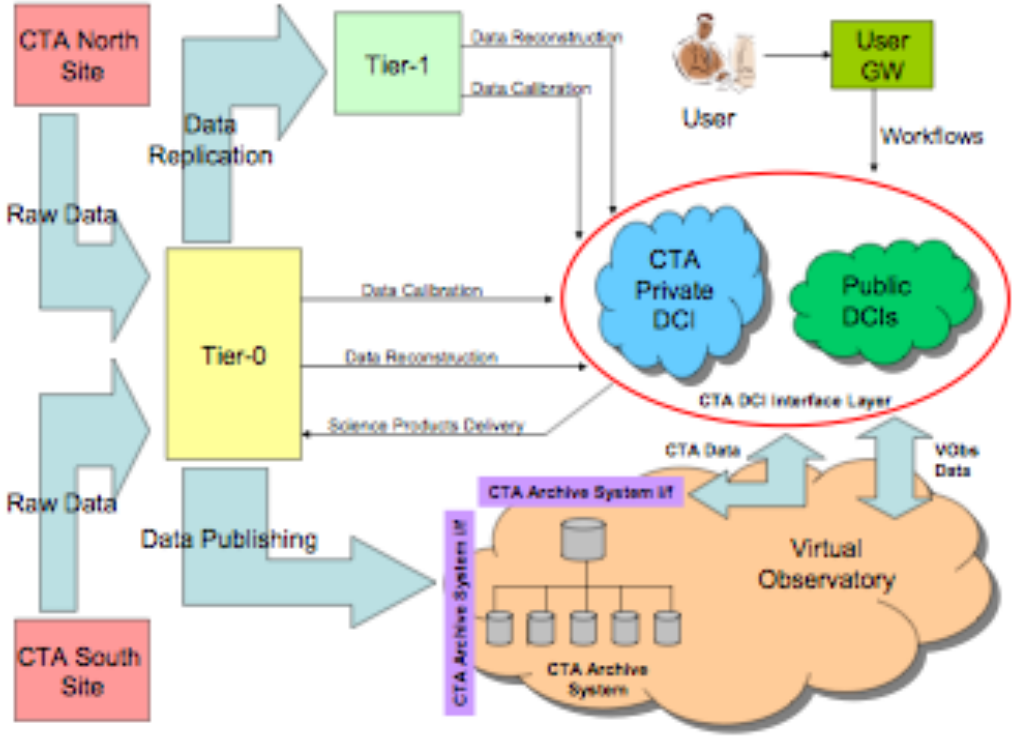
"Modello di calcolo di CTA e sinergie con le strutture di calcolo dell'INFN (CNAF)"

Domenico D'Urso
domenico.durso@pg.infn.it

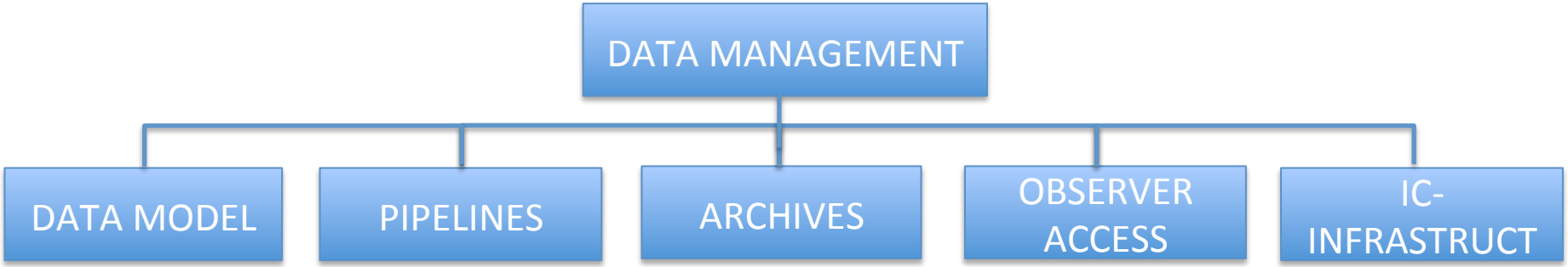
Computing Model

- CTA will produce a huge amount of data that have to be Archived, Transferred, Processed and Accessed



Computing Model

- List of data and number of versions to be kept (DATA MODEL)
- Process data flow with associated input/output data (PIPELINES)
- Data access requirements (Archive), based on use cases
- Availability requirements:Number of replicas, backup copy,…
- Off-site Information and Computing (IC) infrastructure: data processing center (s) and Internet Protocol (IP) communication lines.



