Space Imagery Access Portal (PHAROS) for French Forces

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ABSTRACT

CASSIDIAN, formerly EADS Defence & Security and ASTRIUM, two EADS companies, have developed the PHAROS system for the intelligence community of the French Forces. The system is operational since summer 2011.

The paper describes the PHAROS system and provides a feedback about developing a GeoSpatial Data Infrastructure in a sensitive environment with heavy ingestion load, long term data preservation and dissemination of big images using satellite communication.

Keywords: GSDI, Intelligence, Compression, Online Preview, ISO-19115

INTRODUCTION

PHAROS, in operation since summer 2011, has been developed by CASSIDIAN and ASTRIUM to provide the French Forces intelligence community with a highly secured access to space imagery. It allows to:

- order new space imagery;
- ingest these products;
- store them in a reliable and long term archive;
- search products in this archive;
- and disseminate them to the Forces inside France as well as on the theatres of operation.

PRESENTATION OF PHAROS

Missions

French forces have access to space imagery from several optical and SAR satellites:

- Helios 1 & 2 [1] (FR+IT+SP+GE+BE+GR);
- Pleiades (to be launched in 2012) (FR);
- Cosmo SkyMed (IT);
- SARLupe (GE);
- Commercial satellites;

PHAROS is the natural link between the Forces and the satellite ground segments (Figure 1). It provides the ability to:

- Order new space imagery through the same interface both in France and on the theatre;
- Capitalise space imagery production;
- Access imagery from France and from the theatre (either by network or via media dissemination).

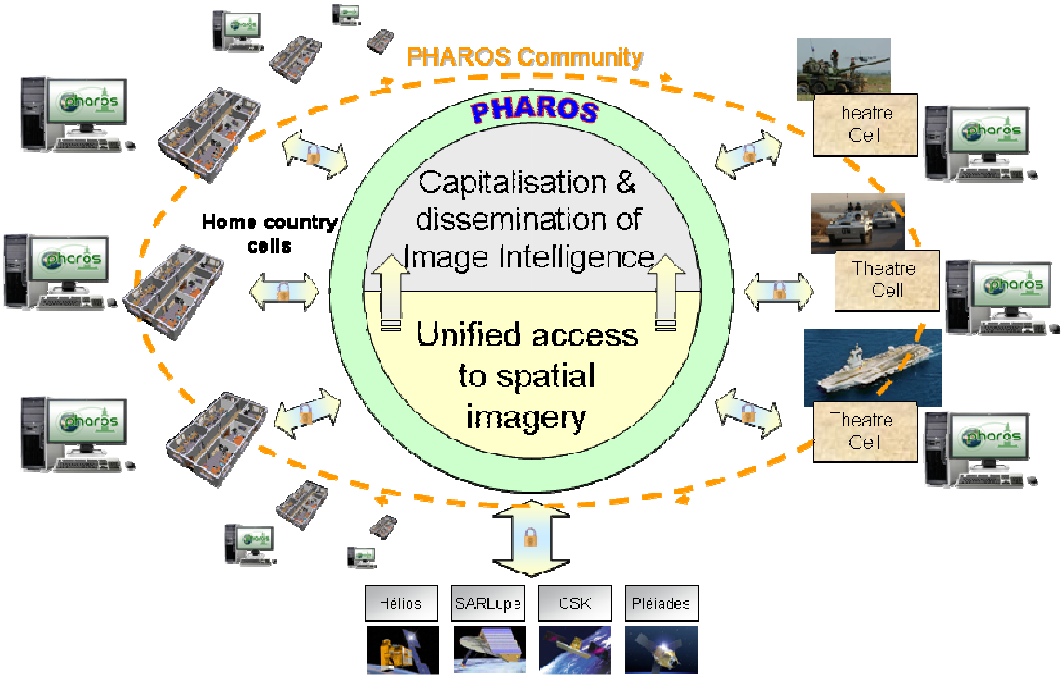

Figure 1: PHAROS missions overview

Challenges

The main challenges the design of PHAROS had to face were to:

- Operate in a highly sensitive environment: interconnection between fixed sites in France, remote projectable cells in the theatres and satellite ground segments (G/S);
- Handles highly sensitive imagery for the military intelligence community;
- Sustain heavy ingestion throughput to support the whole satellites images production;
- Provide fast access to space imagery both in France and from deployed theatres;
- Optimize network use (bandwidth, latency, reliability);
- Optimize storage costs and data access performances to answer operational needs;
- Support continuous operation over a long duration (10 years life-time system).

