



CENTRE NATIONAL D'ÉTUDES SPATIALES

Payload Operations Centres for missions  
devoted to Universe Sciences at CNES :

The COMS facility

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## Content

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- **Operations managed at CNES Toulouse in the field of Universe Sciences**
- **Payload Operation and Data System perimeter**
- **The COMS facility**
- **2 Payload Operation Centres : Chemcam/MSL and Philae/Rosetta**
- **Future missions**
- **Staffing**
- **Conclusion**

# Scientific Missions at CNES Toulouse

## ■ Earth, Environment and Climate

- ◆ Atmosphere
- ◆ Land surfaces
- ◆ Oceans
- ◆ Solid Earth

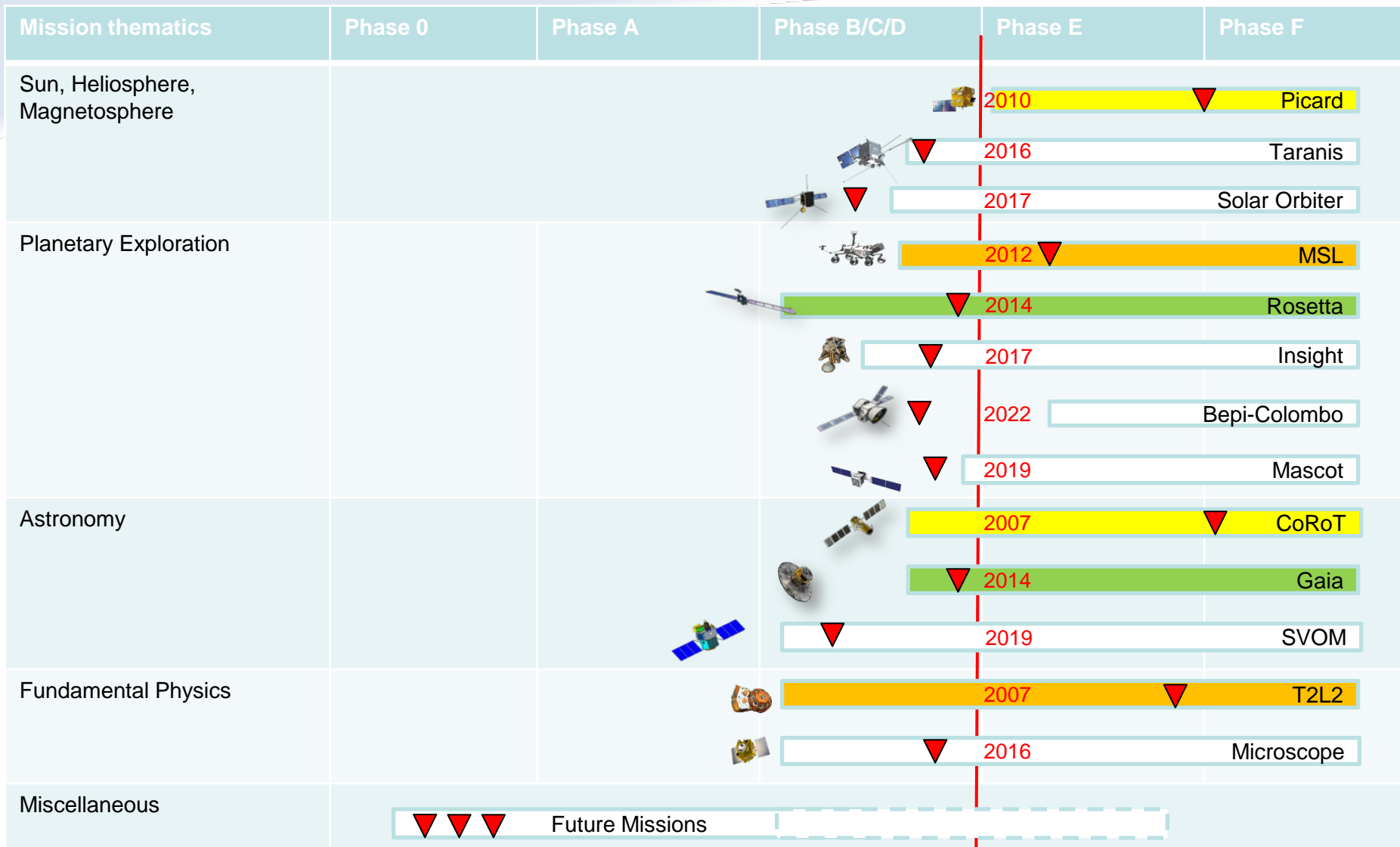
## ■ Universe Sciences

- ◆ Planetary exploration
- ◆ Astronomy
- ◆ Sun, Heliosphere, Magnetosphere
- ◆ Fundamental Physics
- ◆ Exobiology

## ■ Microgravity

- ◆ Life sciences
- ◆ Material sciences

Perimeter of the  
Universe Sciences  
Missions



Not represented: Soho, Cluster, Solar Probe+, Cassini, Mars Express, Venus Express, Maven, Stereo, Planck, Herschell, XMM, Integral, JWST, Euclid, Grace, ...

# Payload Operation and Data System

## ■ Payload Operations

- Various activities in the down- and upstream operational flow (TM, TC, data products, planning, monitoring, ...)
- Needed whatever the mission
- Variable complexity

## ■ Instrument Expertise

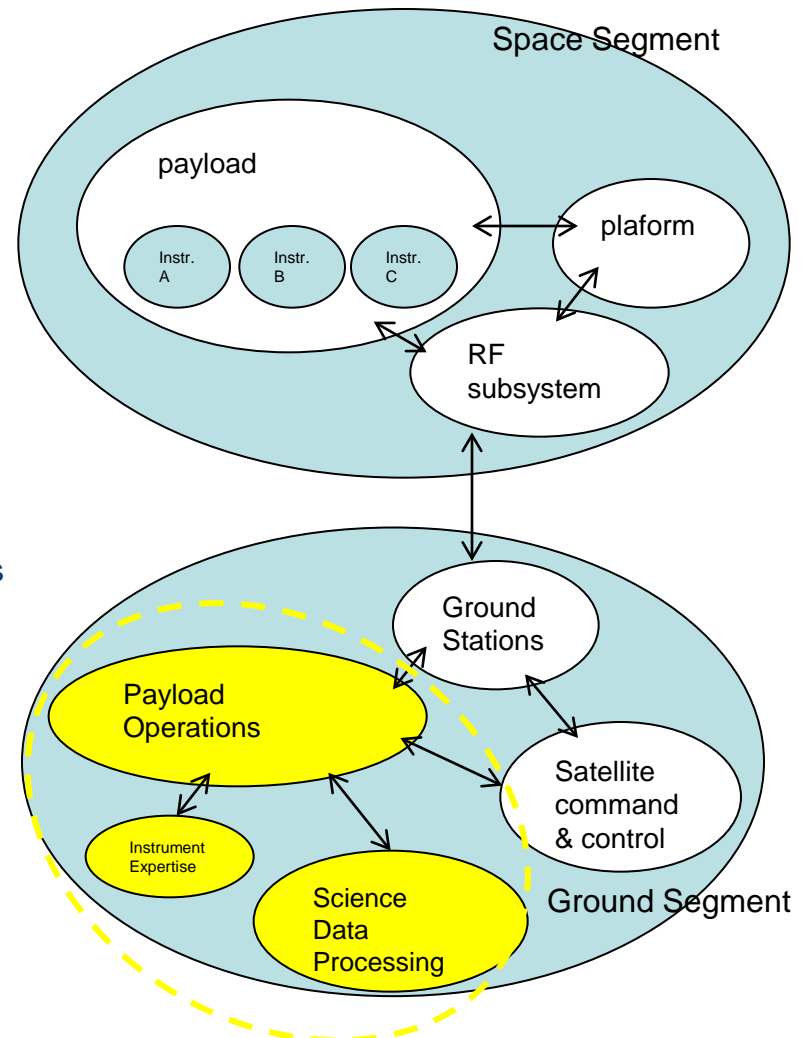
- Operations devoted to one instrument (faults analysis and recovery, performance and trend analysis, data calibration & validation)
- Fitted to the instrument activity

## ■ Data Processing

- Reduced data processing : L1 to L3 science data products
- Not in real time but with regular data flow

## ■ Payload Operation Center

- Its perimeter depends on the responsibility sharing inside the project (International/National, location of the spacecraft Mission an Control centres)
- The 3 activities may be integrated in the POC or breakdown in different centres (including PIs labs, ...)



