

ATLAS Spanish Tier2 experiences during STEP09 period

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- **Spanish Cloud**
 - Spanish Resources
- **PIC-Tier1 (Report thanks to X. Espinal)**
 - ATLAS Services
 - Data transfers
 - Reprocessing
 - User Analysis
- **UAM-Universidad Autónoma de Madrid (Report thanks to J. Pardo & P. Fernández)**
 - Computing: Faire share, cpu load
 - Storage and Bandwidth
- **IFAE-Institut de Física d'Altes Energies, Barcelona (Report thanks to J. Nadal)**
 - Computing
 - MC production
 - Difficulties
 - Distributed Data Management
- **IFIC- Institut de Física Corpuscular, València (Report thanks to J. Sánchez)**
 - Job processing
 - Data Transfer
- **STEP09: towards data taking**
 - Issues achieved and learned
 - Status and plans



SWE Cloud:
 Spain-Portugal
Tier1:
 PIC-Barcelona
Tier2's:
 UAM, IFAE & IFIC
 LIP & Coimbra

- **Tier1 at PIC Barcelona**

- Offers **storage and processing resources** for three LHC experiments: **ATLAS, CMS and LHCb**.
- LHC experiments will store a copy of the collected data from the accelerator at CERN and dispatch a **secondary copy** to the **Tier-1s** centres in order to guarantee the conservation and integrity of the data.
- **~10% of the raw data** from the LHC accelerator will be stored at PIC.
- **Optical Private Network (OPN)** Tier0 (CERN) ↔ Tier1's.
- More than **9 PetaBytes in/out** PIC in 2008.

- Tier1 will provide the infrastructure for **data re-processing**, as the **raw data stored** will be reprocessed several times per year with new parameters, as calibration and alignment constants improve.

| | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|------------------------|--------------|------|------|------|------|------|------|-------|
| CPU (kSI2K) required | ATLAS | 172 | 865 | 1226 | 1960 | 2687 | 3417 | 4872 |
| | CMS | 289 | 477 | 1058 | 2516 | 3292 | 4099 | 6201 |
| | LHCb | 37 | 167 | 307 | 633 | 962 | 1215 | 1263 |
| | TOTAL | 498 | 1509 | 2591 | 5109 | 6941 | 8731 | 12336 |
| Disk (Tbytes) required | ATLAS | 114 | 512 | 902 | 1595 | 2168 | 2743 | 4176 |
| | CMS | 79 | 358 | 630 | 1113 | 1513 | 1915 | 2915 |
| | LHCb | 21 | 97 | 170 | 301 | 409 | 518 | 788 |
| | TOTAL | 214 | 967 | 1702 | 3009 | 4090 | 5176 | 7880 |
| Tape (Tbytes) required | ATLAS | 68 | 385 | 681 | 1182 | 1767 | 2439 | 2819 |
| | CMS | 140 | 487 | 974 | 1677 | 2519 | 3358 | 5186 |
| | LHCb | 18 | 81 | 189 | 543 | 963 | 1456 | 2981 |
| | TOTAL | 226 | 953 | 1844 | 3402 | 5249 | 7253 | 10986 |

Installed Planned

September 09

- Data Storage:
 - Experiments do need **large, reliable and scalable storage services**.
 - To server the data at the required speed in order to maximize the efficiency of the cluster.
 - **Multi-Gigabit Ethernet network architecture**, specially designed to enhance high **speed data movement between WAN** (Tier0, Tier1s, Tier2s) and **LAN** (CPU farm) .
 - **dCache storage system**.

- ATLAS Spanish Federated Tier2

- IFIC: Valencia (coordinator)
- IFAE: Barcelona
- UAM: Madrid

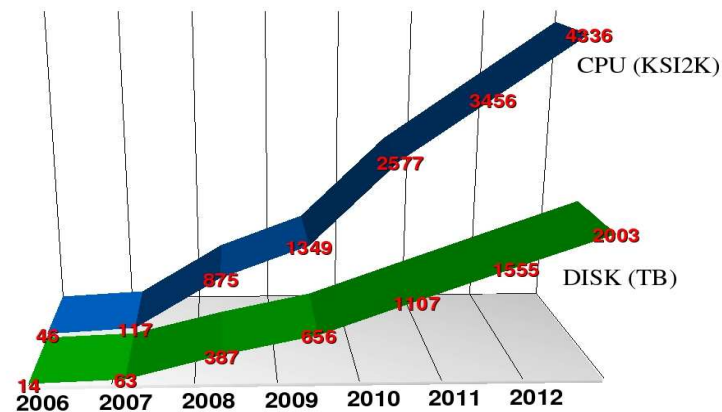
Ramp-up of Tier-2 Resources (after LHC rescheduling) numbers are cumulative

Evolution of ALL ATLAS T-2 resources according to the estimations made by ATLAS CB (Oct.06)

| Year | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------|------|---------|----------|----------|----------|----------|----------|
| CPU(KSI2k) | 925 | 2336.11 | 17494.51 | 26972.76 | 51544.64 | 69128.42 | 86712.2 |
| Disk (TB) | 289 | 1259.04 | 7744.37 | 13112.04 | 22132.3 | 31091.45 | 40050.92 |

Spanish ATLAS T-2 assuming a contribution of a 5% to the whole effort

| Year | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|------------|------|------|------|------|------|------|------|
| CPU(KSI2k) | 46 | 117 | 875 | 1349 | 2577 | 3456 | 4336 |
| Disk (TB) | 14 | 63 | 387 | 656 | 1107 | 1555 | 2003 |



Strong increase of resources

Present resources of the Spanish ATLAS T-2 (August'09)

Hardware is purchased. Working next week to get the pledged resources

| | IFAE | UAM | IFIC | TOTAL |
|-------------|------|-----|------|-------|
| CPU (ksi2k) | 201 | 338 | 96 | 435 |
| Disk (TB) | 215 | 165 | 34 | 414 |

Accounting values are normalized according to WLCG recommendations

- Storage Element System

| | SE (Disk Storage) |
|------|-----------------------|
| IFIC | Lustre+StoRM |
| IFAE | dCache/disk+SRM posix |
| UAM | dCache |

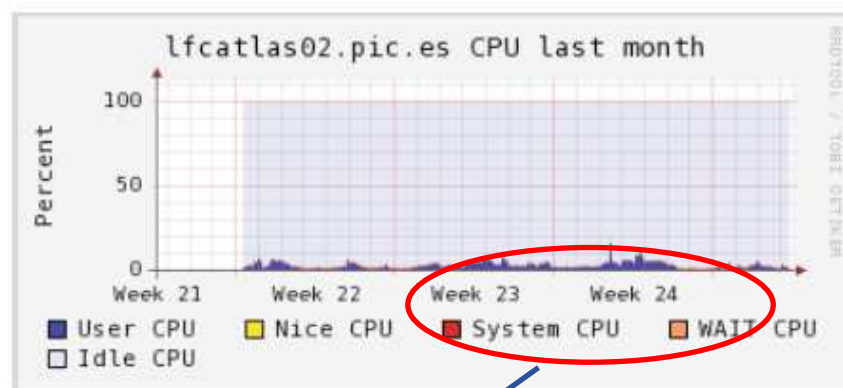
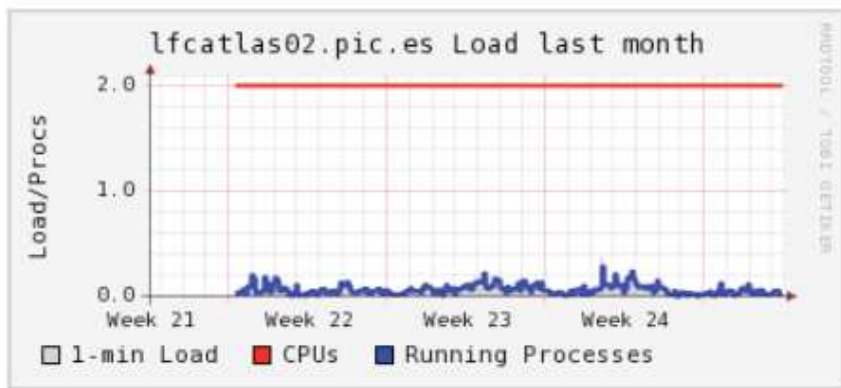
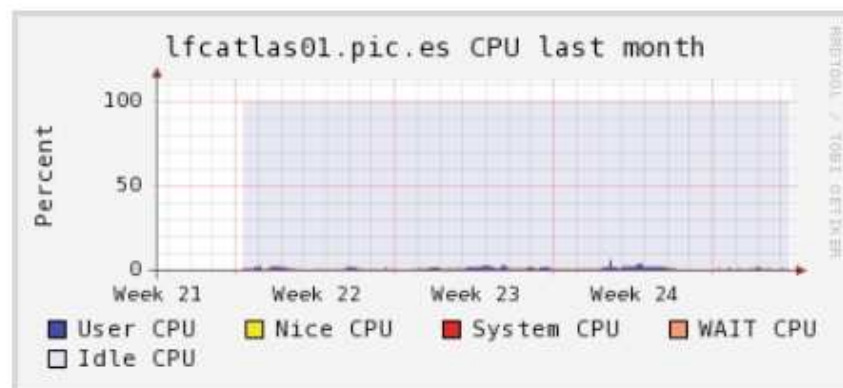
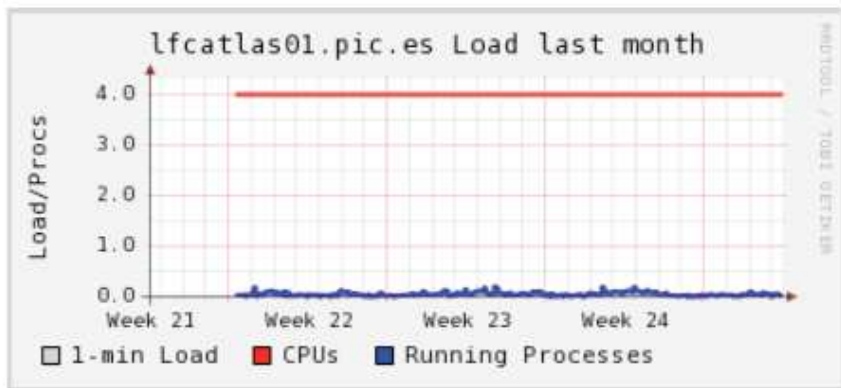
- StoRM: Posix SRM v2
- Lustre: High performance standard file system
- Shares: 50% IFIC, 25% IFAE and 25% UAM

