Demonstrating the practical advantages of the scalable and interoperable astronomical framework FASE

Applications to EUCLID simulations and LUCIFER data reduction

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Abstract

The European OPTICON Networks 3.6 and 9.2 in collaboration with the Virtual Observatory, during the last years have produced a detailed documentation designing the requirements and the architecture of a future scalable and interoperable desktop framework for the astronomical software (FASE). A first reference implementation of FASE framework has been developed at INAF-IASF Milano and applied to different projects we are involved in: a) the simulation software developed to study the performance of EUCLID NISP instrument; b) the LBT LUCIFER instrument reduction pipeline used by the Italian community. An application involving graphical capabilities is also being developed exploiting FASE facilities. We show how the main architectural concepts of FASE framework have been successfully applied to the software mentioned above, providing easy to use and install interoperable software, equipped with distributed and scalable capabilities. See also talk by P. Grosbøl: *A Future Astronomical Software Environment (FASE)*.

The Future Astronomical Software Environment

OPTICON Networks 3.6 and 9.2 in collaboration with NRAO/USVAO have defined the high level requirements and the main architectural concepts (see Figure A) of a common desktop framework for astronomical software named Future Astronomical Software Environment. FASE main objectives are:

- integration of legacy software within a modern framework that allows to extend their functionality to new technologies like Virtual Observatory, GRID and High Performance Computing;
- provide support to the distribution and facilitate the development of new interoperable and scalable software.

A white paper describing the framework have been produced and distributed along with the other documents through the project Twiki site [1]. This work has been carried on thanks to specific EU FP6 and FP7 funding obtained by OPTICON with the purpose of design and then demonstrate the concepts outlined. One practical implementation has been developed at INAF-IASF Milano in collaboration with LAM, starting from from a prototyping work carried on along several years and bringing to the present release (v. 0.5.1) distributed at:
http://faserepo.iasf-milano.inaf.it/fase/

See also talk by P. Grosbøl: *A Future Astronomical Software Environment (FASE)*.

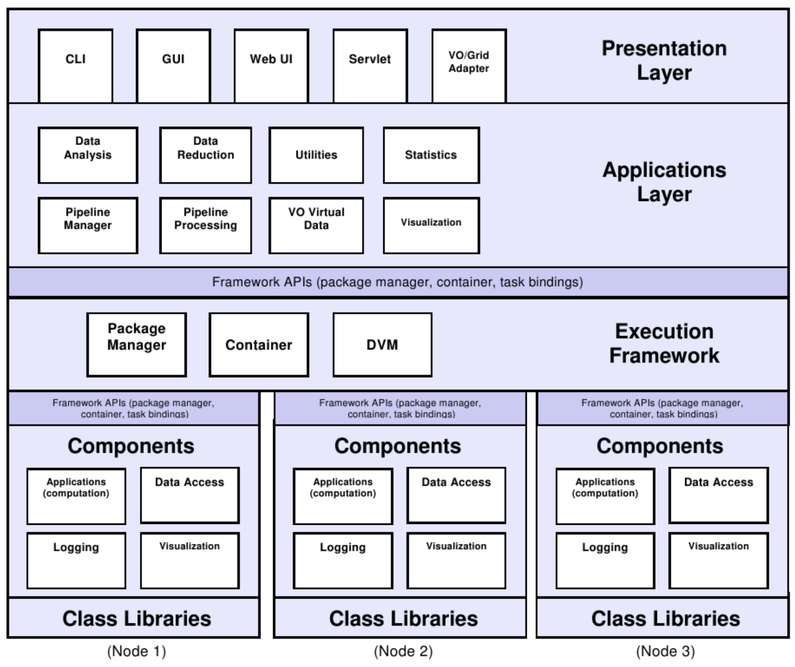

Figure A. The modular architecture of FASE. It can be presented schematically with four layers:
- the presentation layer (what the user sees)
- the application layer (the high level applications code)
- the execution framework (the distributed virtual machine)
- at the final endpoint, the computational components which live within their containers

FASE Reference Implementation

Since the beginning of FASE project, a prototyping work started with a joined effort between INAF-IASF Milano and LAM. The present implementation (v.0.5.1) [2] is the result of such prototyping work, and it provides:

(a) a basic packaging system including a Packaging Wizard;
(b) a package manager and a package installer tool (based on *pip* tool);
(c) an on-line FASE compliant packages repository (based on *Chishop*);
(d) the complete API implemented in Python;
(e) a partial API implementation in ANSI-C which allows to write task components;
(f) a tutorial and examples of FASE compliant packages and applications.