List of Data

Data Level	Short Name	Description	Data reduction factor
Level 0	RAW	Data from DAQ written to disk.	1
Level 1	CALIBRATED	Physical quantities measured in the camera: photons, arrival times etc. (Preliminary image shape parameters could be also included within)	1
Level 2	RECONSTRUCTED	Reconstructed shower parameters such as energy, direction, and particle ID. Several increasingly sophisticated sub-levels are envisaged.	10^{-1}
Level 3	REDUCED	Sets of selected (e.g. gamma-candidate) events.	10^{-2}
Level 4	SCIENCE	High-level binned data products like spectra, skymaps, or lightcurves.	10^{-3}
Level 5	OBSERVATORY	Legacy observatory data, such as CTA survey sky maps or the CTA source catalog.	10^{-5}-10^{-3}

Data Volumes

- Event Data
  - For full waveform, scenario 1:the pulse waveform saved for all the pixels and all the events
  - For full integrated signal, scenario 2: Integral digitized signal for each pixel and event.
  - For mixed ,scenario 3:waveform saved only for some pixels, while the rest of the pixels are integrated.

- <u>Additional data</u>
  - 20% of additional data (Calibration + TECH0)

Associated Raw data Volumes

Hypothesis (MC-TRIG)

CameraPixels: **2000 pixels/camera**

Number of samples per pixel per event: **50 samples/pixel**

Average number of Telescopes for one event: **6 telescopes**

South Array trigger rate: **13000 Hz**

North Array trigger rate : **6000 Hz**

Annual Observation time: **1314 hours**

For the scenario 3, **ratio of full waveform pixels versus integrated signal pixels =2.5%**

Scenario 1 (Full Waveform)

- South Array 19.66 GB/s
- North Array 9.07 GB/s

} Event size 1231 kB and **136 PB per year**

Scenario 3 (Mixed scenario)