Data (AOD) distribution and DDM FT continuously running from Tier1 to Tier2

- A Tier needs a **reliable and scalable storage system** that can hold the users data, and serve it in an efficient way to users.
- A first sketch of a Storage system matrix (evaluation of **different systems on going at CERN**):

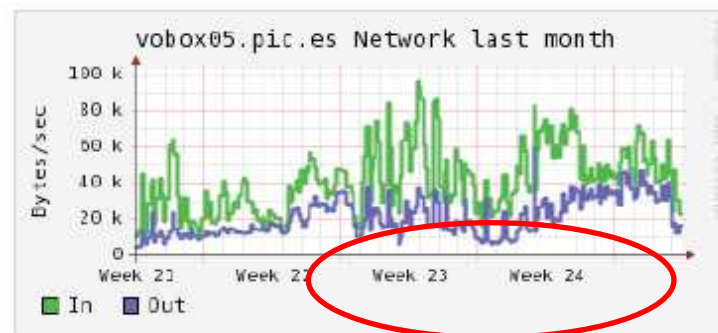
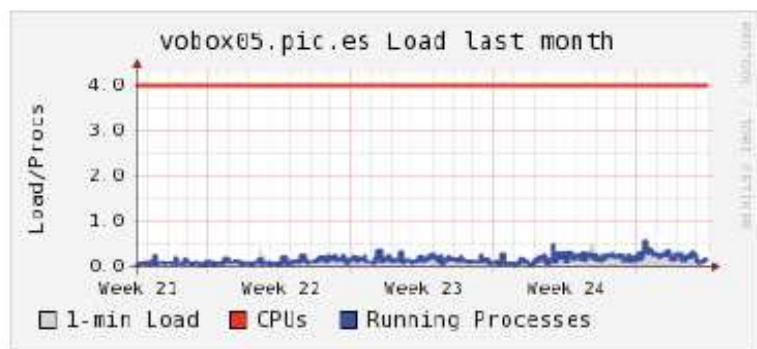
| Storage System | Local Protocol | Load Balancing | Externally Secure | POSIX Access | Single Namespace | Installation Load | Maint Load | Quotas | Cost |
|----------------|----------------|----------------|-------------------|---------------------------|------------------|-------------------|----------------|------------|--------|
| NFS | bad | N | N | Y | N | low | high | Y | \$0 |
| Lustre | Y | Y | w/SRM | Y | Y | medium | medium | Y | \$0 |
| GPFS | Y | Y | w/SRM | Y | Y | high | medium | Y | \$\$\$ |
| xrootd | Y | Y | w/SRM | mkdir/rmdir do nothing | Y | medium | low | partitions | \$0 |
| DPM | Y | Y | Y | special commands | Y | medium-high | low- medium | partitions | \$0 |
| dCache | Y | Y | Y | metadata | Y | high | low- medium | partitions | \$0 |

- ATLAS Services Status: LFC



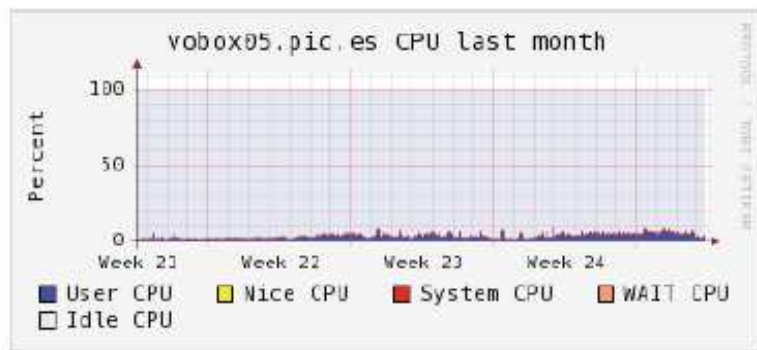
Step09 period

- **ATLAS Services Status: pilot factories**
 - Two pilot factories running at PIC VObox feeding our T1s and T2s
 - MC Production (production role)
 - User Analysis (pilot role)
 - Increased pilot pressure to constantly fill all nodes doesn't affect performance:



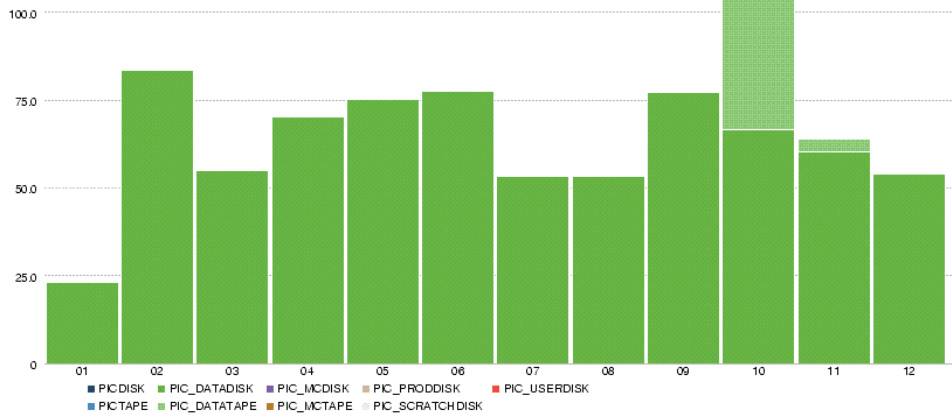
Step09 period

- Constantly queuing 30 pilots at all the sites during STEP09.
- Lowered to 15-20 during low pressure dates.



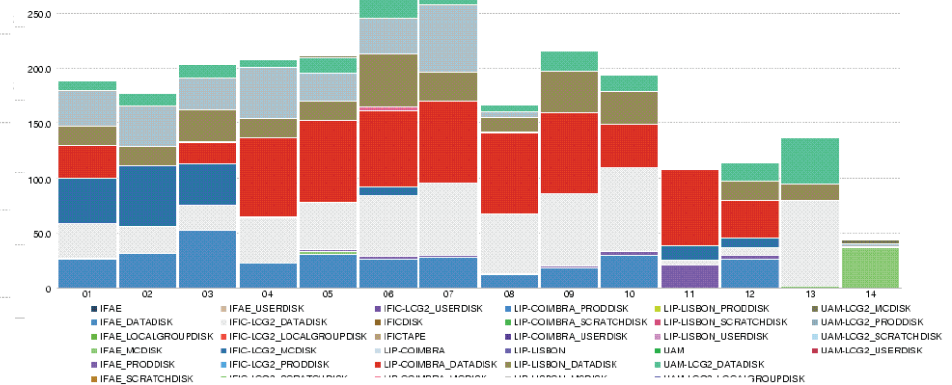
- STEP09 Data Transfers**

Tier-0 to PIC throughput (MB/s)

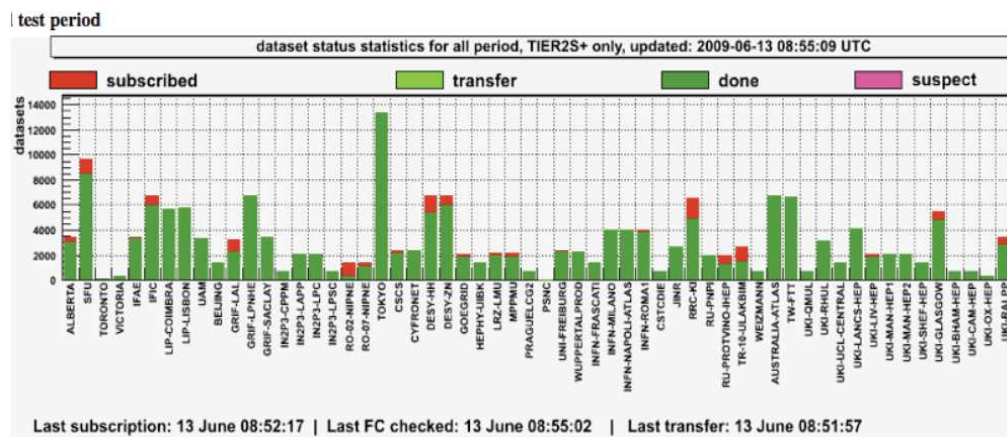


Reached > 250 MB/s with excellent efficiencies (95% to 100%)

