Metrics and Monitoring on FermiGrid

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Outline

FermiGrid Introduction and Background

Metrics

Service Monitoring

Availability (Acceptance) Monitoring

Dashboard

Lessons Learned

Future Plans

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What is FermiGrid?

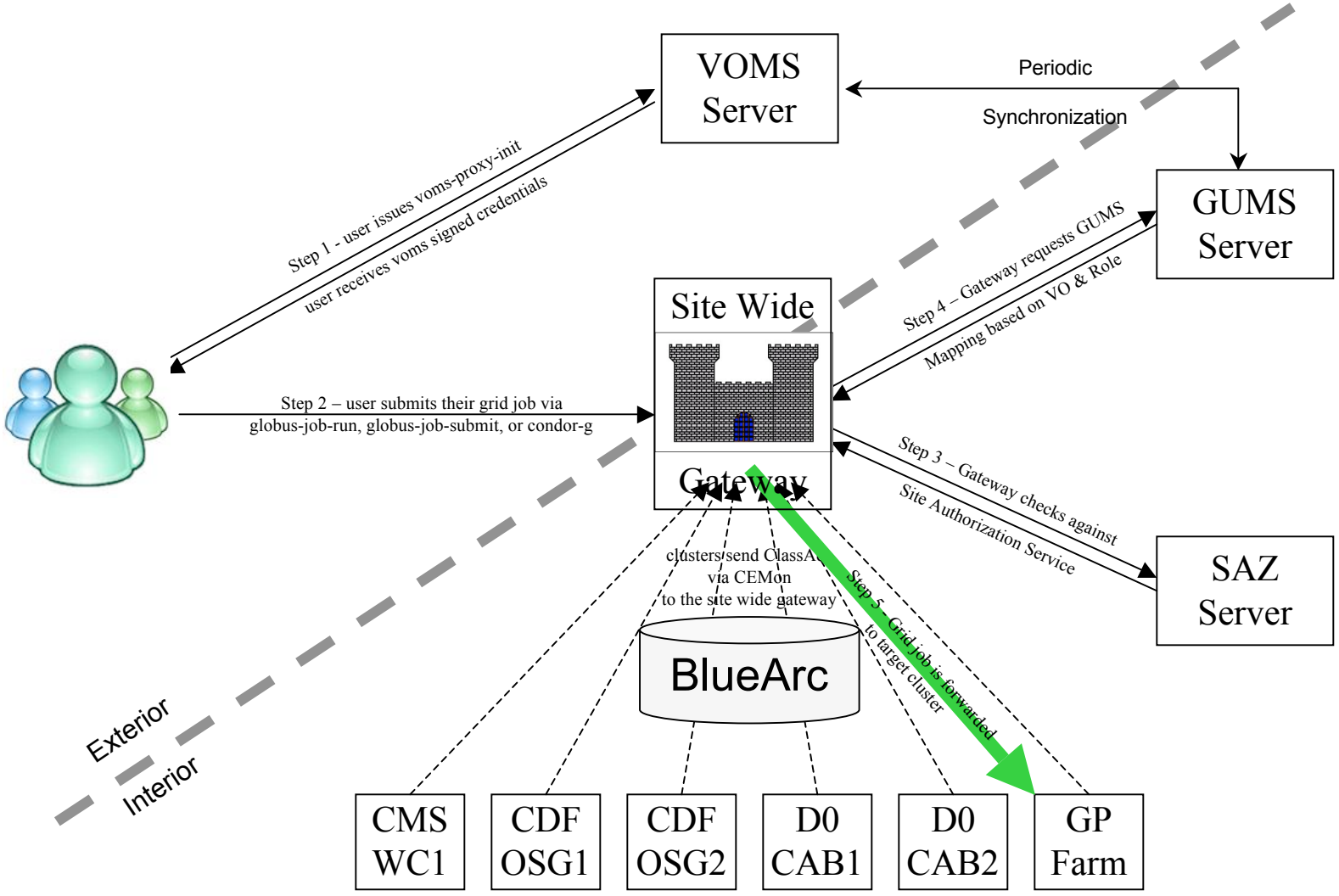
FermiGrid is:

- The Fermilab campus Grid and Grid portal.
  - The site globus gateway.
  - Accepts jobs from external (to Fermilab) sources and forwards the jobs onto internal clusters.
- A set of common services to support the campus Grid and interface to Open Science Grid (OSG) / LHC Computing Grid (LCG):
  - VOMS, VOMRS, GUMS, SAZ, MyProxy, Squid, Gratia Accounting, etc.
- A forum for promoting stakeholder interoperability and resource sharing within Fermilab:
  - CMS, CDF, D0;
  - ktev, miniboone, minos, mipp, etc.
- The Open Science Grid portal to Fermilab Compute and Storage Services.

FermiGrid Web Site & Additional Documentation:

- http://fermigrid.fnal.gov/

FermiGrid - Current Architecture



Software Stack

Baseline:

- SL 3.0.x, SL 4.x, SL 5.0 (just released)
- OSG 0.6.0 (VDT 1.6.1, GT 4, WS-Gram, Pre-WS Gram)

Additional Components:

- VOMS (VO Management Service)
- VOMRS (VO Membership Registration Service)
- GUMS (Grid User Mapping Service)
- SAZ (Site AuthoriZation Service)
- jobmanager-cemon (job forwarding job manager)
- MyProxy (credential storage)
- Squid (web proxy cache)
- syslog-ng (auditing)
- Gratia (accounting)
- Xen (virtualization)
- Linux-HA (high availability)

Timeline

FermiGrid services were initially deployed in April 1, 2005.

The first formal metrics collection was commissioned in late August 2005.

- Initially a manual process.
- Automated during the fall of 2005.

Service monitoring was commissioned in June 2006.

VO Acceptance monitoring was commissioned in August 2006.

Availability monitoring was commissioned earlier this month.

Metrics vs. Monitoring

Metrics collection:

- Takes place once per day.

Service Monitoring:

- Takes place multiple times per day (typically once an hour).
- May have abilities to detect failed (or about to failed) services, notify administrators and (optionally) restart the service.
- Generates capacity planning information.

Acceptance Monitoring:

- Does a grid site accept “my” VO and pass a minimal set of tests.
- May not guarantee that a real application can run - just that it can get in the door.

Availability Monitoring:

- Very lightweight.
- Can be run very frequently (multiple times per hour).
- Optional automatic notification if results are “unexpected”.
- Feeds automatic “Dashboard” display.

Metrics Collection - Mechanics

Metrics collection is implemented on FermiGrid as follows:

- A central metrics collection system launches a central metrics collection process once per day.
  - collect_grid_metrics.sh
- The central metrics collection process in turn launches copies of itself (secondary metrics collection processes) via ssh across all systems (and the services) that are designated for metrics collection.
  - collect_grid_metrics.sh <node> <service> <date> <…>
- The secondary metrics collection processes identify the system, service and metrics to be collected, and then launch a script which has been custom written to collect the desired metrics from the specified service.
  - collect-globus-metrics.sh <date> <…>
  - collect-voms-metrics.sh <date> <…>

Metrics collected within FermiGrid

Globus Gatekeeper:

- # of authenticated, authorized, jobmanager, jobmanager-fork, jobmanager-managedfork
- batch (jobmanager-condor, jobmanager-pbs, etc.), jobmanager-condorg, jobmanager-cemon,
- jobmanager-mis, default.
- # of total IP connections, # of unique IP connections, # of unique IP connections from within Fermilab.

VOMS:

- # of voms-proxy-init's by VO.
- # of voms-proxy-init's by group within the fermilab VO.
- # of total IP connections, # of unique IP connections, # of unique IP connections from within Fermilab.

GUMS:

- # of successful GUMS mapping calls & # of failed GUMS mapping calls.
- # of total certificates, # of unique dn, # of unique mappings, # of unique Vos
- # of voms-proxy-inits, # of grid-proxy-inits.
- # of total IP connections, # of unique IP connections, # of unique IP connections from within Fermilab.

SAZ:

- # of successful SAZ calls & # of rejected SAZ calls.
- # of unique DN, # of unique VO, # of unique Role, # of unique CA.
- # of total IP connections, # of unique IP connections, # of unique IP connections from within Fermilab.

Metrics Storage and Publication

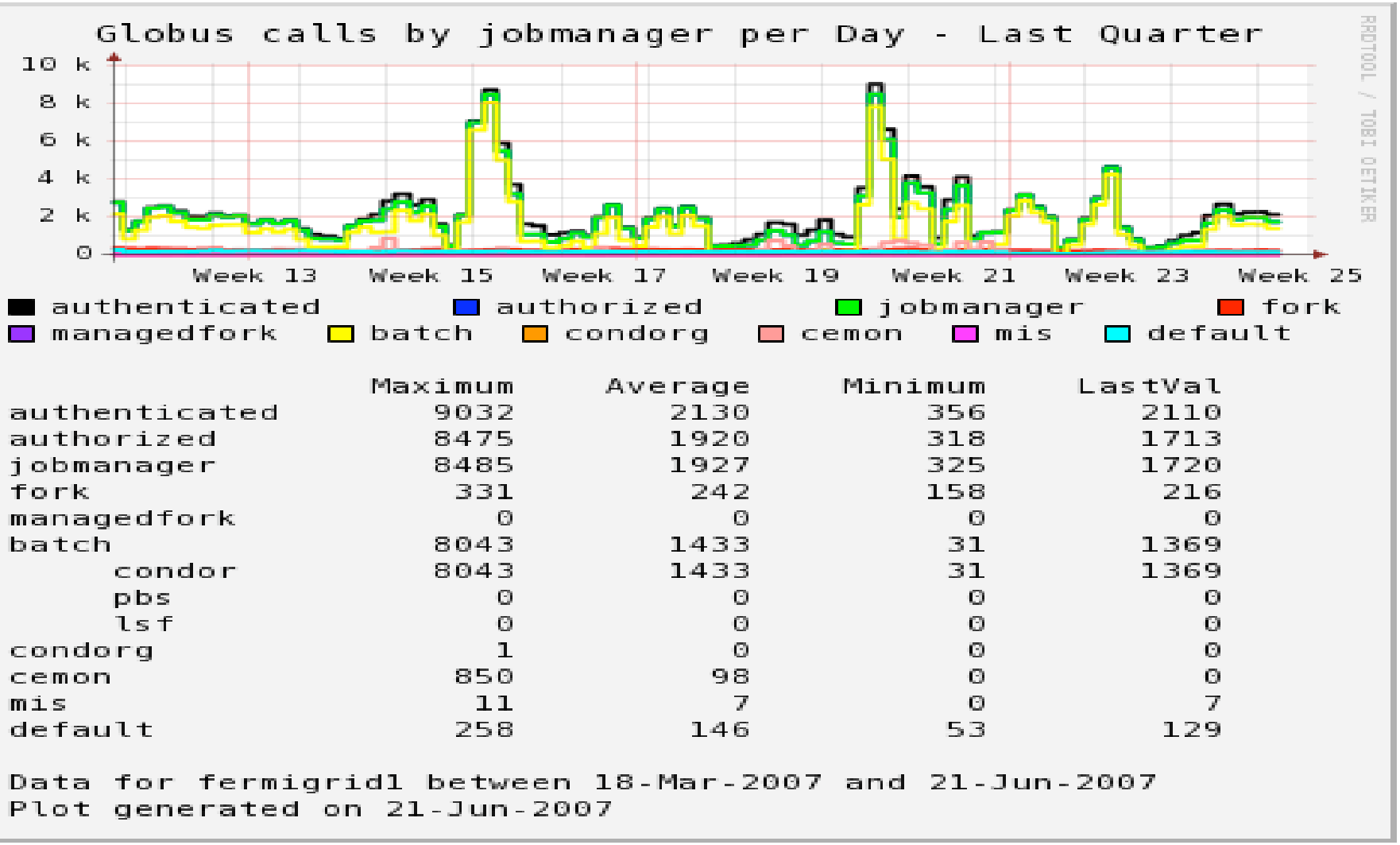
Metrics are stored using two mechanisms:

- First, they are appended to ".csv" files which contain a leading date followed by tag-value pairs. Example:
  - 22-Jun-2007,total=5721,success=5698,fails=53
  - total_ip=5721,unique_ip=231,fermilab_ip=12
- Second, the ".csv" files are processed and loaded in to round robin databases using rrdtool.

