

# FermiGrid Scalability and Reliability Improvements

K. Chadwick, F. Lowe, N. Sharma, S. Timm, D. R. Yocum  
Grid And Cloud Computing Department  
Fermilab  
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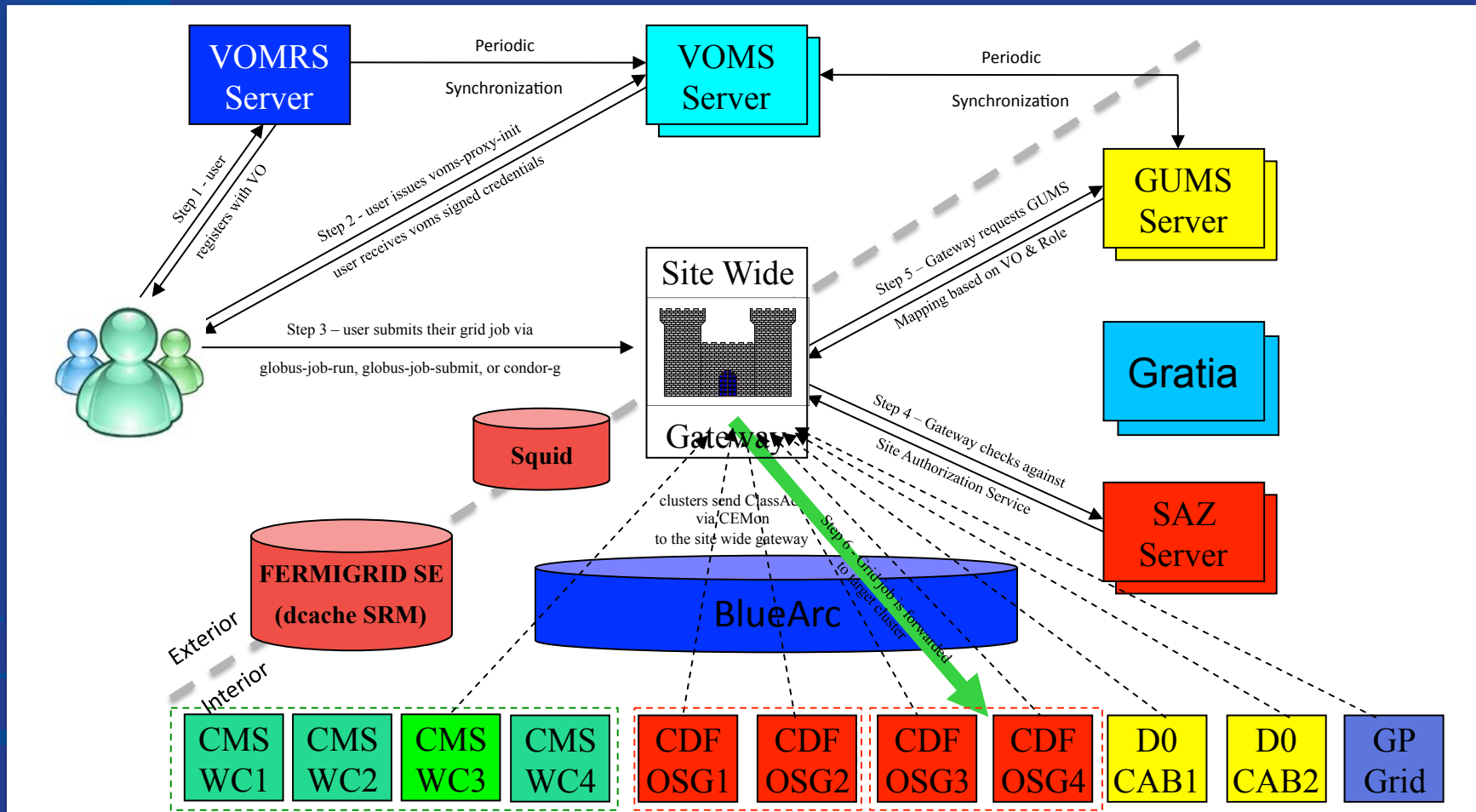
# What is FermiGrid?

- A Meta-facility that provides grid infrastructure for scientific computing at Fermilab,
- Provides highly-available centralized authorization and authentication services,
- Provides site gateway for Globus job submission,
- Coordinates interoperability among stakeholders,
- Provides grid-enabled mass storage services,
- >2,100,000,000 CPU-hours recorded since Gratia accounting started, most in OSG,
- Currently have over 22,500 batch slots, 10 compute elements.

# Key Policies

- Early management directions:
  - Special security enclave for nodes where grid jobs run,
  - There WILL be a single site gateway for OSG jobs,
  - All major users and clusters MUST interoperate,
  - There WILL be a unified DN/VO/FQAN to Unix UID mapping,
  - There WILL be a central banning server,
  - Pilot jobs MUST use gLexec to authenticate 3rd-party jobs,
  - We WILL have our own Certificate Authority (the Fermilab Kerberos Certificate Authority),
  - We WILL keep more than one batch system in production.

