

ATLAS TDAQ System Administration: an overview and evolution

ISGC 2013

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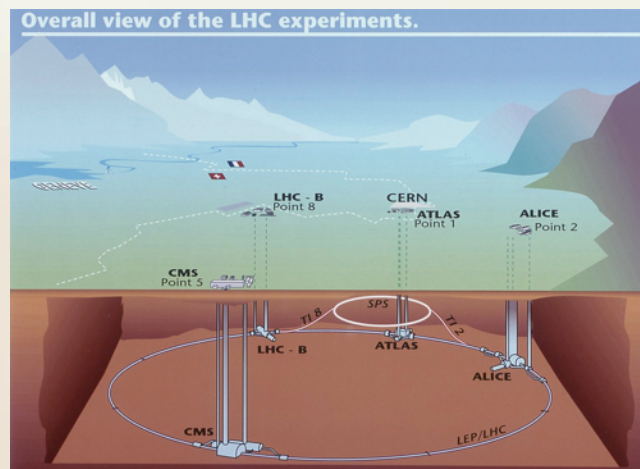
*for and on behalf of the
ATLAS TDAQ SysAdmin team.*

Introduction

LHC & ATLAS



- ◆ Large Hadron Collider, an accelerator, ~100m underground
- ◆ 27 kilometres in circumference
- ◆ Protons are accelerated in opposite directions at $> 99.99 c$
- ◆ Smashing together in the center of ATLAS, one of 7 experiments
- ◆ 600 million collisions per second, The collisions are measured in Luminosity or “number of particle per sec per square cm”, and are recorded by the Trigger and Data Acquisition system
- ◆ After 3 years of LHC runs, Long Shutdown 1 (LS1)



Introduction

Trigger and Data Acquisition



- ◆ Large online computing farm, used to process the data readout from ~100 million channels
- ◆ Ancillary functions (monitoring, control, etc.)
- ◆ Point 1
 - ◆ Approximately 100m underground, in close proximity to the detector (USA15)
 - ◆ On the surface near to the ATLAS Control Centre (P1, SDX1 & SCR)
- ◆ In General Public Network (GPN)
 - ◆ Laboratory for software development, prior to implementation into P1, recently been commissioned (TestBed)



The Racks



- ◆ USA15:
 - ◆ 220 racks deployed over 3 floors
 - ◆ 2009, ~70% filled, 1MW 2013, > 90% filled, 1.29MW*
 - ◆ 2.5MW of cooling can be provided
- ◆ SDX1:
 - ◆ 120 racks deployed over 2 floors
 - ◆ 2009, ~50% filled, 385 kW* 2013, ~91% filled, 709 kW*
- ◆ TestBed:
 - ◆ 22 Racks over 1 floor
 - ◆ 68% filled, 60kW of power. 11 Racks by TDAQ
 - ◆ 100 kW of Cooling can be provided
- ◆ Possibly an increase up to 90 racks (~4000 hosts) to deal with future luminosities