- South Array 1.22GB/s
- North Array 0.57GB/s

} Event size 77 kB and **8.46 PB per year**

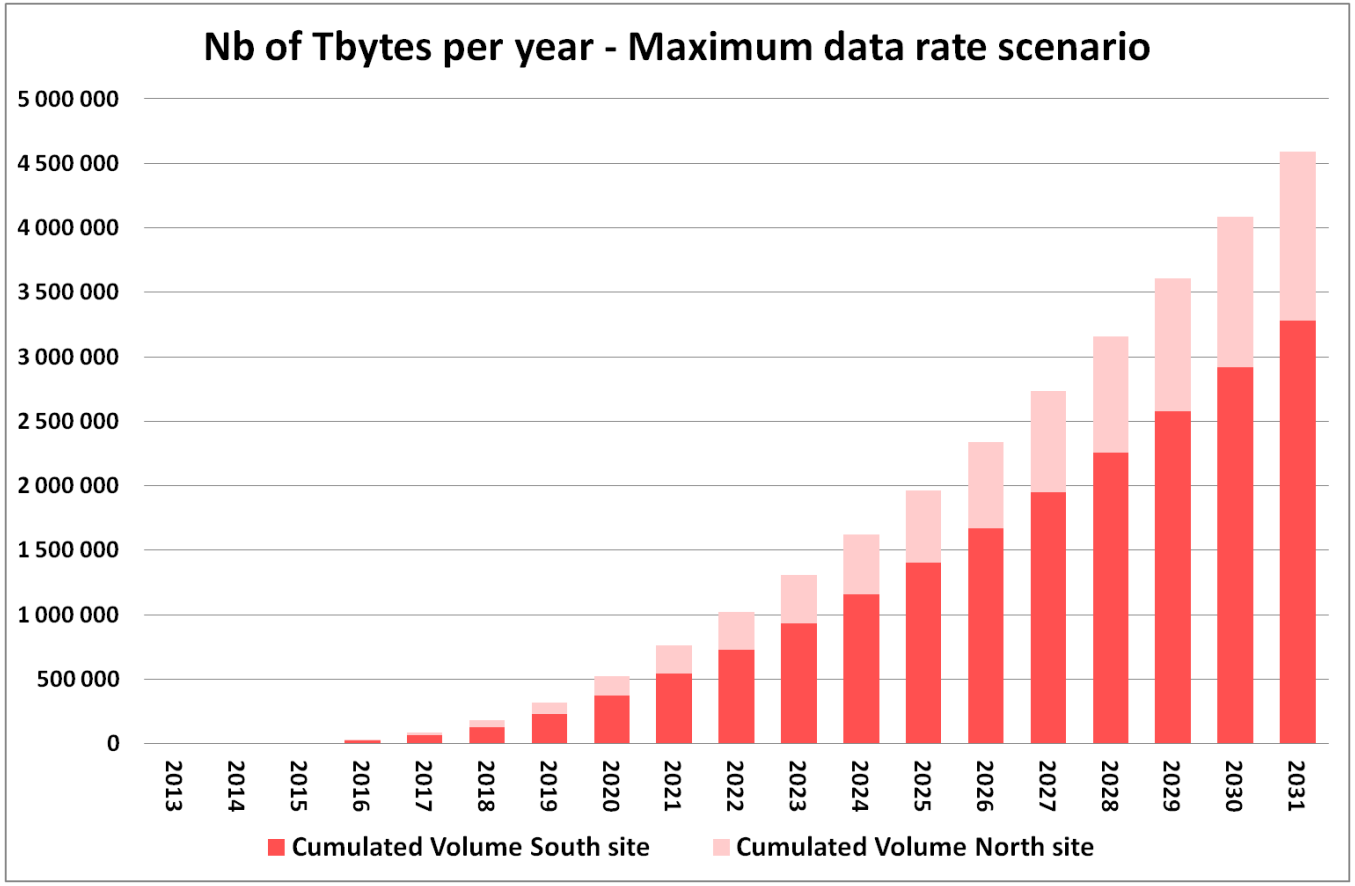
Data Volumes

Data occupying storage – Planned Model (Data)					
	Event Size	Data Access	Disk replicas of each version	Number of versions	Number of Tape Copy
RAW (DL0)	1231 kB	Write once, low read rate	30% kept on disk	1	1 + 1 (Backup)
CALIBRATED (DL1)	100% of RAW		0	0	0
RECONSTRUCTED (DL2)	10% of RAW	New version per year. Low read rate.	30% kept on disk	2	1 + 1 (Backup)
REDUCED (DL3)	1% of RAW	High read rate	1 (100%)	2	1 + 1 (Backup)
SCIENCE (DL4)	0.1% of RAW	High read rate	1 (100%)	1	1 + 1 (Backup)
OBSERVATORY (DL5)	0.1% of RAW	High read rate	1 (100%)	1	1 + 1 (Backup)

