
- LCG Grid evolves faster than the policies themselves, so do "handle with care" ☺

Ανατομία ενός VO: SEE VO



- Κατάλογος χρηστών:
  - VO server & Myproxy
- Κατάλογος πόρων:
  - BDII (LDAP based!)
- Υπολογιστικοί πόροι:
  - Resource Broker (RB)
- Χωρητικοί πόροι:
  - LCG File Catalog (LFC)
- Τοπικές Υποδομές:
  - CE & WNs, SE, UI κλπ.

Support Resources

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- Various channels have been established for User Support
- Problem Reporting
  - EGEE-SEE Helpdesk (https://helpdesk.egee-see.org/)
  - GGUS (https://gus.fzk.de) EGEE-wide
- Localized Documentation, FAQs, Tips, Instructions
  - EGEE-SEE Wiki (http://wiki.egee-see.org/index.php/Users)
  - EGEE-SEE Web Site (http://www.egee-see.org/). Recently restructured to provide easier navigation for the users.
- Other ad-hoc resources (various web sites, documents etc.)

Υποδομή HellasGrid I, Isabella

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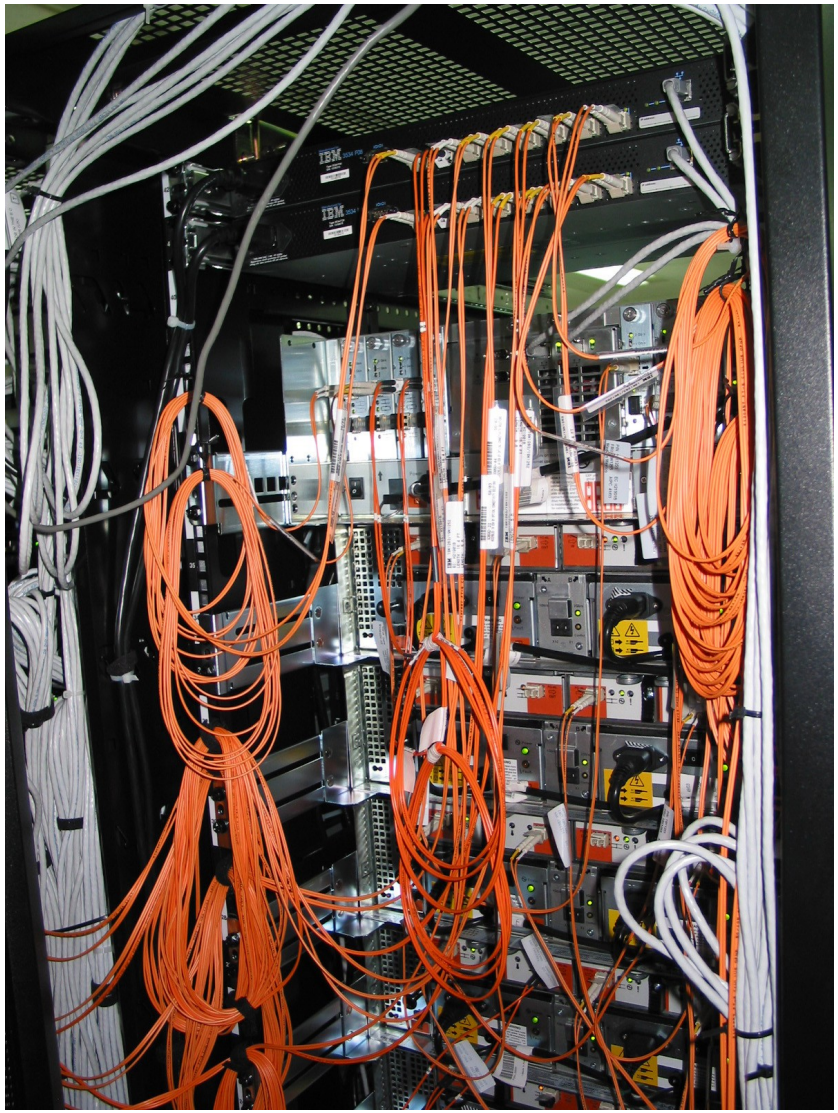