*estimated at ~6.5 kW/rack



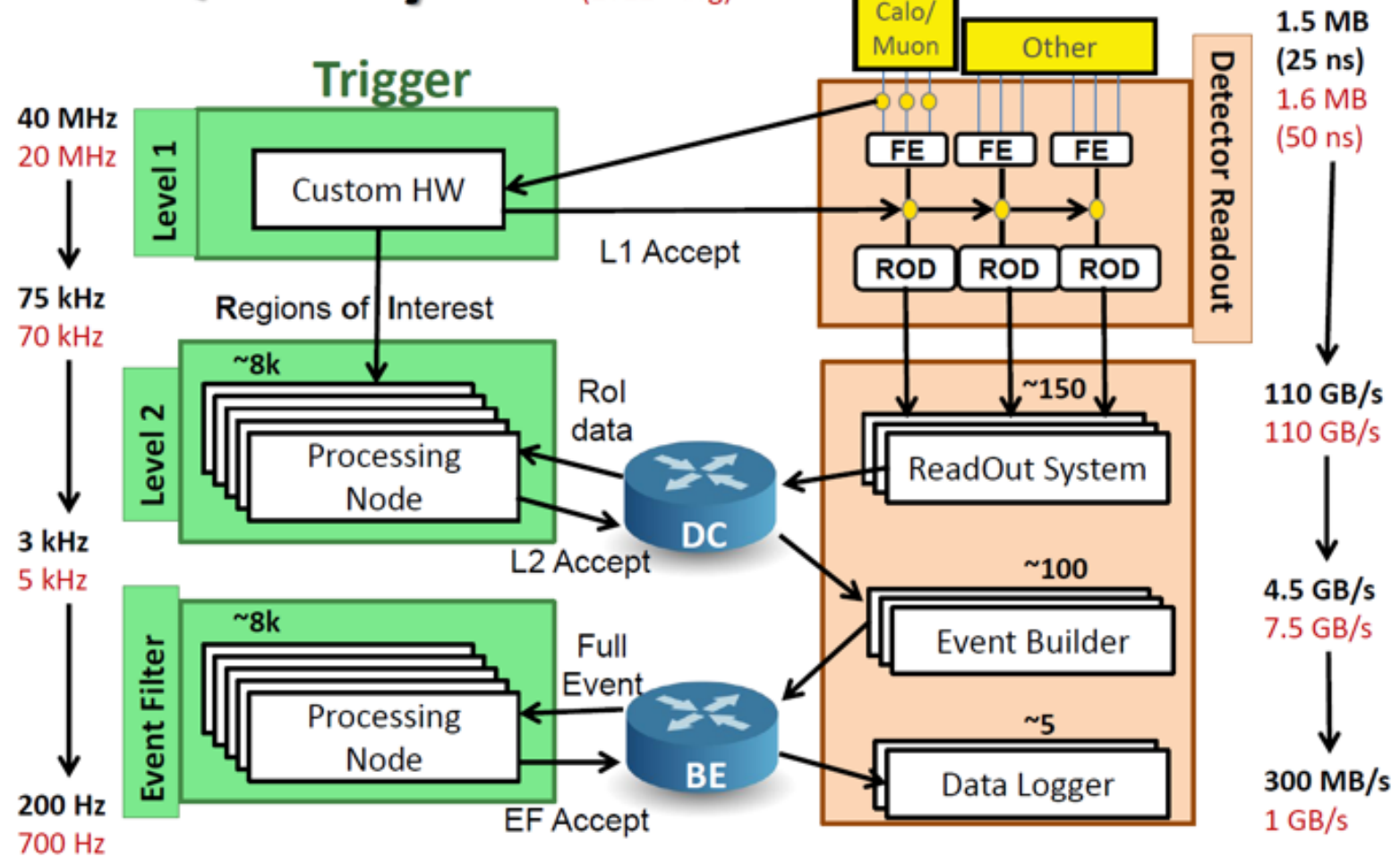


TDAQ Design Overview

TDAQ Today

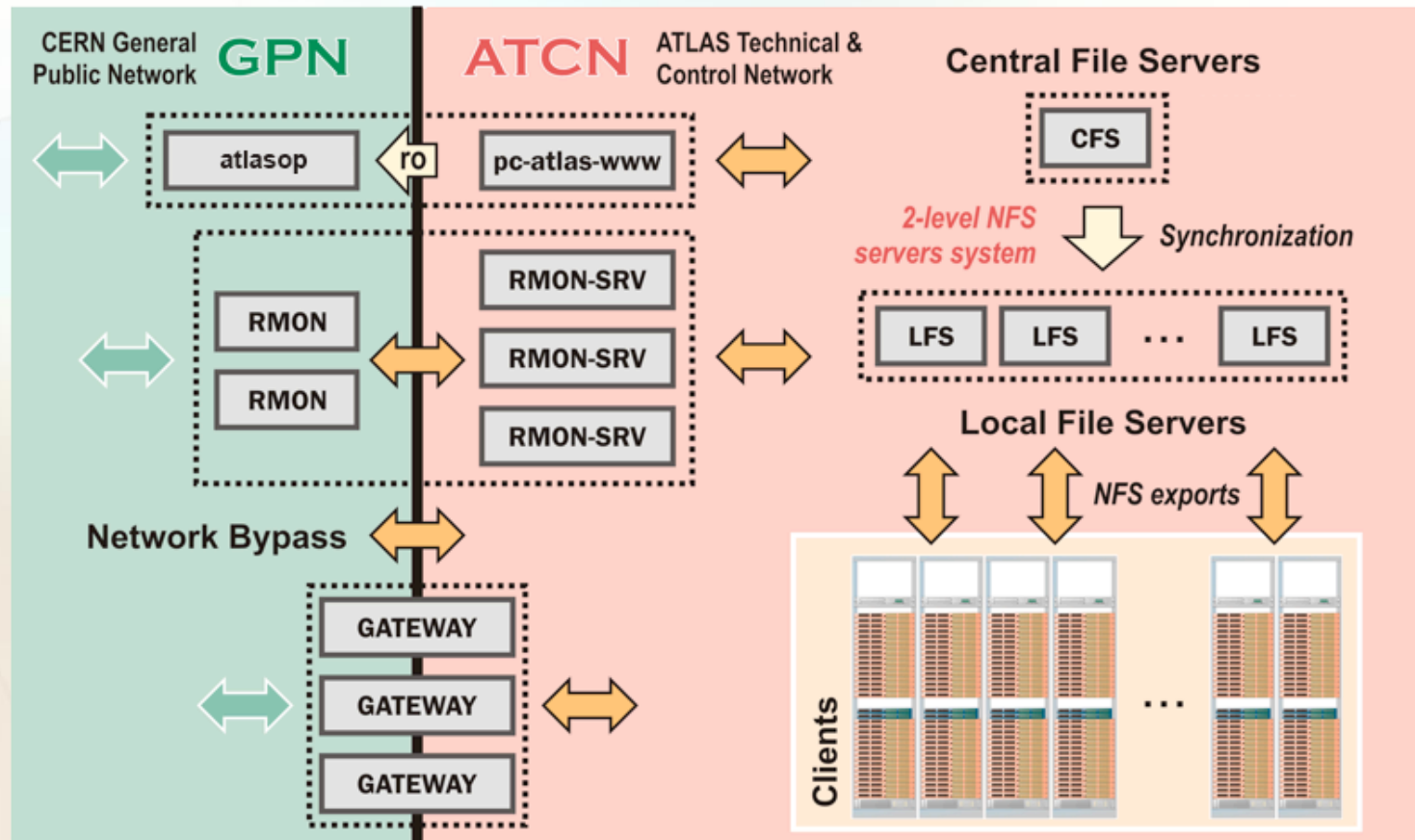
Design
(2012 - avg)