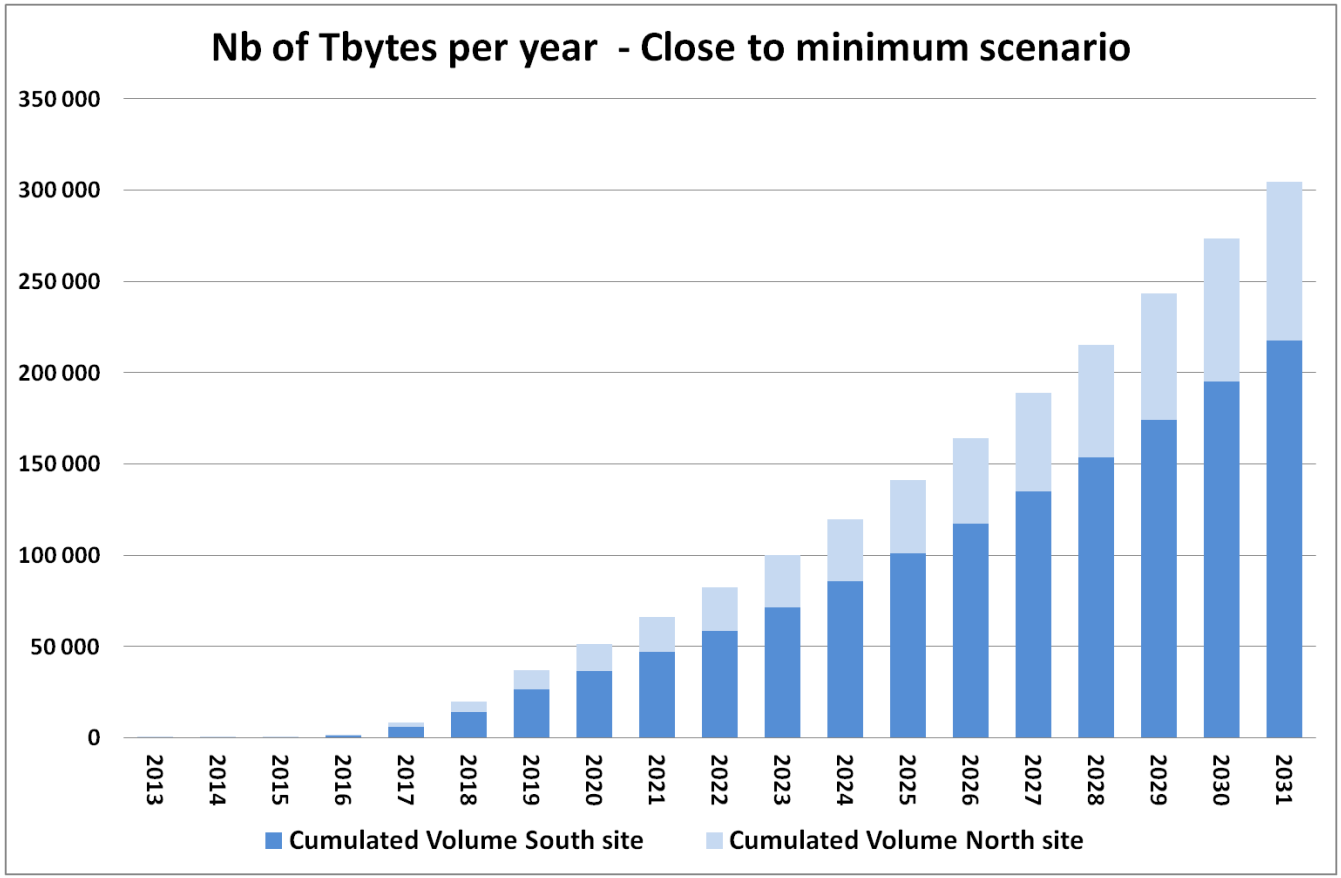
Percentage of data on Disk versus Tape: 30% in average

Number of reconstructed and reduced versions kept after reprocessing: Previous and Current version

Resulting Data Volumes for Scenario 1



Resulting Data Volumes for Scenario 3



Performances

- CTA Expected lifetime 30 years (deployment in 4 years), 1314 hours/y
- Data availability <2 months after observation
- 1 month to reprocess 1 year of data
- CTA sites connection able to transfer 1 night of first level rec events in 5 hours
- raw data transfer in less than 10 days
- 1 full reprocessing every year
- 1day of data processed in less than 24h

CPU resources for the Data Pipeline

Numbers calculated scaling the HESS requirements

- 1 hour calibration and data processing = 150 M HS06
  - 1314 hours/y → 197 G HS06 per year
- Monte-Carlo: Simulation and (IRF) ~ 10% of the annual CPU time for data reduction → 19.7 G HS06

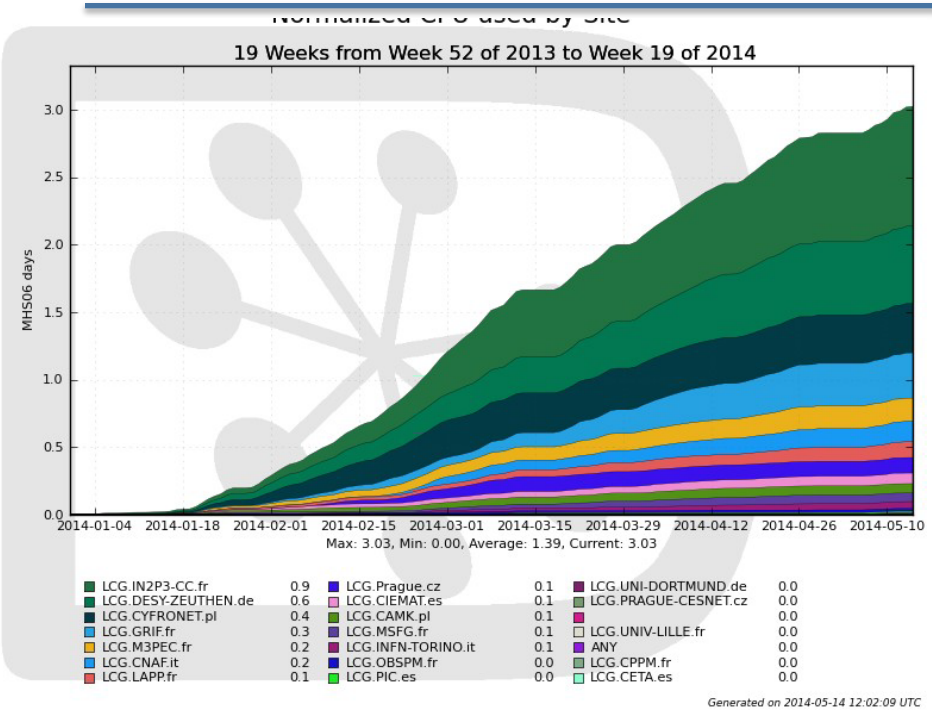
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Data Pipeline	19.7	59.1	98.5	138	197	197	197	197	197	197	197	197	197	197	197	197
MC	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7
Re-processing	0	19.7	78.8	177	315	512	710	907	1104	1301	1498	1695	1892	2089	2286	2483
Cumulated	39	99	197	335	532	729	926	1123	1321	1518	1715	1912	2109	2306	2503	2700