# FermiGrid Architecture





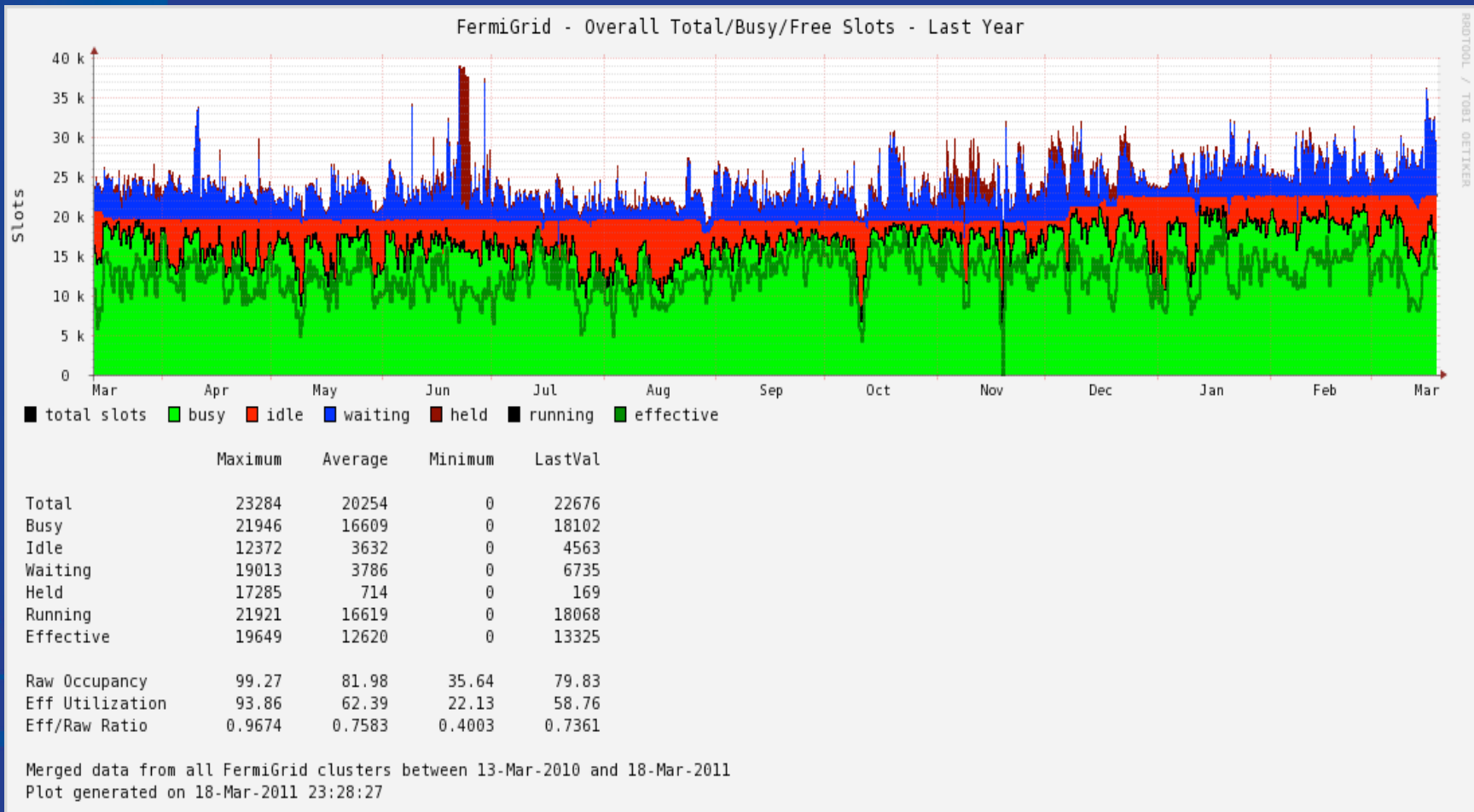
# Condor Classads

- Start with Glue Schema 1.3 LDIF information for each Computing Element and associated Storage Elements,
- Clusters divided up into subclusters based on hardware type,
- gLite CEMon plugin makes one classad for each unique combination of {VO, subcluster, Storage Area},
- Example: 60 VO's x 4 subclusters x 2 Storage Areas = 480 classads in just 1 cluster,
- FermiGrid presently has 7,174 classads,
- OSG presently has 21,981 classads,
- Classads transmitted by CEMon to Resource Selection System,
- Raw LDIF transmitted by CEMon to OSG BDII.

# Recent use case - OS Version

- Needed to upgrade from SLF4 to SLF5, one subcluster at a time,
- Each subcluster advertises:
  - Current OS Version,
  - Extra RSL fields to make sure you run on those nodes when your job matches to that subcluster.
- Users submit job requesting OS (4.7 or 5.3),
- Site gateway finds a matching subcluster and automatically appends right RSL, and forwards job.
- Can also select on memory, disk, batch system.