DAQ





ATLAS Point1 Functional Layout



Redundancy



- ◆ Cant afford downtime & miss out on luminosity provided by the LHC
- ◆ Two centralised UPS lines with diesel backup generators
- ◆ Independent UPS lines available to SDX1 for mission critical equipment
- ◆ Redundant configuration for critical services
 - ◆ DNS/DHCP/NTP
 - ◆ LDAP
 - ◆ Domain Controller
 - ◆ LFS'
- ◆ NetAPP serves the most critical NFS and CIFS areas
 - ◆ 84 HDD's in RAID 6, dual head system with redundant fibre channels
 - ◆ Can survive the loss of one head, any one FC link, one FC interface on a shelf - just not of a whole shelf
- ◆ CERN's Tivoli for critical data
- ◆ SVN



Centralised and Distributed Storage Systems



- ◆ CFS
 - ◆ CFS nodes: user home directories, DAQ software distribution. Nagios RRD files, CIFS/NFS exports
 - ◆ Node configuration area
 - ◆ DAQ configuration area
 - ◆ Exports from the private to public webserver
 - ◆ Dedicated storage area shared among the gateways
- ◆ LFS
 - ◆ Synced from the CFS
 - ◆ Nagios Server
 - ◆ Exports to the clients



Clients

Local Boot



- ◆ Provisioning by PXE + Kickstart
 - ◆ DHCP + PXE provided by an LFS from ConfDB* information
 - ◆ Template-based kickstart files
- ◆ Quattor
 - ◆ CERN standard Configuration Management Tool
 - ◆ Production system, managing 237 hosts in the Online Farm
 - ◆ about 3500 LOCs in PAN (more dense code, less coverage)
 - ◆ Tight control on installed packages
 - ◆ Lack of flexibility for complex configuration/services dependencies
 - ◆ Multiple languages for implementing modules

*See slide 14

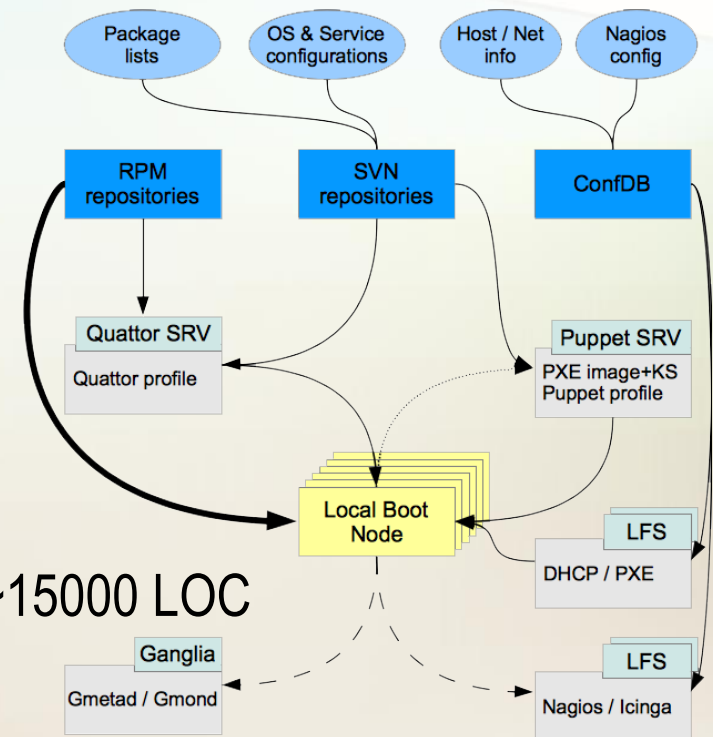


Clients

The Puppet Master



- ◆ Puppet
 - ◆ Widespread industry adoption, active development
 - ◆ Full featured, highly flexible
 - ◆ Gentler learning curve
 - ◆ Focus on consistence and idempotence
 - ◆ In production, manages exclusively 25 complex servers
 - ◆ Complements Quattor
- ◆ Migrate to Puppet and SLC6
 - ◆ our manifest code base has grown to ~15000 LOC
- ◆ Puppet is being adopted by CERN IT