Architecture

PHAROS is composed of a central node and intelligence cells deployed both in homeland fixed facilities and on theatres of operations (Figure 2).

Satellite ground segments are connected to the central node through 2 ways secured interconnections. Intelligence cells in France are connected through a secured and ciphered WAN. Intelligence cells on the theatres are connected through a secured and ciphered satellite communication links.

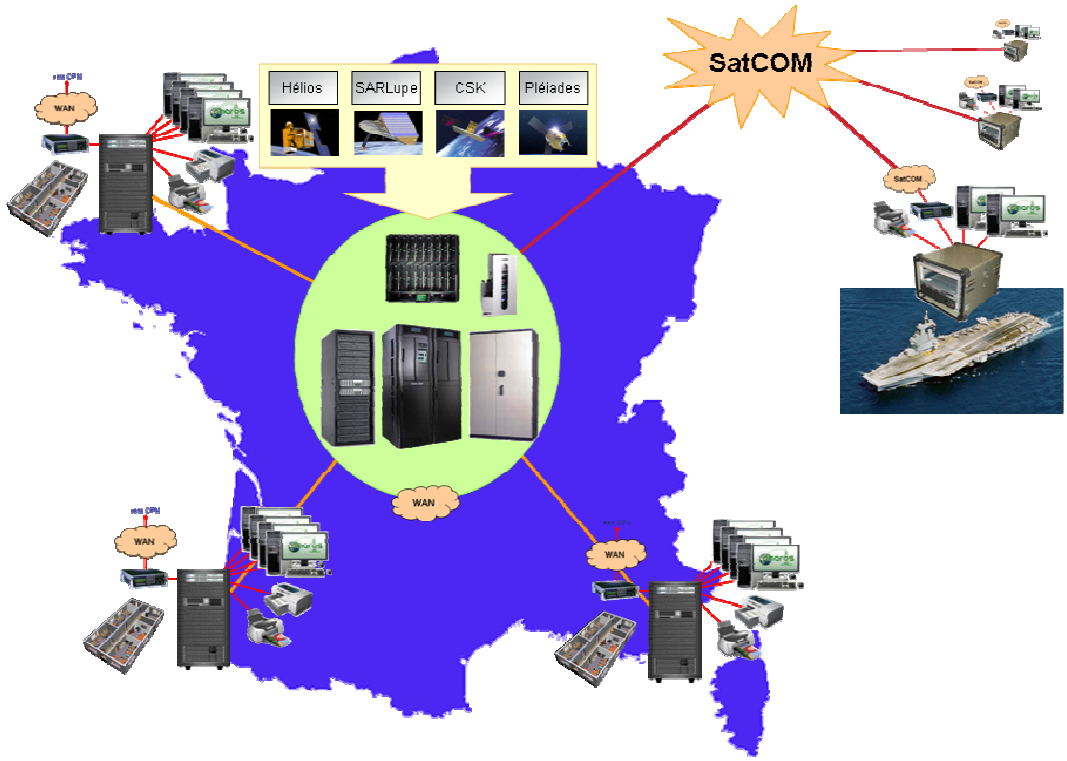

Figure 2: PHAROS architecture

The central node contains all the back office servers, the storage and archiving capabilities, and the media production device (CDROM/DVDROM).

An intelligence cell is made of a server and several diskless workstations.

The GeoSpatial Data Infrastructure software is based on CASSIDIANACTINT® Portal solution.

PRESENTATION OF THE SOLUTION

Hierarchical storage and archive

PHAROS provides several levels of storage and archiving in order to provide the best balance between the various constraints:

- Cost of ownership;
- Data preservation over a long period of time;
- Fast access to data of operational interest;
- Availability of the storage to sustain both ingestion and dissemination throughput.