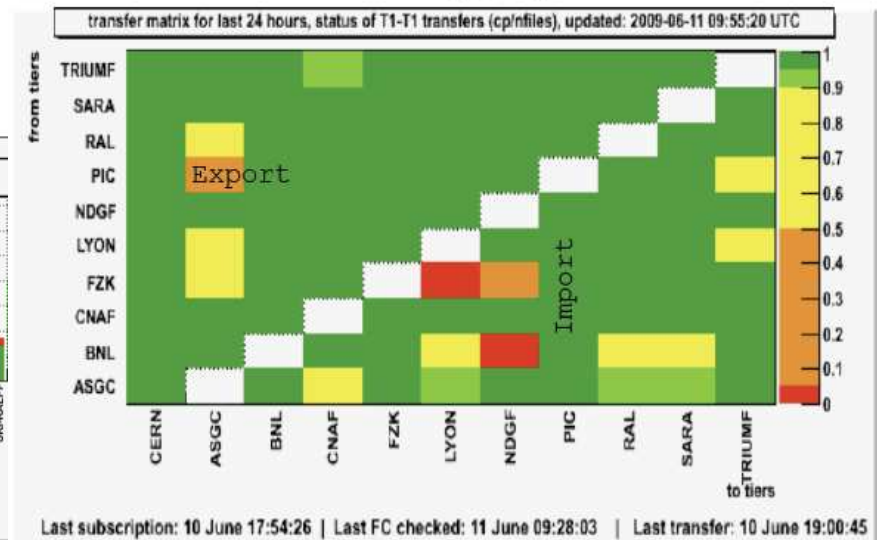
PIC-Tier-2s data transfers (MB/s)



Tier1-Tier2s Data Aggregation



Tier1-Tier1 Data Aggregation

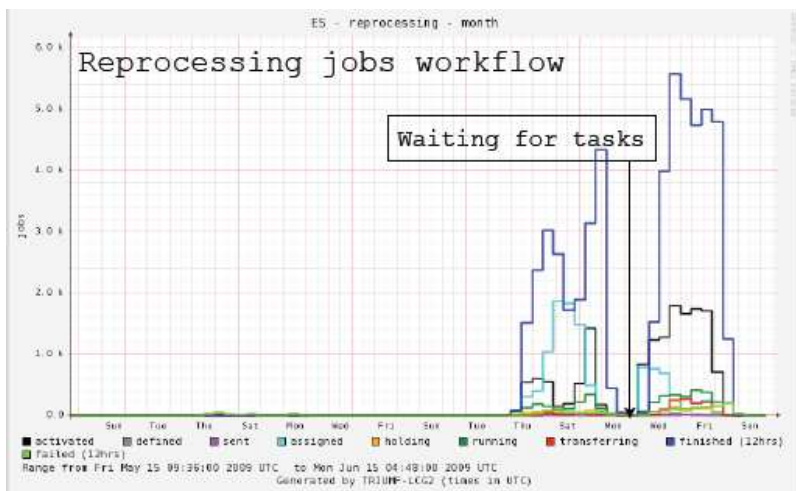


- STEP09 reprocessing**

- Main STEP target and dominant activity at the Tier-1s
 - Read ALL files from tape and store outputs to tape
- Repro workflow fully steered by PanDA (pilots) and DDM
- Metric of success during 10 days:
 - Reprocess at x5 data taking (assuming 40% LHC effc.)
 - PIC (5%T1): complete 16 TB and 10k files
- Gold metric:
 - Reprocess at x5 data taking (assuming 100% LHC eff.)
- PIC completed almost two full repro cycles: gold star ★

Objectives was to reprocess faster nominal data taking rate of 200Hz

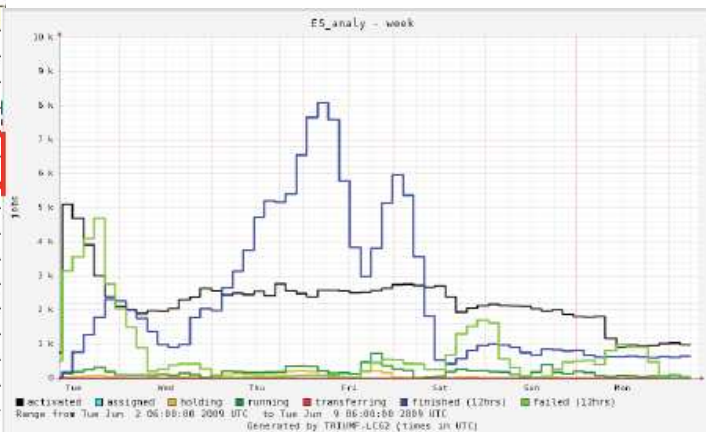
- Baseline metric at 400 Hz (x2)
- Enhanced metric at 1000 Hz (x5) ★



| TI | Base Target | Result | Comment |
|------------|-------------|----------|-------------------------------------------------------|
| ASGC | 10 000 | 4 782 | Many batch system and basic setup problems |
| BNL + SLAC | 50 000 | 99 276 | Also ran high priority validation and other tasks |
| CNAF | 10 000 | 29 997 ★ | |
| FZK | 20 000 | 17 954 | Big tape system problems pre-STEP; no CMS |
| LYON | 30 000 | 29 187 | Very late start due to tape system upgrade, then good |
| NDGF | 10 000 | 28 571 ★ | |
| PIC | 10 000 | 47 262 ★ | |
| RAL | 20 000 | 77 017 ★ | |
| SARA | 30 000 | 28 729 | Tape system performance very patchy |
| TRIUMF | 10 000 | 32 481 ★ | Also ran high priority validation and other tasks |

- User Analysis (WMS job submission and Pilot jobs)
 - Stats was corrected for Upstream Panda Failure:
 - Build job failing at sites were not accounted, includes:
 - 32/64 bits compact issues
 - Releases not/wrong installed

| CLOUD | SUBMITTED | RUNNING | COMPLETED | FAILED | Efficiency | # Files |
|-----------|-----------|---------|-----------|--------|------------|---------|
| CA | 0 | 0 | 5395 | 2344 | 0.70 | 24361 |
| CA_PANDA | 0 | 0 | 26715 | 7504 | 0.78 | 62756 |
| DE | 0 | 0 | 52478 | 19051 | 0.73 | 342093 |
| DE_PANDA | 0 | 0 | 79625 | 25802 | 0.76 | 215302 |
| ES | 0 | 0 | 14038 | 3317 | 0.81 | 95347 |
| ES_PANDA | 0 | 0 | 48075 | 7334 | 0.87 | 141343 |
| FR | 0 | 0 | 26694 | 5411 | 0.83 | 186601 |
| FR_PANDA | 0 | 0 | 116934 | 17516 | 0.87 | 375377 |
| IT | 0 | 0 | 38428 | 4758 | 0.89 | 266703 |
| IT_PANDA | 0 | 0 | 14036 | 2343 | 0.86 | 44358 |
| NG | 0 | 0 | 14551 | 2919 | 0.83 | 20179 |
| NL | 0 | 0 | 10703 | 20257 | 0.35 | 64016 |
| NL_PANDA | 0 | 0 | 25624 | 10119 | 0.72 | 90436 |
| T0_PANDA | 0 | 0 | 0 | 1151 | 0.00 | 0 |
| TW | 0 | 0 | 784 | 770 | 0.50 | 7663 |
| TW_PANDA | 0 | 0 | 18675 | 4140 | 0.82 | 78630 |
| UK | 0 | 0 | 21695 | 15190 | 0.59 | 120972 |
| UK_PANDA | 0 | 0 | 121975 | 23000 | 0.84 | 318112 |
| US | 0 | 0 | 153609 | 9770 | 0.94 | 467732 |
| **TOTAL** | 0 | 0 | 790034 | 182696 | 0.81 | 2921981 |

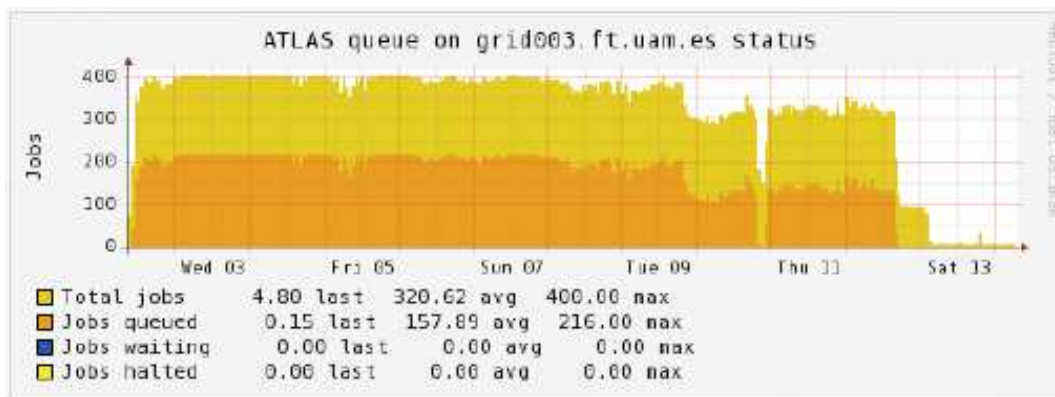


| CLOUD | SUBMITTED | RUNNING | COMPLETED | FAILED | Efficiency | # Files |
|-----------|-----------|---------|-----------|--------|------------|---------|
| CA | 0 | 0 | 32110 | 9848 | 0.77 | 87117 |
| DE | 0 | 0 | 132103 | 44853 | 0.75 | 557395 |
| ES | 0 | 0 | 62113 | 10651 | 0.85 | 236690 |
| FR | 0 | 0 | 143628 | 22927 | 0.86 | 561978 |
| IT | 0 | 0 | 52464 | 7101 | 0.88 | 311061 |
| NG | 0 | 0 | 14551 | 2919 | 0.83 | 20179 |
| NL | 0 | 0 | 36327 | 30376 | 0.54 | 154452 |
| T0 | 0 | 0 | 0 | 1151 | 0.00 | 0 |
| TW | 0 | 0 | 19459 | 4910 | 0.80 | 86293 |
| UK | 0 | 0 | 143670 | 38190 | 0.79 | 439084 |
| US | 0 | 0 | 153609 | 9770 | 0.94 | 467732 |
| **TOTAL** | 0 | 0 | 790034 | 182696 | 0.81 | 2921981 |



- Computing: Faire share (FS)