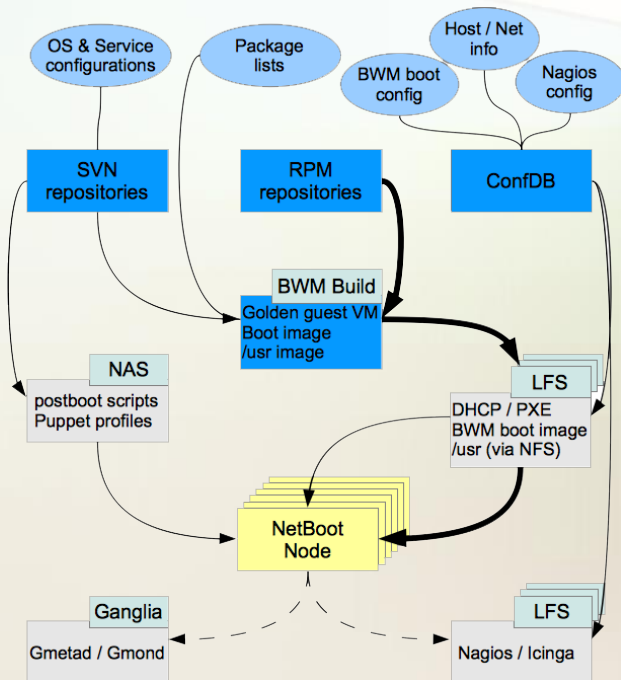


Clients

Look Mom.. No disk



- ◆ The more components one has in a system, the greater the risk of failure, So... reduce any components that are not “needed”
- ◆ In ATLAS, extensive use of PCs with no operating system on disk
- ◆ “NetBooted” via PXE
- ◆ Advantages:
 - ◆ Ease of Maintenance
 - ◆ Reproducibility on a large scale
 - ◆ Reduced "installation" times
- ◆ Disadvantages:
 - ◆ requires ad-hoc development and support
 - ◆ not suitable for running servers



Clients

Netbooted Nodes



- ◆ ~ 2350 Nodes booted Scientific Linux CERN5 OS via PXE
- ◆ 75 Local File Servers (LFS), provide DHCP, PXE, TFTP, for booting, & /usr read-only directory via NFS
- ◆ Configuration of DHCP, PXE and boot parameters are provided by our in house built ConfDB*
- ◆ Boot With Me Tool (BWM)
 - ◆ Generates PXE boot images (kernel + RAMdisk root) and /usr
 - ◆ Uses reference SLC5 VM image as source
- ◆ BWM post-boot script system
 - ◆ Hierarchy of shell scripts, configures servers, disk, and NFS mounts.
 - ◆ Store on a central Network-Attached Storage, executed by the client
- ◆ Subversion repository is used to track changes of the BWM image creation configuration



Clients

Puppet again..



- ◆ Problems with BWM post-boot
 - ◆ No Permanent changes to a working system
 - ◆ Needs to be rebooted
 - ◆ Bash Scripts
- ◆ Move net-booted to puppet as well
 - ◆ Manifests hosted on CFS
 - ◆ No Daemon
 - ◆ Cron job that runs puppet and mails if problems on host
 - ◆ No need to reboot node for changes to take affect
- ◆ Minor problems on low resource machines and TDAQ /ROS drivers



Tools

Configuration Database



- ◆ Management of large number of NetBooted nodes is far from trivial.
- ◆ ConfDB was developed
 - ◆ based on a MySQL database
 - ◆ web based GUI
- ◆ Keep records of all the changes and system configurations
- ◆ Greatly help to speed up routine tasks:
 - ◆ Registering NetBooted clients, with data extracted from CERN's Network Database (LanDB)
 - ◆ Configuring boot options
 - ◆ Client to LFS assignment and migration
 - ◆ Deploying DHCP and NAGIOS configurations
 - ◆ Issuing IPMI and system commands on multiple nodes in parallel



Tools ConfDB UI



ConfDB GUI ADMINISTRATIVE INTERFACE Cluster: All

Hostname: xpu-66 Host type: Clients Search Advanced search Commit changes

Search results:

- pc-tdq-xpu-66001
- pc-tdq-xpu-66002
- pc-tdq-xpu-66003
- pc-tdq-xpu-66004
- pc-tdq-xpu-66005
- pc-tdq-xpu-66006
- pc-tdq-xpu-66007
- pc-tdq-xpu-66008
- pc-tdq-xpu-66009
- pc-tdq-xpu-66010
- pc-tdq-xpu-66011
- pc-tdq-xpu-66012
- pc-tdq-xpu-66013
- pc-tdq-xpu-66014
- pc-tdq-xpu-66015**
- pc-tdq-xpu-66016
- pc-tdq-xpu-66017
- pc-tdq-xpu-66018
- pc-tdq-xpu-66019
- pc-tdq-xpu-66020
- pc-tdq-xpu-66021
- pc-tdq-xpu-66022
- pc-tdq-xpu-66023
- pc-tdq-xpu-66024
- pc-tdq-xpu-66025
- pc-tdq-xpu-66026
- pc-tdq-xpu-66027
- pc-tdq-xpu-66028
- pc-tdq-xpu-66029
- pc-tdq-xpu-66030
- pc-tdq-xpu-66031
- pc-tdq-xpu-66032
- pc-tdq-xpu-66033
- pc-tdq-xpu-66034
- pc-tdq-xpu-66035
- pc-tdq-xpu-66036
- pc-tdq-xpu-66037
- pc-tdq-xpu-66038
- pc-tdq-xpu-66039
- pc-tdq-xpu-66040

Hostname: pc-tdq-xpu-66015 LanDB Nagios Hardware DB

MACs: 00-26-6C-FA-C6-F0, 00-26-6C-FA-C6-F1, 00-26-6C-FA-C6-F3 Manufacturer: DELL Model: POWEREDGE C6100

Rack: Y.08-04.D1 [66] Position in Rack: U18 Building: 3178 Floor: 1W Room: 0804 Host Group: Point 1

Service Tag: OS Version: Net_SLC5_64 Description:

Ipmi Type: ipmi20 Nagios Server: pc-tdq-lfs-066 Config server: Choose...