This implementation has concretely demonstrated FASE architecture and the benefits of using this kind of framework in software development, thanks to the working examples provided through FASE Package Repository site [2]. For this reason it has been selected as platform for two relevant software projects:

- ***IModel***: EUCLID-NISP end-to-end simulation software
- ***LReducer***: LBT-LUCIFER instrument data reduction software

LBT LUCIFER Reduction Pipeline

LUCIFER instrument [6] is a NIR spectrograph installed on the Large Binocular Telescope of Arizona. INAF is an active member of LBT Consortium, and in 2009 established at IASF Milano an LBT spectroscopic data reduction service for the Italian guaranteed time [7]. In order to simplify LBT LUCIFER reduction pipeline development, execution and installation, INAF-IASF Milano team has chosen FASE as underlying framework. In this way, it has been possible to:

- separate the generic purpose libraries (Spectra and Images I/O) from the specific LUCIFER reduction libraries and tasks, packaging them apart and allowing to easily resolve their dependencies through FASE package management system;
- manage the pipeline configuration parameters without writing a single line of extra-code, but relying on FASE parameter set handling mechanism;
- easily interact at coding level with DS9 tool (used to perform some visual parameters adjustment), exploiting the internal IVOA SAMP messaging capability offered by DS9 and its FASE compliant binding available at the FASE Package Repository [3];
- automatically store the logging messages in a database for future inquiries.

So far LUCIFER reduction service has successfully reduced all raw data of the observations performed for the Italian community, and delivered the reduced data products to the owners.

[1] https://www.eso.org/wiki/bin/view/Opticon/WebHome
[2] http://faserepo.iasf-milano.inaf.it/fase/
[3] http://faserepo.iasf-milano.inaf.it/
[4] Laureijs et al. 2011, arXiv:1110.3193v1 [astro-ph.CO]
[5] http://www.cineca.it
[6] http://www.astro.rub.de/LuciferHome/
[7] http://lbt-spectro.iasf-milano.inaf.it/
[8] Garilli et al. 2010, PASP, Volume 122, issue 893, pp.827-838
[9] http://vipers.inaf.it

EUCLID NISP End-to-end simulation software

EUCLID is a Medium Class mission of the ESA Cosmic Vision 2015-2025 programme. The objective of EUCLID surveys is to show how cosmic acceleration affects the expansion history and the 3D distribution of matter in the Universe. This will be done measuring the shapes of more than a billion galaxies and spectroscopic redshifts of tens of millions galaxies.
EUCLID Phase A study has led to a mission design concept supporting the requirements imposed by the need of high visible image quality, near-infrared imaging photometry and slitless spectroscopy over a very large sky area.
The performances attainable with the NISP spectrograph have been evaluated through end-to-end simulations [4] using the *IModel* software developed at INAF-IASF Milano. *IModel*, starting from a suitable objects catalog and from the spectrograph instrument model, creates the simulated frame as it will be observed by the instrument, then extracts the spectra and measures their redshifts. These operations are performed for several pointings and dithers, leading to a huge number of repetitive computational tasks. For this reason *IModel* has been developed exploiting FASE framework and its scalable capabilities: each single *IModel* computational component has been interfaced to the framework implementing a FASE *Task interface*, allowing to launch them locally as normal functions called by a single process, or on distributed clusters as "embarrassingly" parallel processes. In the following we report a description of the systems where *IModel* tasks run exploiting FASE scalable capabilities:

- A local desktop machine for development and debugging (single local process)
- A small testing Beowulf cluster hosted at INAF-IASF Milano (Torque+Maui)
  - 10 parallel processes
- A big IBM AIX 6 cluster hosted at CINECA [5] (Load Leveler)
  - Frames simulations: 100 parallel processes
  - Spectra reduction: 25 parallel processes
  - Redshift measure: 10 parallel process

Spectra Analysis Tool

Along with *iModel* and *LUCIFER pipeline*, INAF-IASF Milano is developing the new generation of EZ software [8], a spectral analysis and redshift measure graphical tool. The main purpose of this new tool is to help the analysis work carried on by the astronomers involved in VIPERS survey [9]. This new tool has been developed using FASE as software framework as well, exploiting:

- the well define packaging system and package manager, which allows to easily resolve and install all the application dependencies in an automatic way;
- the ready to use parameters set handling mechanism, adopted to get/set the user preferences overwriting the default values at will;
- the possibility of interfacing the graphical tool with others IVOA SAMP messaging system compliant applications.

For the time being, the distribution of this new analysis tool is limited only to INAF-IASF Milano partners involved in VIPERS project. However it is ready for the broad distribution through FASE Package Repository [3], but its future will depend on the availability of funding for the software maintenance.