Production Level Grid Infrastructure

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- High Availability
  - Through HW and SW redundancy
- Security aspects thoroughly examined
- Timely Resolution of problems
  - Efficient collaboration between team members
  - Close cooperation with VOs
- Aid in the deployment of New Sites / certification

Hardware Redundancy

- Redundant disks on Service Nodes and WNs (RAID1)
- Redundant Storage Infrastructure for SE/SAN at multiple levels
  - RAID5 Volumes on storage array
  - Redundant FC disk controllers + PSUs.
  - Redundant FC links in fail-over mode AND balancing mode for GPFS storage nodes
  - Node redundancy at the GPFS level

Software Redundancy

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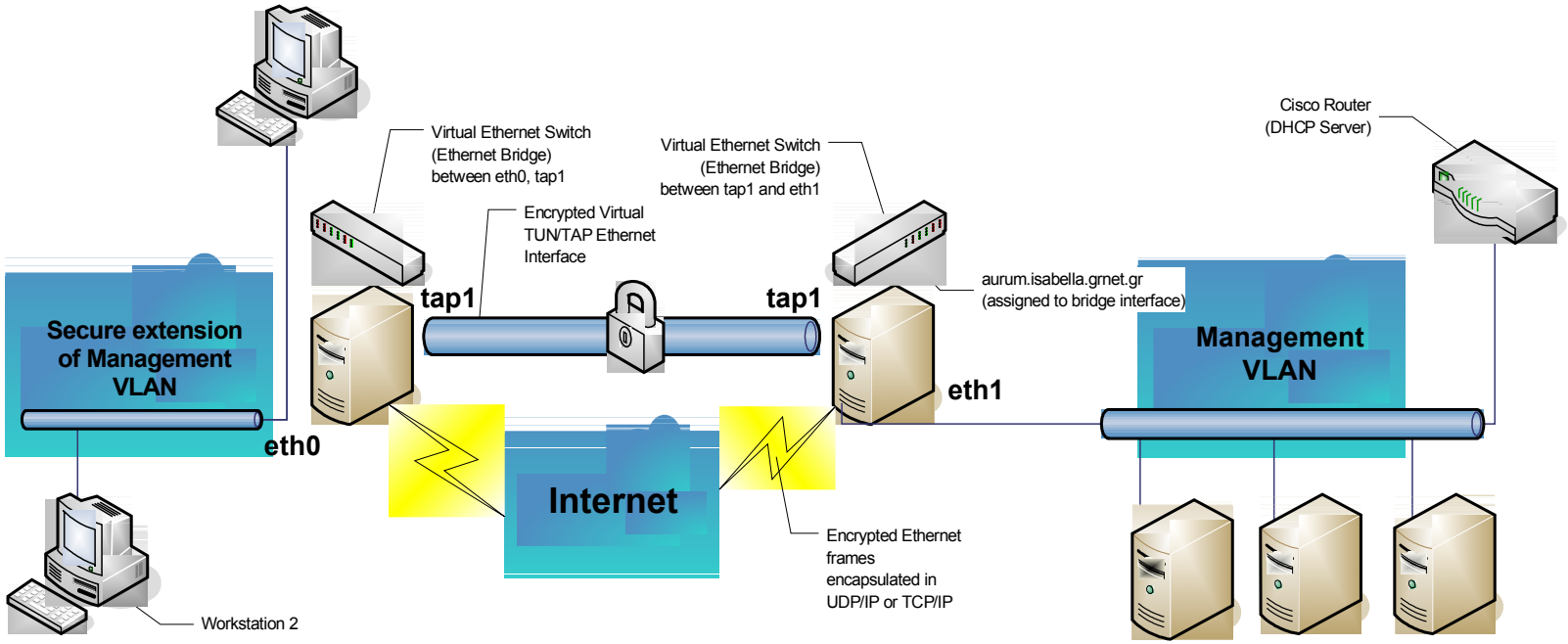
- Redundant GPFS storage nodes
  - One primary / one secondary per Network Storage Device (NSD)
- Redundant network service instances
  - For DNS two on-site, two off-site servers
  - Similar redundancy in handling the NTP protocol