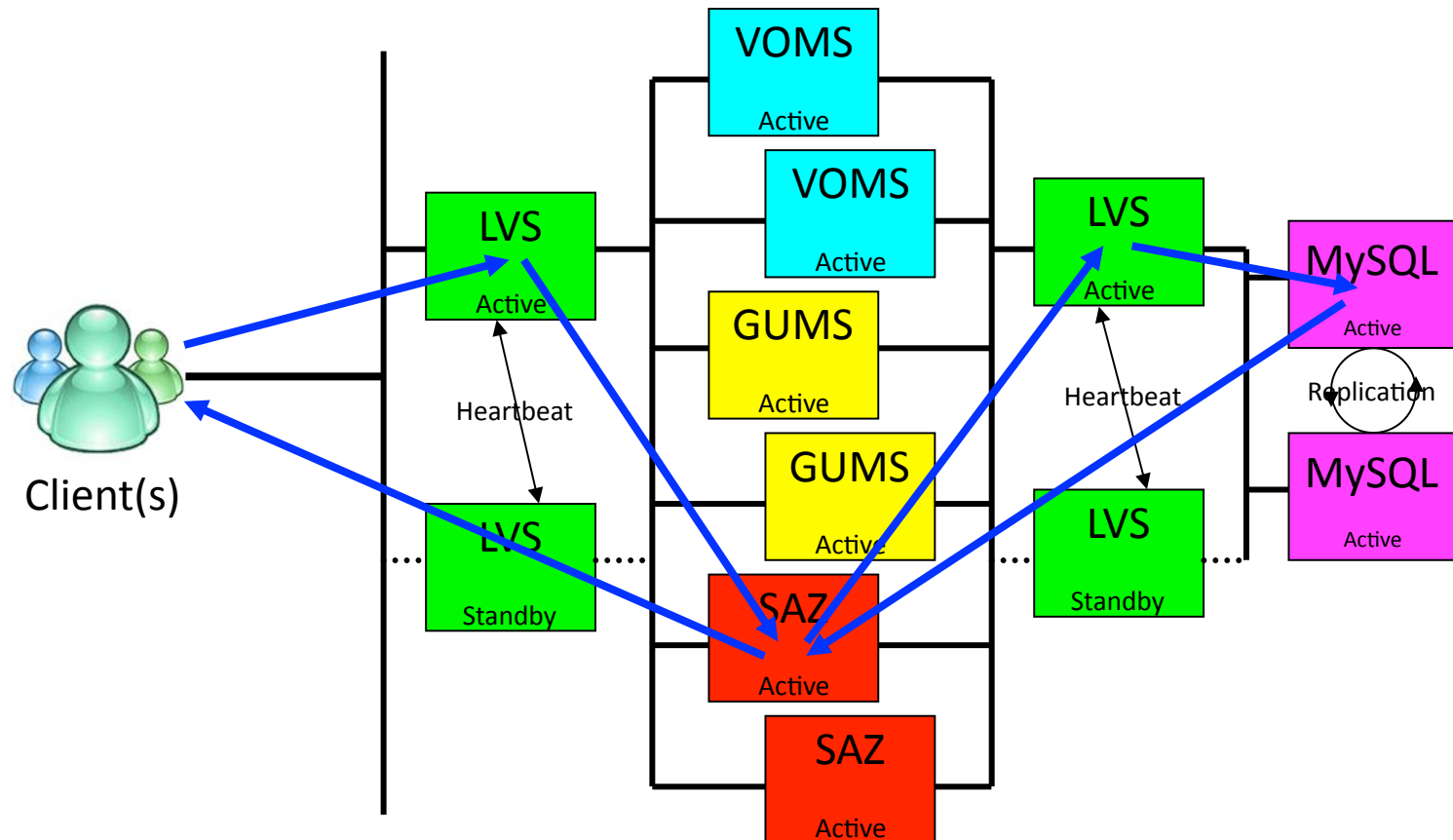
# Overall Occupancy & Utilization



# Batch Systems, Occupancy & Utilization

Cluster	Cluster Batch System	Current Cluster Size (Slots)	Average Cluster Occupancy (%)	Average Cluster Utilization (%)
CDF	Condor	5,600	89.2	61.7
CMS	Condor	7,485	86.3	73.9
D0	PBS	6,916	74.8	49.6
GP	Condor	3,284	69.0	63.0
Overall	----	23,285	82.0	62.4

# FermiGrid HA Services - 1



# FermiGrid-HA Services - 2

## Xen Domain 0

LVS                      Xen VM 0  
Active                      fg5x0

VOMS                      Xen VM 1  
Active                      fg5x1

GUMS                      Xen VM 2  
Active                      fg5x2

SAZ                      Xen VM 3  
Active                      fg5x3

MySQL                      Xen VM 4  
Active                      fg5x4

Active

fermigrid5

## Xen Domain 0

LVS                      Xen VM 0  
Standby                      fg6x0

VOMS                      Xen VM 1  
Active                      fg6x1

GUMS                      Xen VM 2  
Active                      fg6x2

SAZ                      Xen VM 3  
Active                      fg6x3

MySQL                      Xen VM 4  
Active                      fg6x4

Active

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# Measured FermiGrid Service Availability for the Past Year\*

Service	Availability	Downtime
VOMS-HA	100%	0m
GUMS-HA	100%	0m
SAZ-HA (gatekeeper)	100%	0m
Squid-HA	100%	0m
MyProxy-HA	99.943%	299.0m
ReSS-HA	99.959%	215.36m
Gratia-HP	99.955%	233.30m
Database-HA	99.963%	192.62m

\* = Excluding building or network failures

# SAZ – Central Banning Service

- Site AuthoriZation service, developed at Fermilab,
- Allows us to ban any DN, VO, FQAN, or CA,
- Don't have to wait for CA to revoke the certificate or VO to remove from membership,
- Available as Pacman package,
- Details at <http://saz.fnal.gov>
- With glideins, every worker node can be a client simultaneously (have seen 5000+ active clients),
- Significant work has been done to make it more resilient and scalable,
- Code also contains support for new XACML-based authorization protocol.



