Extending the *Fermi*-LAT Dataprocessing Pipeline to the Grid

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Summary: We discuss the *Fermi*-LAT Pipeline and its potential extension to the use of Grid services.

Abridged Abstract: The Data Handling Pipeline ("Pipeline") has been developed for the Fermi Gamma-Ray Space Telescope (Fermi) Large Area Telescope (LAT) which launched in June 2008. Since then it has been in use to completely automate the production of data quality monitoring quantities, reconstruction and routine analysis of all data received from the satellite.
In addition it receives heavy use in performing production Monte Carlo tasks. In daily use it receives a new data download every 3 hours and launches about 2000 jobs to process each download, typically completing the processing of the data before the next download arrives.
We evaluate a separate interface to the Dirac system in order to communicate with EGI sites to utilize Grid resources, using dedicated Grid optimized systems rather than developing our own.

The *Fermi*-LAT Mission

- High-energy gamma-ray observatory
- energy range: **20 MeV - > 300 GeV**
- Pair conversion telescope
- very large field-of-view **(~2.4 sr)**
- designed for **10 years of lifetime** (launched June 2008) [1]
- Continuous all-sky survey with Complete sky coverage every 3 hours (2 orbits)
- Data **public** (more details see QR)
- In addition release of catalogs, diffuse models

Figure 1: ***The LAT on-board the Fermi satellite (concept drawing)***

Computing Requirements

- **Time-critical** setup (data is released as soon as it is processed)
- Event **reconstruction rate 4 Hz**, downlink **rate 500 Hz** need **125** computing cpus, peak **800 cores per downlink**
- complex **generic graphs of processes** to be processed [2]
- Raw data (**15 GB/ day**) reconstructed equals some **750 GB** (processing, database storage, **~200 MB delivered to public**)
- Peak usage **45.000 jobs per day** (job = stream in the Pipeline language, complete procedure of batch jobs and scriptlets) [3]
- In addition use Pipeline for **Monte Carlo and scientific analysis** jobs (e.g. GRB blind search)

Pipeline Components, Existing Grid Infrastructure and Challenges with generic Interfaces