A set of "standard" png plots are automatically generated from the rrdtool databases.

All of these formats (.csv, .rrd and .png) are periodically uploaded from the metrics collection host to the central FermiGrid web server.

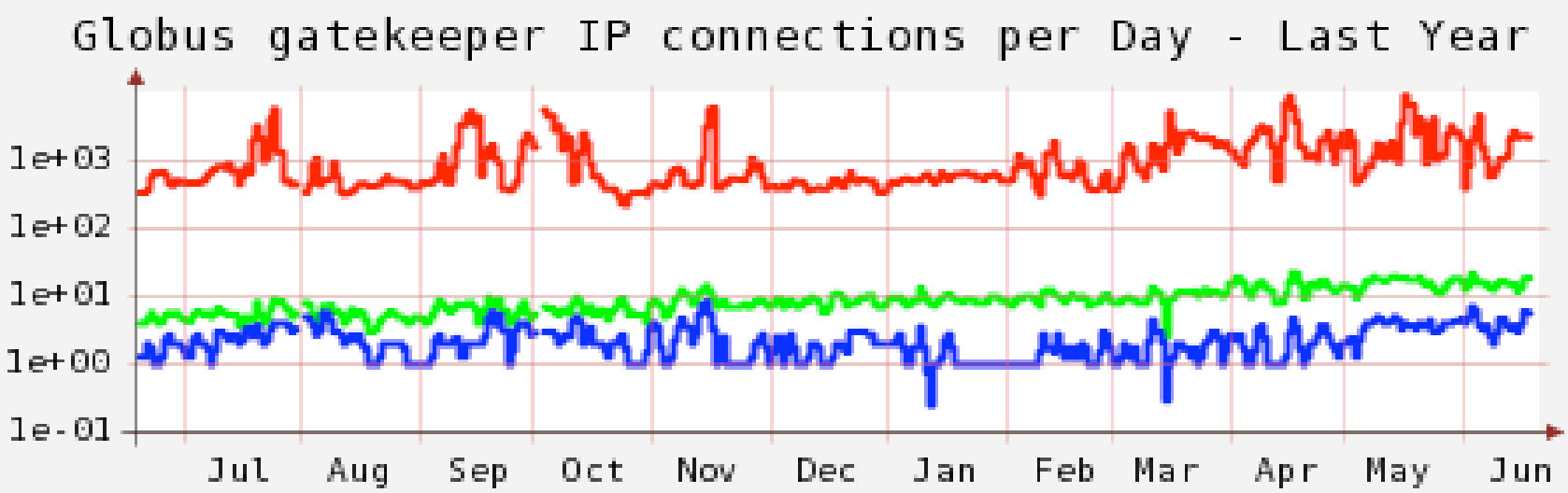
Globus Gatekeeper Metrics 1



	Maximum	Average	Minimum	LastVal
authenticated	9032	2130	356	2110
authorized	8475	1920	318	1713
jobmanager	8485	1927	325	1720
fork	331	242	158	216
managedfork	0	0	0	0
batch	8043	1433	31	1369
condor	8043	1433	31	1369
pbs	0	0	0	0
lsf	0	0	0	0
condorg	1	0	0	0
cemon	850	98	0	0
mis	11	7	0	7
default	258	146	53	129

Data for fermigrid1 between 18-Mar-2007 and 21-Jun-2007
Plot generated on 21-Jun-2007

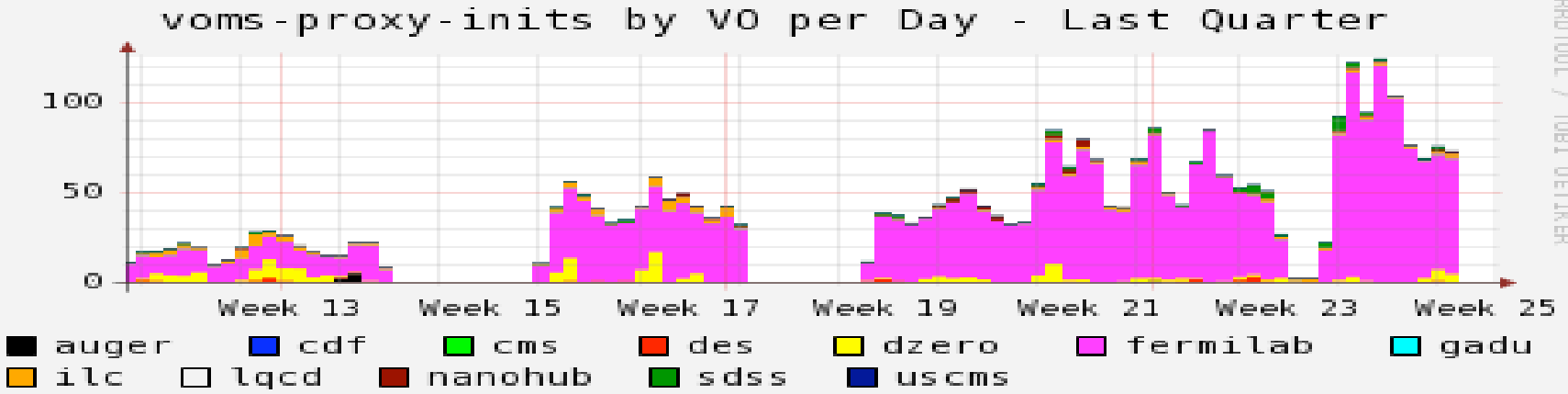
Globus Gatekeeper Metrics 2



	Maximum	Average	Minimum	LastVal
total	9075	1229	224	2204
unique	22	9	3	19
fermilab	8	2	0	6

Data for fermigrid1 between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

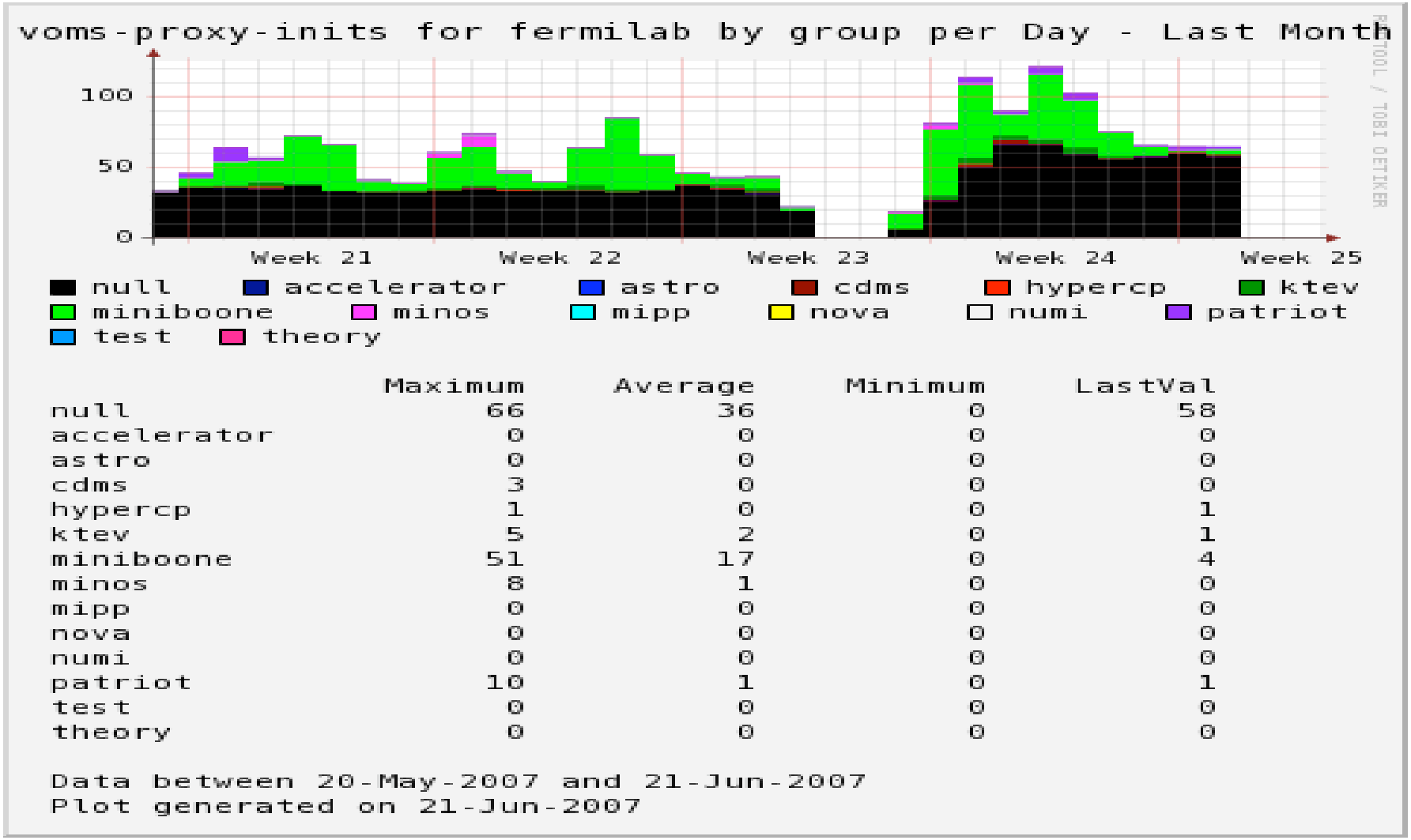
VOMS Metrics 1



	Maximum	Average	Minimum	LastVal
auger	5	0	0	0
cdf	0	0	0	0
cms	0	0	0	0
des	3	0	0	0
dzero	17	2	0	5
fermilab	120	31	0	64
gadu	0	0	0	0
ilc	6	1	0	3
lqcd	0	0	0	0
nanohub	4	0	0	1
sdss	8	1	0	0
uscms	0	0	0	0