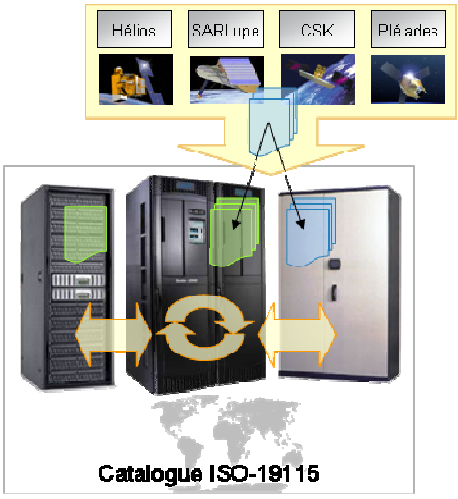

Figure 3: PHAROS storage levels

1st level: Fast access storage based on a disk array storing image products in the PHAROS optimized format. This level is man managed according to operational needs.

2nd level: Mid-term storage based on an HSM tape library. It stores image products in the PHAROS optimized format. It provides an automatically managed rolling storage capability.

3rd level: Long-term archive based on off-line tapes. It stores image products in their native input format as provided by the ground segments. It provides a virtually infinite archiving capability. Tapes are written within the HSM and removed from the HSM periodically.

Images entering the system are written both in level 2 and 3 in two different formats (PHAROS and native).

The first level supports the fast access capability. Itis fed with images of major operational interest. It contributes to availability of storage for dissemination.

The second level provides storage for both ingestion and dissemination. Image products received from G/S are written in this storage level in the PHAROS optimized format. Thanks to the HSM caching it contributes to the fast access requirement for recently used images. Thus received images can be accessed immediately for dissemination.

The third level provides data preservation over a long period of time, with a low cost of ownership. Image products received from G/S are written in this archive level in their native format.

Central catalogue & interoperability

A central catalogue references all PHAROS products in the 3 levels (Figure 3) as well as products stored in other systems (G/S for instance). One can search the catalogue and request:

- PRODUCT dissemination if in level 1 or 2;
- Product disarchiving & dissemination if in level 3;
- Product ordering & dissemination if stored in other systems.

Thus, PHAROS provides the users with a unified access to existing products wherever they are stored.

The catalogue is part an ACTINT® Portal software component. It provides a PostgreSQL database with an ISO-19115 compliant datamodel. The datamodel has been extended to adapt to the French Forces requirements. It provides catalogue interoperability allowing ingestion of catalogues from other systems (G/S for instance).

The software components and know-how from our partner GAEL Consultant are used to handle the wide heterogeneity of product and catalogue format.

User access

Users deployed on the theatre have the same access to PHAROS as those located in France.

The main user interfaces are:

- Query interface: search for products based on a set of criteria and present results (Figure 4);

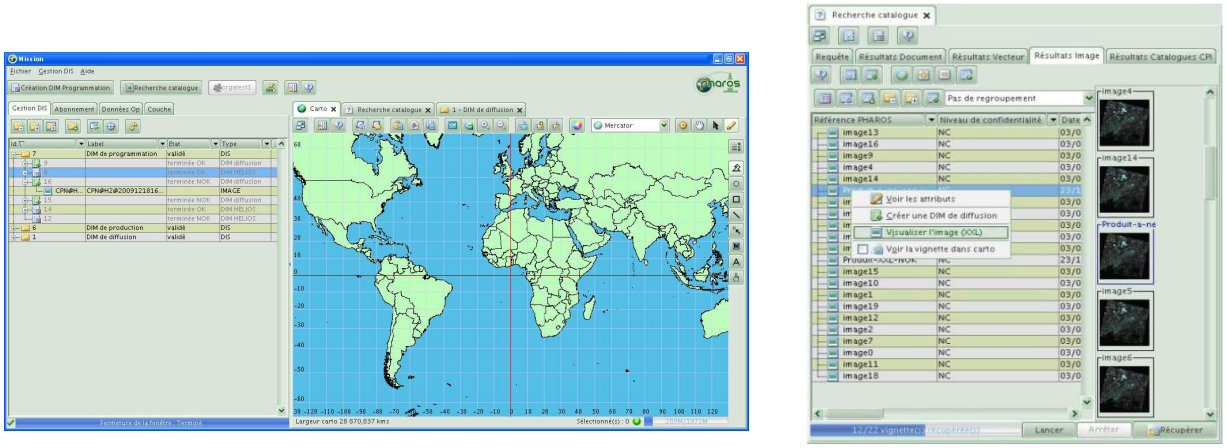

Figure 4: PHAROS query interface

- Full resolution preview of image products (Figure 5) based on the software components and know-how of our partner Spigraph. It implements:
  - Lossless JP2K compression;
  - Pyramiding & tiling;
  - Caching on client side;
  - Efficient tile download policy.