Mission thematics	Control Centre	Payload Operation	Instrument Operation	Expertise	Data Processing	Data dissemination
Sun, Heliosphere, Magnetosphere		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span> Picard	For all missions : - long term preservation - Transfer to Thematics data centers
		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span> Demeter	
		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span> Taranis	
		<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span> Solar Orbiter	
Planetary Exploration		<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span> MSL	
		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span> Rosetta/Philae	
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Astronomy		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span> Corot	
		<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span> Gaia	
		<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span> SVOM	
Fundamental Physics		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span> T2L2	
		<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFD700;"> </span>	<span style="background-color: #FFFFFF;"> </span>	<span style="background-color: #FFFFFF;"> </span> Microscope	

Despite this large variety, we try to keep a common approach in designing and operating the various MOC

# Payload Operation Centre (POC) – Common approach

**Payload Operation Centre** : offers the capability of various operations on payload and on scientific data

**Virtual link between**

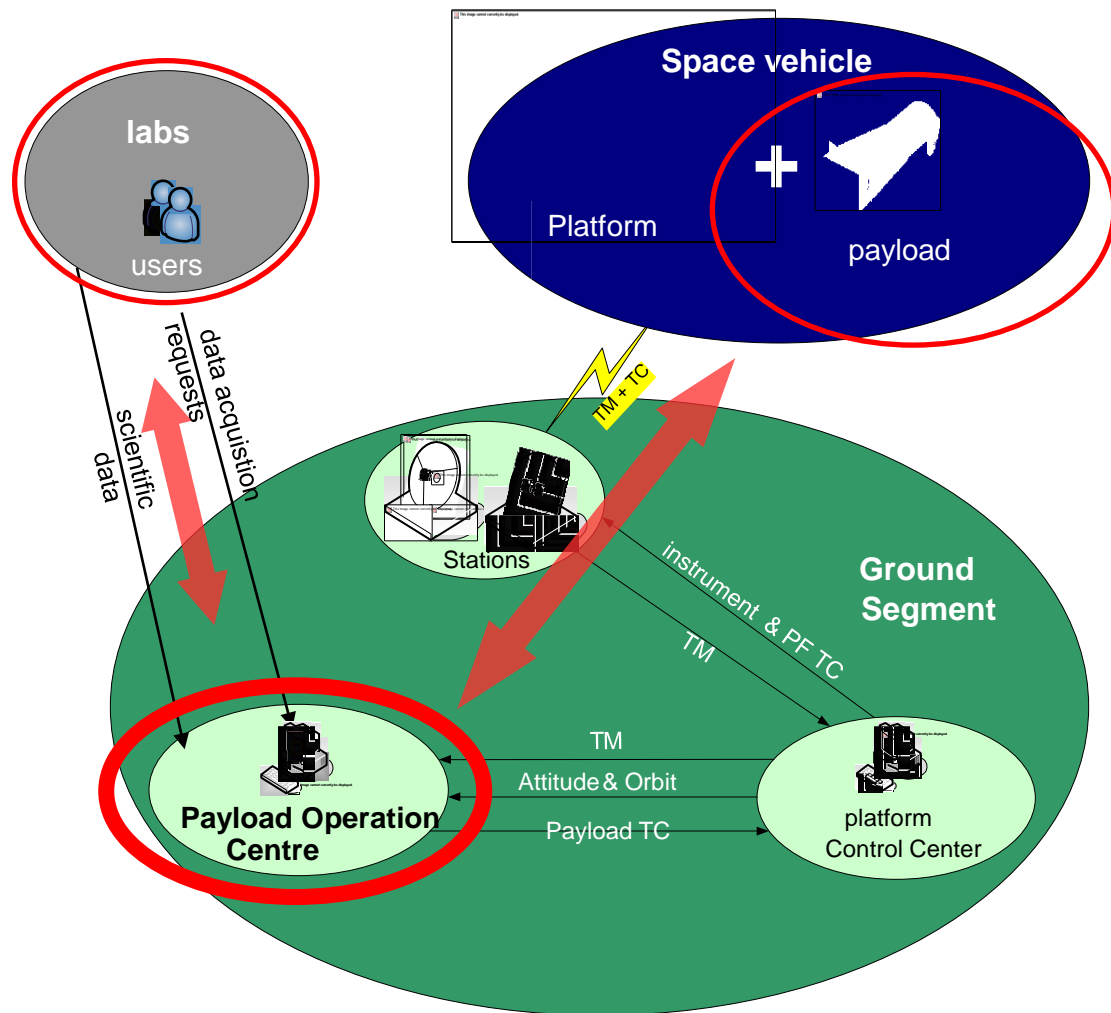
- The Science team (PIs & co-Is) &
- Their Scientific instruments

**Unloads laboratories from**

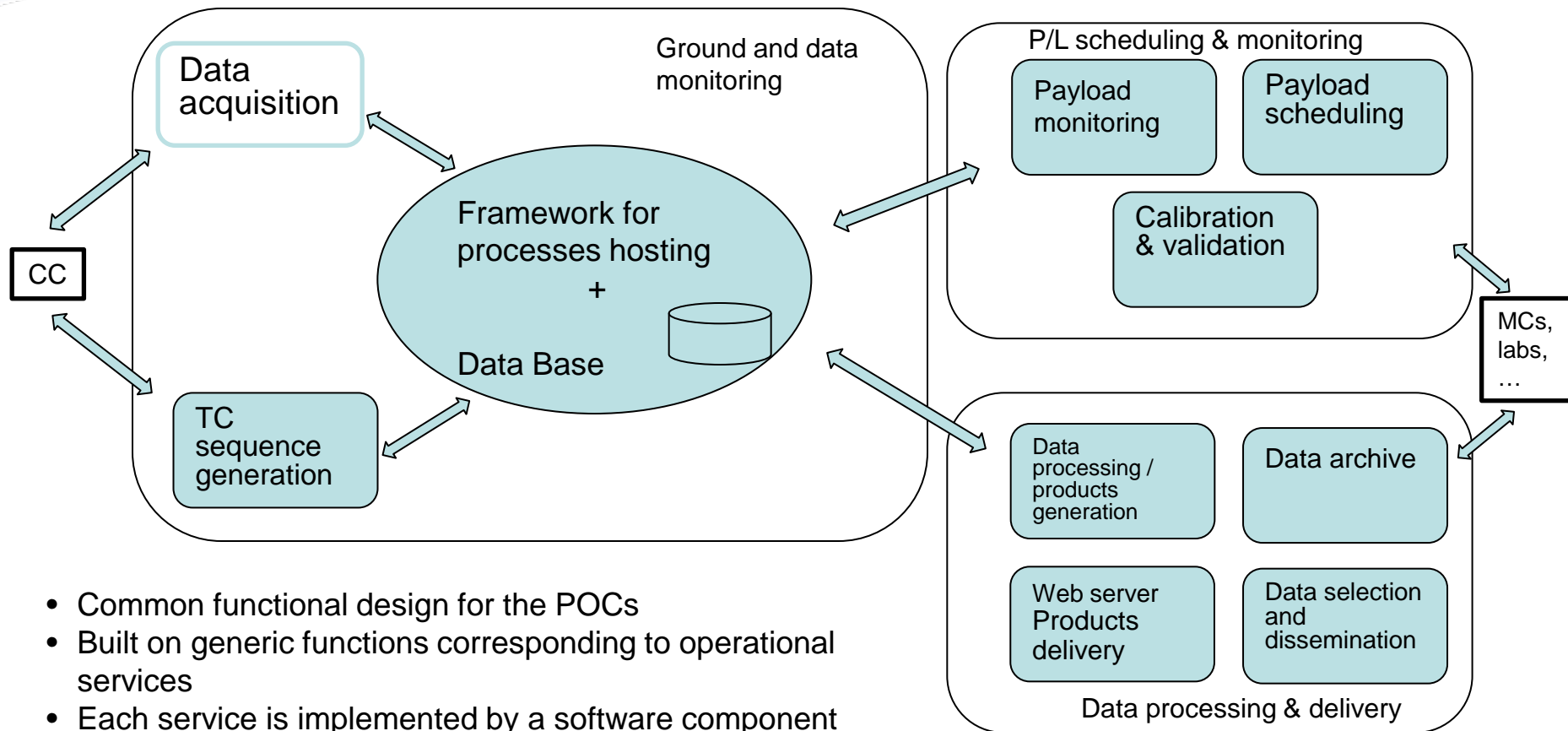
- monitoring operations
- Routine activities