Data between 18-Mar-2007 and 21-Jun-2007
Plot generated on 21-Jun-2007

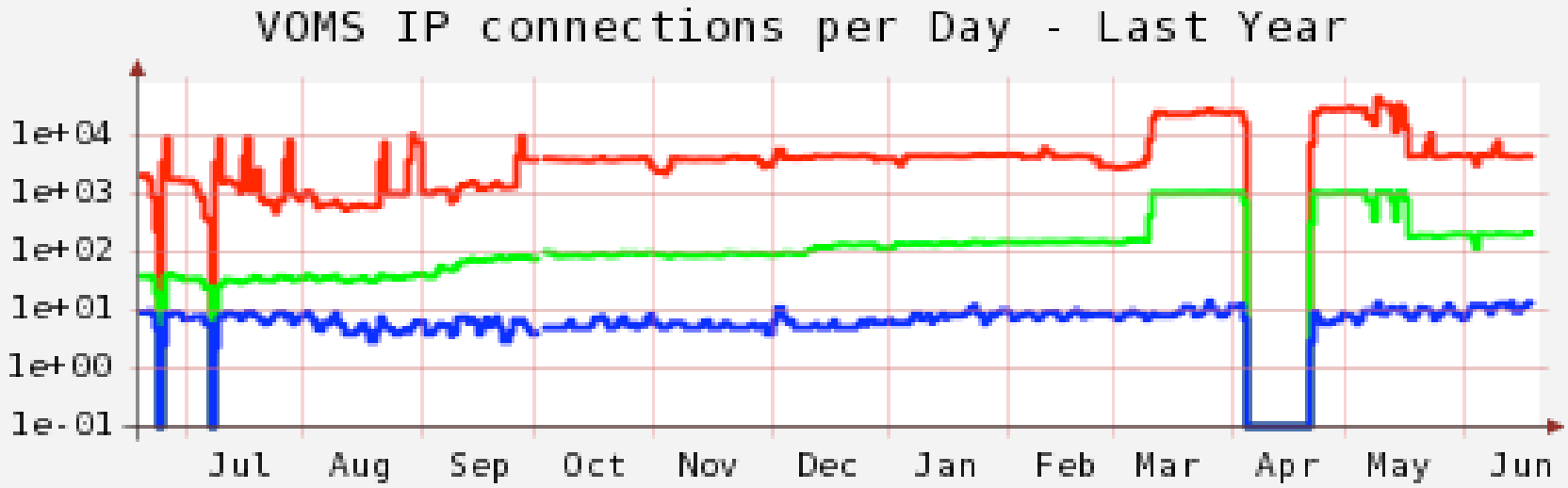
VOMS Metrics 2



	Maximum	Average	Minimum	LastVal
null	66	36	0	58
accelerator	0	0	0	0
astro	0	0	0	0
cdms	3	0	0	0
hypercp	1	0	0	1
ktev	5	2	0	1
miniboone	51	17	0	4
minos	8	1	0	0
mipp	0	0	0	0
nova	0	0	0	0
numi	0	0	0	0
patriot	10	1	0	1
test	0	0	0	0
theory	0	0	0	0

Data between 20-May-2007 and 21-Jun-2007
Plot generated on 21-Jun-2007

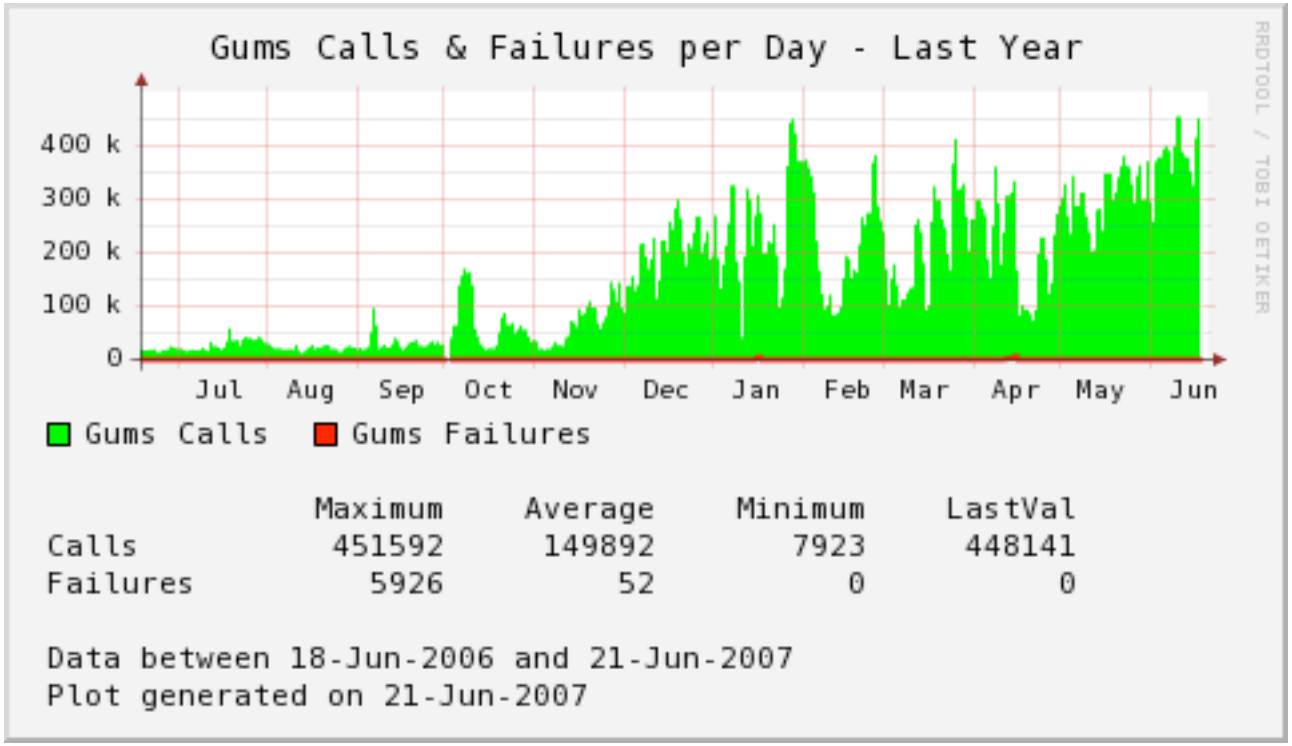
VOMS Metrics 3



	Maximum	Average	Minimum	LastVal
total	44043	6371	0	4480
unique	1058	220	0	211
fermilab	14	7	0	13

Data for fermigrid2 between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

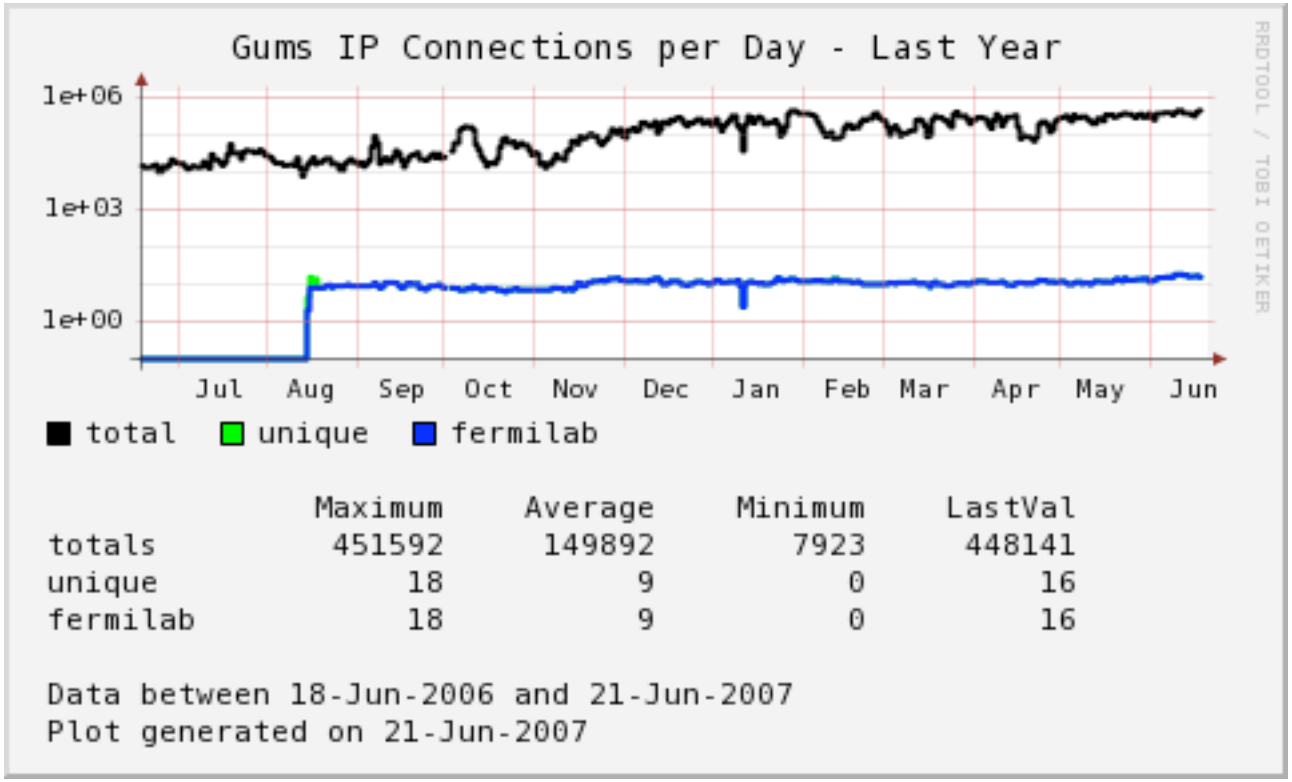
GUMS Metrics 1



	Maximum	Average	Minimum	LastVal
Calls	451592	149892	7923	448141
Failures	5926	52	0	0