Queue on CE



5th June
(Wrong FS)

| Group | Running Jobs | Queued Jobs | %FS |
|-----------------------|--------------|-------------|-------|
| Production | 31 | 1 | 40.42 |
| User analysis (wms) | 11 | 199 | 41.81 |
| User analysis (pilot) | 144 | 0 | 17.72 |

8th June
(Right FS)

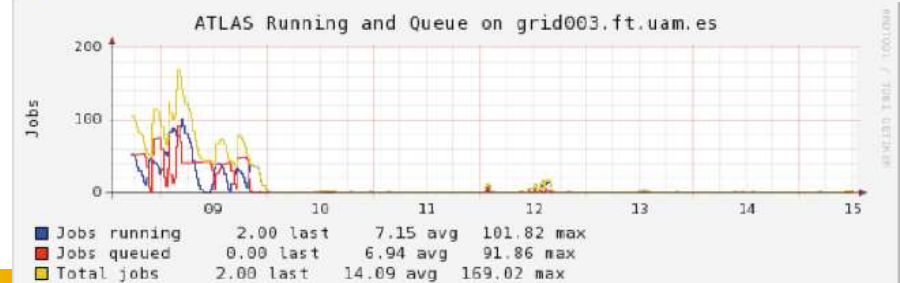
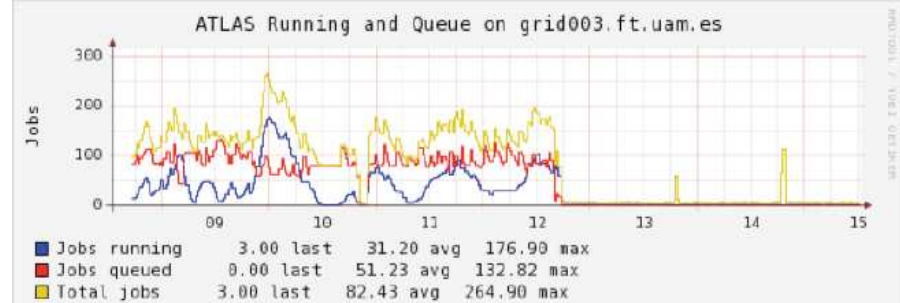
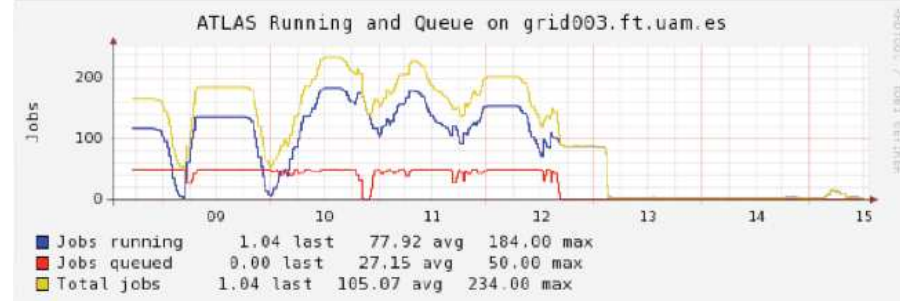
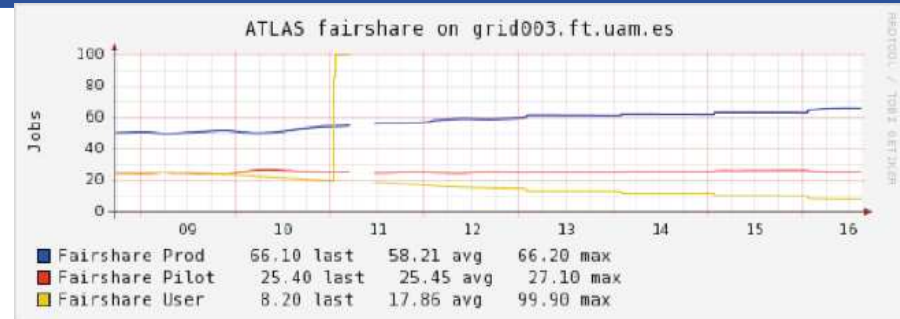
| Group | Running Jobs | Queued Jobs | %FS |
|-----------------------|--------------|-------------|-------|
| Production | 48 | 29 | 49.76 |
| User analysis (wms) | 110 | 57 | 25.27 |
| User analysis (pilot) | 26 | 90 | 24.92 |

- Computing: Faire share

Production

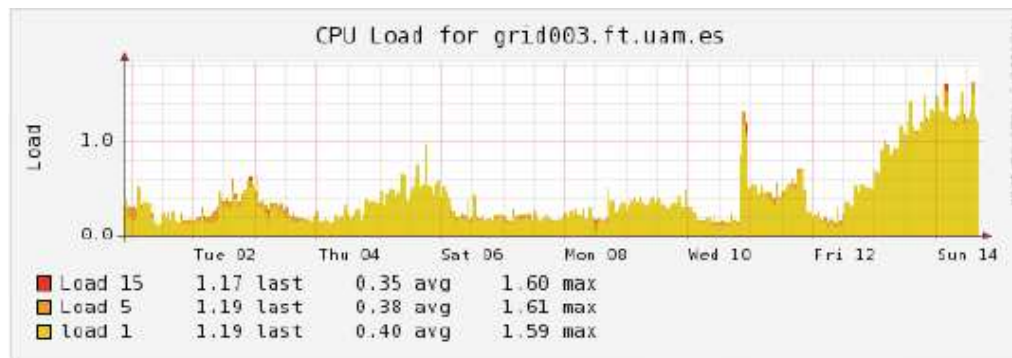
Analysis (Pilot based)

Analysis (WMS submission)



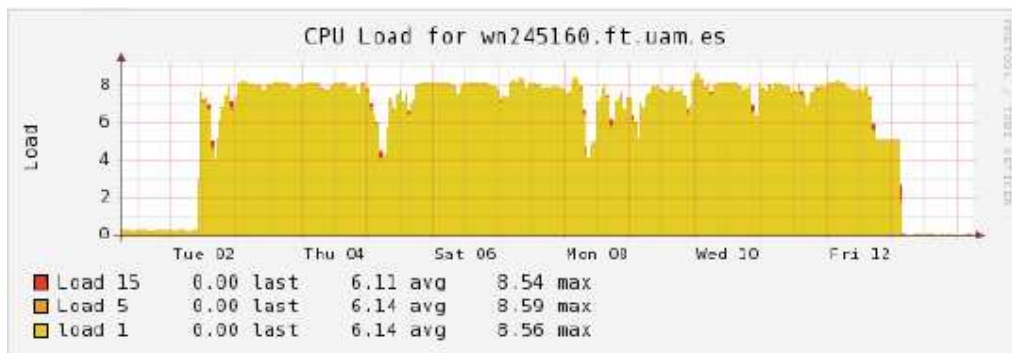
- Computing: CPU Load

CE



All WNs had a huge load but the CE worked without problems

WN



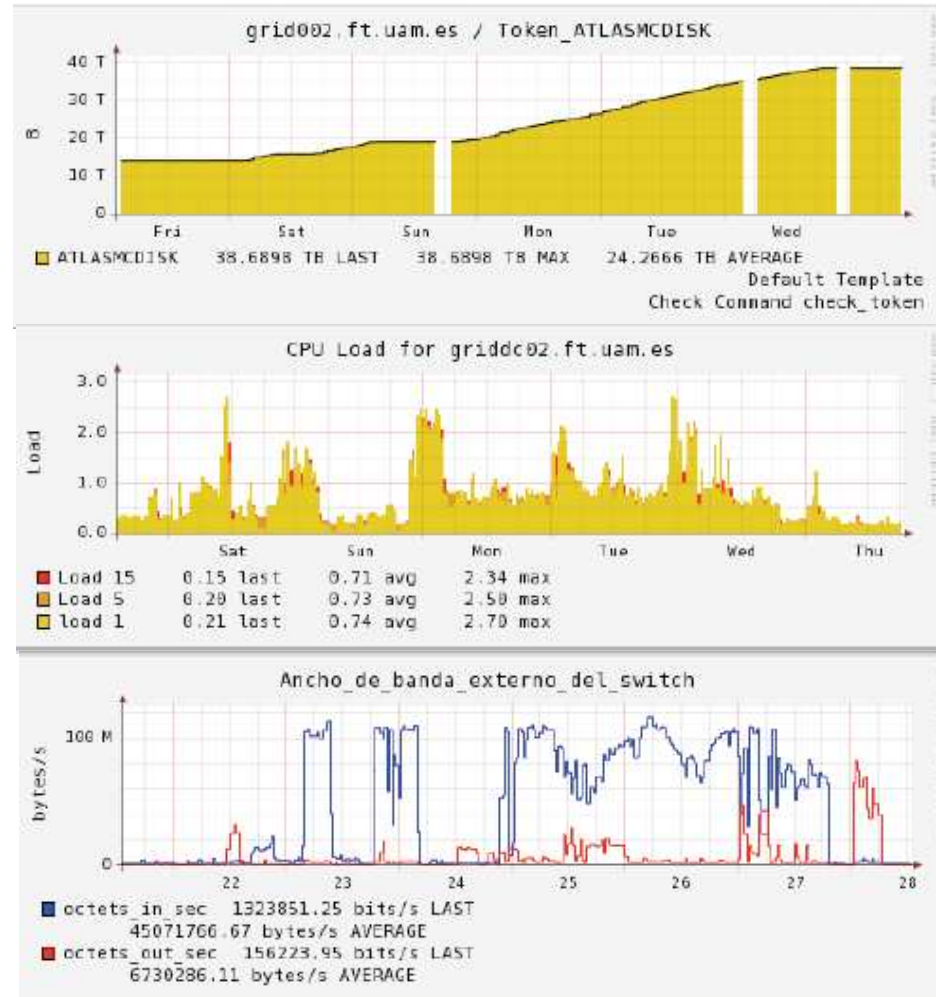
- Storage and Bandwidth: Previous transfers