Security: OpenVPN



- Management interfaces unreachable from the outside
- Secure remote access to management VLAN using the free OpenVPN tool
  - Certificate-based authentication
  - SSL-based encryption

Security: Node hierachy

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- Nodes are kept in a security hierarchy with different levels
  - Platinum: Backup server, Remote Console Access
  - Gold: Management Server, HW monitoring
  - Copper: Services & Worker Nodes for the Grid
- Explicitly defined trust relationships!

Security: IDSs & logging

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- System-based Intrusion Detection Systems
  - OSS tools (e.g. chkrootkit)
  - Custom-written scripts (chksetuid with md5sum)
- Network based Intrusion Detection Systems
  - Snort
- *Factorized* Logging infrastructure based on syslog-ng
  - Logs collected centrally at the management server
  - Logs replicated at off-site location

Timely resolution of HW / SW problems

- Support contracts with vendors in place
  - IBM is the provider of the hardware of the HellasGrid I node
  - HP is the provider of the hardware of the HellasGrid II nodes
  - Support contracts are in place, in order to ensure timely replacement of components that are found to malfunction. It has been used in practice, equipment needs maintenance after all.
  - Support contracts extend to equipment such as the Uninterruptible Power Supply and the Air-Conditioners
  - Vendors are willing to keep up their promises, but the complexity of the equipment and its configuration setup should not be underestimated

Day-to-day Operations: Shifts

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- Two shifts per day
  - 09:00 – 15:00, 15:00-21:00, Monday to Friday
- Ensures proper response in case of an emergency
- Handling of tickets coming from EGEE
- Timely service of requests from User Support team

Day-to-day ops: Monitoring Tools

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- EGEE Site Functional Tests
- Local monitoring tools
  - Ganglia
  - MRTG
- Vendor-specific tools
  - IBM Cluster Systems Management
    - Monitors various node health parameters
    - Sends e-mail alerts which can be routed to mobiles

Collaboration of Team Members

- **Request Tracker**
  - Web-based Ticketing System
  - Used for day-to-day collaboration
  - Permanent archive of information on all events during shifts
  - Facilitates integration of new team members
  - Knowledge base for all of HellasGrid' clusters
- **Weekly meetings**
  - Review of open tickets
  - Planning of future activities

Introduction of new sites in HG

- Streamlining of new site installations
  - Guide for new HW installations
  - Customized instructions for OS deployment
- Certification Period
  - Certification SFTs run by the HG-01-GRNET team for all yet uncertified sites
  - Site enters production when the tests have run without problems for 5 days