Data between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

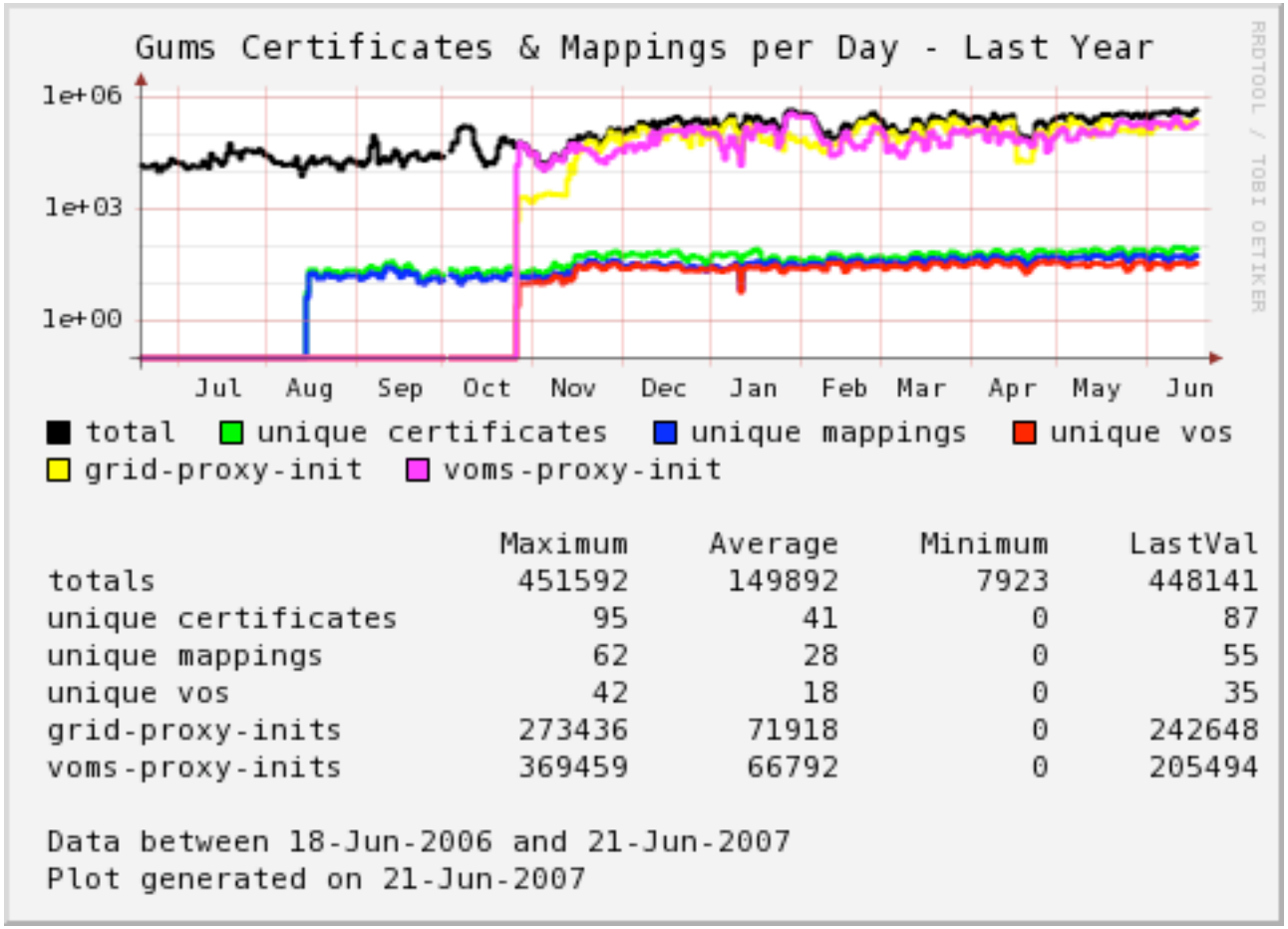
GUMS Metrics 2



	Maximum	Average	Minimum	LastVal
totals	451592	149892	7923	448141
unique	18	9	0	16
fermilab	18	9	0	16

Data between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

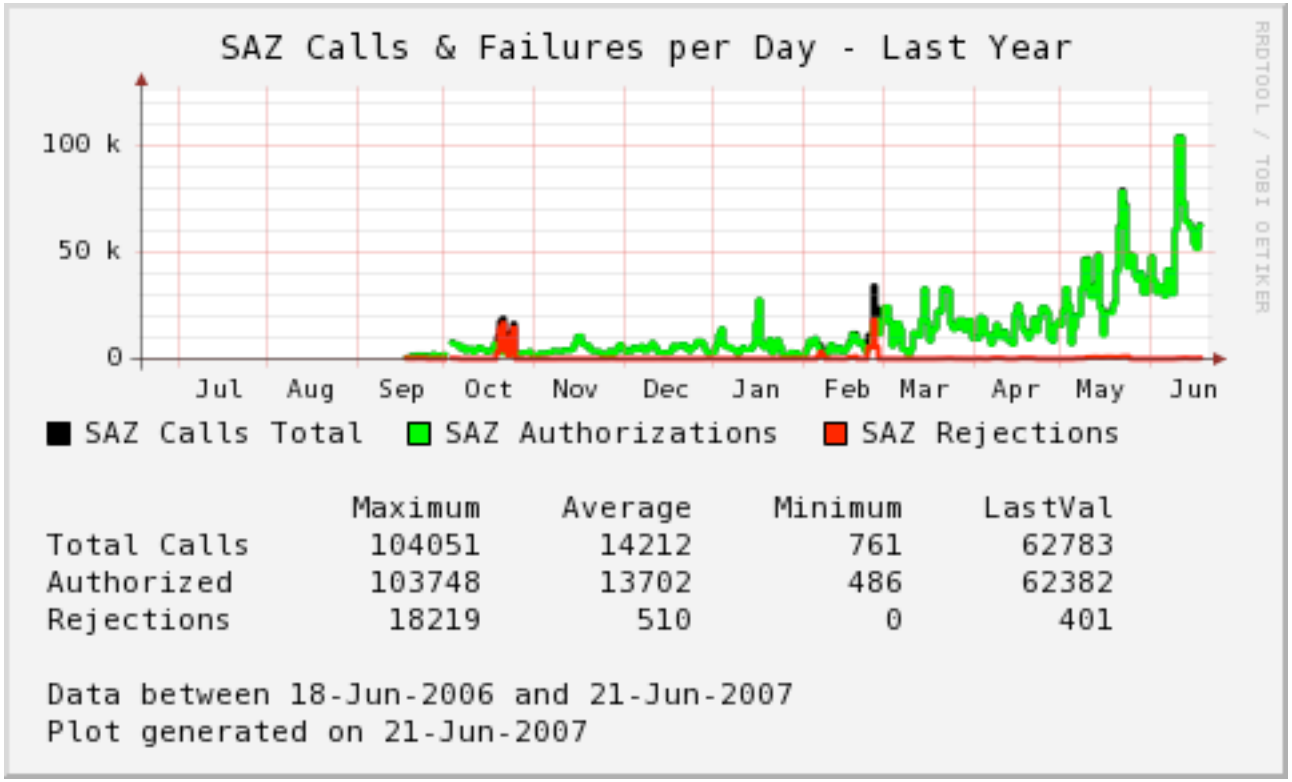
GUMS Metrics 3



	Maximum	Average	Minimum	LastVal
totals	451592	149892	7923	448141
unique certificates	95	41	0	87
unique mappings	62	28	0	55
unique vos	42	18	0	35
grid-proxy-inits	273436	71918	0	242648
voms-proxy-inits	369459	66792	0	205494

Data between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

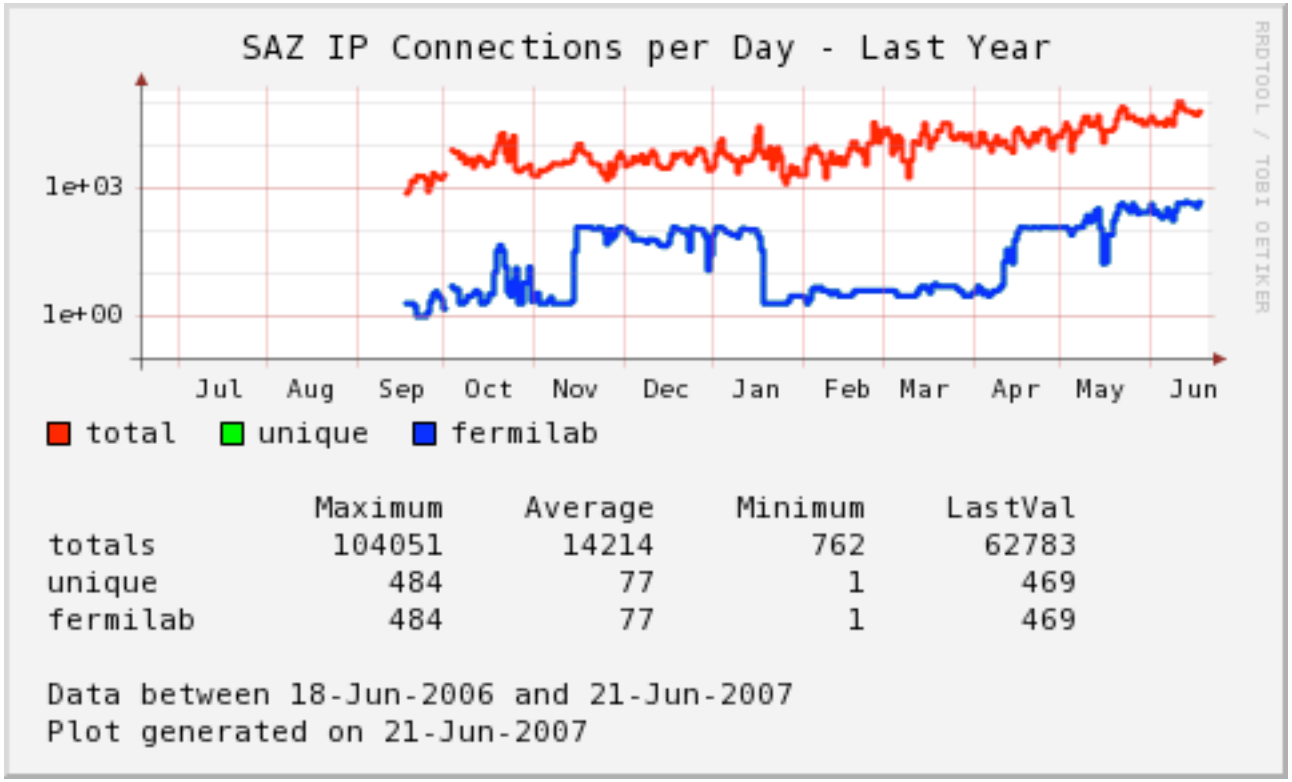
SAZ Metrics 1



	Maximum	Average	Minimum	LastVal
Total Calls	104051	14212	761	62783
Authorized	103748	13702	486	62382
Rejections	18219	510	0	401

Data between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

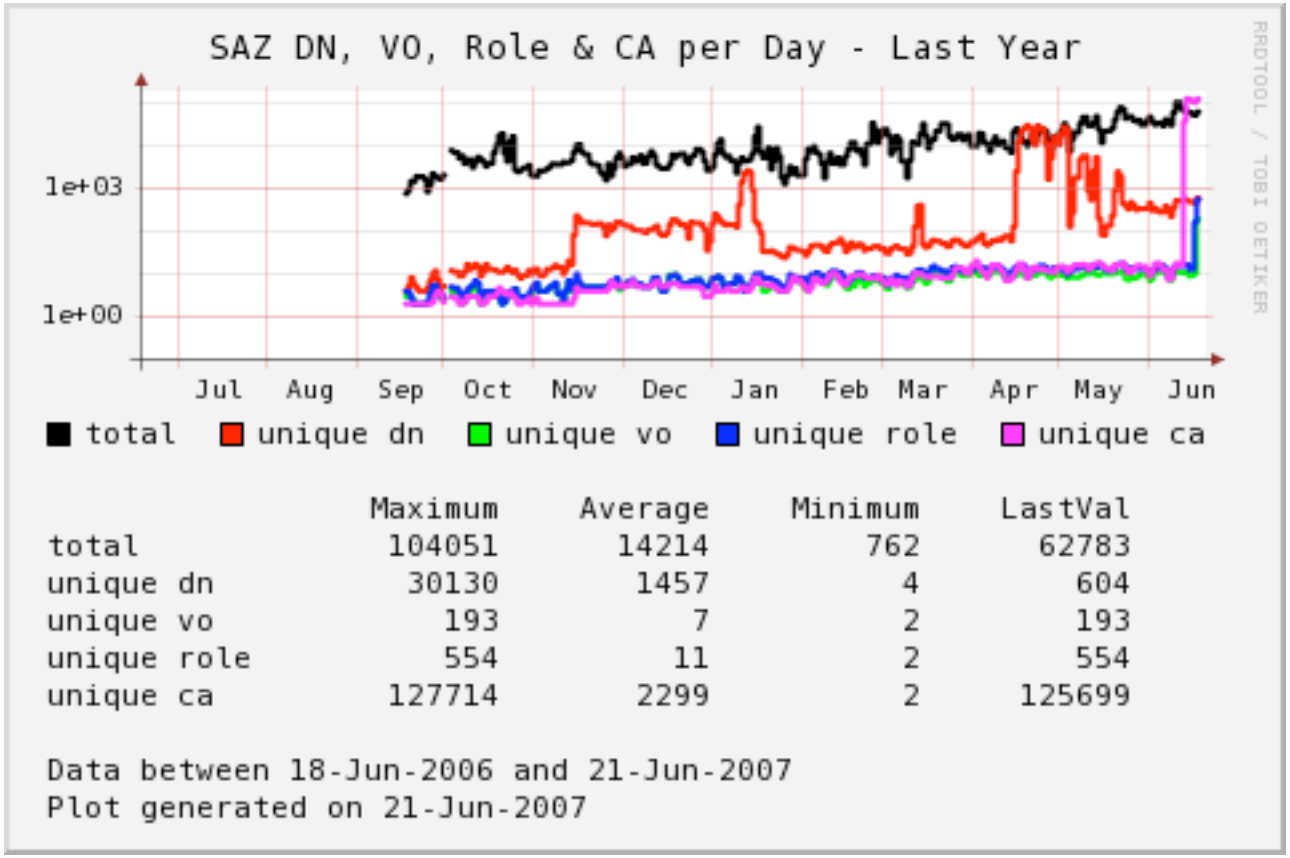
SAZ Metrics 2



	Maximum	Average	Minimum	LastVal
totals	104051	14214	762	62783
unique	484	77	1	469
fermilab	484	77	1	469