BMC Specification: 37_1_1.26_2.0_20569_55 Include in DHCP relay list Don't include in DHCP Sync Nagios home directory Net Booted

PC Type: pc Netboot Server: pc-tdq-lfs-066

Boot parameters: [Open](#)
» root=/dev/ram0 ramdisk=131072 ip=dhcp selinux=0

NICs

- » Type: control, Name: pc-tdq-xpu-66015, IP: 10.146.95.45, MAC: 00-26-6C-FA-C6-F0, Netmask: 255.255.255.0, Gateway: 10.146.95.1, Network domain: ATLAS
- » Type: dc2, Name: pc-tdq-xpu-66015-dc2, Alias: pc-tdq-xpu-66015-ef2-vlan12, IP: 10.150.60.29, Netmask: 255.255.0.0, Gateway: 10.150.1.1, Network domain: ATLAS, Vlan ID: 12
- » Type: ef2, Name: pc-tdq-xpu-66015-ef2, IP: 10.151.43.49, MAC: 00-26-6C-FA-C6-F1, Netmask: 255.255.255.0, Gateway: 10.151.43.1, Network domain: ATLAS
- » Type: mgmt, Name: pc-tdq-xpu-66015-mgmt, IP: 10.146.95.44, MAC: 00-26-6C-FA-C6-F3, Netmask: 255.255.255.0, Gateway: 10.146.95.1, Network domain: ATLAS

Templates: [Open](#)
» BASIC-XPU
» INTERFACE_UP!"to,ctrl0,ef2,vlan12"

Delete host(s) Update host info from LanDB Commit changes



Tools

OS Repository Management



- ◆ Simple custom-made system for managing "time-frozen" snapshots of CERN package repositories
- ◆ Sufficient functionality through 2012, controlled upgrades, (theoretical) rollback capability
- ◆ We want more flexible functionality and easier management
 - ◆ Partial upgrades, client status reporting etc.
 - ◆ May adopt a third-party open source tool, e.g. Pulp
- ◆ Rollback/versionlock are possible in principle but not easy Puppet +yum does not offer the same detailed control as Quattor+SPMA



Monitoring Nagios



- ◆ Nagios has been used since 2007
- ◆ Primarily monitors:
 - ◆ the health status of the OS
 - ◆ the hardware, selected services and network components
 - ◆ provides alerting for critical events
 - ◆ Significant development effort into hardware status via IPMI
- ◆ Separate Nagios server instance on each of the 80 LFS nodes
- ◆ Feeding data to a central storage area to a single MySQL Cluster
- ◆ A web-based interface was developed in-house
- ◆ Configurations integrated in ConfDB
- ◆ Over 5 years, machines monitored by NAGIOS increased from ~1500 to ~3000 in Point 1



Monitoring



GROUPS	TOTAL	ONLINE	OFFLINE	BROKEN	RESERVED
⊕ Gateways	6	6	0	0	0
⊕ WebServers	2	2	0	0	0
⊕ FileServers	2	2	0	0	0
⊕ DNS	2	2	0	0	0
⊕ CFS	1	1	0	0	0
⊕ LDAP	4	4	0	0	0
⊕ MYSQL	5	5	0	0	0
⊕ VH	2	2	0	0	0
⊕ ACR	128	119	0	0	9
⊕ SCR	49	33	16	0	0
⊕ TDQ	2186	2168	2	9	7
⊕ LFS	74	73	0	0	1
⊕ ONL	33	33	0	0	0
⊕ AMS	7	7	0	0	0
⊕ MON	32	32	0	0	0
⊕ GMON	6	5	0	1	0
⊕ ROS	157	156	1	0	0
⊕ SFI	48	48	0	0	0
⊕ SFO	9	9	0	0	0
⊕ DC	12	12	0	0	0
⊕ L2SV	8	8	0	0	0
⊕ XPU	1208	1196	0	8	4
⊕ EF	448	448	0	0	0
⊕ PRESERIES	131	129	1	0	1
⊕ RMON SRVs	3	3	0	0	0
⊕ NET-MON	7	7	0	0	0
⊕ SYS	3	2	0	0	1
⊕ SBC	161	153	5	2	1
⊕ PUB	14	12	2	0	0
⊕ DCS	102	98	4	0	0
⊕ MU-CALSRV	2	2	0	0	0
⊕ SWITCH	100	100	0	0	0
⊕ OTHERS	156	132	21	0	3
TOTAL	2926	2841	50	11	20



Monitoring Ganglia



- ◆ 2011, we introduced Ganglia for performance monitoring and trending
- ◆ We are currently evaluating on a smaller scale system
- ◆ Used primarily for special purpose nodes
 - ◆ local boot nodes
 - ◆ Monitoring
 - ◆ Online sub-farms
- ◆ Single central server
- ◆ Round-Robin Database (RRD) caching daemon used for performance
- ◆ Ganglia is used by many Grid facilities
- ◆ Integration with Icinga





ICINGA and Gearman



Monitoring

- ◆ Icinga+Gearman provide active checks with distributed scheduling
- ◆ Alerting
- ◆ Icinga+Gearman adopted by CMS
- ◆ Icinga can reuse Nagios Plugins, and much of Nagios configuration