**Basic operational services are ;**

- Payload planning and programming
- Payload HKTM monitoring
- Ground processes scheduling
- Instrument data calibration
- Data processing : science products generation
- Stacking
- Data publishing and promotion



# POC – General Functional Scheme

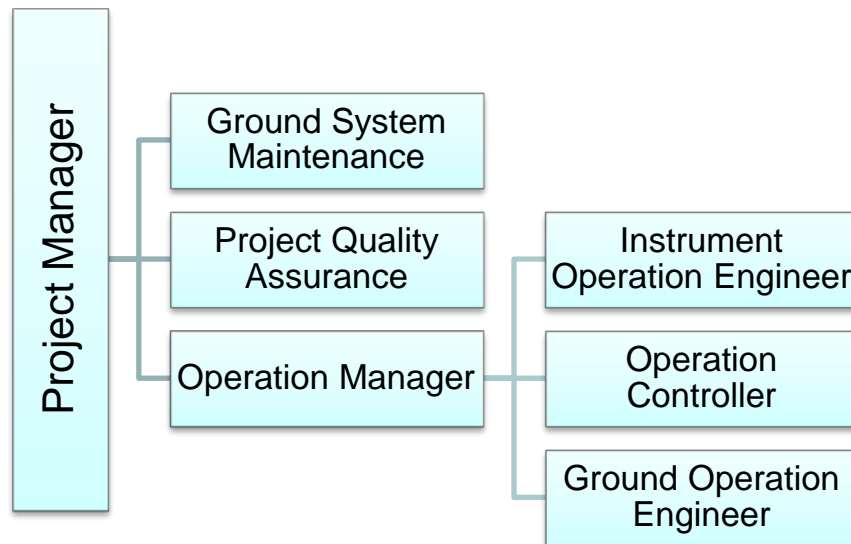


- Common functional design for the POCs
- Built on generic functions corresponding to operational services
- Each service is implemented by a software component
- Software components (tools) are variable according to each mission



## POC - Operational staffing plan

- As soon as the ground segment development starts, a POC representative is named and acts as future operation manager
- Basically, for each position, the person works in time sharing between a POC in preparation and one in operation (except the Project Manager)



- The staffing plan grows along the life time of the project and reach its maximum at the launch date,
- According to the importance of the mission (24/24, 7/7, ..) several persons could be required for one work position,
- At contrary for a mission with less operational needs several work positions could be handled by the same person.

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# The COMS facility – Guidelines for implementation

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- **Building a common infrastructure for operating several mission centres :**
  - ◆ On a single ground facilities platform
  - ◆ Sharing common operational tools
  - ◆ According to a common technical and operational organization for and with scientific laboratories collaboration
    - Allow laboratories to concentrate on science
    - Allow CNES to have an efficient experience feed back for future missions
  
- **Anticipation during development phase, through identification of the Mission Operation Concept**
  - Mission characteristics
  - Programmatic & operational constraints
  - Space segment characteristics
  - Ground segment components
  - Scheduling
  
- **Favouring shared methods and tools throughout development**
  - ◆ When there is a common frame for the Space and Ground Segments, many issues can be fixed as soon as the Preliminary Design starts (e.g. PROTEUS and Myriade series, based on a common Control Centre structure)
  - ◆ When CNES has an expertise on one instrument and is responsible for the its monitoring/calibration/validation, existing tools can be used and are preferred

## The COMS facility – Infrastructure and platform

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- **The COMS facility hosts several POCs in several rooms on 2 platforms**
- **Each POC follows identical principles**
  - ◆ **Platforms design**
    - for hosting users with only PCs and facilities to perform operations
    - All server machines are outside the POC room, in CNES Data Center
  - ◆ **Rooms configuration :**
    - In operation phase : One POC = one room (the surface can be variable according to the different mission phases)
    - In preparation phase : a room could be configured for hosting several POC
  - ◆ **Facilities:**
    - A/V loops with the others external centres, printers, ...
    - Displays for reference times and countdown for AOS passes
- **Common services**
  - Controlled access
  - Network : wire, wifi, security, redundancy
  - Lunch room