25 TB from 22nd to 25th May

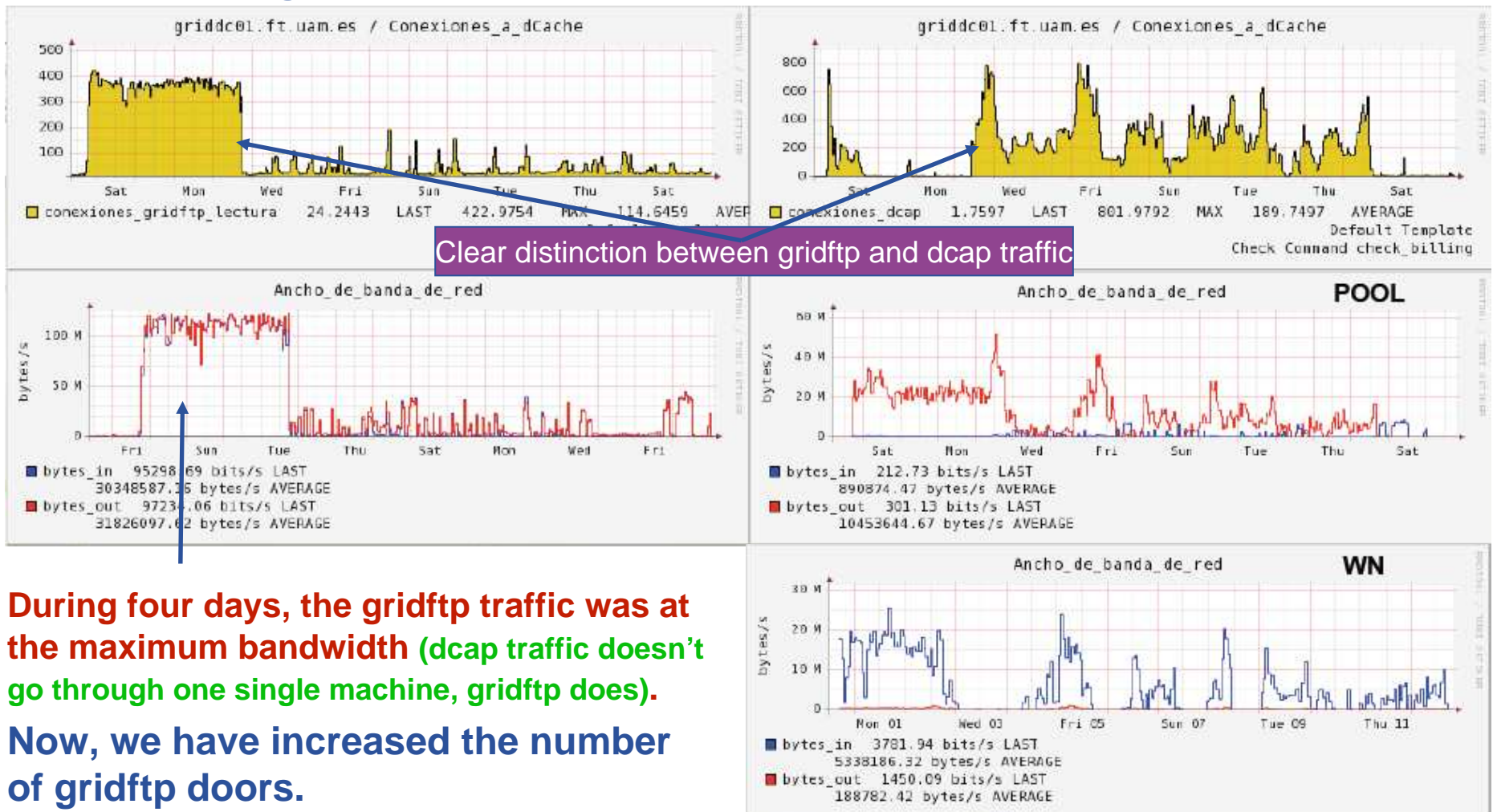
During the test, MCDISK was increased barely 500 GB on the fly

PNFS load was high, causing some random SAM checks to fail (timeouts)

External bandwidth was very busy



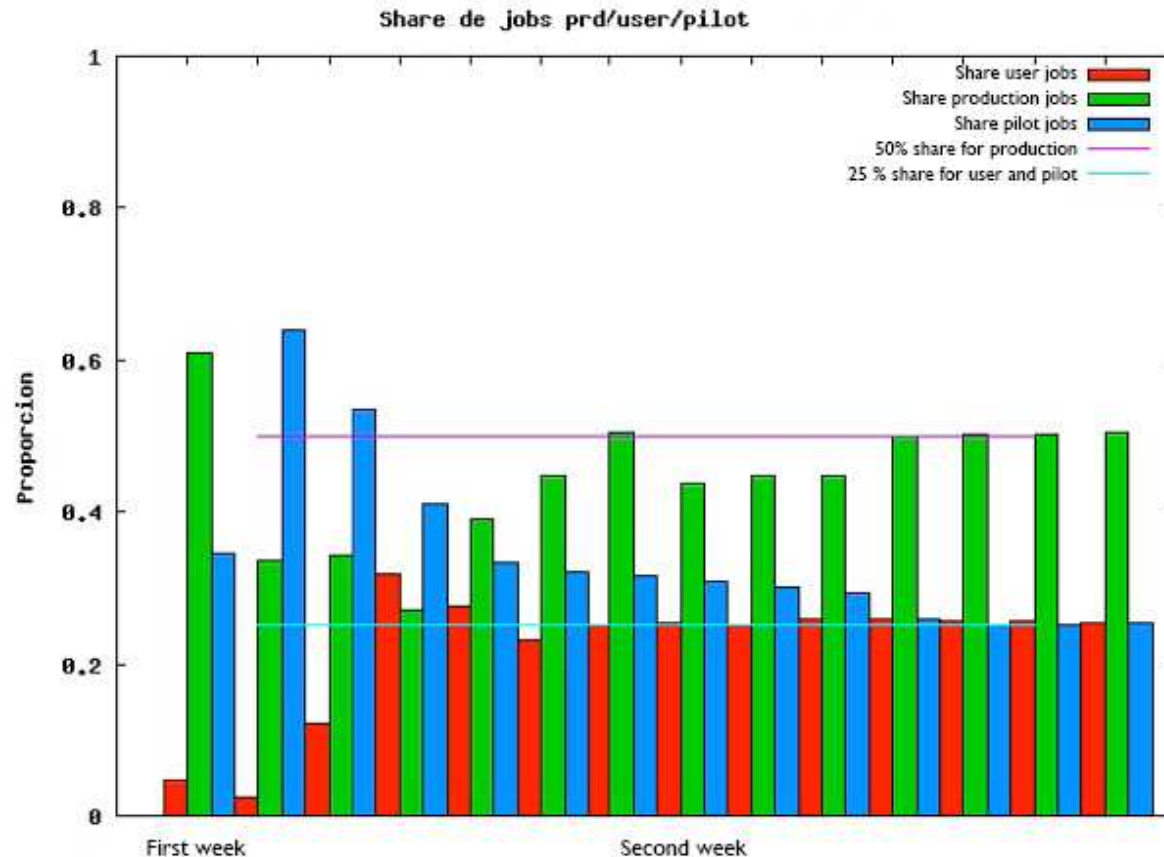
- Storage and Bandwidth: During Step09 test
gridftp
dcap



During four days, the gridftp traffic was at the maximum bandwidth (dcap traffic doesn't go through one single machine, gridftp does).

Now, we have increased the number of gridftp doors.

- Computing



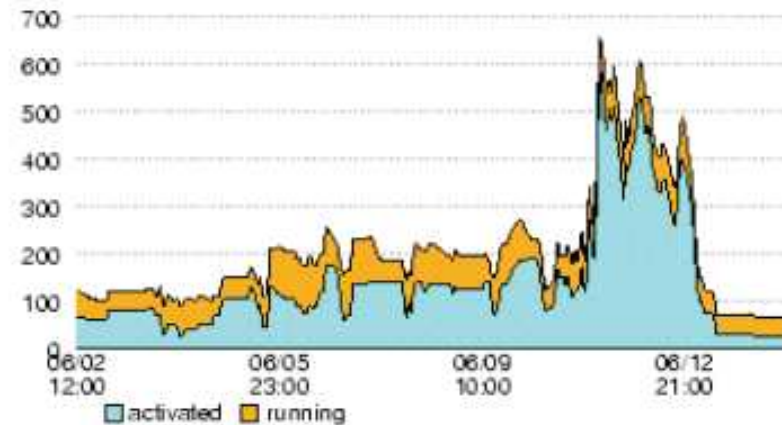
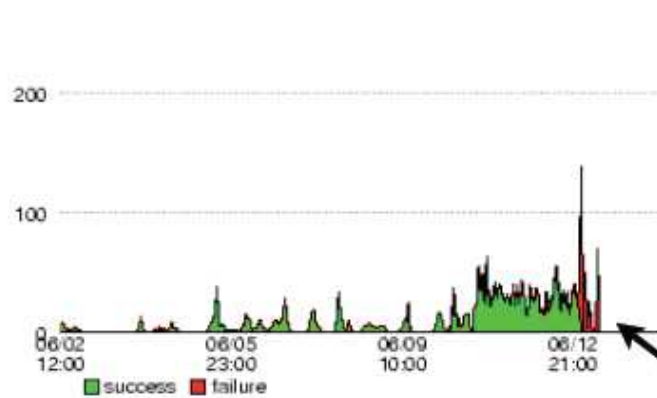
Blue: role value for user analysis (25% analysis pilot based)