# Why a new SAZ Server?

- Previous SAZ server (V2\_0\_1b) had shown itself extremely vulnerable to user generated authorization "tsunamis":
  - Very short duration jobs
  - User issues condor\_rm on a large (>1000) glidein.
- This was fixed in the new SAZ Server (V2\_7\_2) using tomcat and pools of execution and hibernate threads.
- Various other bugs were found and fixed in the current SAZ server and sazclient.
- Added support for the XACML protocol (used by Globus).
  - NOT transitioning to using XACML (yet).
- New SAZ Servers (V2\_7\_2) have been in operation since May 2010.
  - Have repeatedly demonstrated in production that they are robust against authorization "tsunamis".

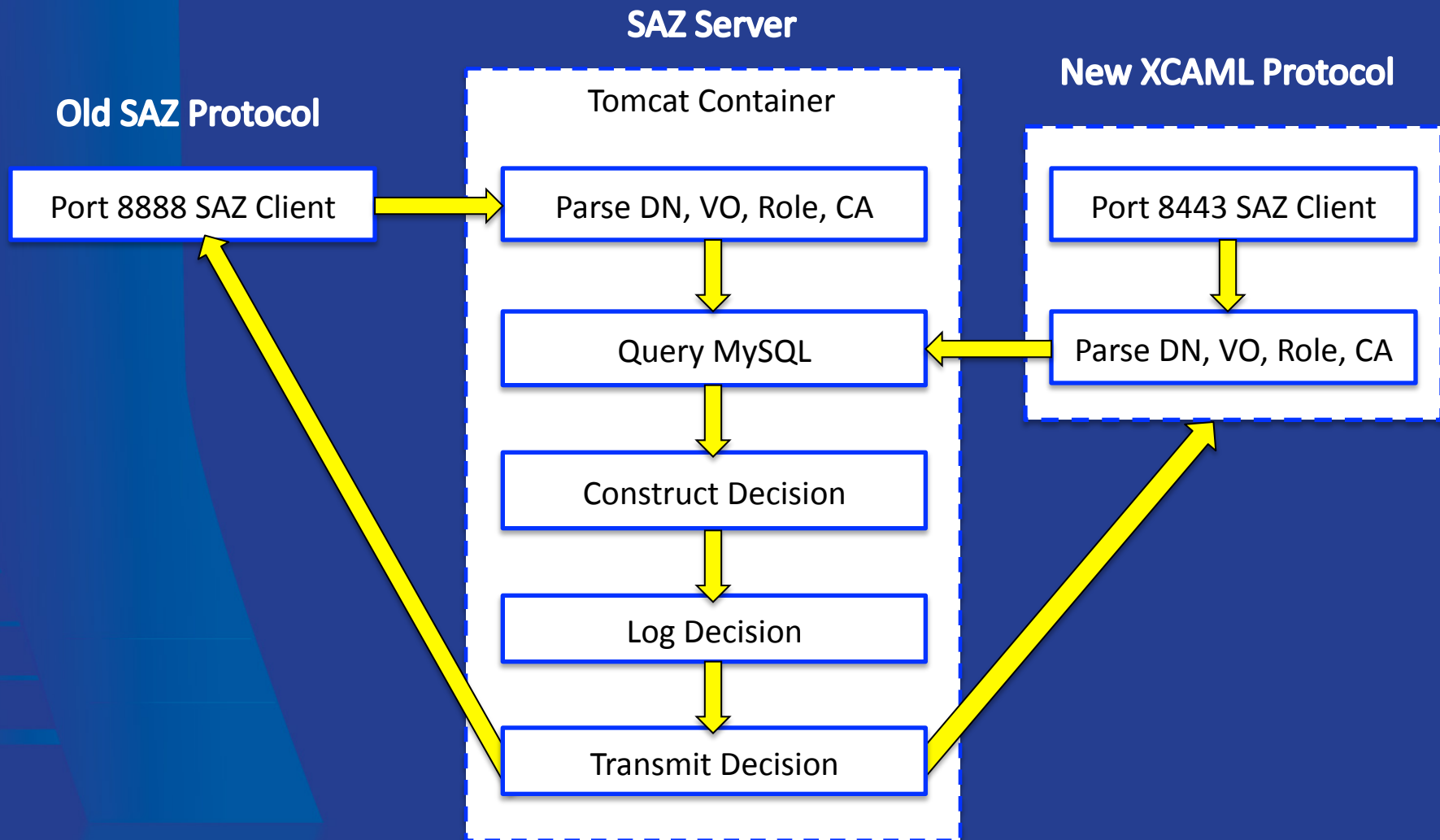
# Old (“current”) SAZ Protocol – Port 8888

- Client sends the public certificates in the users proxy to the SAZ server via port 8888.
- Server parses out DN, VO, FQAN, CA.
  - In the old SAZ V2.0.0b, the parsing logic frequently did not work well, and as a workaround, the SAZ server had to invoke a shell script voms-proxy-info to parse the proxy.
  - In the new SAZ V2\_7\_2, the parsing logic has been completely rewritten, and it no longer has to invoke the shell script voms-proxy-info to parse the proxy.
- Server performs MySQL queries.
- Server constructs the answer and sends it to the client.