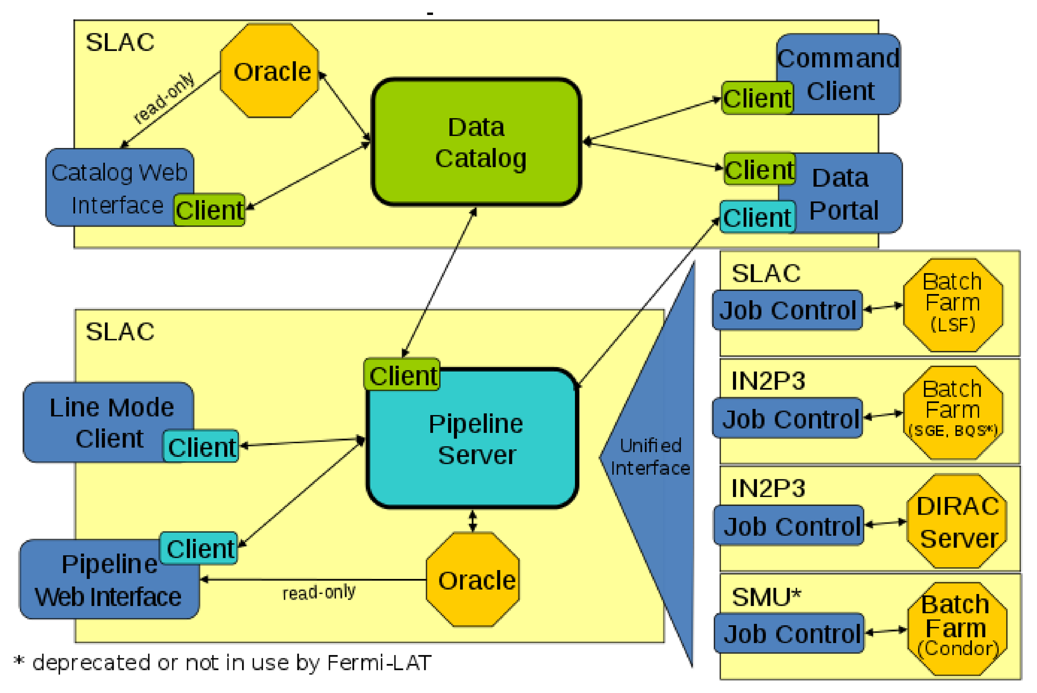


Figure 2: ***Pipeline and Data Catalog Implementation***

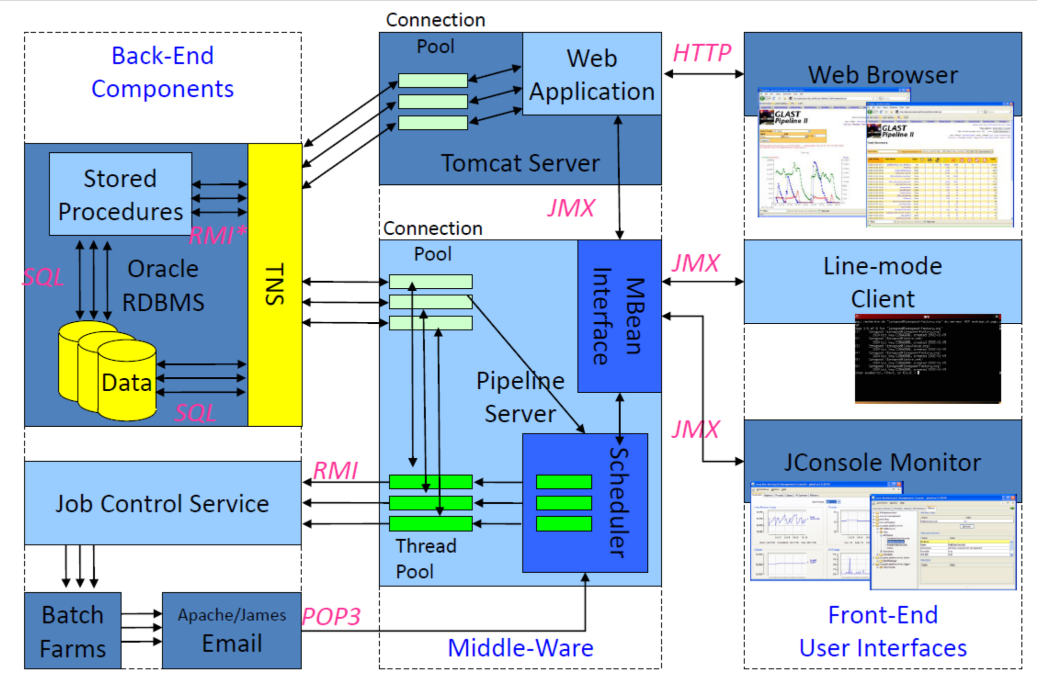
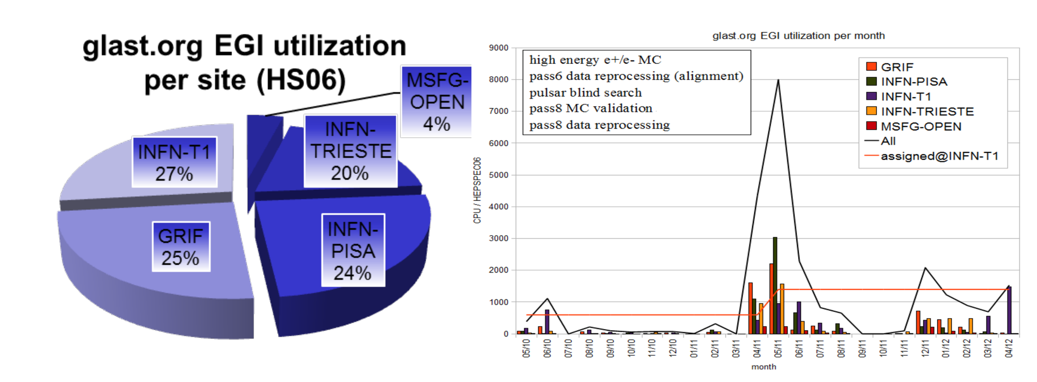


Figure 3: ***Schematic view of Pipeline Components and Key Technologies***



Site	Place	CPU	Reserved	disk / TB	Fermi SW installed
INFN-PISA	INFN Pisa	3238	87	2	y
TRIESTE	INFN Trieste	2243	150	1.5	y
INFN-T1	CNAF/Bologna	8482	175	60	y
GRIF	LAL/POL Paris	3204	(200)		y
MSFG-OPEN	Montpellier	200	(<=100)		y
PERUGIA	INFN Perugia	166	2 + 24(*2)		y
INFN-NAPOLI-PAMELA	INFN Napoli	184	?		y
SNS-PISA	SNS Pisa	632	(30)		n, down till July
OBSPM	Paris Meudon	112	?		n, configuration issue

Figure 4: ***Some usage statistics of the VO glast.org***

Main Challenges

- direct **Email sending** from worker nodes **not possible**
- Grid **certificates** are **personal** (vs. Generic user ID for Pipeline tasks)
- Data **transfer back to SLAC** and connection to data catalog problematic

Integrating with DIRAC

- Independence from **Grid middleware** (handled by DIRAC)
- Re-use code as much as possible
- Grid **inefficiencies specifically targeted by DIRAC** (maximize science output)
- additional **functionality** from DIRAC development efforts

The VO glast.org

- **glite middleware**, sites enabled in France & Italy
- allocation: 400 cpus (1000 possible)
- ~60 TB of storage
- Only some sites run Fermi SW
- heavy **use for pulsar blind search, simulations outside of Pipeline**

