MS³: a Solution for Satellite Remote Sensing Ground Stations

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Introduction

The objective of this work is to present the system developed to record, process and distribute satellite images of interest to the Brazilian Government. The requirements for the Multi-Satellite Station System (MS³) were created taking into account the 30 years of Brazil's National Institute for Space Research (INPE) experience in receiving and processing data from Earth Resources Satellites. Brazil needed a system that could not only handle its new series of CBERS satellites, a partnership with China, but that would also enable the creation of digital products from its extensive historical archive.

Features

Multi-Satellite support, with easy integration of new instruments;
Low-cost, PC hardware architecture;
Based on **open source** software;
Scalable.

System Architecture

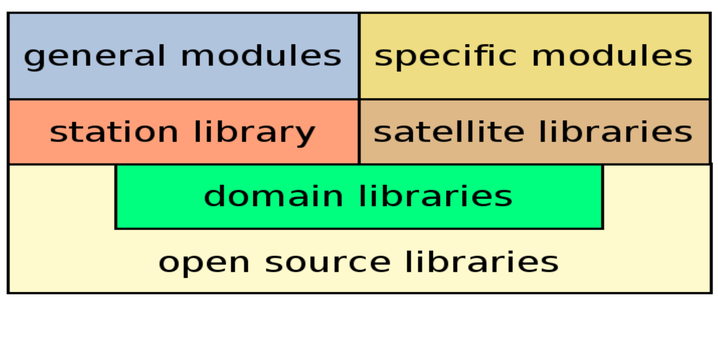
As one of the most important objectives of the project is the reduction of software and hardware costs, the **GNU/Linux** operating system was chosen as the platform to be used. Time-critical processes are developed in **C++**, non time-critical processes in **Python**. For the product distribution that is done using the internet, the **PHP** language was chosen.

Among the **open source libraries** used we have: **tiff, geotiff, jpg and HDF5**. Instead of using some of those libraries directly, we decided that a level of abstraction would be better. Those abstraction libraries are a part of our **domain libraries**.

In order to ease the addition of new satellites and instruments, a set of **interfaces** is defined to allow each sub-system to remain as stable as possible. The interfaces and other **common classes** shared by different satellites are defined in the **station library**. This library is the basis for the implementation of each satellite specific library.

Sub-system functionality is provided through **modules**. The **general modules** are unaware of the different satellite implementations of the interfaces they use, this is achieved by the **dynamic linkage** of the **specific satellite library** during runtime.

Unit and functional tests provide a safety net while adding new functionality to the system. This is a must-have for a system with **300,000** lines of code.



Software Layers

MS3 multi·satellite station system

Sub-systems

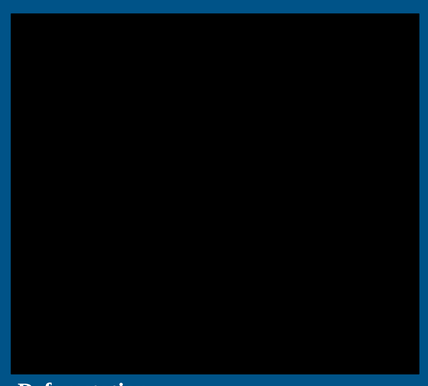
Ingestion and Data Recording
- Real-time recording,
- Real-time visualization of image data;

Catalog
- User interface used to request scenes;

Product Generation
- Level 1 - radiometric correction,
- Level 2 - system geometric correction,
- Level 3 - geometric correction using automatic control-points,
- Level 4 - orthorectification;

Evaluation & Quality Control
- Radiometric evaluation,
- Geometric evaluation,
- Possible causes for detected issues,
- Comparative scenarios analysis;

Production Management
- Task scheduling,
- Task control.



Deforestation

Fire

Results

The low-cost and scalability of the MS³ solution were important factors in Brazil's decision to release its historical archive **free-of-charge** on the internet. This decision changed the way Remote Sensing is done in Brazil, allowing any citizen to benefit from the investment done by its government.

After 3 years of CBERS-2 operations over **300,000** scenes were delivered to **15,000** institutions and **30,000** users.

Testing has been started on the use of products generated from the MODIS instrument. The speed with which INPE can produce these images is of the utmost importance for its use in two of the most important national programs that work to prevent **deforestation** (PRODES) and **fire** (DETER) on the rain forest.

Conclusion

The Multi-Satellite Station System is a work in progress and currently supports the following satellites and sensors:

LANDSAT 1-3 (MSS), LANDSAT 4-5 (MSS and TM), LANDSAT 7 (ETM+), CBERS 1 and 2 (CCD, IRMSS and WFI), AQUA (MODIS), TERRA (MODIS), RADARSAT 1 and SPOT 1-4 (HRV and HRVIR). Support for CBERS 2B (CCD, WFI and HRC) will be completed in the middle of 2007.