Red: WMS submission (25% analysis)

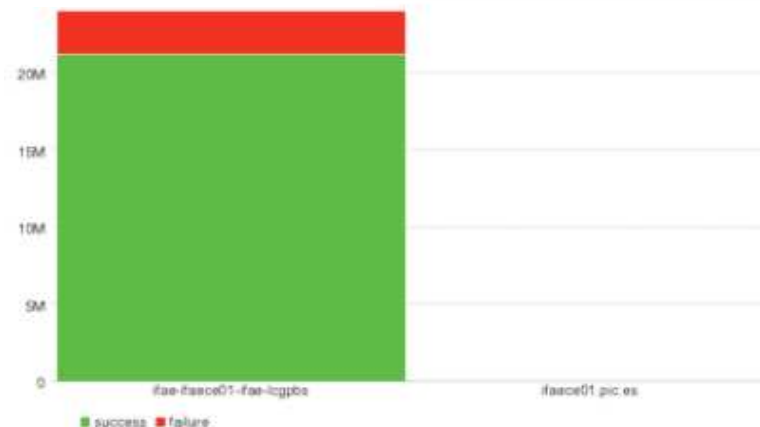
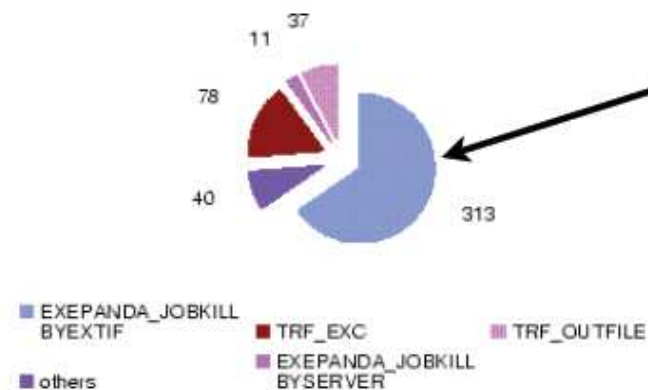
Green: Official MC production

The share imposed in the IFAE's pbs was being accomplished.

- MC production during STEP09:
 - Good achievement in the efficiency 92.5%

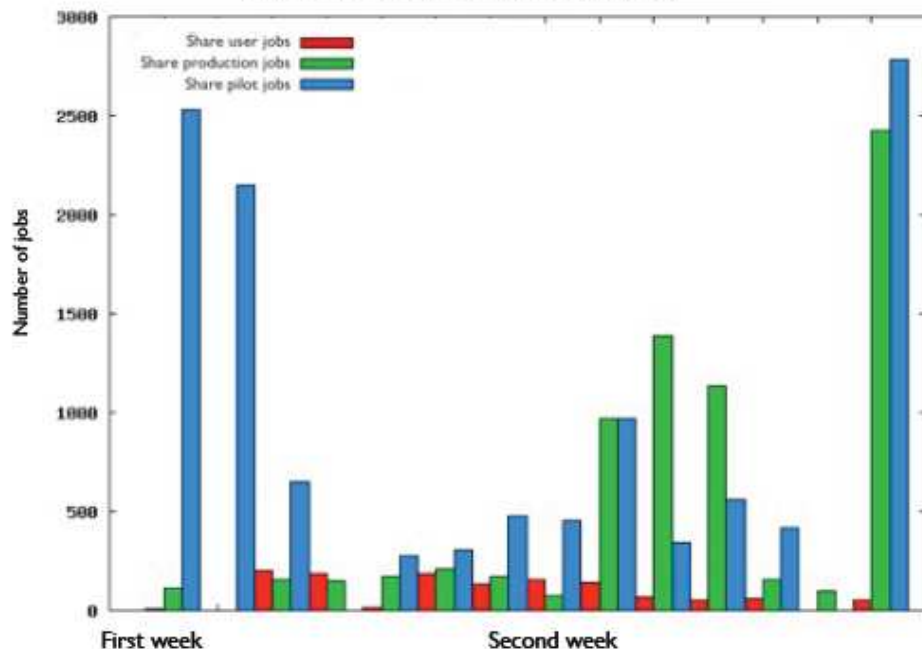


Most of the errors came from "aborted by ExtIF"
nothing to do with IFAE site.



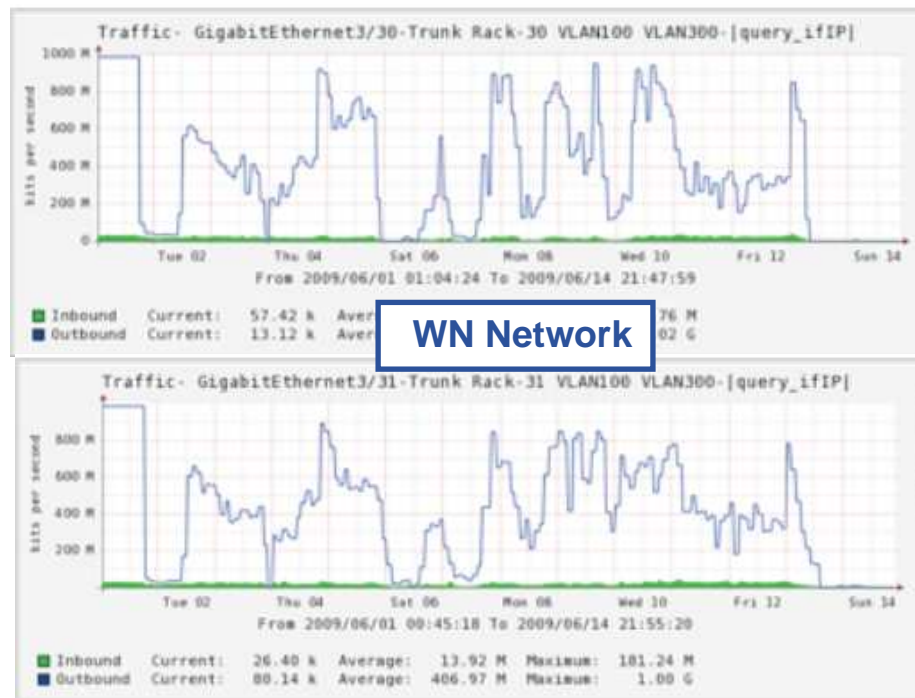
- Difficulties:**

Number of jobs per day prd/user/pilot during STEP09



Issue with the faire share during the first days; Scheduler's historical information should have been removed:

- The farm was mainly dominated by Panda jobs (in blue), queuing all others.
- Some error from the WMS jobs were found due to the time outs; This jobs were waiting for a long time

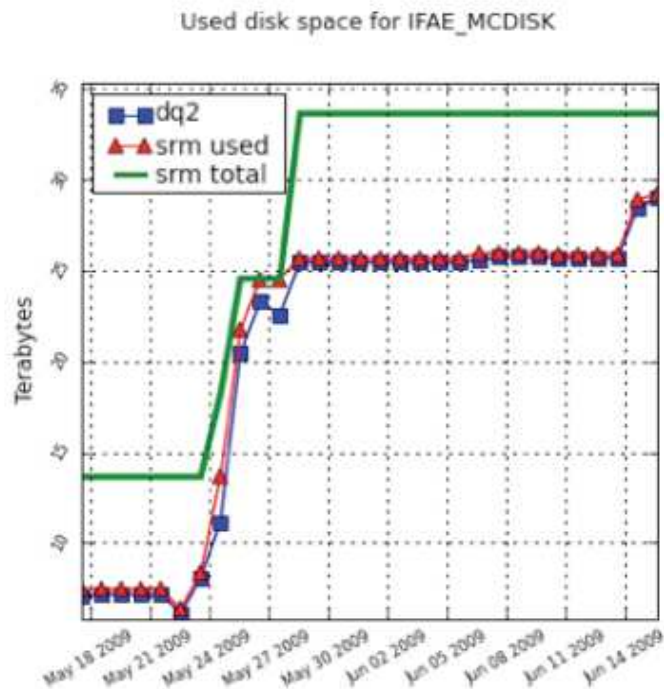


Some errors with some very “weird” jobs were experienced. They were not able to ran but just blocking the queues.

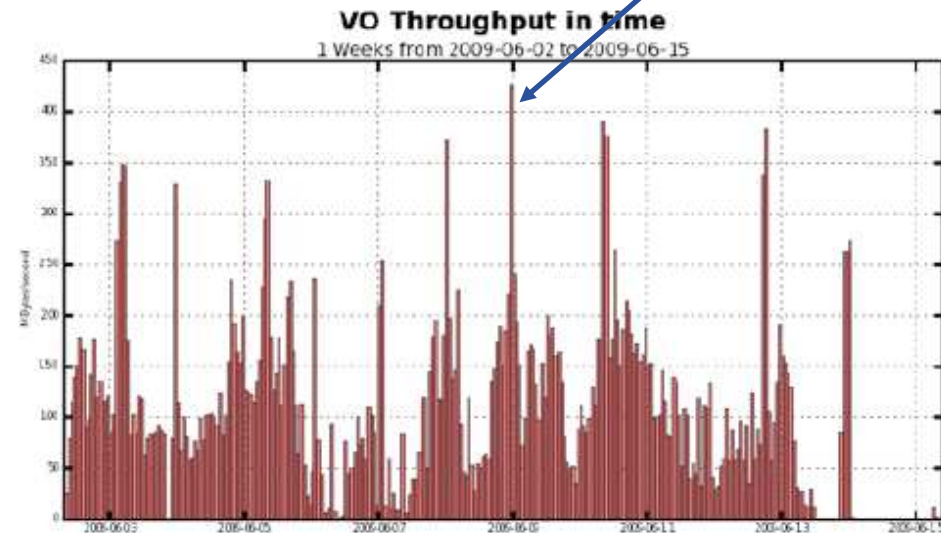
But at the end IFAE got a pilot analysis efficiency around 90% and 76% for the WMS jobs

- Distributed Data Management:**

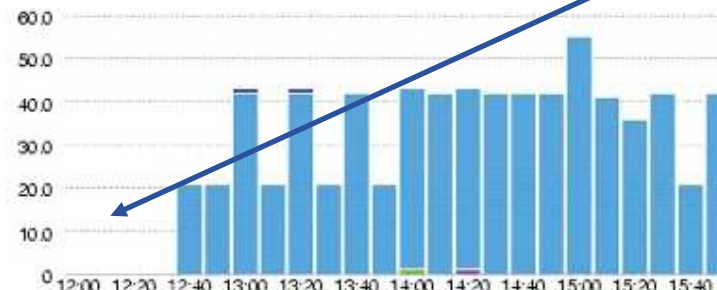
- 20 TB were placed.
- **Green lines** shows the available space of the MCDISK token



9th June more than **400 Mbytes/s** were reached



9th June DATADISK token was running out of space. Increased with 10 TB. This error lasted during 3 hours and was detected from Atlas DDM monitoring



- Distributed Data Management:**

- Data moved from/to IFAE these days and also the efficiency which was affected by the errors:
 - Space problem caused some transfer errors.