CTA Virtual Organization

Activities:

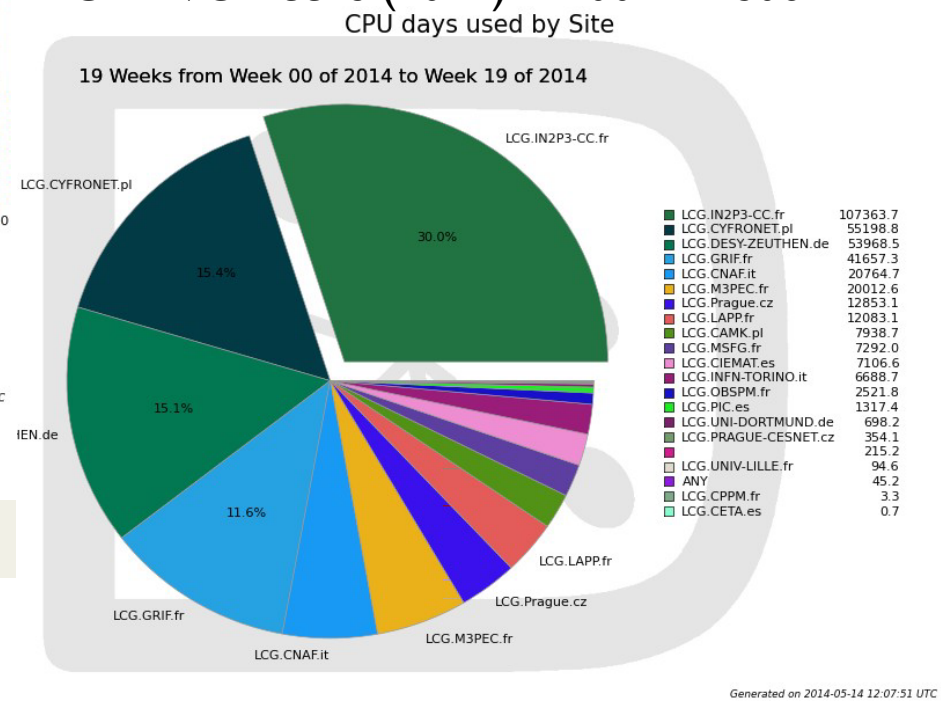
- MC simulation
  - Site selection
  - Layout optimization
  - SST performance comparison
  - MST/SCT (single/double mirror) comparison
  - Detector Angular Dependency