# COMS main room implementation

## ■ Payload Operation Centres currently operated :

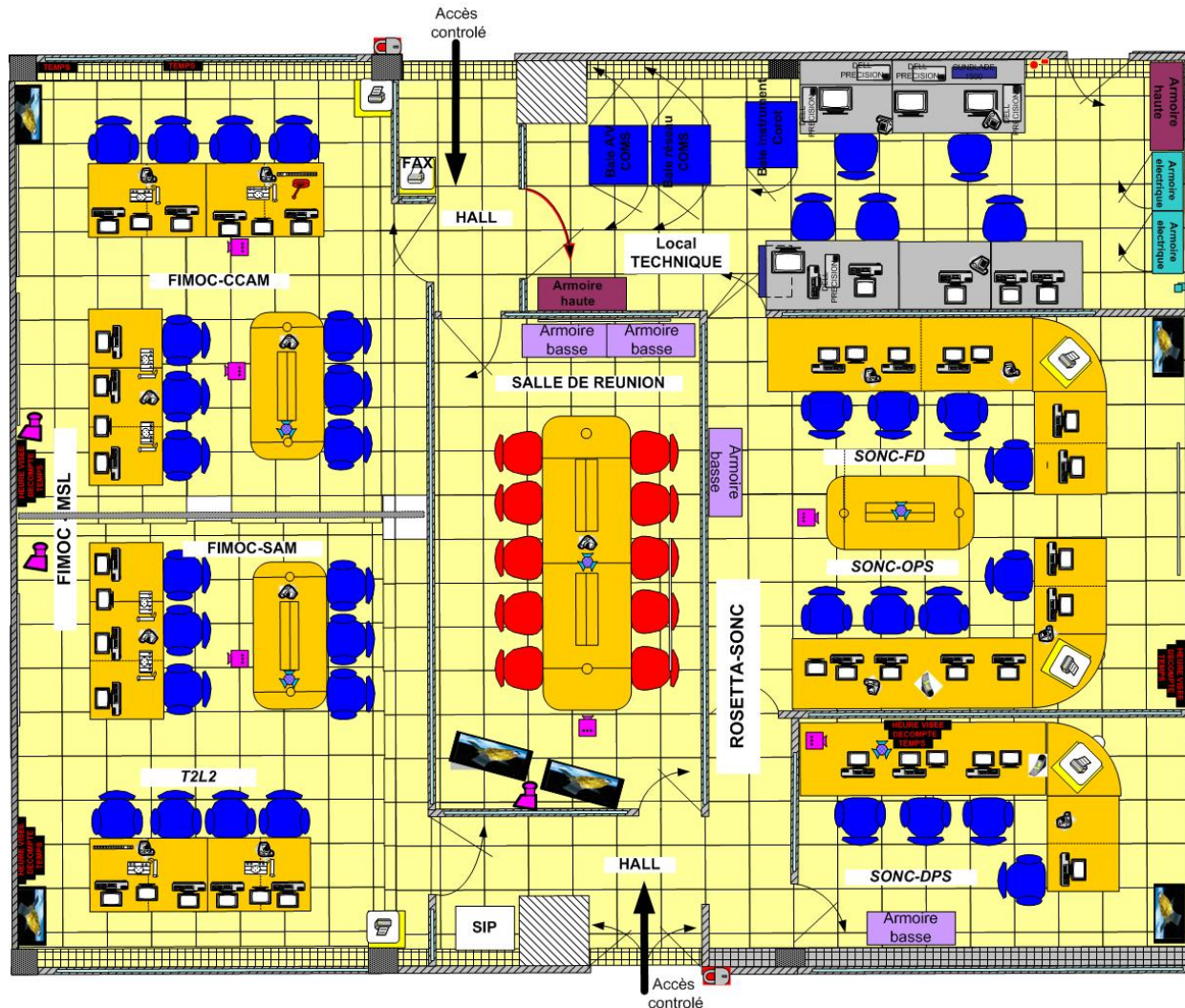
- **Rosetta/Philae SONC**
  - updated for comet phase
- **MSL/ FIMOC**
  - CCAM operations In alternance with LANL
  - also hosting SAM operations (in alternance with GSFC)

- **T2L2**

## ■ A technical zone

## ■ 2 Centres in development :

- **Microscope**
  - Will take the Rosetta SONC room in 2015
- **INSIGHT**
  - Will be incorporated in FIMOC room in 2015 instead of T2L2



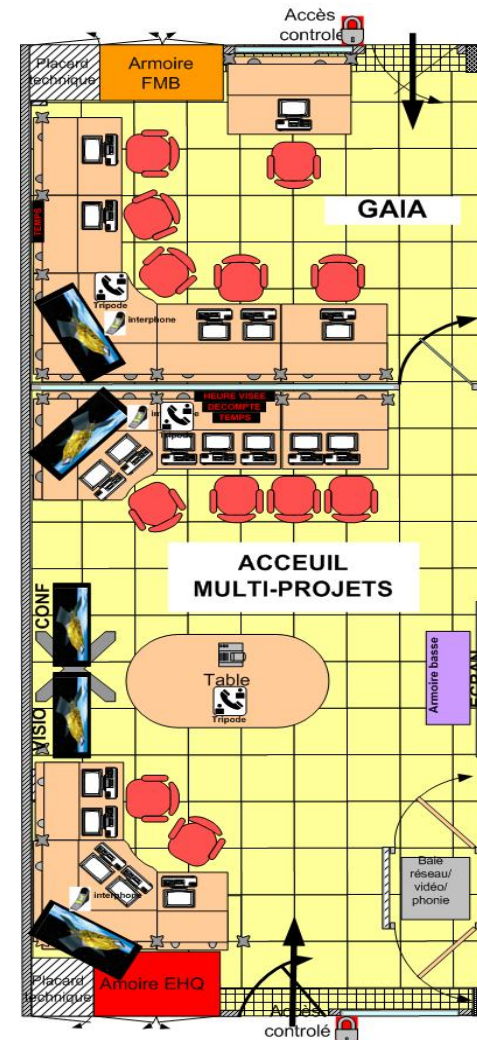
# COMS extension room implementation

## ■ A Data Centre in Operational Readiness Tests

- ◆ GAIA (to be launched in November 2013)

## ■ Multi-mission zone for hosting technical validations

- ◆ Maintenance activities
  - Rosetta / SONC
  - MSL / FIMOC
- ◆ New developments
  - Microscope
  - INSIGHT
- ◆ Also used as a second meeting room