Host	Service	Status	Last Check	Duration	Response Time	Output
itazg02-00	nethttp	OK	2013-03-08 15:32:52	74 15h 40m 25s	1/3	HTTP OK: HTTP/1.1 200 OK - 569 bytes in 0.005 second response time
	nettcpdport	OK	2013-03-08 15:23:34	1144 20h 56m 44s	1/3	TCP OK - 0.001 second response time on port 3128
	netssh	OK	2013-03-08 15:31:49	1716 1h 31m 12s	1/3	SSH OK - OpenSSH_5.3 (protocol: 1.99)
itazg02-01	nethttp	OK	2013-03-08 15:32:52	64 15h 40m 25s	1/3	HTTP OK: HTTP/1.1 200 OK - 569 bytes in 0.006 second response time
	nettcpdport	OK	2013-03-08 15:25:45	1144 20h 46m 16s	1/3	TCP OK - 0.006 second response time on port 3128
	netssh	OK	2013-03-08 15:31:52	1154 3h 24m 27s	1/3	SSH OK - OpenSSH_5.3 (protocol: 1.99)
itazg02-02	nethttp	OK	2013-03-08 15:32:51	64 15h 40m 26s	1/3	HTTP OK: HTTP/1.1 200 OK - 569 bytes in 0.005 second response time
	nettcpdport	OK	2013-03-08 15:29:41	234 0h 11m 52s	1/3	TCP OK - 0.005 second response time on port 3128
	netssh	OK	2013-03-08 15:31:56	234 0h 14m 5s	1/3	SSH OK - OpenSSH_5.3 (protocol: 1.99)
itazg04-00	nethttp	OK	2013-03-08 15:23:39	354 3h 55m 7s	1/3	HTTP OK: HTTP/1.1 200 OK - 569 bytes in 0.008 second response time
	nettcpdport	OK	2013-03-08 15:25:48	354 3h 52m 58s	1/3	TCP OK - 0.003 second response time on port 3128
	netssh	OK	2013-03-08 15:29:45	156 1h 45m 1s	1/3	SSH OK - OpenSSH_5.3 (protocol: 1.99)
itazp-b-1	gangliacpu_uptime	OK	2013-03-08 15:32:46	274 1h 48m 27s	1/5	OK System check - OK (1) --OK_cpu_uptime = 99.8 %
	gangliacpu_wio	OK	2013-03-08 15:32:53	34 20h 46m 29s	1/10	OK System check - OK (1) --OK_cpu_wio = 0.0 %
	gangliapart_max_used	OK	2013-03-08 15:29:49	364 4h 18m 4s	1/3	OK System check - OK (1) --OK_part_max_used = 45.8 %
	nethttp	OK	2013-03-08 15:23:45	64 0h 22m 15s	1/3	HTTP OK: HTTP/1.1 302 Found - 404 bytes in 0.014 second response time
itazp-b-2	nethttp	OK	2013-03-08 15:25:56	94 18h 52m 51s	1/3	HTTP OK: HTTP/1.1 302 Found - 430 bytes in 0.112 second response time
	netssh	OK	2013-03-08 15:32:12	364 4h 37m 7s	1/3	SSH OK - OpenSSH_4.3 (protocol: 2.0)
	gangliacpu_uptime	OK	2013-03-08 15:32:56	274 1h 48m 25s	1/5	OK System check - OK (1) --OK_cpu_uptime = 94.0 %
	gangliacpu_wio	OK	2013-03-08 15:32:49	44 1h 57m 11s	1/10	OK System check - OK (1) --OK_cpu_wio = 0.0 %
itazp-b-3	gangliapart_max_used	OK	2013-03-08 15:31:00	384 1h 34m 12s	1/3	OK System check - OK (1) --OK_part_max_used = 29.2 %
	nethttp	OK	2013-03-08 15:29:07	94 13h 34m 16s	1/3	HTTP OK: HTTP/1.1 302 Found - 414 bytes in 0.004 second response time
	nettcpdport	OK	2013-03-08 15:32:27	74 3h 20m 50s	1/3	HTTP OK: HTTP/1.1 302 Found - 440 bytes in 0.025 second response time
	netssh	OK	2013-03-08 15:32:26	884 3h 1m 0s	1/3	SSH OK - OpenSSH_4.3 (protocol: 2.0)
itazp-b-4	gangliacpu_uptime	OK	2013-03-08 15:32:19	274 1h 48m 25s	1/5	OK System check - OK (1) --OK_cpu_uptime = 99.8 %
	gangliacpu_wio	OK	2013-03-08 15:32:12	34 1h 29m 11s	1/10	OK System check - OK (1) --OK_cpu_wio = 1.4 %
	gangliapart_max_used	OK	2013-03-08 15:30:09	384 2h 20m 37s	1/3	OK System check - OK (1) --OK_part_max_used = 59.4 %
	pinging	OK	2013-03-08 14:43:07	654 3h 57m 3s	1/3	PNM OK: itazp-b-04 ping (loss=0%, rtt=0.200000 ms)
itazp-b-5	nethttp	CRITICAL	2013-03-08 15:29:13	34 20h 57m 10s	3/3	CRITICAL: No DHCP OFFERS were received
	netssh	OK	2013-03-08 15:32:26	654 0h 7m 23s	1/3	SSH OK - OpenSSH_4.3 (protocol: 2.0)
itazp-b-6	Current Users	OK	2013-03-08 15:30:05	1894 7h 15m 10s	1/4	USERS OK - 0 users currently logged in
	icinga Startup Delay	OK	2013-03-08 15:29:01	1894 7h 4m 54s	1/4	OK: Icinga started with 1 seconds delay
	Root Partition	OK	2013-03-08 15:31:11	1894 7h 15m 10s	1/4	DISK OK - free space / 19001 MB (91% inode=90%):
	Swap Usage	OK	2013-03-08 15:30:11	1894 7h 15m 10s	1/4	SWAP OK - 100% free (8189 MB out of 8189 MB)
	Total Processes	OK	2013-03-08 15:29:05	354 15h 17m 51s	1/4	PROCS OK - 148 processes with STATE = RSDZT
itazp-b-7	netssh	OK	2013-03-08 15:32:30	1894 7h 7m 48s	1/3	SSH OK - OpenSSH_4.3 (protocol: 2.0)
	netssh	CRITICAL	2013-03-08 15:26:15	794 8h 30m 40s	1/3	CRITICAL: - Socket timeout after 10 seconds
itazp-b-8	netssh	CRITICAL	2013-03-08 15:30:12	94 5h 24m 29s	1/3	CRITICAL: - Socket timeout after 10 seconds
	netssh	OK	2013-03-08 15:22:35	644 16h 52m 56s	1/3	PNM OK - itazp-b-01 ping (loss=0%, rtt=0.700000 ms)
itazp-b-9	netssh	OK	2013-03-08 15:24:08	154 2h 4m 17s	1/3	SSH OK - OpenSSH_4.3 (protocol: 2.0)