DIRAC @ Pipeline II

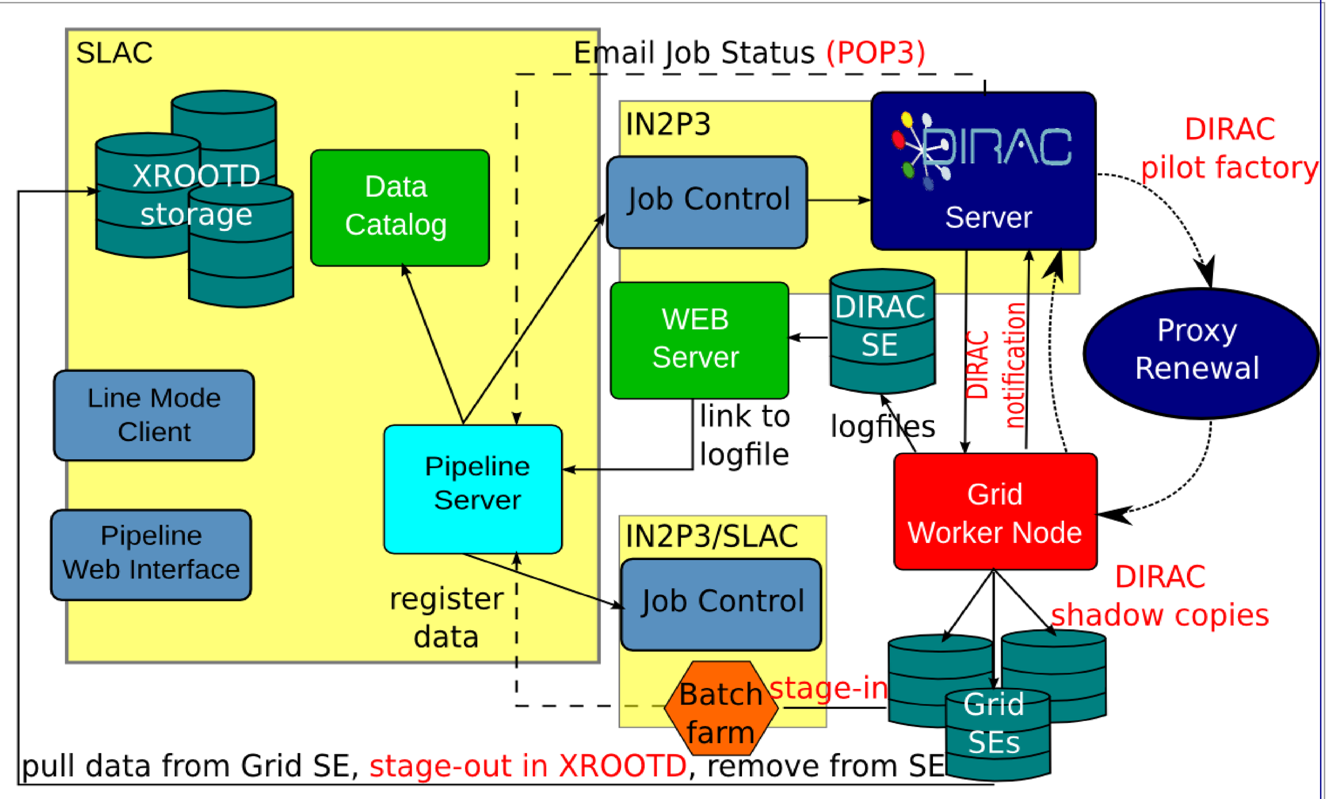


Figure 5: ***DIRAC Pipeline Integration***

- DIRAC (Distributed Infrastructure with Remote Agent Control) project [4] forms **additional layer** between any particular community and various computing resources
- Pilot factory used as technology to **automatically renew proxies**
  - closed connection, **not accessible** from outside
  - enables use of **generic grid certificate**
- Re-use **stage-in/stage-out functionality** from Pipeline and extend to support DIRAC data catalog queries (handled by DIRAC server)
- Emails **re-routed to DIRAC server** and relayed to Pipeline Server
- Increase reliability through integrated shadow copies
  - Data **remains on Grid SEs** until **successful transfer to central SLAC XROOTD** storage
  - Additional **copies of data** on available SEs
- Additional monitoring tools through DIRAC
  - provides more detailed monitoring (**major/minor job statuses**)
  - Read-only design to **not interfere** with Pipeline Server controls
- Log files stored on dedicated DIRAC SE
  - No **journaling allows fast access** to small files
  - storage element **locally situated** at Lyon computing site (IN2P3), **accessible through web interface**
  - Pipeline server connects to web server to access log files (remain on DIRAC SE)

Conclusions

- existing computing resources by VO suggest use for Pipeline purposes, in particular Monte Carlo simulations
- establish a new Job Control Daemon that communicates with a **multiVO DIRAC server** located at IN2P3, Lyon (France).
- use the **pilot-factory functionality** in DIRAC **to renew Grid certificates automatically** and the **DIRAC notification** system to handle **Email services** with Pipeline server
- re-route all products to IN2P3 that is already integrated in the Pipeline system and **use existing technologies to connect the Pipeline to DIRAC services**
- leave **meta-data** management to the **existing Pipeline** services
- Services can be extended to other tasks (e.g. reprocessing of data to account for changes in reconstruction tools)

References & Acknowledgments

[1] Atwood et al. ApJ 697, 2009
[2] Flath et al. XVII ADASS 2008
[3] Dubois, XVII ADASS 2008
[4] A. Tsaregorodtsev et al. CHEP 2007

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