Grid technologies applied to instrument processors and image analysis

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We have analyzed the feasibility of implementing Grid technologies in the instrument processing and quick look image analysis systems of a Science Operations Control Center based on the standard ESA SCOS-2000 infrastructure. Several advantages and disadvantages are found, depending on the processing levels and required user feedback in the image inspection. But in general, it is expected that existing Grid technologies usage is compatible with standard SOC architectures and generic processing tools. The XMM-Newton Science Control System (XSCS) is used as working example.

INTRODUCTION

As the complexity of astronomical missions increase, the number of involved organizations and countries increase as well. These missions are based on a continuous and interlaced flow of data among several science centers and institutions. The Mission Operations Center (MOC) is mainly in charge of the s/c control operations and the Science Operations Center (SOC), mainly in charge of supporting the scientific instrument (and perhaps data) operations, including instrument dedicated processors (XSCS PMS) and quick look analysis systems (XSCS QLA)

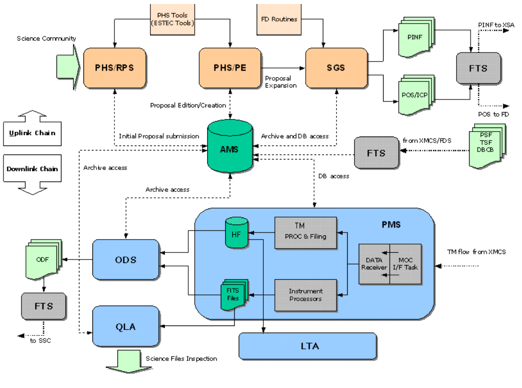

Fig1: The data flow in the XSCS (XMM-Newton Science Control System)

GRID TECHNOLOGIES IN THE DOWNSTREAM FLOW

XMM-Newton processing systems proved to be quite intensive demanding, both in terms of CPU and disk access, tasks. In fact, the TM processing and FITS creation were initial bottlenecks in the early XSCS.

With the migration of the SOC towards a distributed infrastructure based on ESA SCOS-2000 kernel, CORBA-based, XSCS incorporated the possibility of having a distributed processing architecture, sharing the TM processing among several clients.

This sharing approach can be further extended by using Grid computing techniques.

Grid technologies are ideal for high-throughput demanding applications. They are now mature enough to be used in the TM processing flow of a Science Control Center. Grid existing interfaces [1], both at low level (i.e. C interfaces) and high level (I.e. shell-like commands) already provide the required services, taking advantage of distributed environments.

Fig2: The XSCS QLA in charge of performing fast Quick Analysis

INSTRUMENT PROCESSING (PMS, ODS)

In addition to the already existing distributed processing capabilities of SCOS-2000, we are interested in adding grid capabilities to the high-demanding TM instrument processors FITS creation tasks.

The Instrument processors can be modified to receive the corresponding TM data and to process it independently of the physical location of the client, in a per-instrument basis. Due to (near) real–time issues, the usage of Grid services through the C interface is required, as well as additional buffering systems, in charge of avoiding flow bottlenecks in the highly critical TM monitoring tasks.

Available bandwidth across the net is a major issue. But by filtering the instrument required data, near real time processing is possible by embedding the interface in the distribution task (as proved by the XRTMS SCOSI project). In that way, the CPU and the disk demands are more easily handled along the whole XSCS.

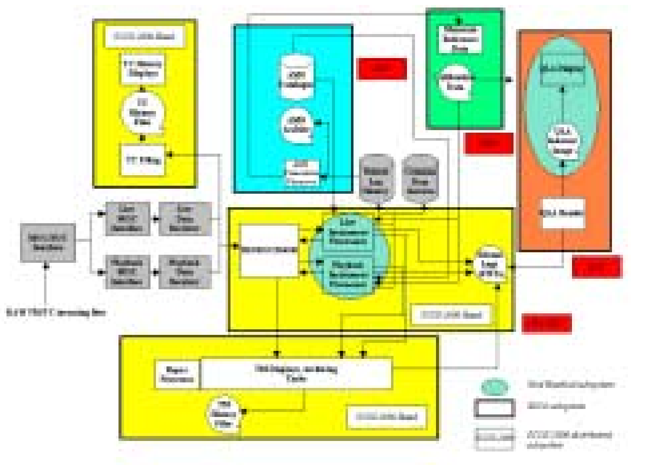

Fig3: The XSCS downlink flow, and the distributed/Grid-enabled systems

QUICK LOOK ANALYSIS (QLA)

Quick Look analysis systems require fast (sometimes interactive) astronomical processing capabilities based in the first level processing and handshake with the PMS FITS creation. By other hand, they are usually not real time critical systems.

The XSCS QLA is already built with a wrapper of scripting languages, in order to use existing astronomical libraries. Such architecture is ideal for including Grid-enabled interfaces based on shell scripts, without deep changes to the critical PMS interface.

CONCLUSIONS

In a distributed operations mission, each processing step may be located in a different physical location of the same virtual organization. Negative and positive issues are to be faced [2],

- Negative: tough problems in Mission definition (political, infrastructure, ...), in software development and in conducting the operations themselves.

- Positive: a distributed and Grid-enabled SOC enhance the flexibility of the mission and allow to gain expertise to a wider community, both the usage and operation, balancing as well the high-throughput demanding tasks among the whole net of processing nodes.

In the XSCS example, the affected tasks are those regarding the TM and FITS file creation (PMS,ODS subsystems) and in the Quick Look Analysis subsystems (performing basic astronomical analysis). Such activities can be extended to other S2K based control centers [3] as they share the XSCS functional commonalities.

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