Security

Remote Access Subsystems



- ◆ Security at Point 1 is of utmost importance
- ◆ Access to the ATLAS Technical and Control Network (ATCN) is highly restricted
- ◆ only allowed via one of the following gateway systems:
 - ◆ ATLAS Point 1, Allowing expert users access to their restricted machines via SSH or SCP protocols
 - ◆ ATLAS Remote Monitoring System provides the graphical terminal services required for organising the remote participation in the ATLAS sub-detector monitoring shifts
 - ◆ ATLAS DCS Windows Terminal Servers, allowing DCS experts access to the supervisory control and data acquisition (SCADA) systems in ATLAS
- ◆ Host and network based accounting, security monitoring and intrusion prevention systems are configured on all the gateways



Security

Role Based Access Control



- ◆ Own user database in the form of an LDAP server based on OpenLDAP software
- ◆ Standalone but for consistency it is synchronized with IT
- ◆ User based authentication, NOT group based authentication
- ◆ Slave Windows Domain Controller using the CERN NICE credentials.
- ◆ Local service accounts, authentication (passwords) in LDAP
- ◆ Role Based Access Control (RBAC) authorization system
- ◆ 150 unique roles in a hierarchical structure and ~1600 Users

- ◆ BUT..

Access ONLY authorised by ShiftLeader, to on-call experts, during shifts



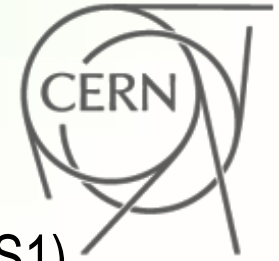


Virtualisation

- ◆ More in an "opportunistic" fashion than as a full battle plan
- ◆ Machines currently running as VM's
 - ◆ Gateways
 - ◆ Few Windows services
 - ◆ Core Nagios servers
 - ◆ Public Nodes
 - ◆ Domain Controllers
 - ◆ Development Web servers
 - ◆ Puppet & Quattor
- ◆ Xen on Gateways (Bastion Hosts) KVM with SLC6 for everything else
- ◆ Currently :
 - ◆ 35 machines in Point 1
 - ◆ 11 in GPN
- ◆ Expected:
 - ◆ Additional ~100 DCS
 - ◆ ~1500 for Sim@P1



Sim @ P1



- ◆ HLT Farm would be mostly idle during Long shutdown 1 (LS1)
- ◆ Use it for ATLAS simulations jobs considerable fraction (>10%) of ATLAS Grid
- ◆ Support from BNL during the setup phases
- ◆ Support from NetAdmin for dedicated network
- ◆ Preserve security of ATCN by isolating VMs and VLANs
- ◆ Tests are ongoing in TDAQ Lab4 Test Bed

#	Type	CPU Cores: non-HT / HT	Memory	Local disk
341	Dell PE 1950	8 / 8 (*)	16 GB	80 GB
320	Dell PE 6100	8 / 16	24 GB	250 GB
832	Dell PE 6100	12 / 24	24 GB	250 GB
1493	Total	15272 / 27816	33 TB	315 TB