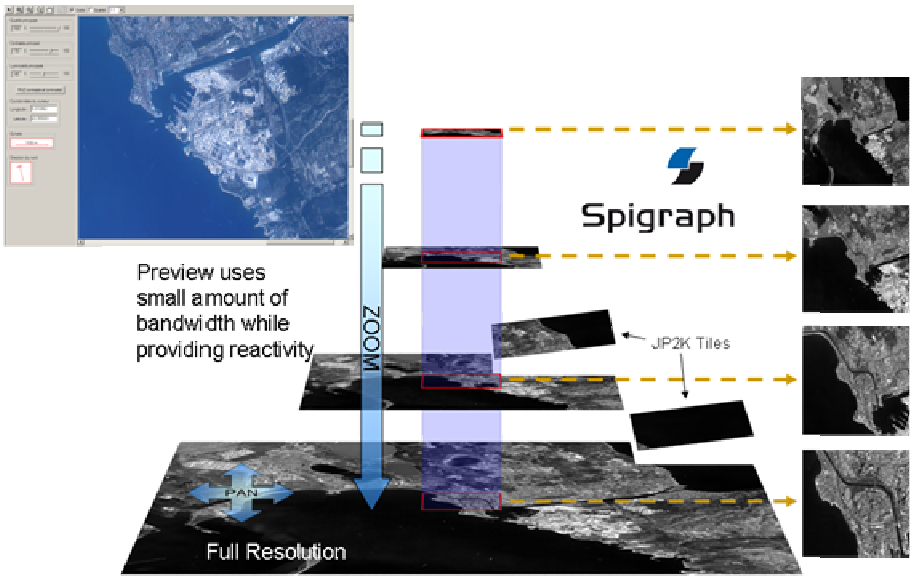

Figure 5: PHAROS full resolution preview

This feature provides a good viewing experience for satellite imagery even in case of limited bandwidth / high latency network such as SatCOM. It is very appreciated by users because they can see immediately if the image answers their needs and thus avoid an unnecessary transfer.

Advanced Compression/Dissemination

Having selected an image answering his need, the user can ask PHAROS to disseminate the product. The usual way to do so is to compress the whole image as much as possible and transfer it through a single big transfer.

This is not satisfactory from the military users because of their tight time constraints. PHAROS provides an additional degree of freedom for the dissemination since the user can select areas in the images (thanks to the full resolution preview) and select different compression levels for each area (Figure 6). Thus he can find the best balance between his needs and dissemination constraints.