## New SAZ (XACML) Protocol – Port 8443

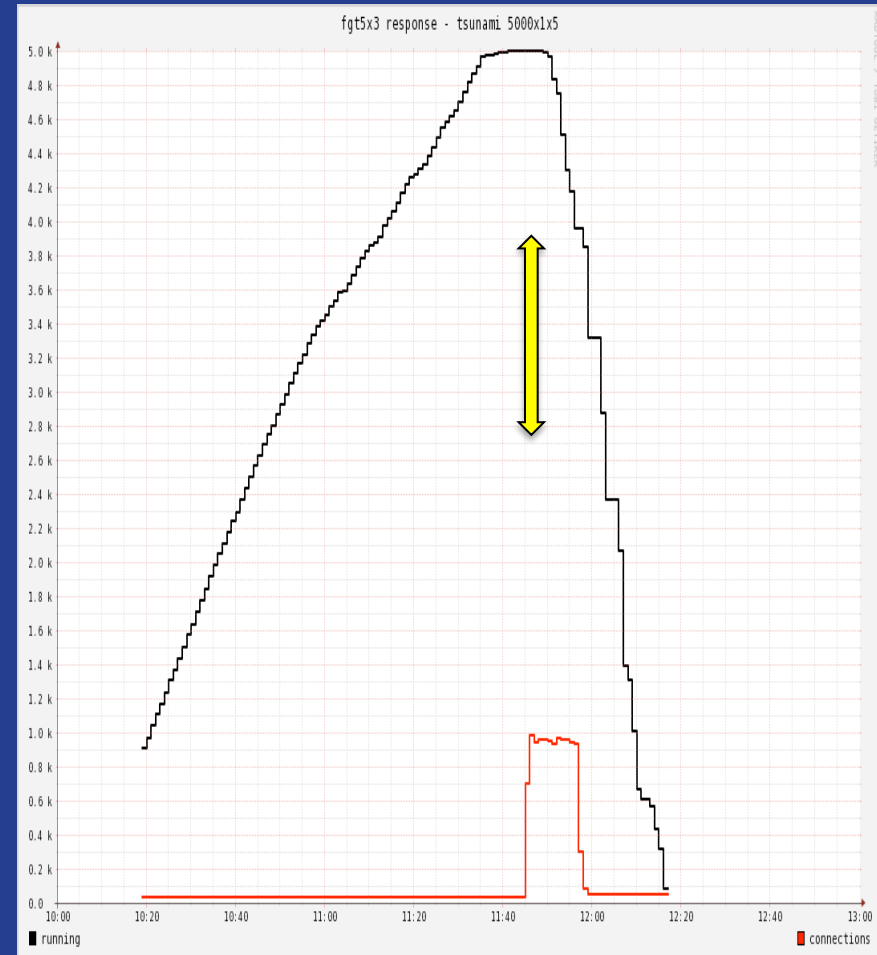
- Client parses out DN, VO, FQAN, CA and sends the information via XACML to the SAZ server via port 8443.
- Server performs MySQL queries.
- Server constructs the answer and sends it to the client.
- The new SAZ server supports both 8888 and 8443 protocols simultaneously.

# Comparison of Old & New Protocol



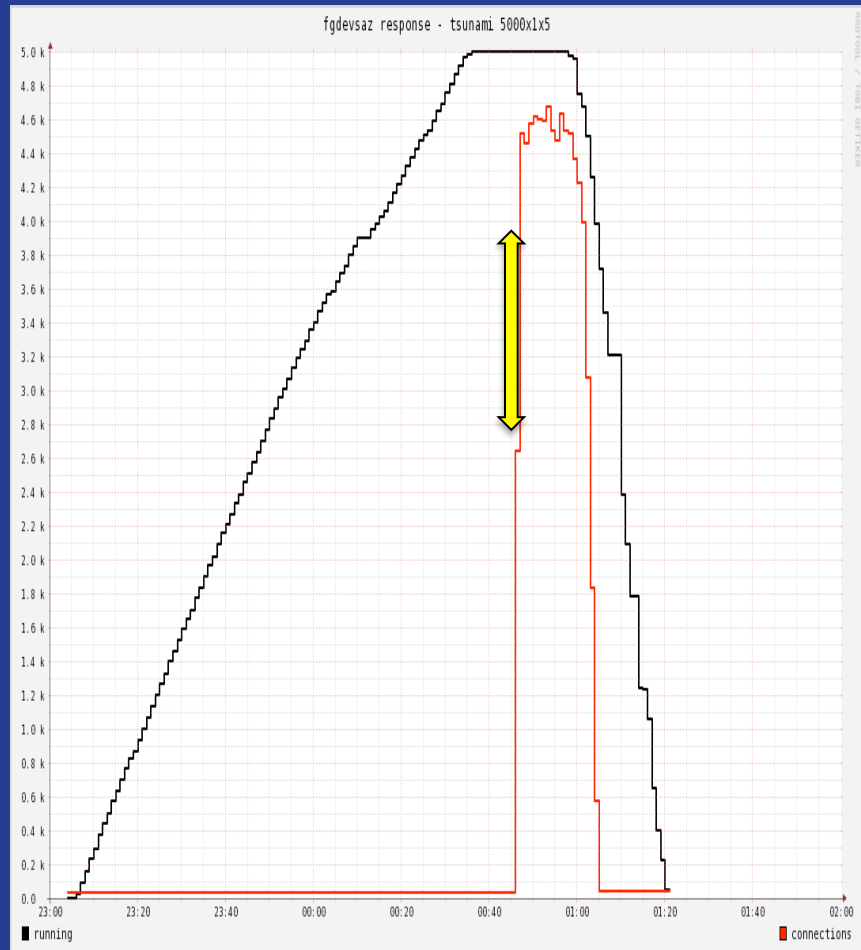
# Previous SAZ Server Performance

- Using development server,
- Black = number of condor jobs,
- Red = number of saz network connections.
- Trigger @ 11:45:12
- Failures start @ 11:45:19
- 25,000 Authorizations
- 14,183 Success
- 10,817 Failures
- Complete @ 11:58:28
- Elapsed time 13m 16s