Data between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

SAZ Metrics 3



	Maximum	Average	Minimum	LastVal
total	104051	14214	762	62783
unique dn	30130	1457	4	604
unique vo	193	7	2	193
unique role	554	11	2	554
unique ca	127714	2299	2	125699

Data between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

Service Monitoring - Mechanics

- A central service monitor system launches the central service monitor collection script once per hour.
  - monitor_grid_script.sh
- The central service monitor process in turn launches **background** copies of itself (secondary service monitor processes) across all systems (and the services) that are designated for service monitoring.
  - monitor_grid_script.sh
- The secondary service monitor processes identify the system, service to be monitored, and then launch a script which has been custom written to monitor the specified service.
  - monitor_<service>_script.sh
  - monitor_gatekeeper_script.sh
  - monitor_voms_script.sh
  - monitor_gums_script.sh
  - monitor_saz_script.sh

Service Monitor Configuration

Configuration of the service monitor system is via a central configuration file:

```
fermigrid0      fermigrid0.fnal.gov       master
fermigrid1      root@fermigrid1.fnal.gov  publish      var/www/html
#
fermigrid0      fermigrid0.fnal.gov       vo           fermilab
fermigrid1      fermigrid1.fnal.gov       gatekeeper
fermigrid2      fermigrid2.fnal.gov       voms         voms.fnal.gov
fermigrid3      fermigrid3.fnal.gov       gums         gums.fnal.gov
fermigrid3      fermigrid3.fnal.gov       mapping      cms
fermigrid3      fermigrid3.fnal.gov       mapping      dteam
fermigrid4      fermigrid4.fnal.gov       saz          saz.fnal.gov
fermigrid4      fermigrid4.fnal.gov       myproxy      myproxy.fnal.gov
fermigrid4      fermigrid4.fnal.gov       squid        squid.fnal.gov
#
fcdfosg1        fcdfosg1.fnal.gov         gatekeeper
fcdfosg2        fcdfosg2.fnal.gov         gatekeeper
d0cabosg1       d0cabosg1.fnal.gov        gatekeeper   ssh:/grid/login/chadwick
d0cabosg2       d0cabosg2.fnal.gov        gatekeeper   ssh:/grid/login/chadwick
###cmsosgce     cmsosgce.fnal.gov         gatekeeper   grid:/uscms/osg/app/fermilab/chadwick
###cmsosgce2    cmsosgce2.fnal.gov        gatekeeper   grid:/uscms/osg/app/fermilab/chadwick
```

Service Monitor - Information Collected

Globus Gatekeeper:

- # of authenticated, authorized, jobmanager, jobmanager-fork, jobmanager-managedfork, batch (condor, pbs, lsf, etc.), condorg/cemon, mis, default.
- The value of uptime, load1, load5 and load15.

VOMS:

- # of voms-proxy-init's
- # of apache and tomcat processes
- The rss and vmz of the Tomcat VOMS server process.
- The value of uptime, load1, load5 and load15.

GUMS:

- # of successful GUMS mapping calls & # of failed GUMS mapping calls.
- # of apache and tomcat processes
- The rss and vmz of the Tomcat GUMS server process.
- The value of uptime, load1, load5 and load15.

SAZ:

- # of successful SAZ calls & # of rejected SAZ calls.
- # of apache and tomcat processes
- The rss and vmz of the Tomcat SAZ server process.
- The value of uptime, load1, load5 and load15.

Service Monitor Storage and Publication

Results of the service monitors are stored using two mechanisms:

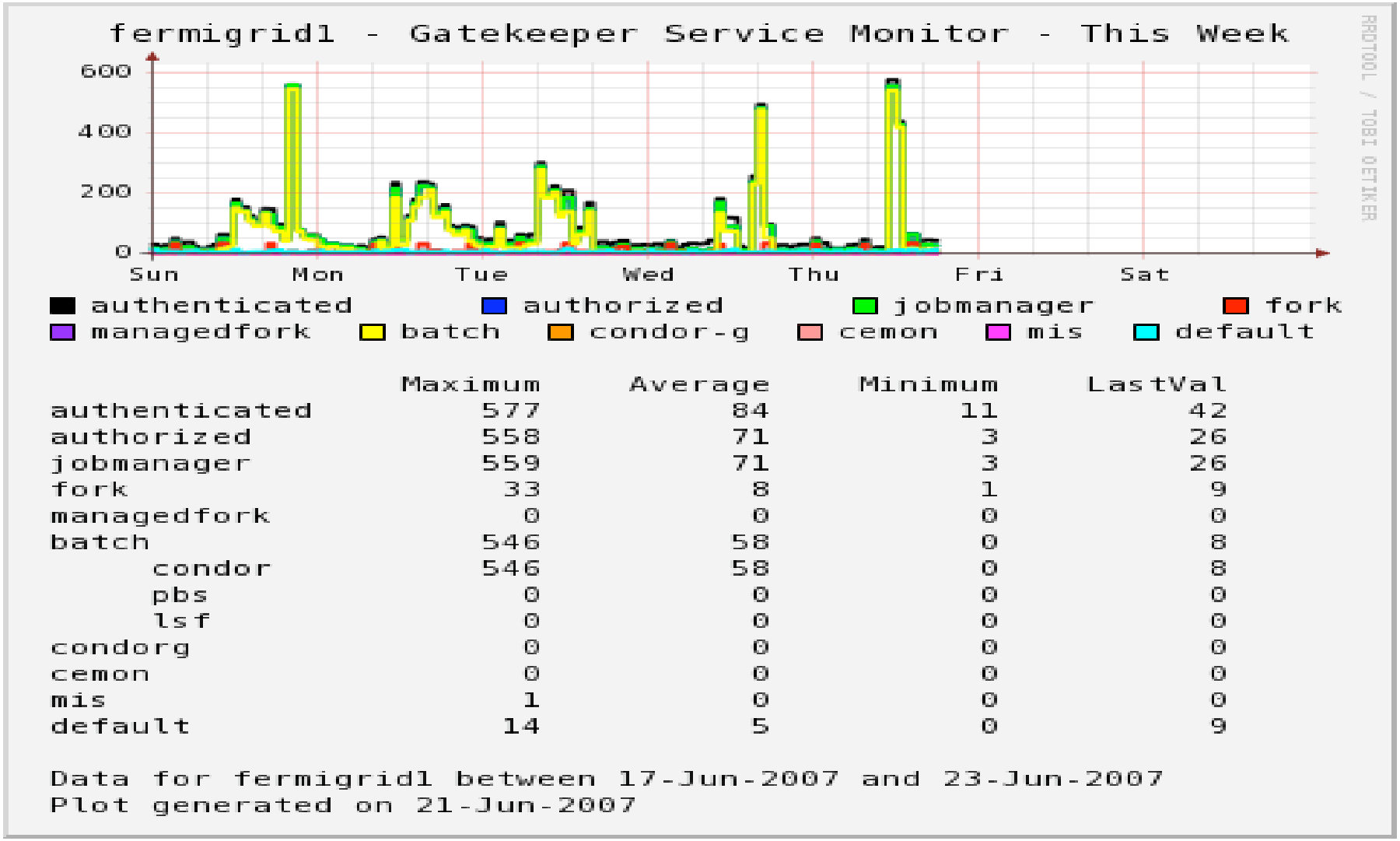
- First, they are appended to ".csv" files which contain a leading time (in seconds from the Unix epoch) followed by tag-value pairs. Example:
  - time=1182466920,authenticated=42,authorized=26,jobmanager=26

Second, the ".csv" files are processed and loaded in to round robin databases using rrdtool.

A set of "standard" png plots are automatically generated from the rrdtool databases.

All of these formats (.csv, .rrd and .png) are periodically uploaded from the metrics collection host to the central FermiGrid web server.