CPU Usage



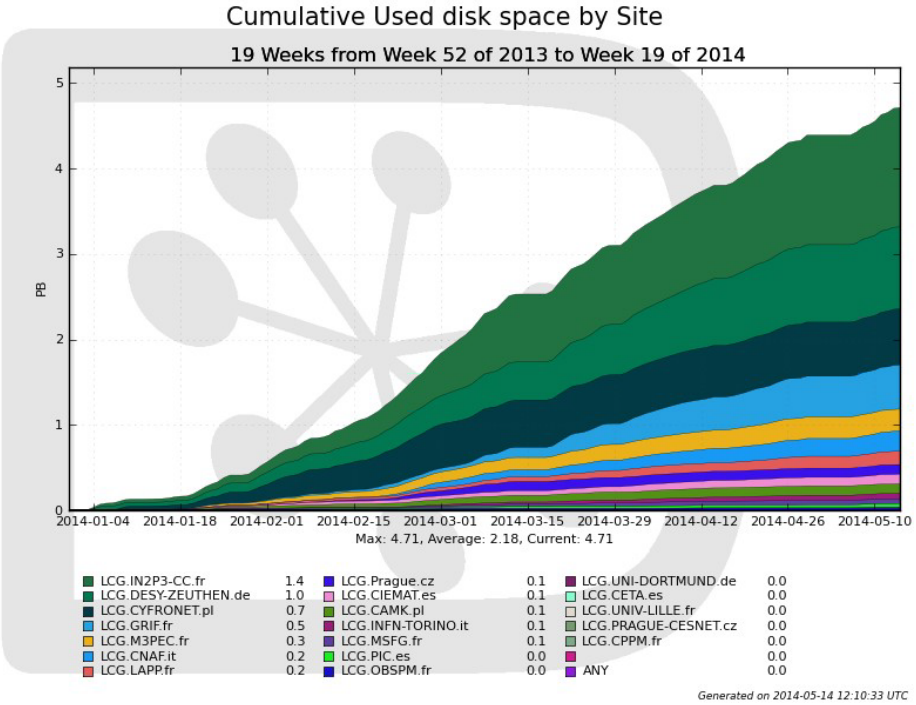
~ 72 M HS06 hours consumed since Jan 2014
~ 190M by the end of 2014

CTA-VO needs (2014) = 100 M HS06

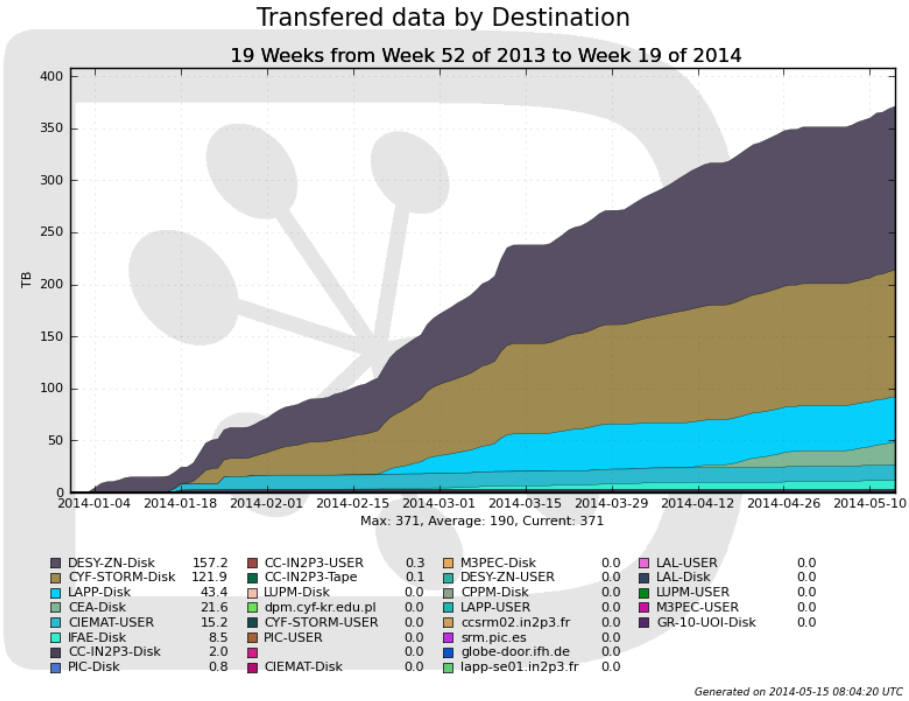


CNAF contributed about 5.8% so far

Disk Usage



The cumulative disk space is the overall disk written-erased-rewritten ..... on the site disks