RT ticketing system: the big picture

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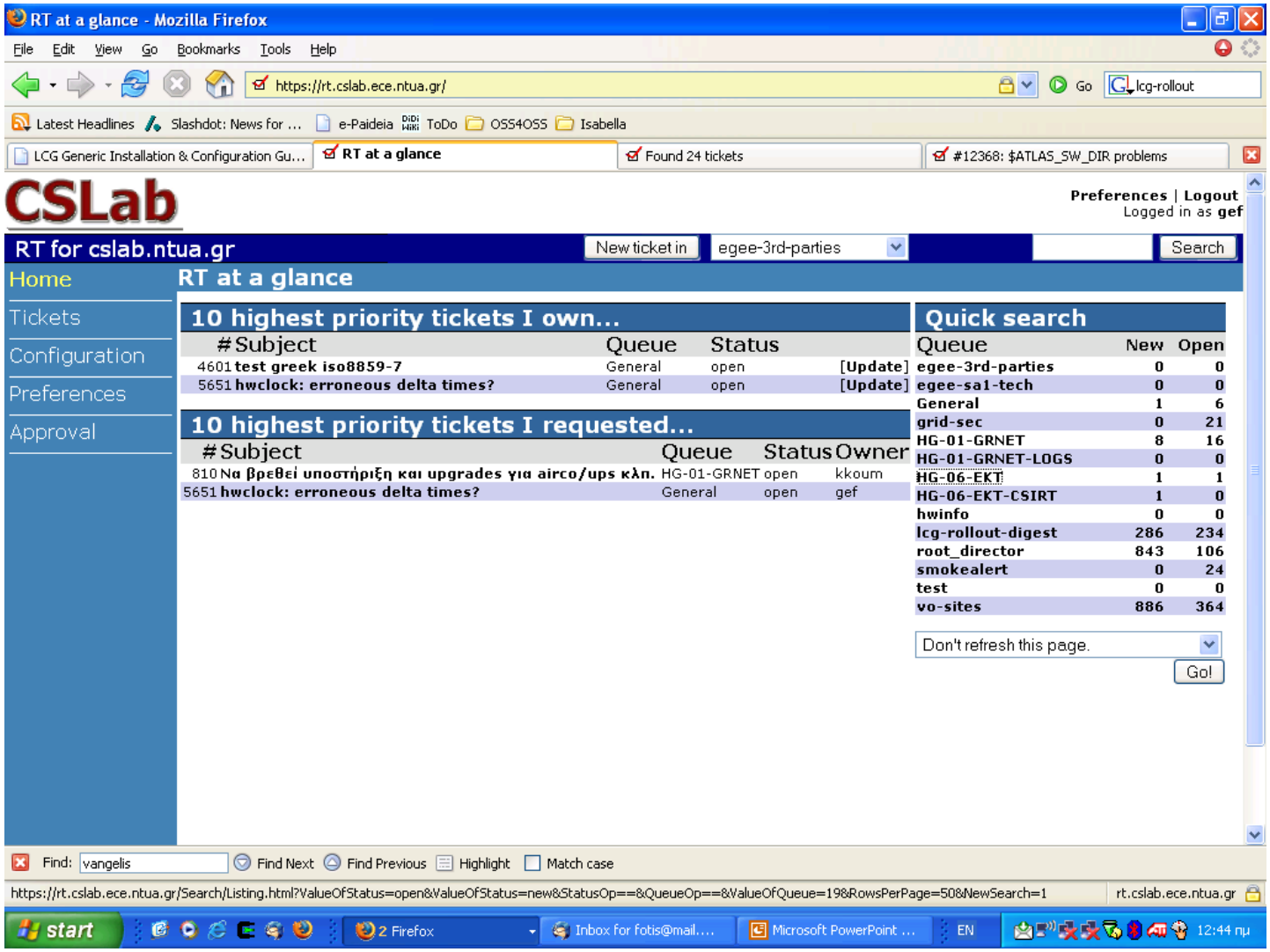