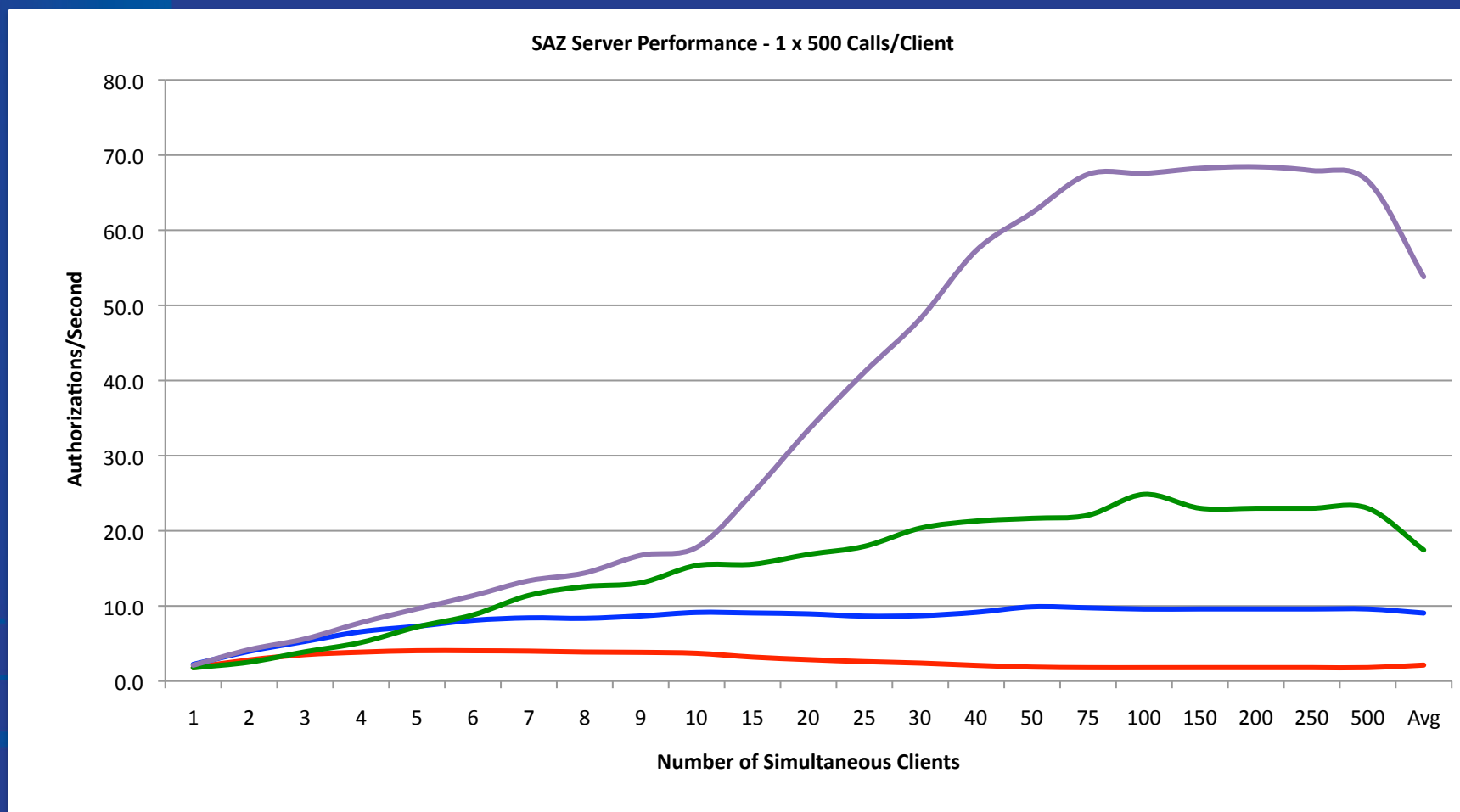


# Current SAZ Server Performance

- Using development server
- Black = number of condor jobs,
- Red = number of saz network connections.
- Trigger @ 00:46:20,
- 25,000 Authorizations,
- 25,000 Success,
- 0 Failures,
- Complete @ 01:05:03,
- Elapsed time = 18m 43s,
- 22.26 Authorizations/sec.