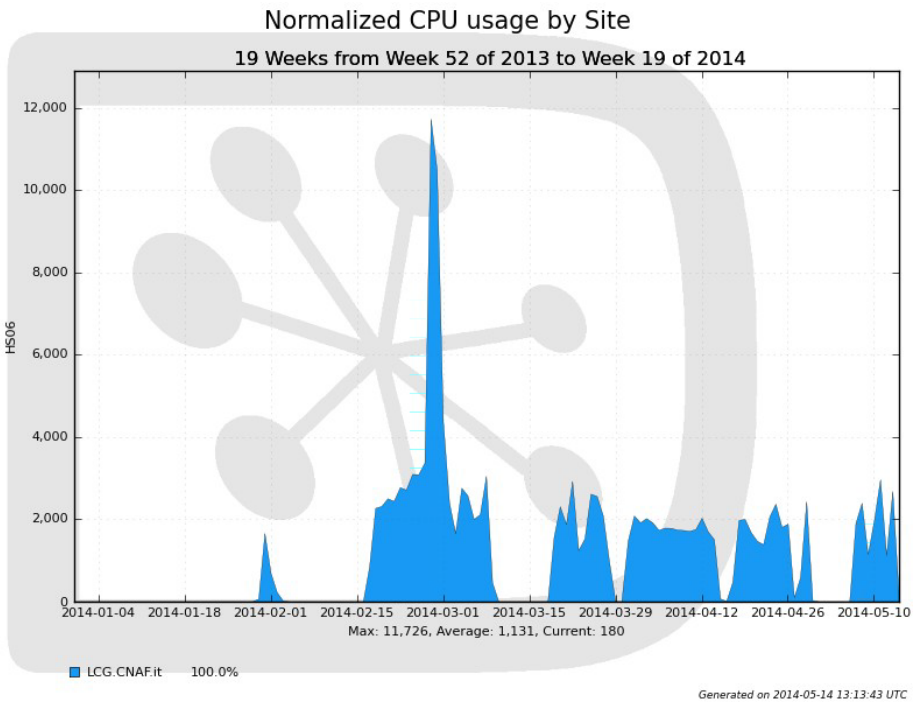
The transferred data plot shows the amount of data "temporarily" stored on the storage elements.

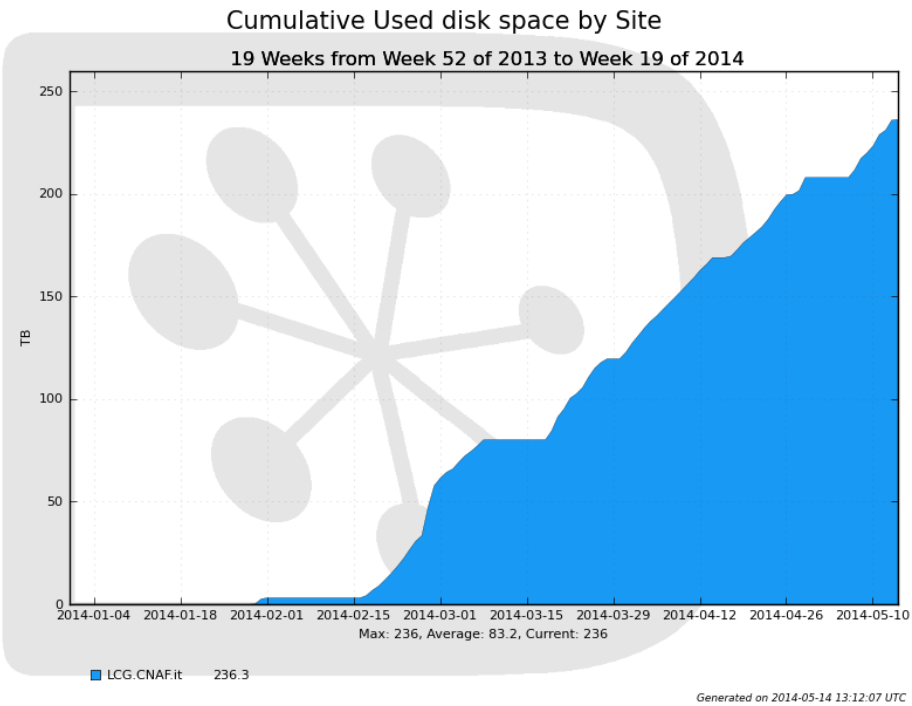
INFN Contribution

CTA VO supported by two INFN institutes (2014):