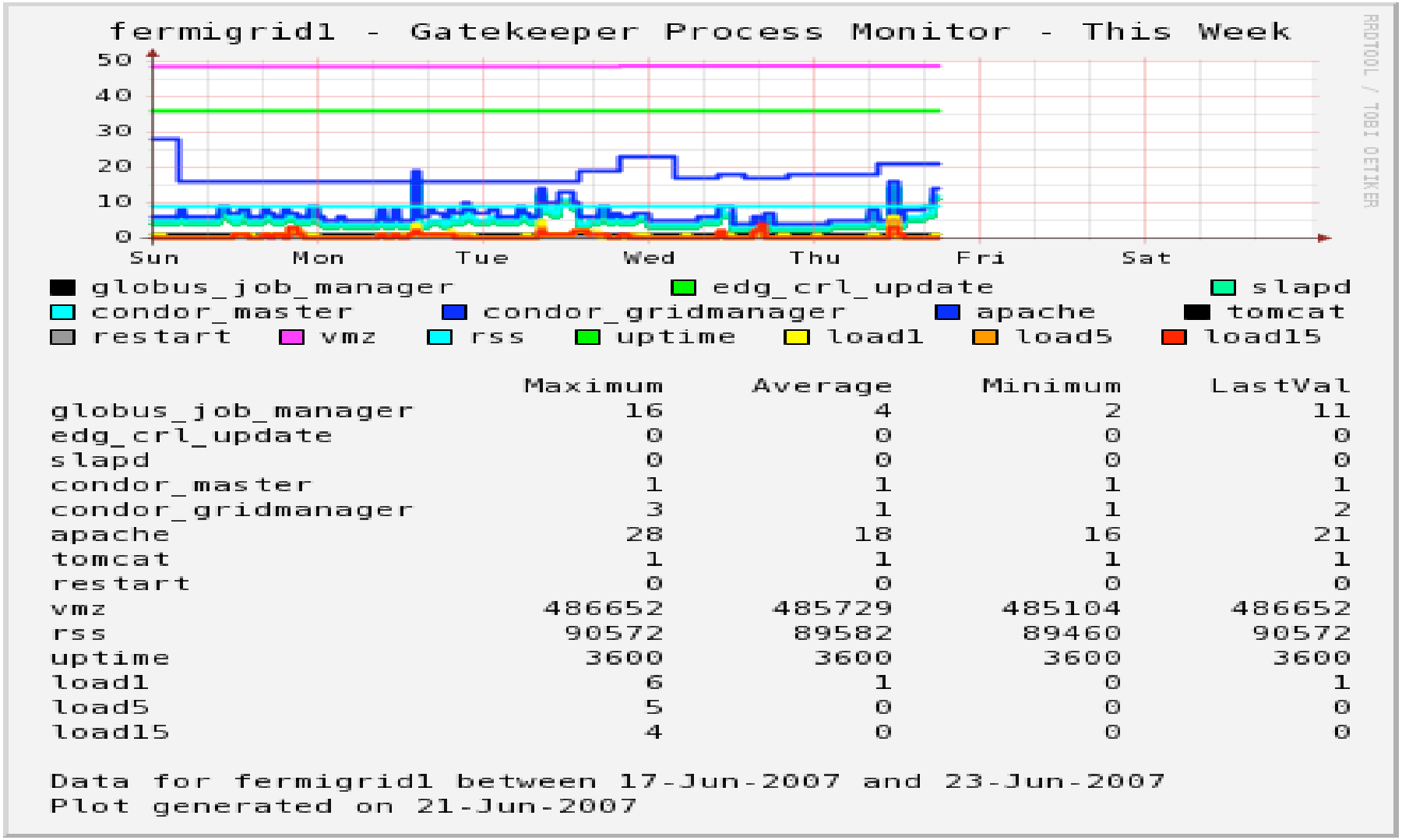
Globus Gatekeeper Monitor 1



	Maximum	Average	Minimum	LastVal
authenticated	577	84	11	42
authorized	558	71	3	26
jobmanager	559	71	3	26
fork	33	8	1	9
managedfork	0	0	0	0
batch	546	58	0	8
condor	546	58	0	8
pbs	0	0	0	0
lsf	0	0	0	0
condorg	0	0	0	0
cemon	0	0	0	0
mis	1	0	0	0
default	14	5	0	9

Data for fermigrid1 between 17-Jun-2007 and 23-Jun-2007
Plot generated on 21-Jun-2007

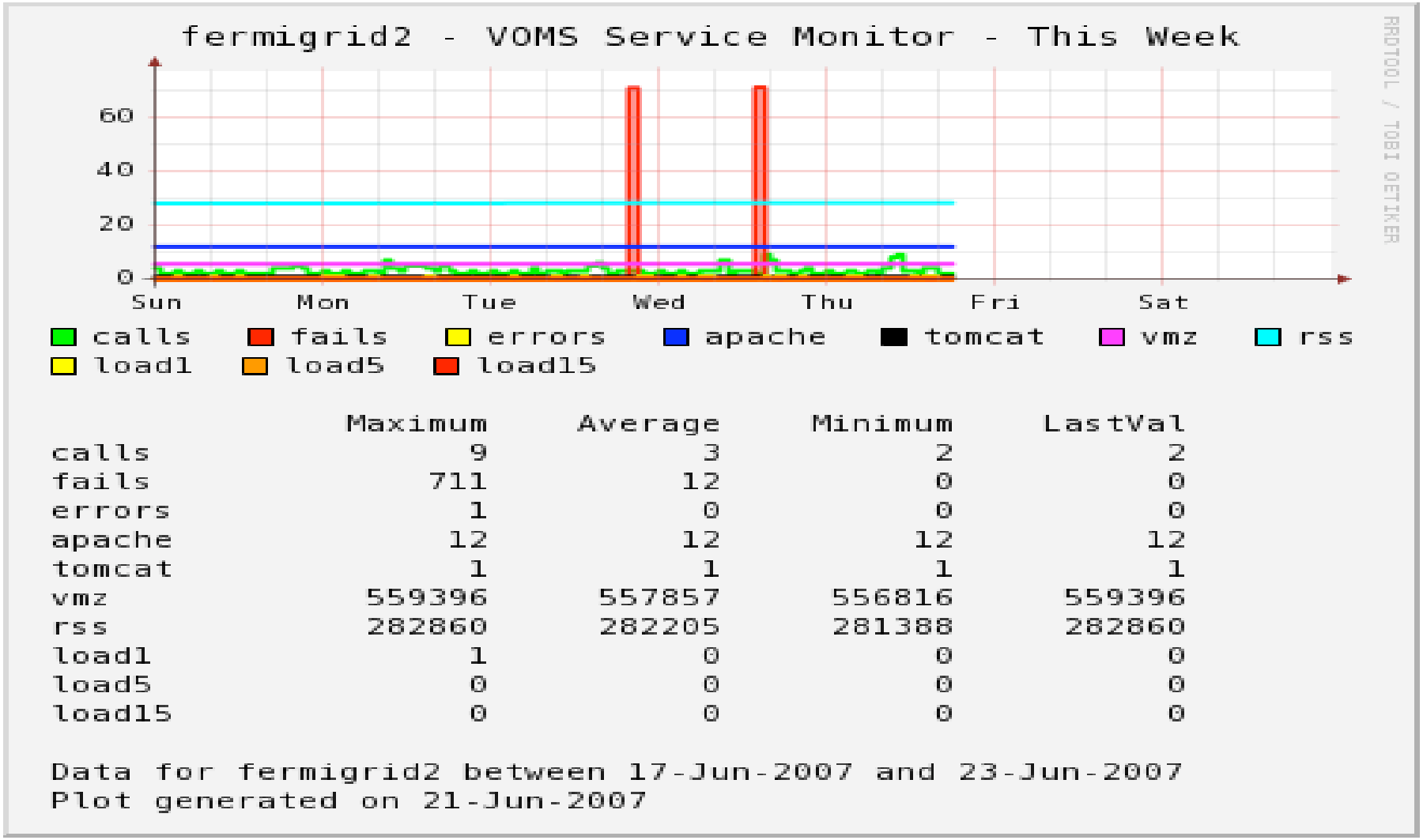
Globus Gatekeeper Monitor 2



	Maximum	Average	Minimum	LastVal
globus_job_manager	16	4	2	11
edg_crl_update	0	0	0	0
slapd	0	0	0	0
condor_master	1	1	1	1
condor_gridmanager	3	1	1	2
apache	28	18	16	21
tomcat	1	1	1	1
restart	0	0	0	0
vmz	486652	485729	485104	486652
rss	90572	89582	89460	90572
uptime	3600	3600	3600	3600
load1	6	1	0	1
load5	5	0	0	0
load15	4	0	0	0

Data for fermigrid1 between 17-Jun-2007 and 23-Jun-2007
Plot generated on 21-Jun-2007

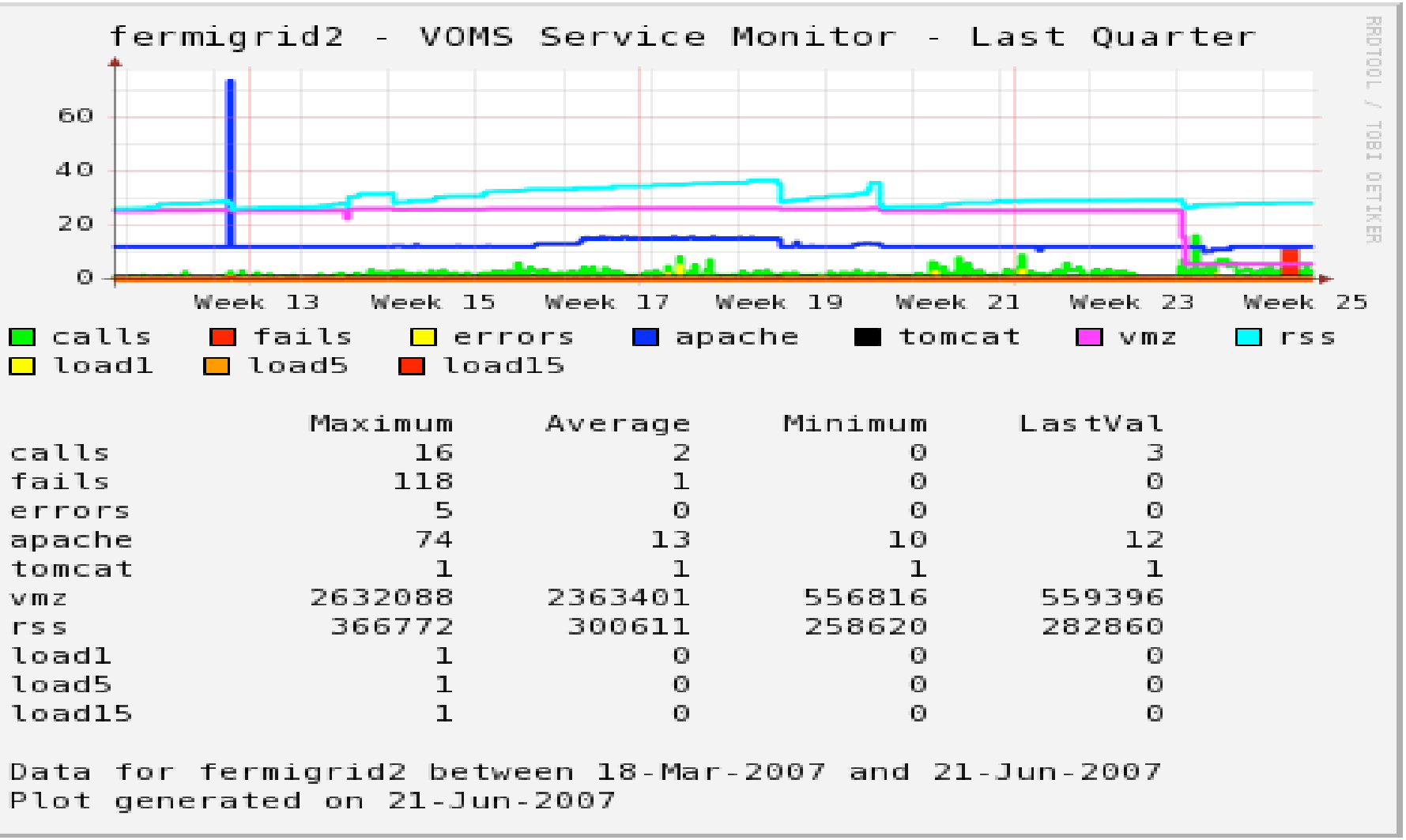
VOMS Monitor 1



	Maximum	Average	Minimum	LastVal
calls	9	3	2	2
fails	711	12	0	0
errors	1	0	0	0
apache	12	12	12	12
tomcat	1	1	1	1
vmz	559396	557857	556816	559396
rss	282860	282205	281388	282860
load1	1	0	0	0
load5	0	0	0	0
load15	0	0	0	0

Data for fermigrid2 between 17-Jun-2007 and 23-Jun-2007
Plot generated on 21-Jun-2007