# Multiple Client SAZ production performance Old (red) vs. Current (purple)

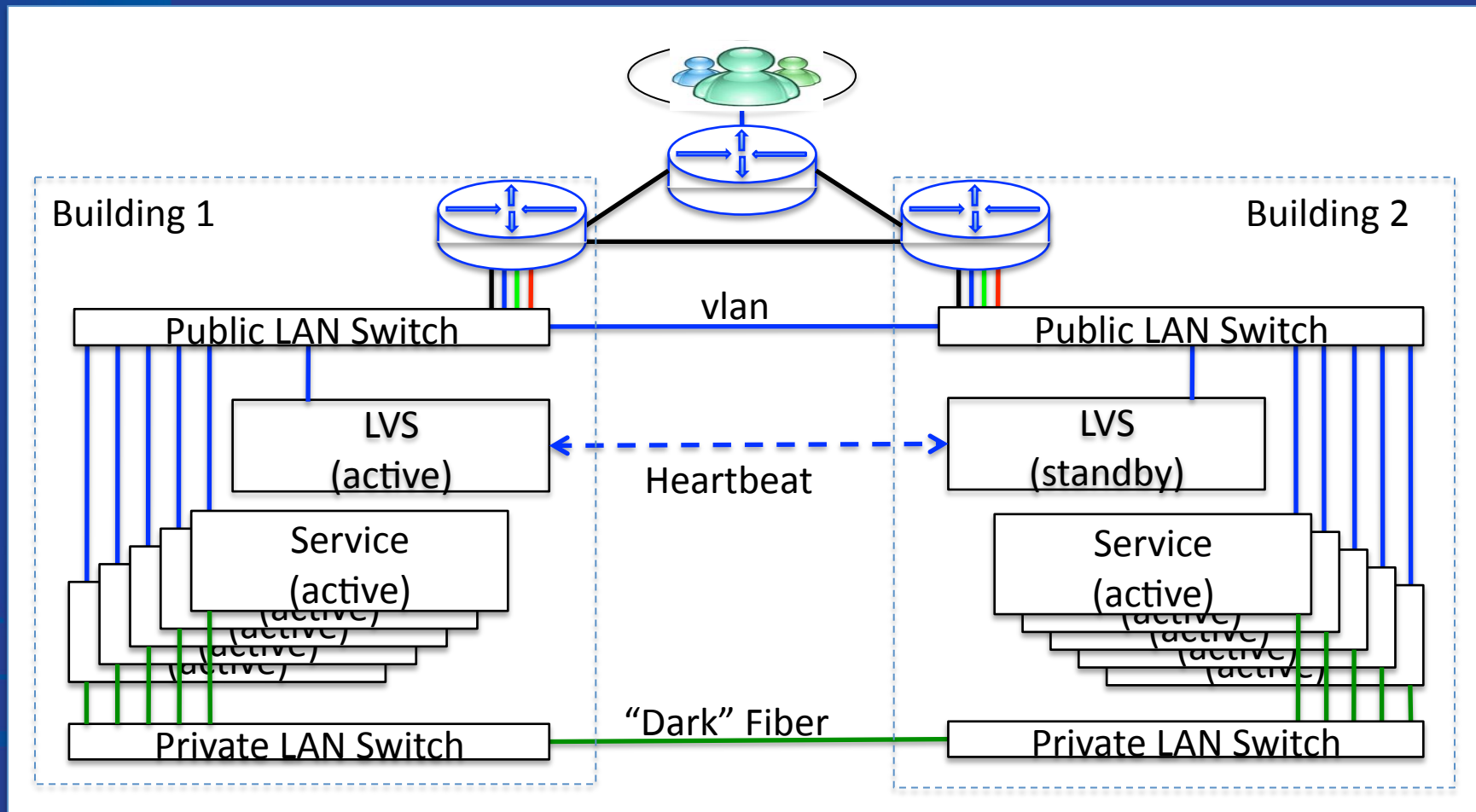


# FermiGrid-HA2 Project

- At present, the FermiGrid machines are all in the FCC1 computer room – a single building with the corresponding power and network infrastructure,
  - Vulnerable to building issues (4X in past 14 months),
  - Vulnerable to network issues (6X in past 6 weeks).
- The goal of the FermiGrid-HA2 project is to spread the systems and services between two buildings to lessen the chance of network cut or power outage disrupting all service,
- High availability:
  - Web services: LVS active/active with MySQL back end,
  - File systems: DRBD + Heartbeat, (MyProxy and Gratia now, Compute Element soon),
  - Native HA – Condor collector/negotiator.



# FermiGrid-HA2 Network



# FermiGrid-HA2 Rack Layouts

- Two (almost) identically configured racks:
  - One with 120VAC power distribution,
  - One with 208VAC power distribution,
- Both currently located in FCC1 computer room,
- Waiting on some equipment deliveries, installations and network configuration changes,
- 1<sup>st</sup> rack will be moved to FCC2 computer room,
- 2<sup>nd</sup> rack will be moved to GCCB computer room.