(*) HT not enabled



Sim @ P1

The Plan



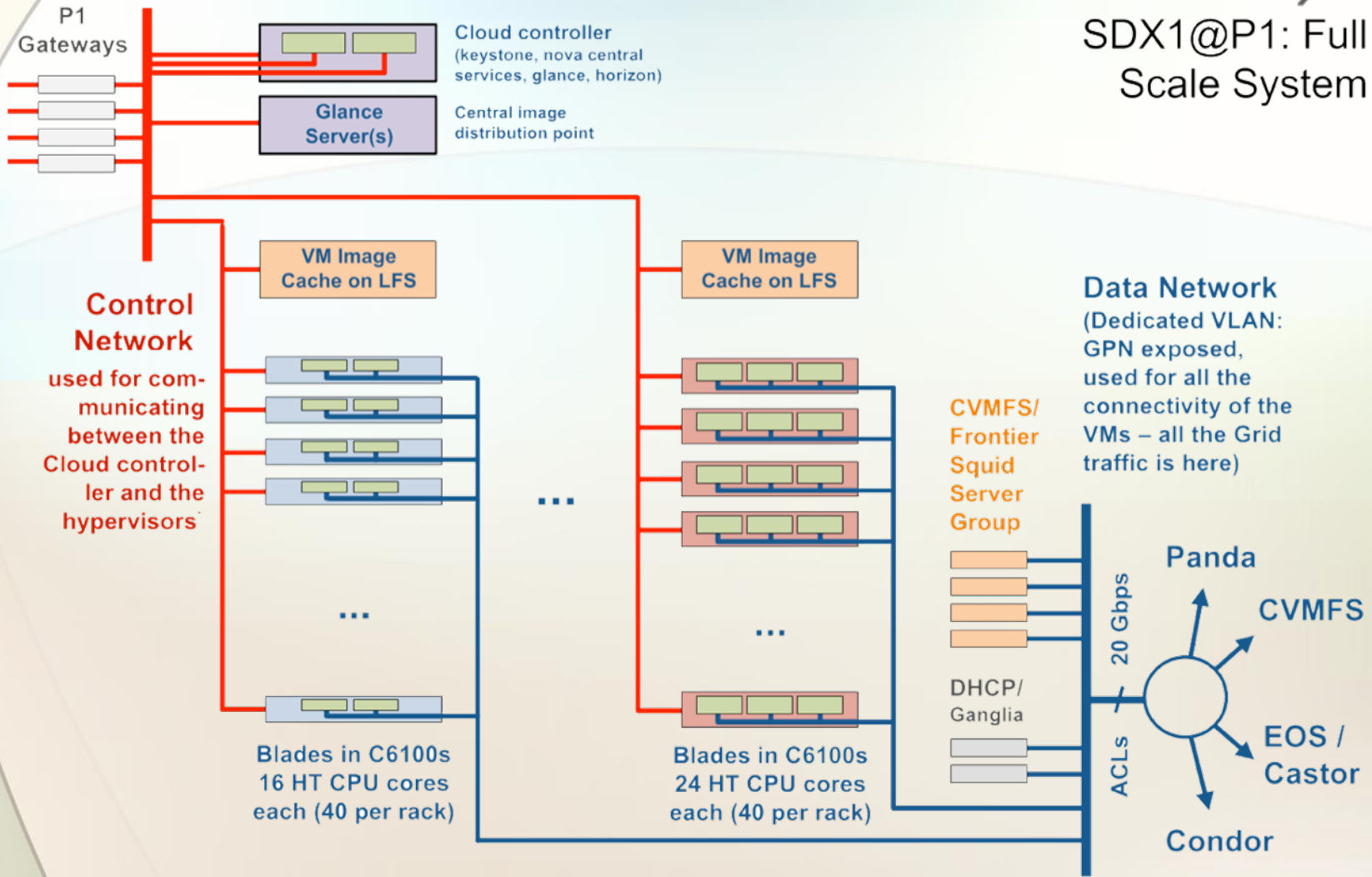
- ◆ *OpenSTACK*, as an overlay infrastructure
 - ◆ Provides necessary management of VM resources
 - ◆ Support & control of physical hosts remain with TDAQ
 - ◆ Delegate VM Farm support to Offline Operations
- ◆ Easy to quickly switch from HLT ↔ GRID
 - ◆ During LS1: monthly full-scale test of TDAQ sw upgrade
 - ◆ Can be used in the future also during short LHC stop
- ◆ BNL, CERN IT, CMS
 - ◆ Sharing experiences
 - ◆ Support if needed
 - ◆ ATLAS is already, successfully using BNL cloud resources



Sim @ P1



SDX1@P1: Full Scale System



Conclusion



- ◆ 3 years of LHC run point to a **good, linear scalability** of the LFS-based architecture, **OK overall**, but to be kept under control
- ◆ LFS' have the performance for serving more than one rack of clients, BUT:
 - ◆ Network locality decreases load on control network
 - ◆ More clients would be affected in case of failure of an LFS
- ◆ Netboot limited functionality, great flexibility in OS migration
- ◆ Localboot, used to be harder to configure, Puppet changing that
- ◆ Overall, the current architecture is **sound and performing well**, and the possible **changes** would increase complexity and **not give drastic improvements**
- ◆ We have decided to focus on trying to simplify and streamline the system where possible, making it **more robust and maintainable**



Backups / Spares



SFO



- ◆ Sub Farm Output
- ◆ Historically (2003), 200 Hz average output rate
- ◆ Defined as a compromise between physics goals and yearly data production volume and therefore offline storage requirements ... at least this is what the elders say ...
- ◆ 10 years later, in 2012, data storage and network capabilities allowed to run at an average of 600 Hz
- ◆ For 2015+, the proposal is to run at 1kHz average output
- ◆ The offline community has still however to acknowledge this new target