RT ticketing system: Queue status

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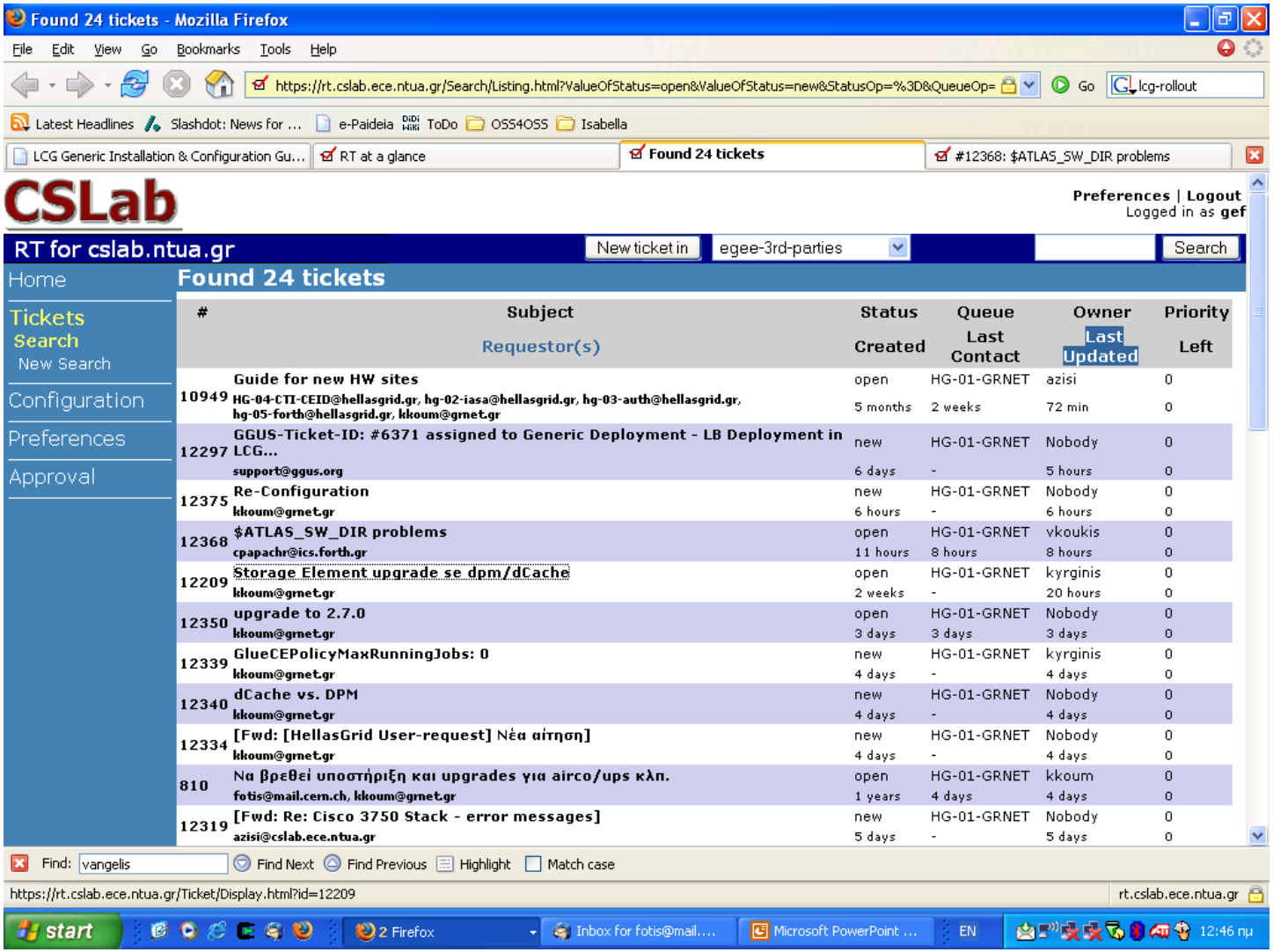
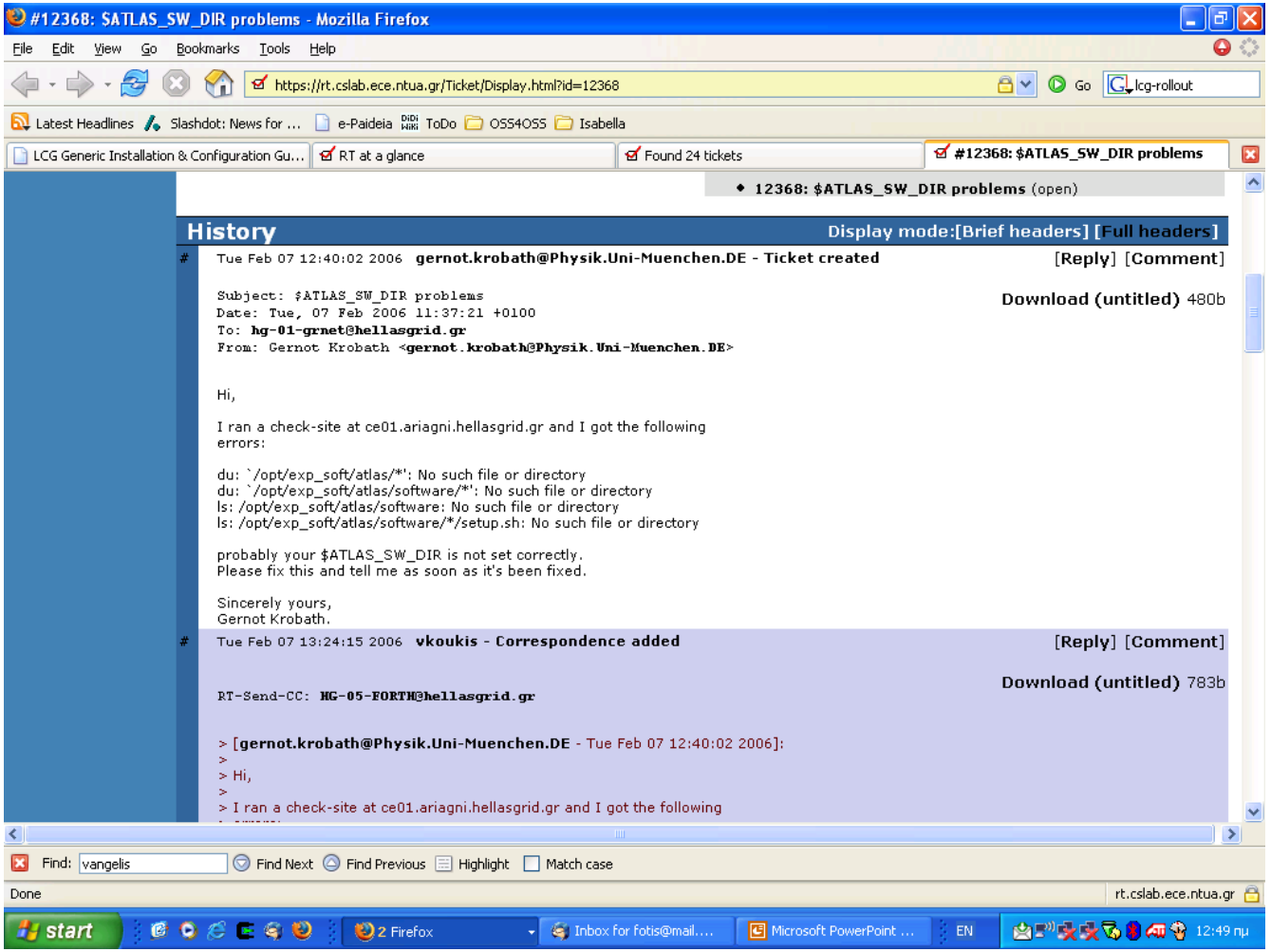