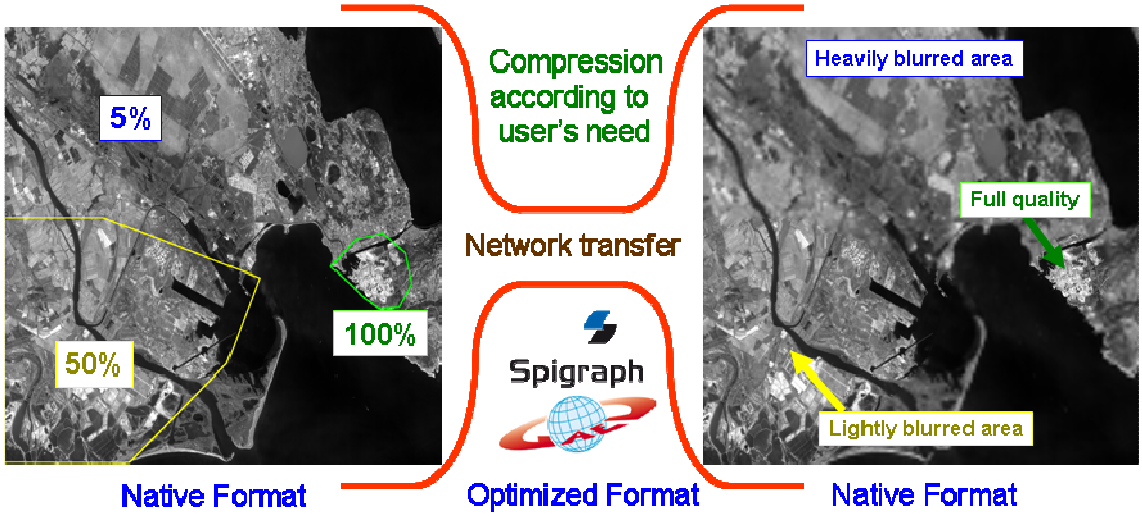

Figure 6: PHAROS adaptive compression for dissemination

This feature is implemented using a combination of techniques from CASSIDIAN, Spigraph and GAEL Consultant. The adaptive compression cuts out part of the pyramid and part of tiles (compression was performed during ingestion) so the operation is very fast. The transfer is resilient to network latency and failure. On the client side, the image is rebuilt and made available in the native format (image as it was provided to PHAROS) for exploitation on dedicated systems.

Dissemination does not need the user to be present. He can request several images, logout and come back later when the transfer is done. In addition, dissemination and preview share the same caching mechanism. Thus, what was downloaded during preview will not need to be transferred a second time for dissemination.

In case of network failure the user can get a partial product based on what was transferred before transfer interruption.

Virtualization

PHAROS strongly relies on virtualization for:

- Lifetime support: virtualization provides an abstraction layer keeping existing software compatible with future hardware.
- Providing load balancing and share the same set of hardware with different platforms;
- Servicing: Virtual Machine (VM) can be moved out of a defective server and moved back when server is fixed;
- Avoiding COTS incompatibilities (COTS sharing the same port for instance).

The virtualization solution is using VMWare ESX deployed on a rack of HP blade servers.

In addition, virtualization allowed us to have specific services and tasks on dedicated servers. For instance, VM dedicated to logging with specific access rights.

Cutting edge computer science techniques such as virtualization has been used under the heavy constraints of interconnecting several security realms with level up to Secret.

Security

PHAROS is at the very heart of French Image intelligence. Thus security is of paramount importance to prevent both intrusions and leaks. PHAROS is working at the SECRET level while being interconnected with satellite G/S and intelligence cells worldwide.

Security relies on several key points:

- Same hardened Linux version everywhere from back-office to workstation;
- Diskless workstations;
- Strong authentication for users and services;
- Use of Security-Enhanced Linux, sealing of files, anti-viruses…
- Military class ciphering for communication;
- 2 ways security gateways (EAL4+);

SYSTEM IN OPERATION

PHAROS is in operation since June 2011[2] and is used both in France and on theatre. The expected life time of the system is more than 10 years and new capabilities will be added as soon as new satellite resources are available. The Pleiades satellite ground segment will be connected to PHAROS in 2012.

As told by a French MoD representative [3]:

"Among the obvious advantages [of PHAROS], the tremendous gain of time should be highlighted since images [can] be ordered directly from the theatre and automatically sent through electronic means once they are produced."

LESSON LEARNT

Hardware deployed

HP Blade Server 460c

NetApp FAS3040

Quantum Scalar i2000 & StorNext

Linux EL RedHat 5.2

VMWare ESX 3.5

Virtualization

The impact on performances as proved to be limited.

Increased system complexity due to larger number of servers (virtual one) balanced by easier COTS integration and deployment.

Conflict between security and integration of COTS/OS

One of the key challenges of PHAROS was security. High level security requires OS hardening (remove anything that is not used, close any port not necessary, prevent writing or altering files, etc.). This has a major impact for systems relying on COTS.

As far as the OS is concerned, Linux proved to be very flexible to implement innovative security such as diskless workstations and security gateways.

JP2K Compression

PHAROS optimized format implements JP2K compression of the whole image. Compressing the production of several satellite ground segments requires a lot of CPU resources. Compression is performed when the image enters PHAROS once and for all. Dissemination does not require additional compression. JP2K compression decreases the amount of storage required despite the overhead of pyramiding. In addition, the optimized format supports full resolution preview and adaptive compression capabilities.

CONTACT & LINKS

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Christophe DEMANGE - GAEL Consultant (christophe.demange@gael.fr)

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http://www.defense.gouv.fr/dga/equipement/information-communication-espace/helios-ii/%28language%29/fre-FR#SearchText=H%C3%A9lios#xtcr=1

[2] PHAROS delivered press release: http://www.defense.gouv.fr/content/view/full/123538

[3] PHAROS presentation on DGA web site (French):

http://www.defense.gouv.fr/dga/actualite/pharos-portail-d-acces-a-l-ensemble-des-ressources-spatiales