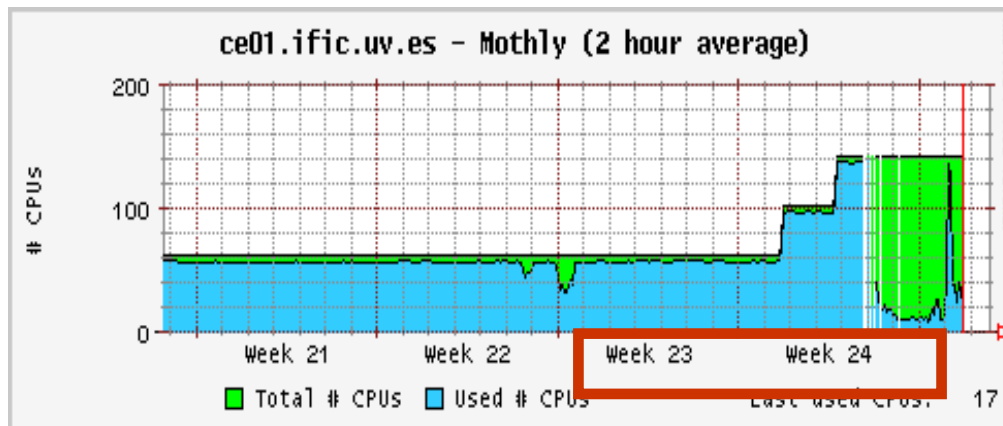
| Cloud | Transfers | | | Registrations | | |
|-----------------------|------------|------------|-----------|---------------|-------|----------|
| | Efficiency | Throughput | Successes | Datasets | Files | Transfer |
| - IFAE_DATADISK | 65% | 23 MB/s | 10425 | 2595 | 8401 | 5540 |
| PIC_DATADISK | 65% | 23 MB/s | 10425 | | | 5540 |
| + IFAE_LOCALGROUPDISK | 0% | 0 MB/s | 0 | 0 | 0 | 0 |
| - IFAE_MCDISK | 100% | 3 MB/s | 2334 | 19 | 2332 | 0 |
| PIC_MCDISK | 100% | 3 MB/s | 2334 | | | 0 |
| - IFAE_PRODDISK | 87% | 3 MB/s | 2225 | 255 | 2200 | 332 |
| PIC_DATADISK | 100% | 0 MB/s | 415 | | | 0 |
| PIC_DATATAPE | 84% | 3 MB/s | 1697 | | | 332 |
| PIC_MCDISK | 100% | 0 MB/s | 113 | | | 0 |

- Job processing
 - Pilot role was added in VOMS mapping
 - But **no proper scheduling policy could be setup in time**
 - In order to achieve this, **a new account pool had to be setup** but it was **not easy with the present configuration tool (*quattor*)**.

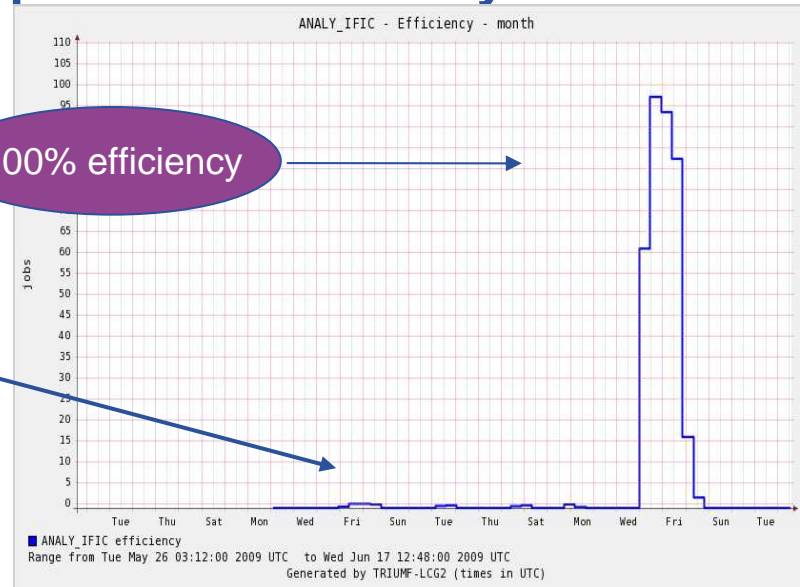
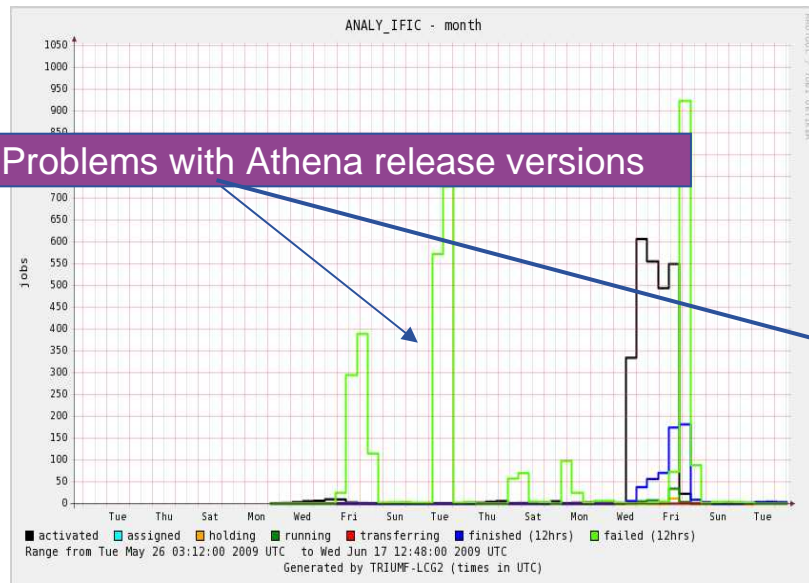
| Group | % | Target |
|-----------------------------|-------|--------|
| Atlas users(WMS and pilots) | 43.23 | 50 |
| Atlas production | 56.49 | 50 |

- Farm occupancy was high and we added 40+40 cores more in last week (24)

The number of cores we added stressed the CPU power at the CE (Pentium D CPU 3.20 GHz) and we decided to upgrade it in that coming weeks.



- Job statistics from ANALY and IFIC queue from 17th May to 17th June.



- In the first week we had problems with panda jobs trying to use an non existing Athena version
- For that reason, our efficiency for pilot jobs was around 21% (ANALY_IFIC) while for WMS jobs (IFIC-LCG2_MCDISK) was around 82% on 17th June

After installing the Athena versions used for panda our pilot job efficiency raised to 17% in a few minutes being around 100% in the last days.

| ES | SUBMITTED | RUNNING | COMPLETED | FAILED | Efficiency | #Files Expected | #Files Processed |
|------------------|-----------|---------|-----------|--------|------------|-----------------|------------------|
| IFIC-LCG2_MCDISK | 62 | 96 | 1130 | 299 | 0.82 | 8105 | 8105 |
| ANALY_IFIC | 443 | 109 | 455 | 1691 | 0.21 | 1506 | ? |