# Case 1 : Philae / Rosetta Mission

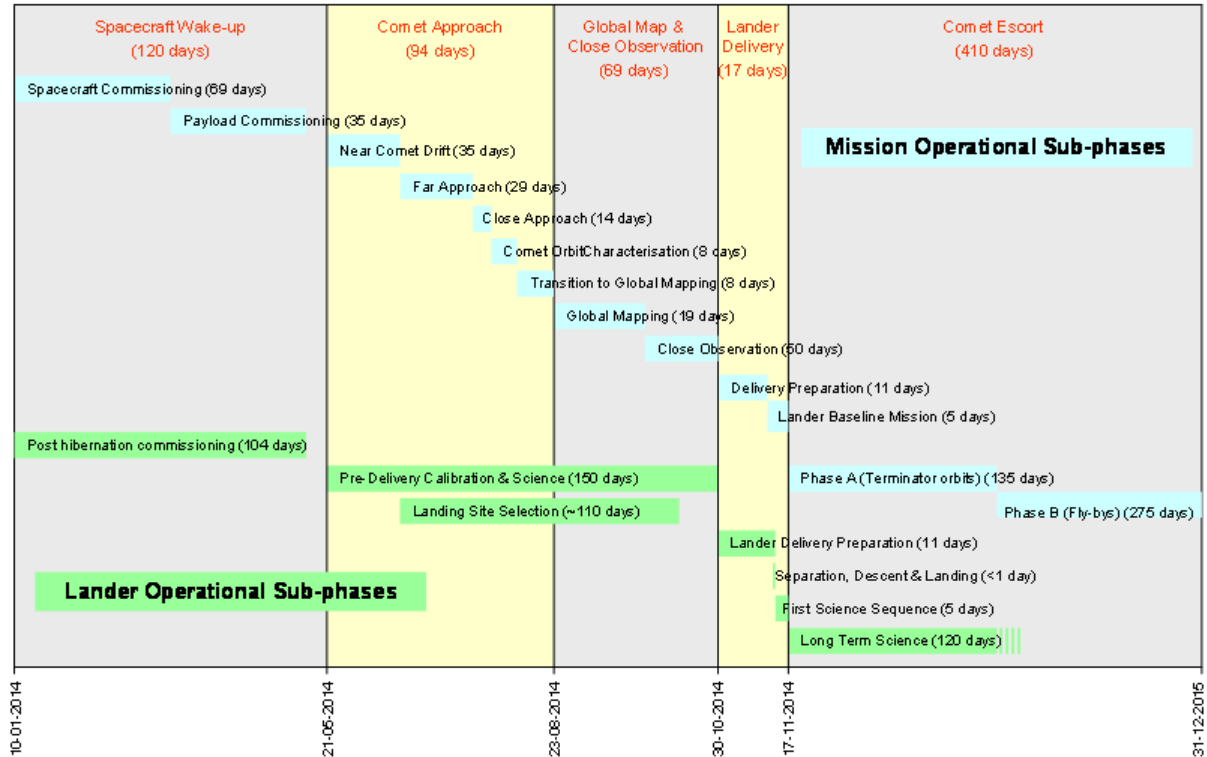
## ■ Mission aims

Exploration of a Comet  
Analysis

- Launched in 2004 – Comet phase Operation in 2014

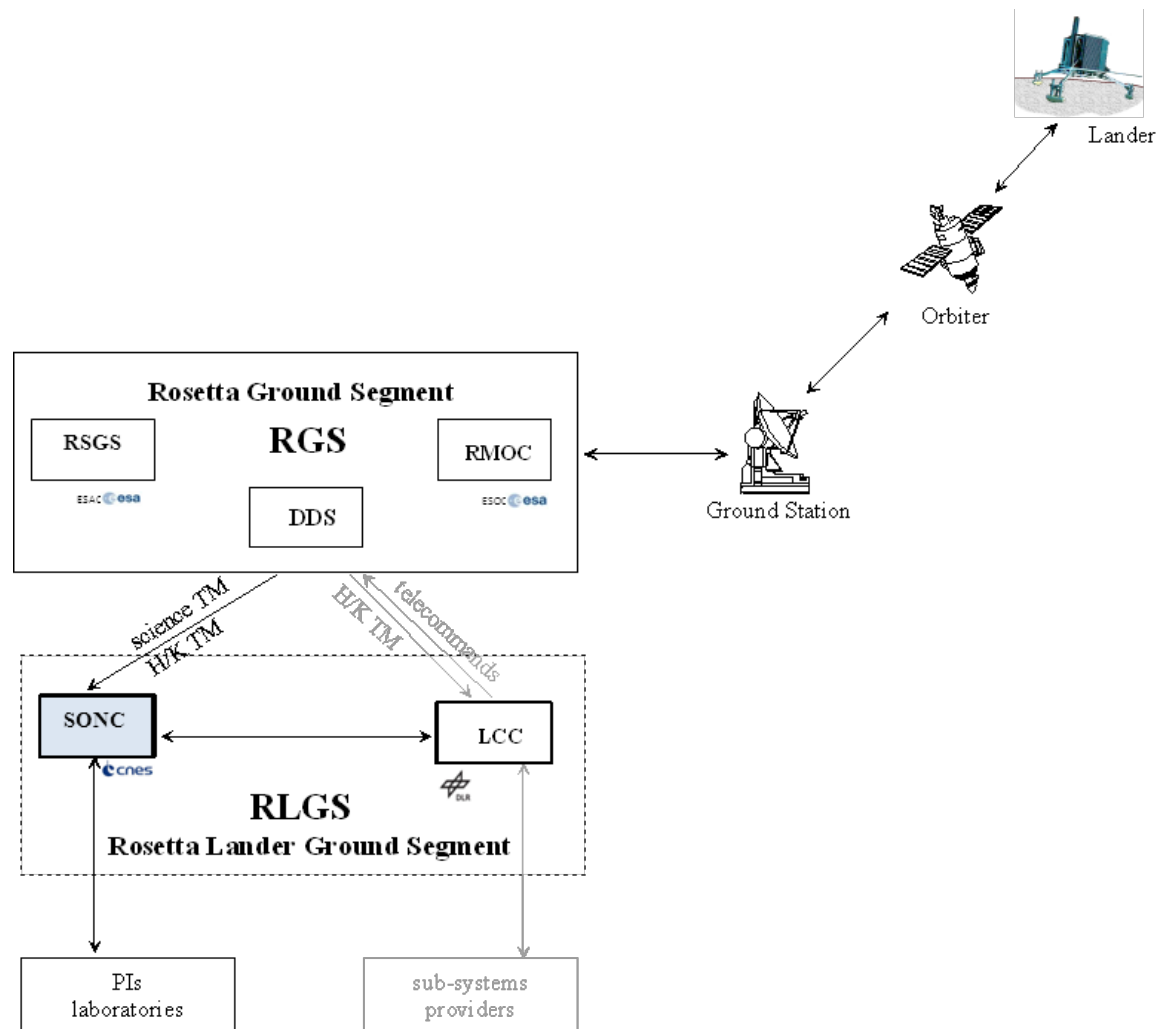


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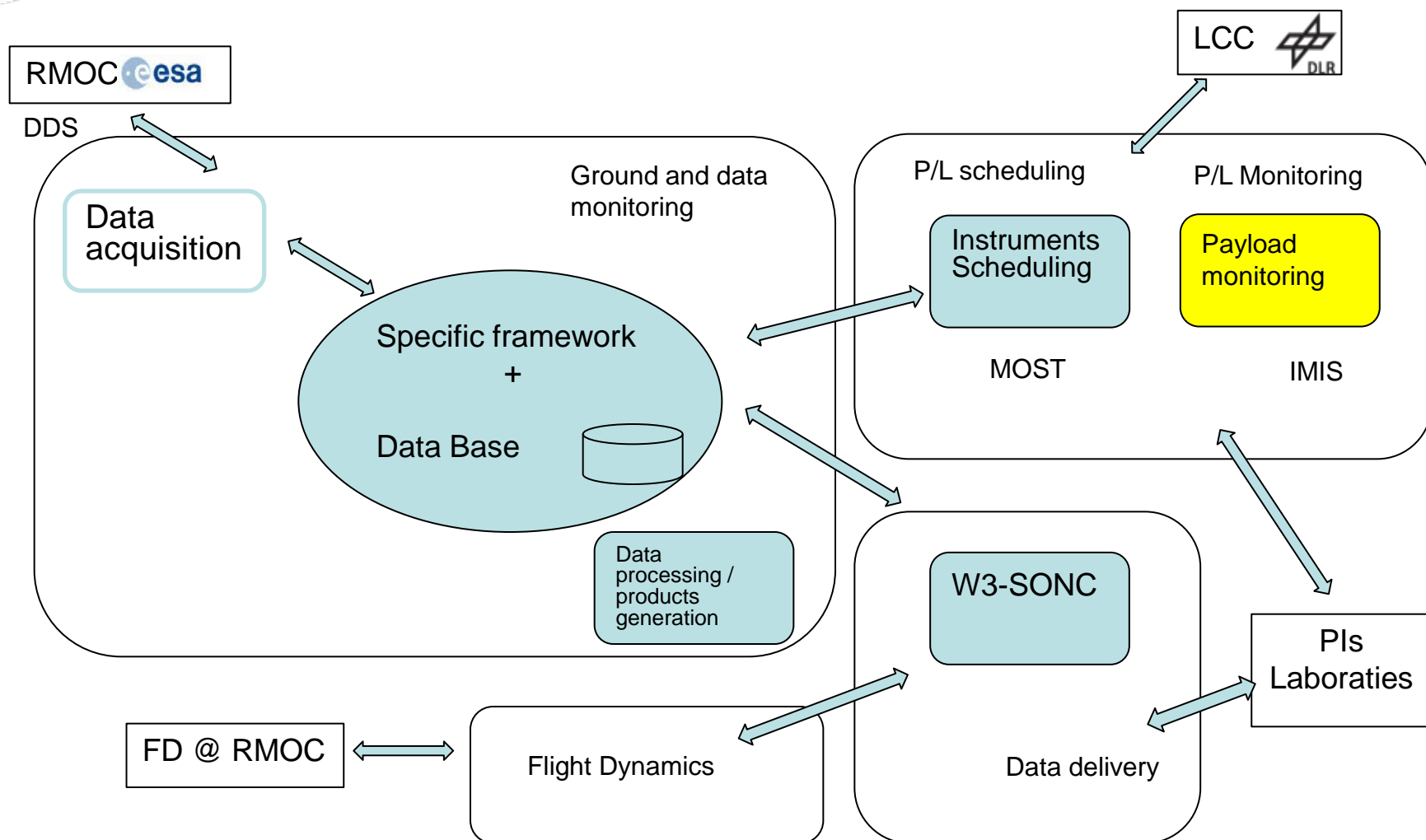