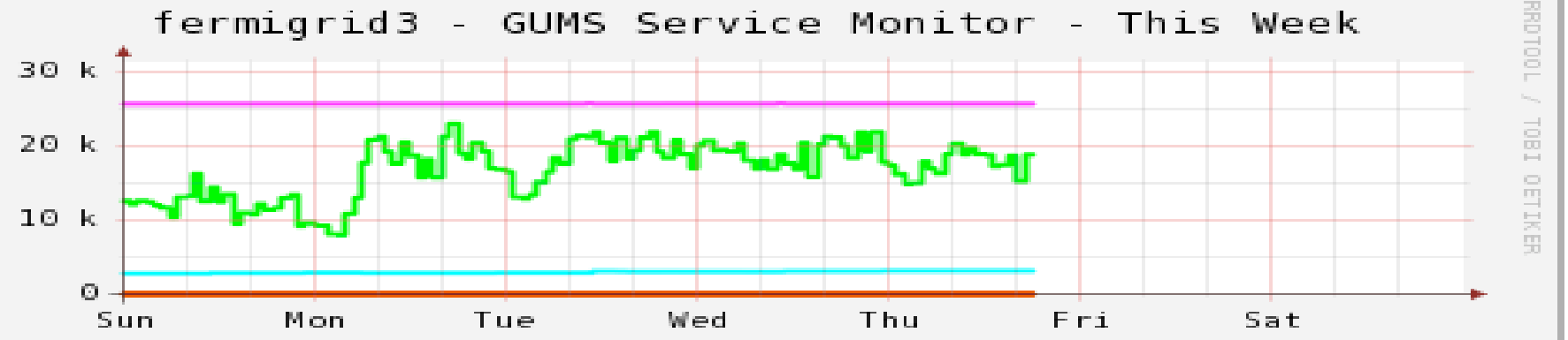
VOMS Monitor 2



	Maximum	Average	Minimum	LastVal
calls	16	2	0	3
fails	118	1	0	0
errors	5	0	0	0
apache	74	13	10	12
tomcat	1	1	1	1
vmz	2632088	2363401	556816	559396
rss	366772	300611	258620	282860
load1	1	0	0	0
load5	1	0	0	0
load15	1	0	0	0

Data for fermigrid2 between 18-Mar-2007 and 21-Jun-2007
Plot generated on 21-Jun-2007

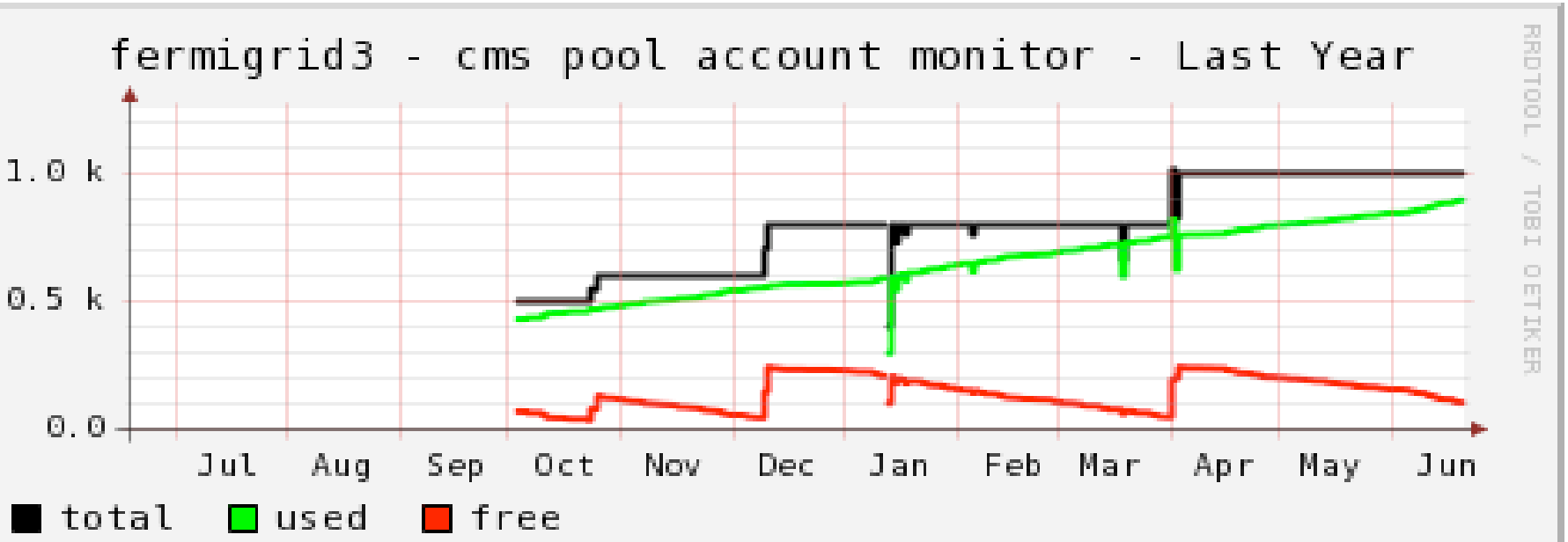
GUMS Monitor 1



	Maximum	Average	Minimum	LastVal
calls	23018	16758	8006	18822
fails	0	0	0	0
errors	0	0	0	0
apache	13	11	11	11
tomcat	1	1	1	1
vmz	2573168	2566588	2566268	2566784
rss	315292	297684	277284	315292
load1	3	2	1	2
load5	3	1	1	1
load15	2	1	0	1

Data for fermigrid3 between 17-Jun-2007 and 23-Jun-2007
Plot generated on 21-Jun-2007

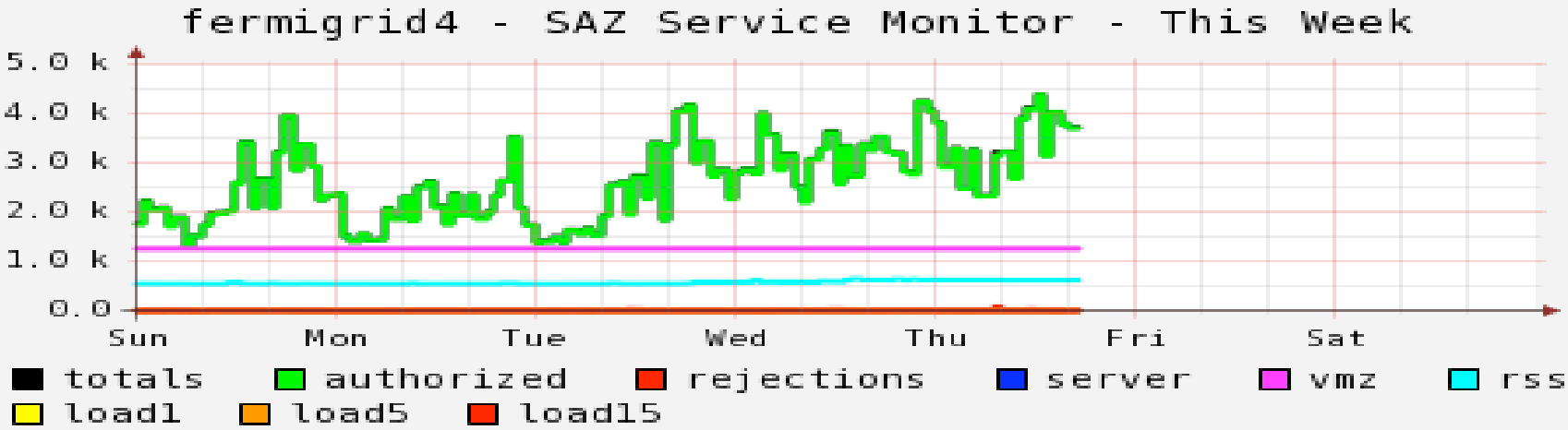
GUMS Mapping Monitor



	Maximum	Average	Minimum	LastVal
total	1014	797	400	1001
used	897	656	298	897
free	242	142	36	104

Data for fermigrid3 between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

SAZ Monitor 1



	Maximum	Average	Minimum	LastVal
totals	4377	2618	1313	3715
authorized	4367	2603	1300	3699
rejections	78	15	2	16
server	1	1	1	1
vmz	1255088	1255088	1255088	1255088
rss	64516	57098	53892	62044
load1	3	2	0	2
load5	2	1	0	2
load15	2	1	0	1

Data for fermigrid4 between 17-Jun-2007 and 23-Jun-2007
Plot generated on 21-Jun-2007

VO Acceptance Monitoring

Monitor the acceptance of a VO across a Grid in order to:

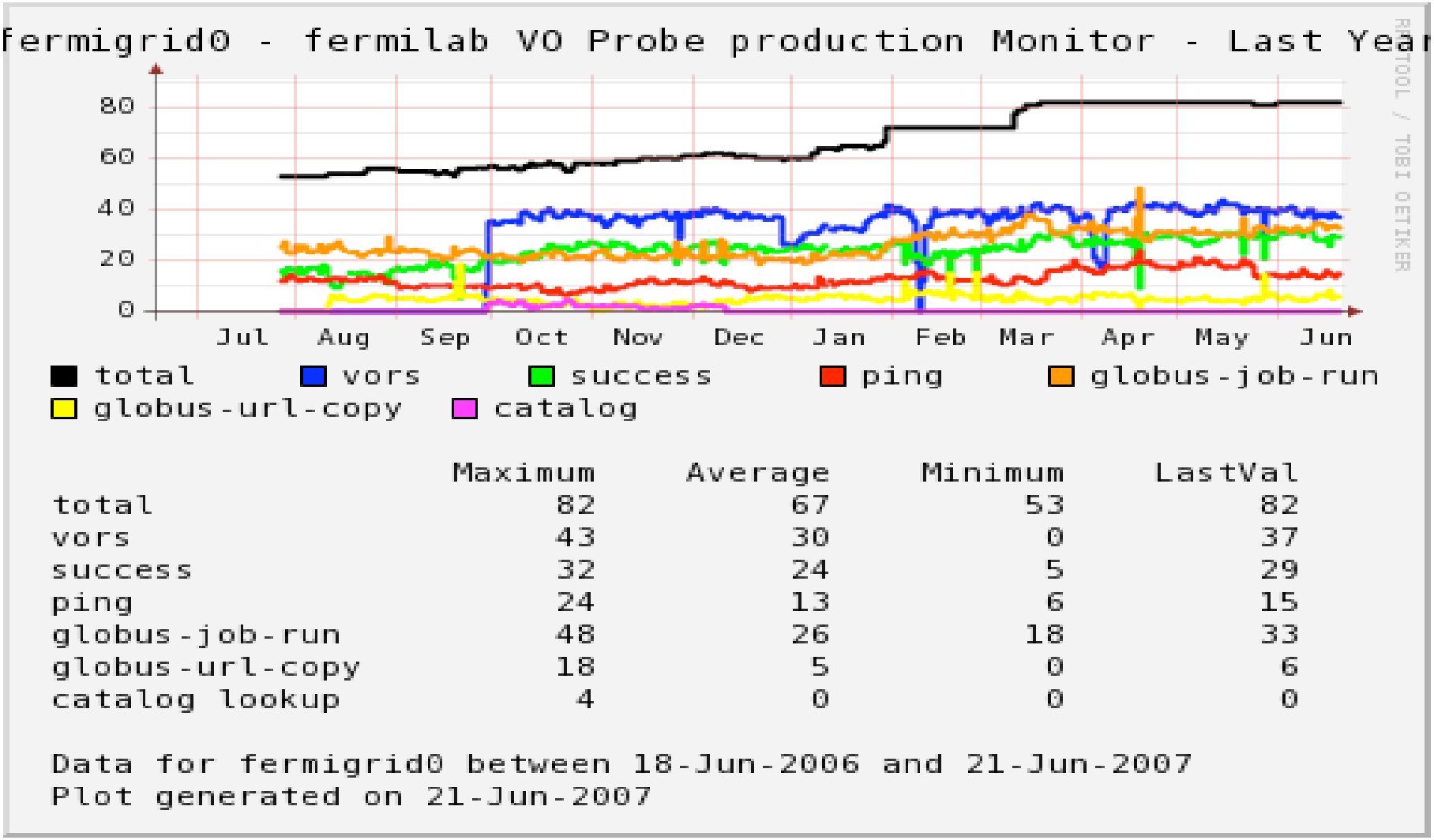
- Identify where the members of the VO can consider running jobs.
  - Not a guarantee that the job can actually run.
- Identify misconfigured sites that advertise that they "support" the VO but to not actually accept jobs from VO members.
- Log formal trouble tickets through the OSG GOC.
  - Ideally have the sites respond and fix their configuration.
  - Unfortunately some sites have not been very responsive.
  - And still other sites have responded by removing support for the VO.