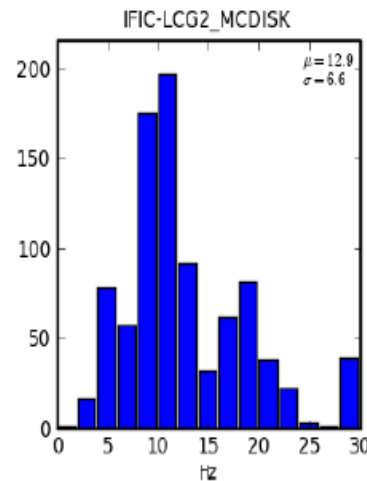
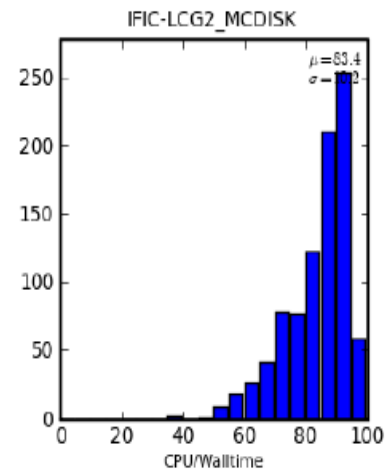
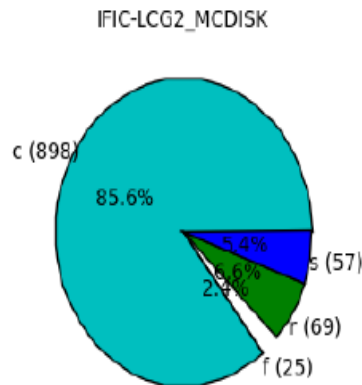
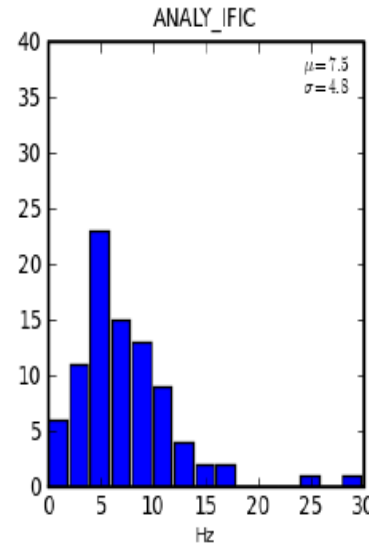
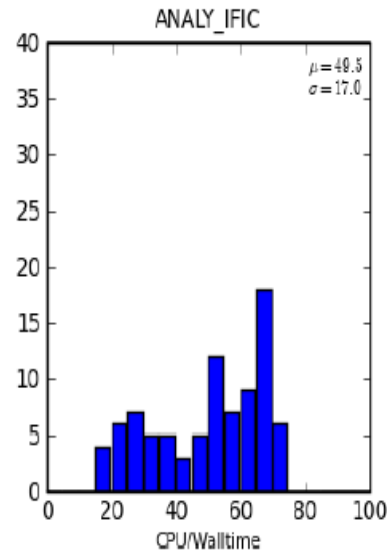
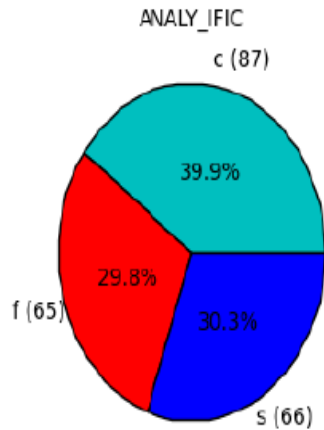
Statistics taken from: <http://gangarobot.cern.ch/st/status.html>

Influence on the **input data protocol** on **CPU/Wall time efficiency** was tested in previous UA tests.

Sites with **POSIX-like access to the file system (Lustre)** perform **better without triggering copies** in the background using lcg tools (file stager)

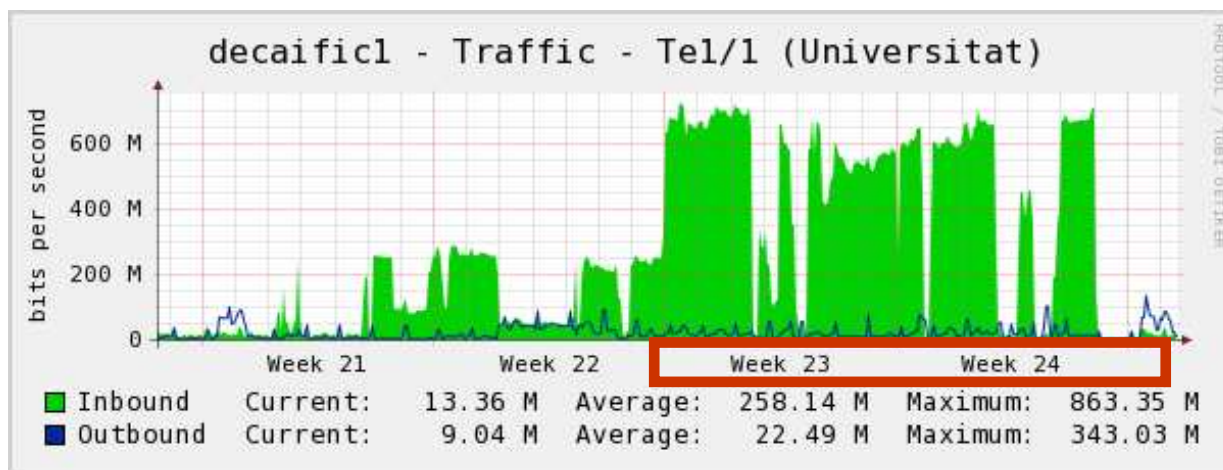
- The same results was found in STEP09 test for WMS jobs but not for PANDA pilot jobs, CPU/Wall time efficiency was reduced from 83.4% to 49.5%.

Panda pilot based analysis used your site's ANALY queue local mover to copy data to the worker node; the WMS based analysis used a mixture of the file stager (copy to worker node) and local LAN protocol (known as DQ2_LOCAL, resolved to dcap, rfio or xroot).



- **Data transfer**

- Data distribution in the week previous to the STEP09 showed a **bottleneck in the gridftp server.**
 - We deployed a new machine and the bandwidth increased from 200 Mbps to 600 Mbps.
 - During the test data transfer rate was steady during long periods. No problems were observed in the network infrastructure neither local or remote.
- WN accessed to the data using local posix I/O (read only) and gridftp protocols.



WNs and disk servers are connected to Cisco switch at 1Gbps.

In the test configuration:

WNs share 1 Gbps in groups of 8
Disk servers share 1 Gbps in groups of 2.

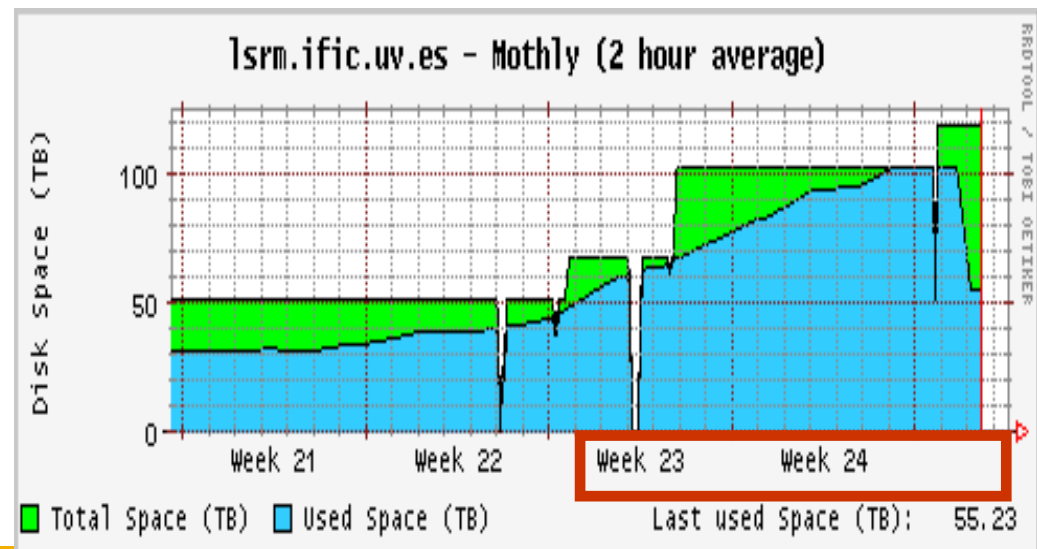
Present configuration:

1 Gbps for every WN
2 Gbps for every disk server

- From June 1st to 14th data size transferred to our SE was:
 - 57 TBytes incoming (112TB total, 50% to IFIC) in our ATLASDATADISK space token
 - 1TBytes outgoing in our ATLASPRODDISK space token.
- During the test **disk went to full two time**.
 - More space was added on the fly with the deployment of two new disk servers (17TB + 34 TB) to reach 102 TBytes
 - Quick reaction and the flexibility to add more servers easily to Lustre file system lead us to absorb the data.

Space tokens were updated to reflect the used and available space but:

- ATLAS tools seems to ignore the values and continue transfers even when no space available was published.



- **Targets achieved:**
 - Data Transfers:
 - Reach >250MB/s in T1-T2 distribution
 - Excellent efficiencies (95% to 100%)
 - No major issues for IFAE, IFIC and UAM rather than disk space shortage
 - MC production
 - Nice behavior not only during STEP but since more than 1 year (efficiencies ~95%)
 - User Analysis
 - First bulk experience together with many other demanding activities
 - First days fair-share inconsistency for the scheduler problem
 - Good efficiencies overall:
 - 85% for WMS jobs and 96% efficiency for the PanDA based analysis pilot jobs
 - Minor (and not site related) issues
 - Reprocessing:
 - Passed successfully even though we'll continue to tune the tape by system by installing more tape drives and optimizing the recall pool schema.
 - ATLAS thinking about using T2s for repro with FronTier technology

- **Issues learned and to improve:**
 - Storage still the most critical services all across sites
 - Minor issues at our cloud:
 - *SE instabilities: gridftp doors overload, disk space shortages*
 - Optimization for User Analysis (UA):
 - Take advantage of site's architecture:
 - *Distinguish and enforce DQ2Local or FS to target best site performance*
 - Enhance for using native and optimized protocols
 - File:// for POSIX like SE (IFIC and LIPs)
 - Tune RA for dCache sites (currently 32kb is the default in UA system)
 - Need periodic checking of the activities
 - Good implication of site people during STEP. Helped a lot to be a good ATLAS clouds !!!

- **Status and plans:**
 - ES sites are ready, showed robustness, stability and performed good.
 - ATLAS computing system is ready:
 - DDM improved during the last two years
 - PanDA MC and UA system increased global efficiencies and running stable
 - *Now centralized at CERN*
 - Last updates should be thought well in advance to have the sites ready for November and avoid big interventions after the end of the month.