- Orbiter (developed by ESA)
    - Bus : 2.8 x 2.1 x 2.0 metres
    - 11 instruments
  - Lander (developed by an international Consortium)
    - Platform : around 100 kg
    - 10 instruments
- Exploration of a Comet  
Analysis of the nucleus

# Philae Operation System Overview



# Case 1 : the Rosetta Science Operation and Navigation Centre (SONC)



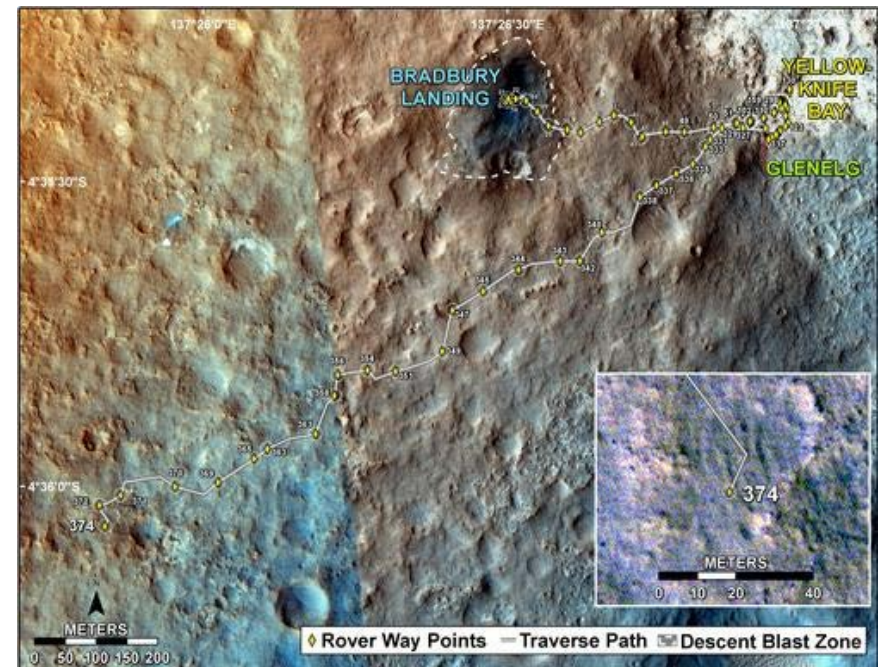
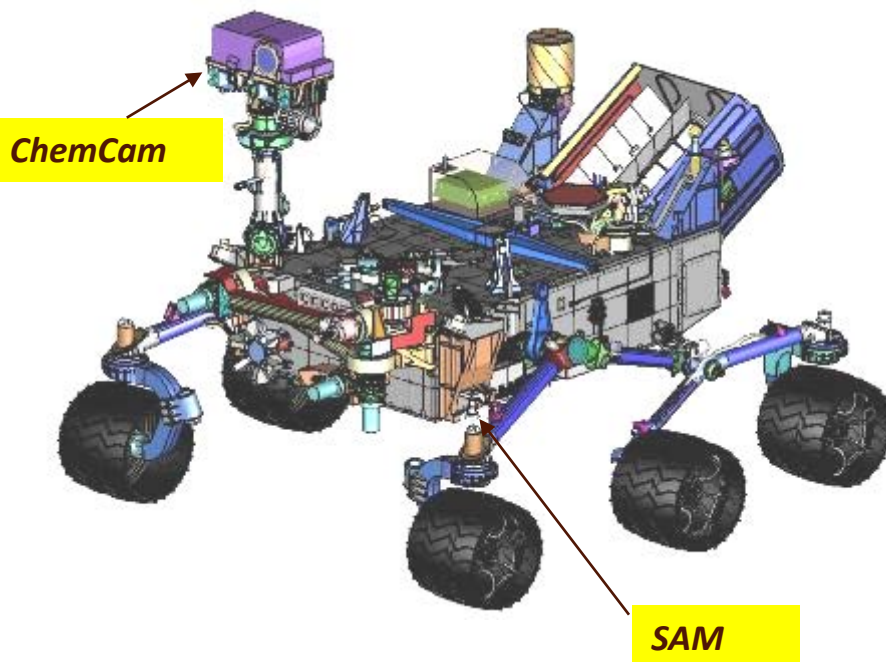


## Case 2 : Chemcam / MSL Mission

- Mission : chemical analysis of soils
- Operated since August 2012
- Vehicle : Curiosity rover
- Chemcam Instrument :
  - ♦ Laser-Induced Breakdown Spectrometer (LIBS)
  - ♦ Remote Micro-Imager (RMI)
- SAM-GC :
  - ♦ Gas chromatograph
  - ♦ One out of 3 SAM (Sample Analysis at Mars) instruments

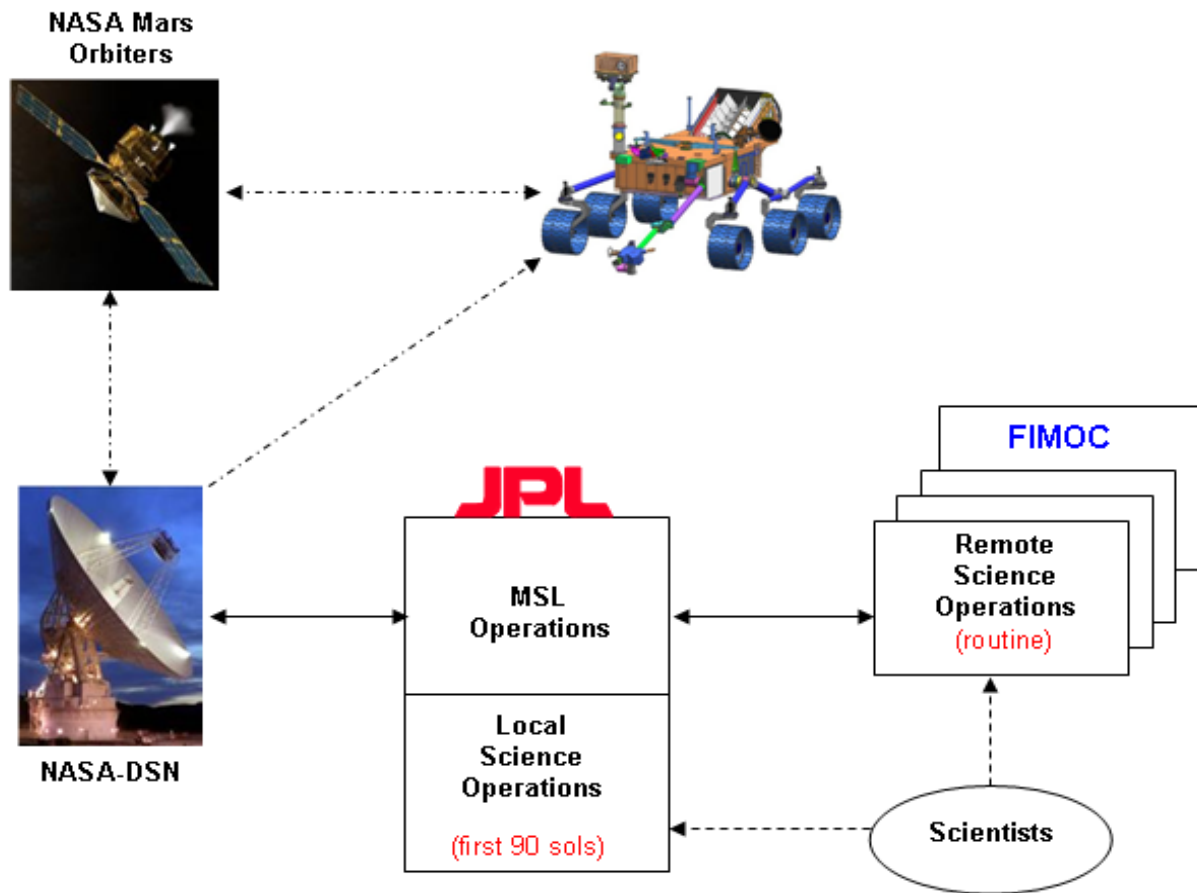
### ■ Mission scenario :