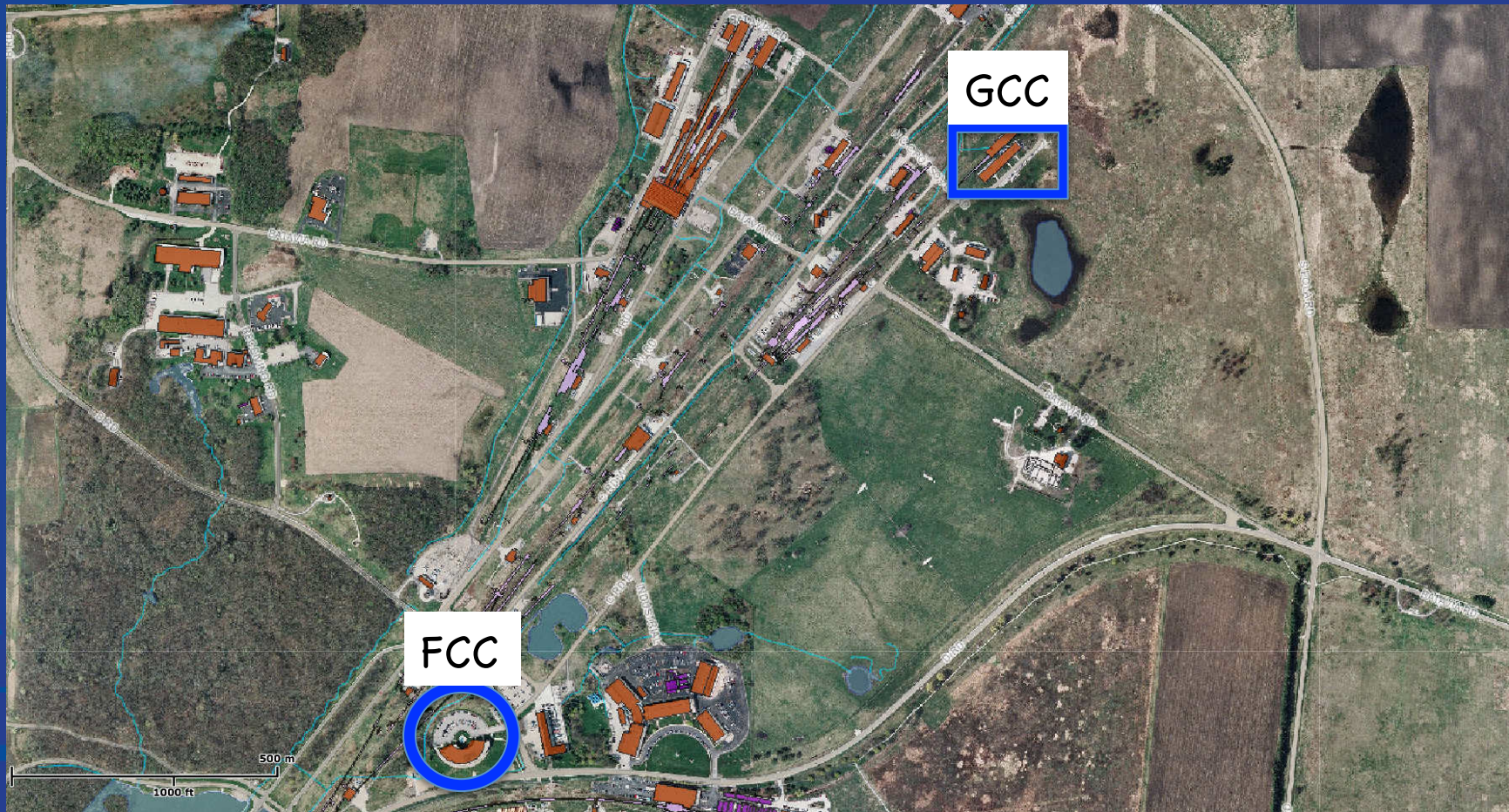
FermiGrid-HA2 Rack Front	Rack "U"	FermiGrid-HA2 Rack Rear
	42	Cisco Nexxus / 2960G Public LAN Switch
	41	Cyclades AlterPath Console Server 16
blank - 2U	40	fnpcsrv8 / blank - 1U
fnpcsrv8 / blank - 1U	39	fnpcsrv5 / fnpcsrv9
fnpcsrv5 / fnpcsrv9	38	fnpcsrv3 / fnpcsrv4
fnpcsrv3 / fnpcsrv4	37	blank - 1U
blank - 1U	36	
d0osgsrv1 / d0osgsrv2	35	d0osgsrv1 / d0osgsrv2
	34	
blank - 2U	33	blank - 2U
	32	
fcdfsrv3 / fcdfsrv4	31	fcdfsrv3 / fcdfsrv4
	30	
fcdfsrv1 / fcdfsrv2	29	fcdfsrv1 / fcdfsrv2
	28	
fcdfsrv0 / fcdfsrv5	27	fcdfsrv0 / fcdfsrv5
	26	Cyclades PM10-L30A 120VAC
blank - 2U	25	Cyclades PM10-L30A 120VAC
Display / Keyboard / Mouse	24	Display / Keyboard / Mouse
Raritan MasterConsole MCCAT116 KVM	23	Omniview PS3 16 port KVM
blank - 1U	22	Linksys SR2024 Private LAN Switch
Slave KDC - Sun Netra X1	21	APC Transfer Switch
blank - 1U	20	blank - 1U
	19	
	18	
gratia12 (FCC) / gratia13(GCC)	17	gratia12 (FCC) / gratia13(GCC)
	16	
	15	
gratia10 (FCC) / gratia11 (GCC)	14	gratia10 (FCC) / gratia11 (GCC)
blank - 1U	13	blank - 1U
	12	
ress01 / ress02	11	ress01 / ress02
	10	
fermigrid5 / fermigrid6	9	fermigrid5 / fermigrid6
	8	
fermigrid2 / fermigrid3	7	fermigrid2 / fermigrid3
	6	
fermigrid1 / fermigrid4	5	fermigrid1 / fermigrid4
	4	
fermigrid0 / fermigrid7	3	fermigrid0 / fermigrid7
	2	Cyclades PM10-L30A 120VAC
blank - 2U	1	Cyclades PM10-L30A 120VAC

# FermiGrid-HA2 Pictures





# Geographical Redundancy



# Conclusions

- Good policy planning gave FermiGrid an extensible architecture that we have been able to scale,
- More than 210,000,000 CPU-Hours delivered thus far, most in Open Science Grid,
- Testing at very large scale is key to operating at large scale,
- Expect completion of FermiGrid-HA2 by late May 2011:
  - Will give us resilience against single building failure,
  - FCC power outage currently scheduled for June 2011 will be an important test.
- Ongoing planning and testing is key to reliable service delivery.

# Fin

- Any Questions?