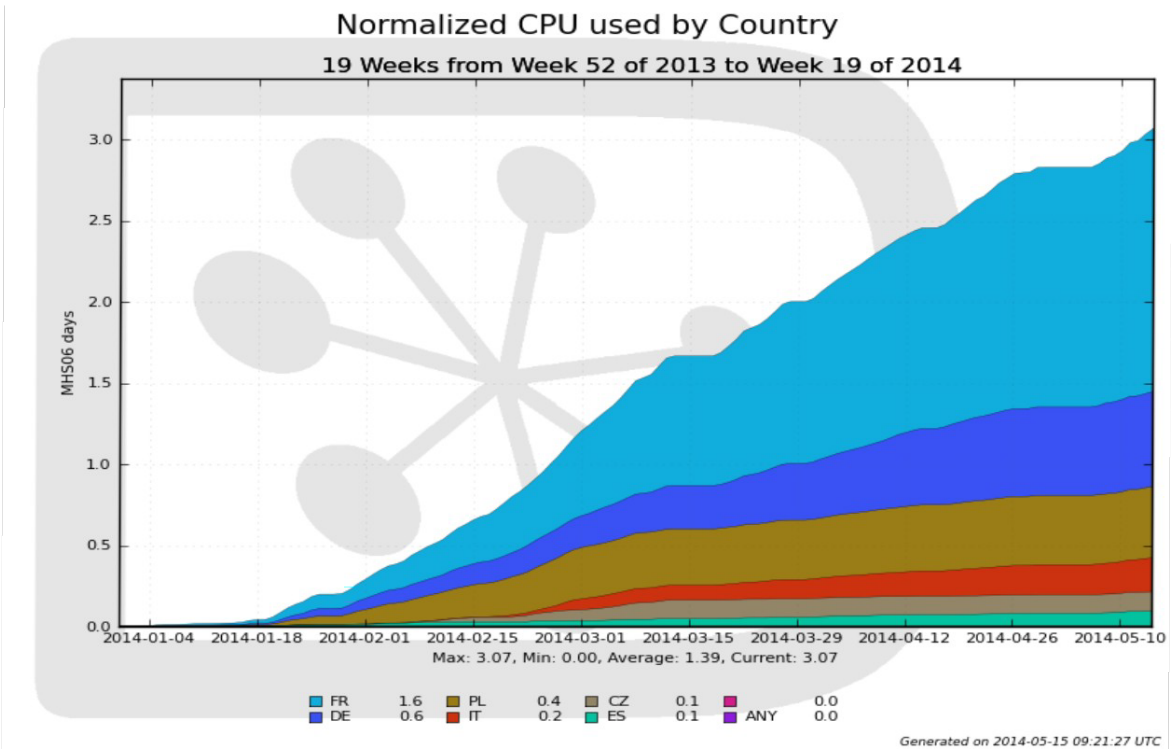
- CNAF
  - 2000 HS06
  - 30 TB disk space
  - 120 TB on tape
- Torino Tier2
  - ~380 HS06

Usage @ CNAF


Normalized CPU usage by Site
19 Weeks from Week 52 of 2013 to Week 19 of 2014
HS06
12,000
10,000
8,000
6,000
4,000
2,000
0
2014-01-04
2014-01-18
2014-02-01
2014-02-15
2014-03-01
2014-03-15
2014-03-29
2014-04-12
2014-04-26
2014-05-10
Max: 11,726, Average: 1,131, Current: 180
LCG.CNAF.it 100.0%
Generated on 2014-05-14 13:13:43 UTC


Cumulative Used disk space by Site
19 Weeks from Week 52 of 2013 to Week 19 of 2014
TB
250
200
150
100
50
0
2014-01-04
2014-01-18
2014-02-01
2014-02-15
2014-03-01
2014-03-15
2014-03-29
2014-04-12
2014-04-26
2014-05-10
Max: 236, Average: 83.2, Current: 236
LCG.CNAF.it 236.3
Generated on 2014-05-14 13:12:07 UTC

CPU contribution by Country



Main Contributors

Site	Disk Space [TB]	CPU [MHS06 h]
CYFRONET	448	20(2013)
DESY	336	36.8
IN2P3-CC	80	27
LAPP	60	8
GRIF	50	6
CNAF	30	17.5

Conclusions

- CTA Data Model still under study (distributed computing model has been also considered)
- Pipelines for Data and MC processing are under optimization
- Data Volumes under studies considering different scenarios
- Under test different solutions for databases to allow access to a huge amount of data to a large number of user

Conclusions

- INFN is supporting CTA activities since Jan 2014
  - 4th country in terms of cpu and 6th country in terms of disk space
  - CNAF main site involved (2000 HS06)
- INFN contribution will increase in the next years to support CTA computing activities and in particular the INFN studies of SST/LST layout optimization
  - 1500 HS06 and 50 TB of disk space will be required for 2015 to reach 3500 HS06 and 80 TB