RT system: managing a ticket



Notorious Tickets of the past

- #62: Evaluating GPFS suitability for our case
- #304: Optimizing configuration of CISCO switch stack
- #809: Document startup, boot, halt shutdown procedures
- #888: Daily check-list of the hg-01-grnet node
- #942: GPFS debugging & tiobench tests
- #2078: mprime and kernel-compiles, cpu temperature tests
- #4804: Heavy stress tests of HG-01-GRNET (minor repairs)
- #7200: Getting mpirun to work correctly with torque
- #7293: VPN architecture and OOB management
- #8460: Unscheduled downtime due to power
- #8617: Unscheduled downtime due to air-condition failure

Our know-how

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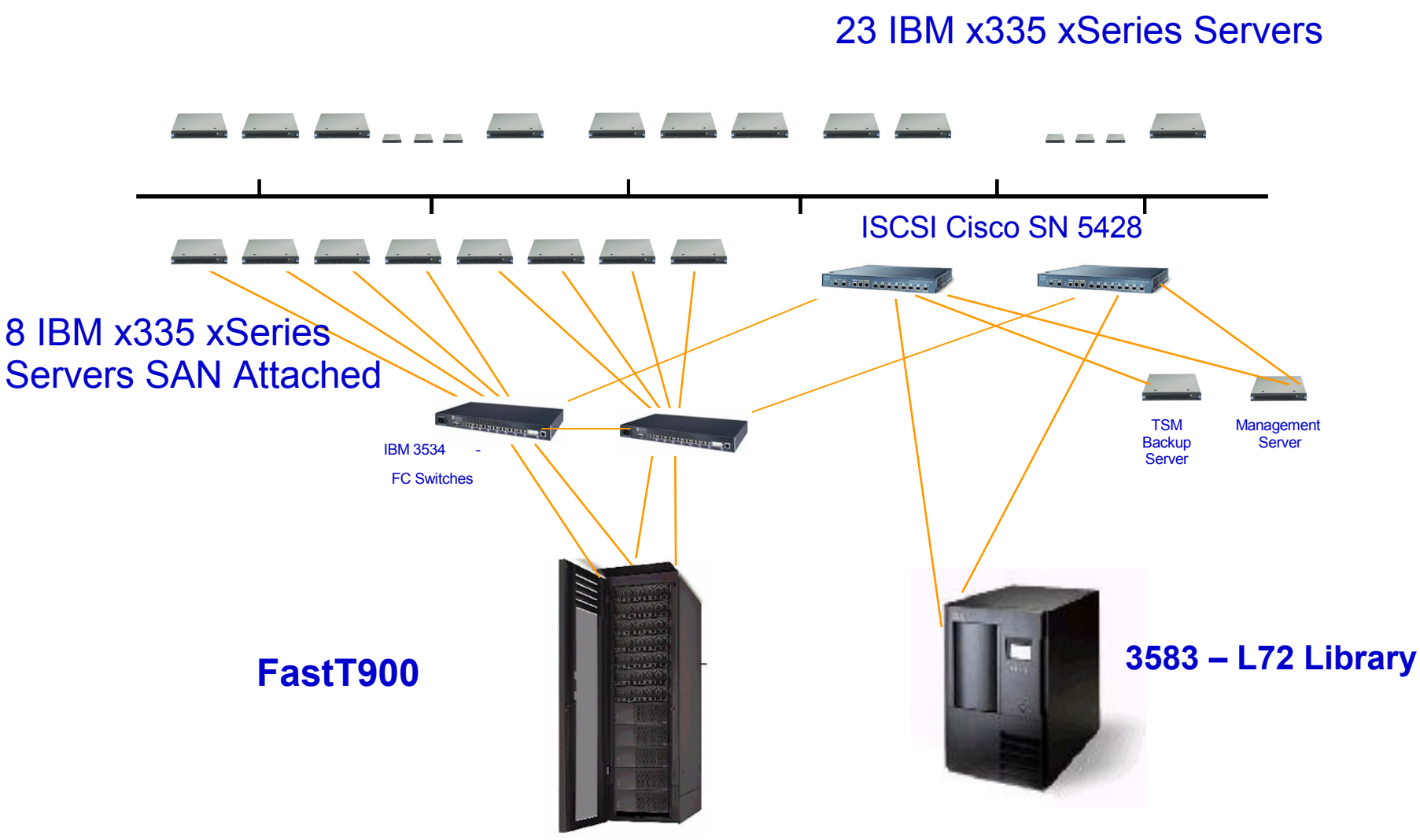
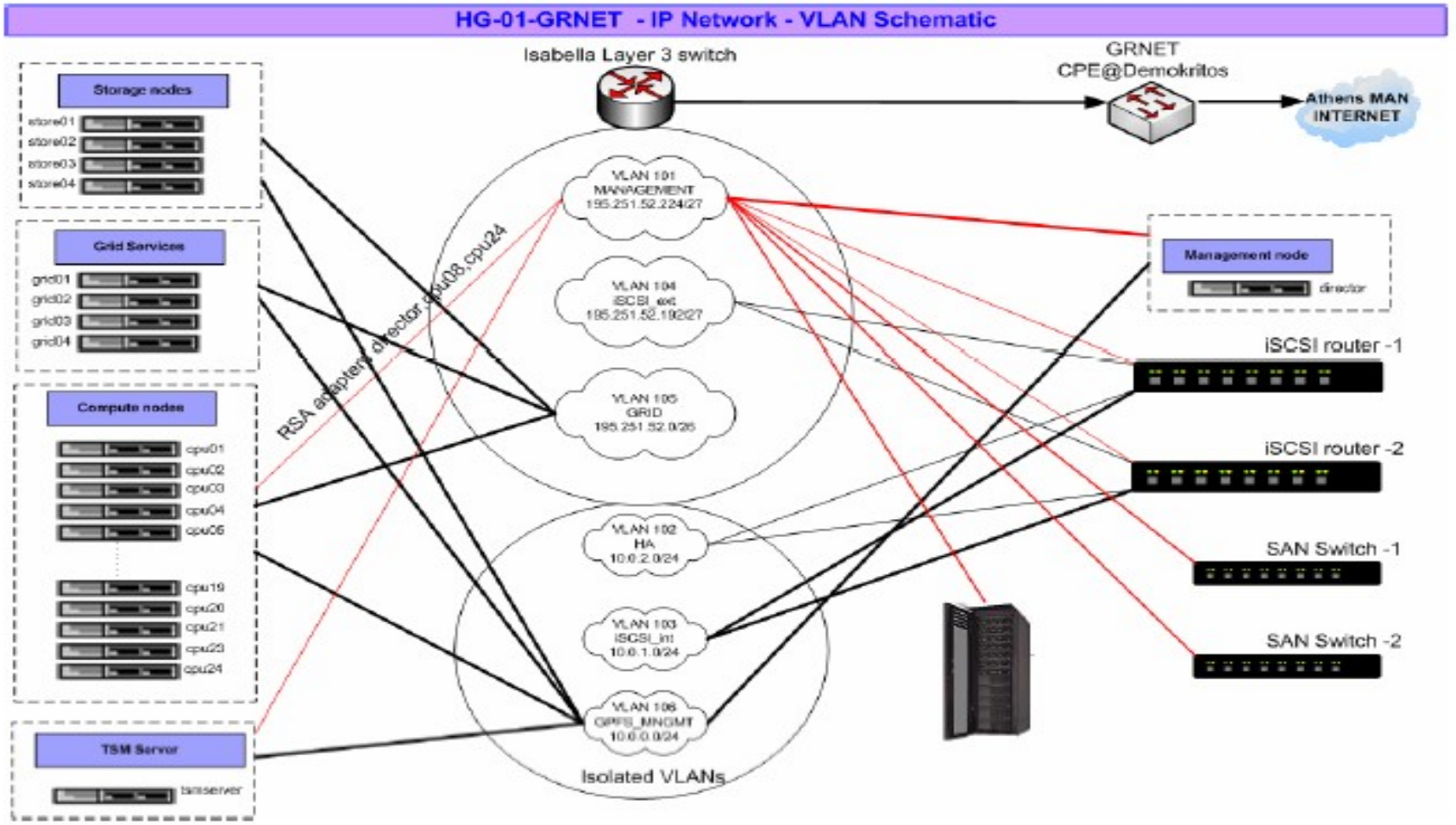
- Evaluating GPFS suitability for our case
- Optimization configuration of CISCO switch stack
- Document startup, boot, halt and shutdown procedures
- Build a daily check-list for the HG-01-GRNET node
- GPFS debugging & tiobench tests
- kernel-compiles and cpu temperature tests with mprime
- Heavy stress tests of HG-01-GRNET (with minor repairs)
- Unscheduled downtime due to power
- Unscheduled downtime due to air-condition failure

Get ready to coordinate with the plumber… ☺

Putting it all together



HellasGrid I, Isabella



GPFS Capabilities

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- High-performance parallel, scalable file system for Linux/AIX cluster environments
- Full Load Balancing: Shared-disk filesystem where every cluster node can have concurrent read/write access to (**meta-**)data
- Fail-over: High availability through automatic recovery from node and disk failures

Monitoring of HG-01-GRNET

- hg-01-grnet@hellasgrid.gr, hwinfo(…)@rt.cslab.ntua.gr
- Tivoli Storage Manager – TSM backup interface
- CISCO switch stack
- CISCO iSCSI switches
- Cluster Systems Management (CSM) utilities, RSA, RCM
- GPFS and filesystems monitors
- Storage Area Network GUI client

Another “minor” cluster waiting 4 u

Q & A

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