- ♦ Profiling chemistry along the drive (up to 100 m/day or more)
- ♦ Selecting targets and preparing sample analysis
- ♦ One programmation/day on JPL time

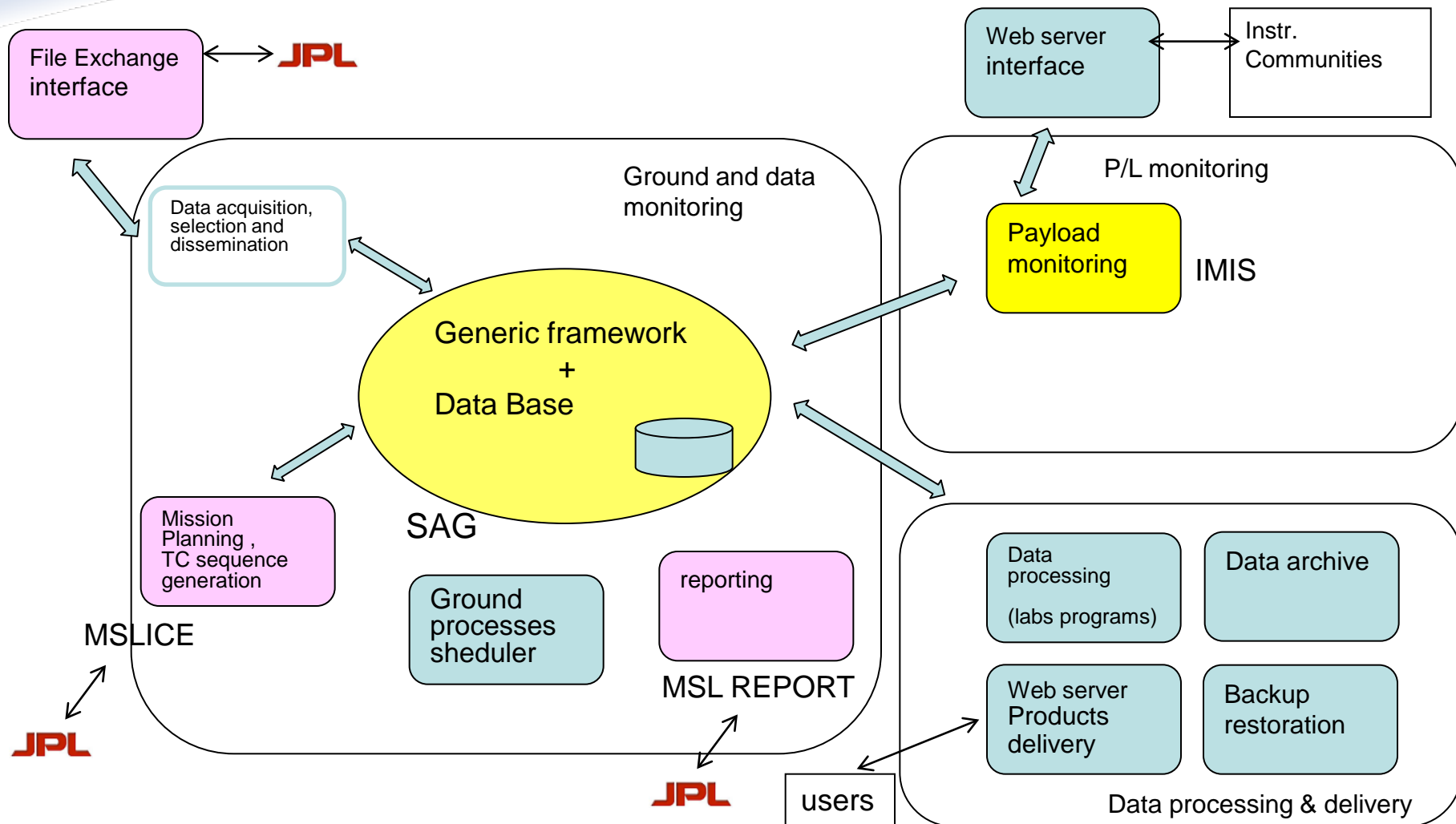


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# MSL instruments operation system overview