VO Acceptance Monitoring Mechanics

How it is done:

- A cron script periodically launches kcroninit.
- kcroninit launches a script which does authentication:
  - kx509
  - kxlist -p
- Robot certificate “issued” by the Fermilab KCA:
  - /DC=gov/DC=fnal/O=Fermilab/OU=Robots/CN=cron/CN=Keith Chadwick/UID=chadwick
- Get VO signed credentials:
  - voms-proxy-init -noregen -voms fermilab:/fermilab
- Pulls the list of OSG sites from the OSG gridscan reports
  - http://scan.grid.iu.edu/cgi-bin/get_grid_sv?get=set1
- For each site in the report, the acceptance monitor tests:
  - Unix ping.
  - globusrun -a -r (authenticate).
  - globus-job-run (existing application - typ /usr/bin/id).
  - globus-url-copy (to and from).
- Periodically I review the list of failing sites and if appropriate, log trouble tickets.

VO Acceptance Monitor 1



	Maximum	Average	Minimum	LastVal
total	82	67	53	82
vors	43	30	0	37
success	32	24	5	29
ping	24	13	6	15
globus-job-run	48	26	18	33
globus-url-copy	18	5	0	6
catalog lookup	4	0	0	0

Data for fermigrid0 between 18-Jun-2006 and 21-Jun-2007
Plot generated on 21-Jun-2007

Availability (Infrastructure) Monitoring

Designed to be very “lightweight”.

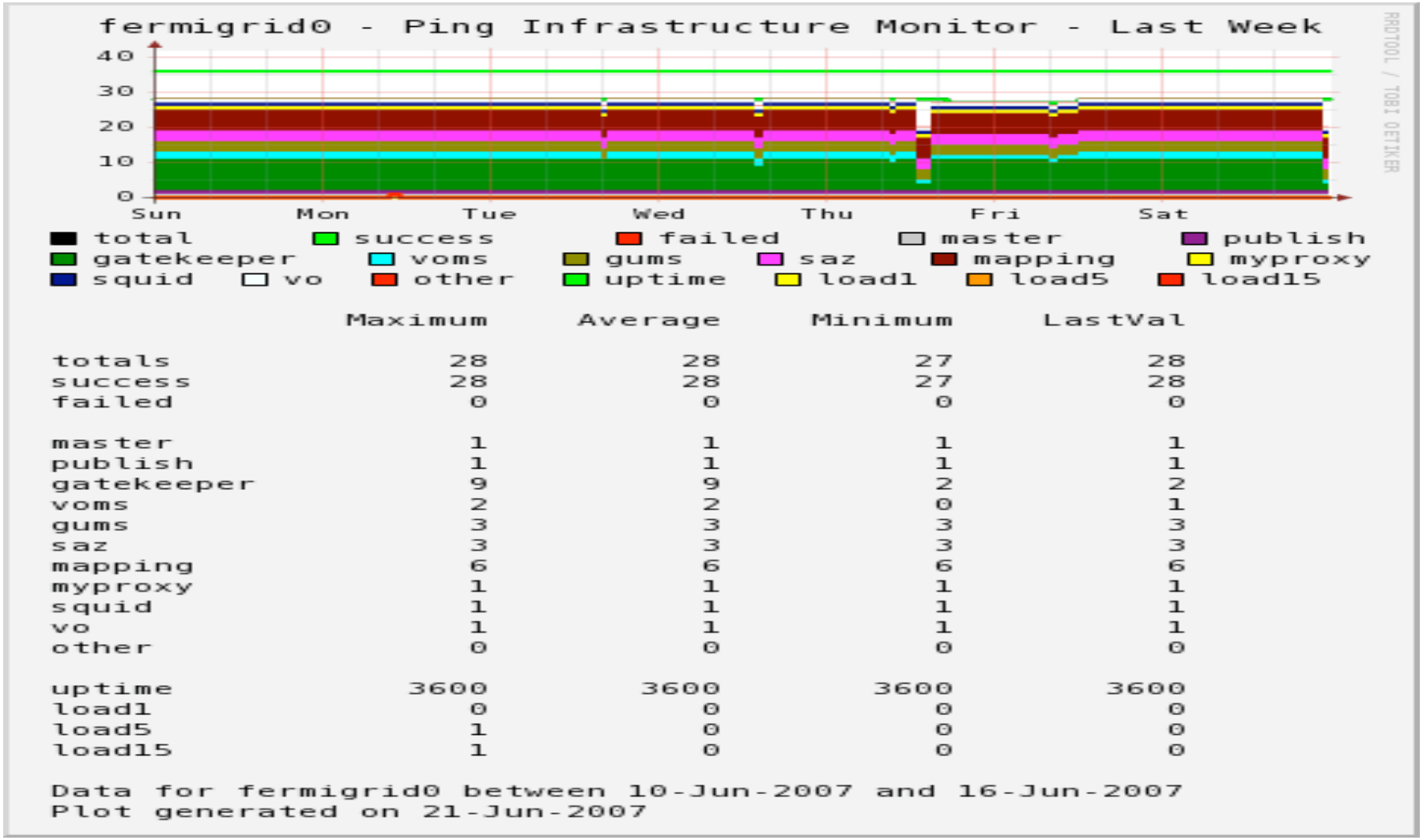
Currently running with the service monitor, but designed and implemented so that it can run much more frequently.

Monitors both the host system and the service which is running on the system.

Driven by the same configuration file as the service monitor.

http://fermigrid.fnal.gov/monitor/fermigrid0-ping-monitor.html

Base Infrastructure Monitor



	Maximum	Average	Minimum	LastVal
totals	28	28	27	28
success	28	28	27	28
failed	0	0	0	0
master	1	1	1	1
publish	1	1	1	1
gatekeeper	9	9	2	2
voms	2	2	0	1
gums	3	3	3	3
saz	3	3	3	3
mapping	6	6	6	6
myproxy	1	1	1	1
squid	1	1	1	1
vo	1	1	1	1
other	0	0	0	0
uptime	3600	3600	3600	3600
load1	0	0	0	0
load5	1	0	0	0
load15	1	0	0	0

Data for fermigrid0 between 10-Jun-2007 and 16-Jun-2007
Plot generated on 21-Jun-2007

Dashboard

Based on a secondary analysis of the infrastructure monitor data.

Design goal is to be a simple “health” dashboard:

http://fermigrid.fnal.gov/monitor/fermigrid-dashboard.html

Dashboard - Typical Display

FermiGrid Dashboard Summary - Updated at Thu Jun 21 18:01:50 CDT 2007

System	Ip Name	Ping Status	Service Name	Service Status	Service Alias
fermigrid0	fermigrid0.fnal.gov	Up	master	Up	
fermigrid0	fermigrid0.fnal.gov	Up	vo	Up	
fermigrid1	fermigrid1.fnal.gov	Up	gatekeeper	Up	
fermigrid1	fermigrid1.fnal.gov	Up	publish	Up	
fermigrid2	fermigrid2.fnal.gov	Up	voms	Up	
fermigrid3	fermigrid3.fnal.gov	Up	gums	Up	
fermigrid3	fermigrid3.fnal.gov	Up	mapping	Up	
fermigrid4	fermigrid4.fnal.gov	Up	myproxy	Up	myproxy.fnal.gov
fermigrid4	fermigrid4.fnal.gov	Up	saz	Up	
fermigrid4	fermigrid4.fnal.gov	Up	squid	Up	
d0cabosg1	d0cabosg1.fnal.gov	Up	gatekeeper	Up	
d0cabosg2	d0cabosg2.fnal.gov	Up	gatekeeper	Up	
fcdfosg1	fcdfosg1.fnal.gov	Up	gatekeeper	Up	
fcdfosg2	fcdfosg2.fnal.gov	Up	gatekeeper	Up	
fgitb-gk	fgitb-gk.fnal.gov	Up	gatekeeper	Up	
fngp-osg	fngp-osg.fnal.gov	Up	gatekeeper	Up	
fgtest1	fgtest1.fnal.gov	Up	gatekeeper	Up	
fgtest2	fgtest2.fnal.gov	Up	voms	Up	
fgtest3	fgtest3.fnal.gov	Up	gums	Up	
fgtest3	fgtest3.fnal.gov	Up	mapping	Up	
fgtest4	fgtest4.fnal.gov	Up	saz	Up	
fgtest5	fgtest5.fnal.gov	Up	gums	Up	
fgtest5	fgtest5.fnal.gov	Up	mapping	Up	
fgtest6	fgtest6.fnal.gov	Up	gatekeeper	Up	
fgtest6	fgtest6.fnal.gov	Up	saz	Up	

Lessons Learned 1

Metrics and Service Monitoring is difficult:

- Every service has it's own log file format (at least today).
  - find, grep, awk are your friends.
  - The format of the messages within the service log file will change as new versions of the services are deployed.
- Some services don't log all necessary and/or interesting information "out of the box", they need additional logging options enabled.
  - You may have to work with the service developers to insure that they log the necessary service information.
- Some services are extremely "talkative" and place lots of information (that I am certain is useful to the developers) in the log file along with the "golden nuggets" that is needed by the metrics collection and service monitoring.
  - You may have to work with the service developers to insure that they log the necessary service information.
- You may have to extract and correlate information from multiple logs.
- You must also monitor services that the monitored service depends on (especially apache and tomcat).

Lessions Learned 2

Out of band access and monitoring is quite useful and necessary.

- ssh, ksu as well as grid.

Using grid services to monitor other grid services may not correctly identify the problem:

- Did some local (non-grid) service fail?
  - kx509, kxlist -p
- Did the local grid service fail?
  - voms-proxy-init
- Did some intermediate service fail or timeout?
  - Network congestion
- Did the remote grid service fail or timeout?
  - Globus gatekeeper

Lessons Learned 3

Service monitoring with automatic service recovery can be very useful.

- Especially when responding to automated security probing,
- And also for getting a full nights rest…

Automatic service recovery will usually require some level of root access.

- Sites are understandably reluctant to grant “remote” root access (I know that I am…).

Robot certificates are extremely useful for automating grid service monitoring.

Plans for the Future

Continue with the development of additional metrics and monitor probes.

Continue with the development of automated reports & publication.

Integrate/incorporate the new OSG SAM probes to fermilab VO monitoring.

As part of the FermiGrid-HA deployment, enhance the metrics and monitoring infrastructure:

- Collect from all [voms,gums,saz] service instances.
- Collate a HA view of the services.

Work towards making this infrastructure more portable.

Fin

Any questions?