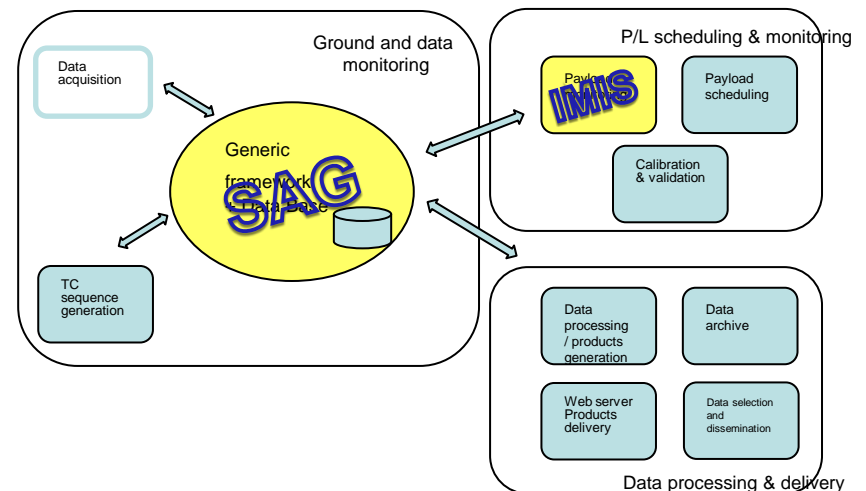


# Case 2 : the MSL French Instrument Mission Operation Centre (FIMOC)

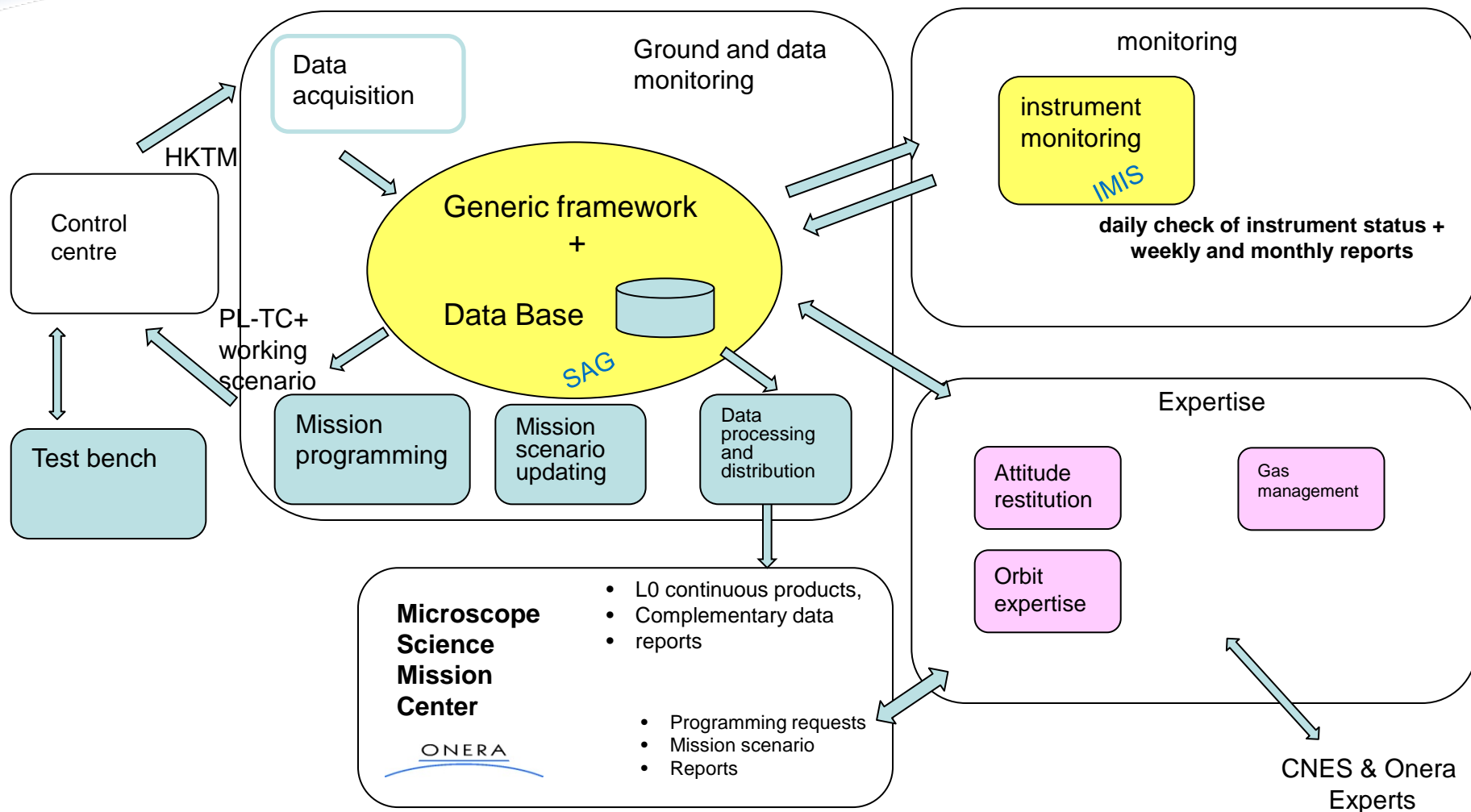


## Next missions POCs

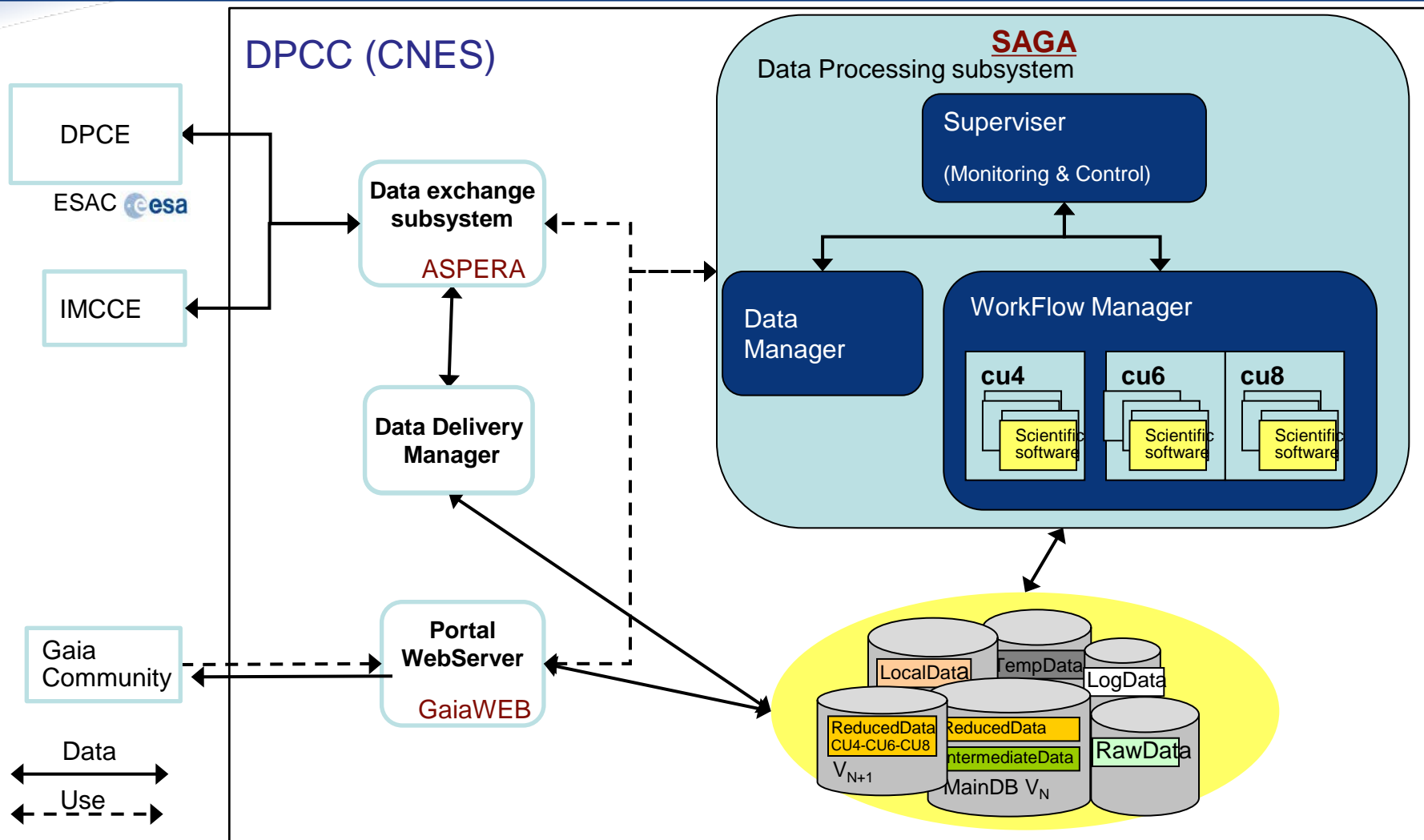
- The three next missions which POCs will be integrated in COMS are Microscope, Insight and possibly SVOM
  - ♦ Microscope is a CNES-ESA mission in the field of fundamental physics, aiming at testing the equivalence principle with an resolution of  $10^{-15}$ .  
For this mission the MOC will involve an Expertise Center.
  - ♦ Insight is a JPL mission mainly dealing at exploring the inner of the Martian geoid by the use of an ultra-sensitive seismometer.  
For this mission the MOC will re-use the structure and the tools of the MSL one.
  - ♦ SVOM (Space Variable Objects Monitor) is a CNES-CNSA mission which main objective is the observation and characterization of the Gamma-Ray Bursts from the deep Universe through X and gamma rays instruments
  
- Already 2 generic tools used for these MOCs, as in numerous others ones of French Missions : SAG and IMIS
  - ♦ SAG is the core of a MOC system, based on a scalable architecture, which provides :
    - Software to access catalog data
    - Integration of processing components
    - Interfaces between data and processing modules
  - ♦ IMIS is a monitoring tool which provides detailed and synthetized information to the operators of a payload instrument.
  
- Future MOCs will integrate more generic tools : for data acquisition, reporting, payload scheduling, ...



# Example : Microscope



# Special case : the Gaia Data Processing Center



# Staffing

## ◆ Engineers and technicians (including in house contractors)

Missions	Rosetta	MSL	T2L2	GAIA(*)	future	Total
Project Management	●			●		3
Operation Lead	●	●	●	●	●	3,5
Payload Operations	●	●	●			8
Data Processing	●	●	●	●		4
Flight Dynamics	●					4
Control		●	●	●		2
Quality Assurance	●	●	●			1
Support & Maintenance	●	●	●	●		2
					<b>TOTAL</b>	<b>27,5</b>

*(Red circles show the shared positions)*

(\*) Assessment phase

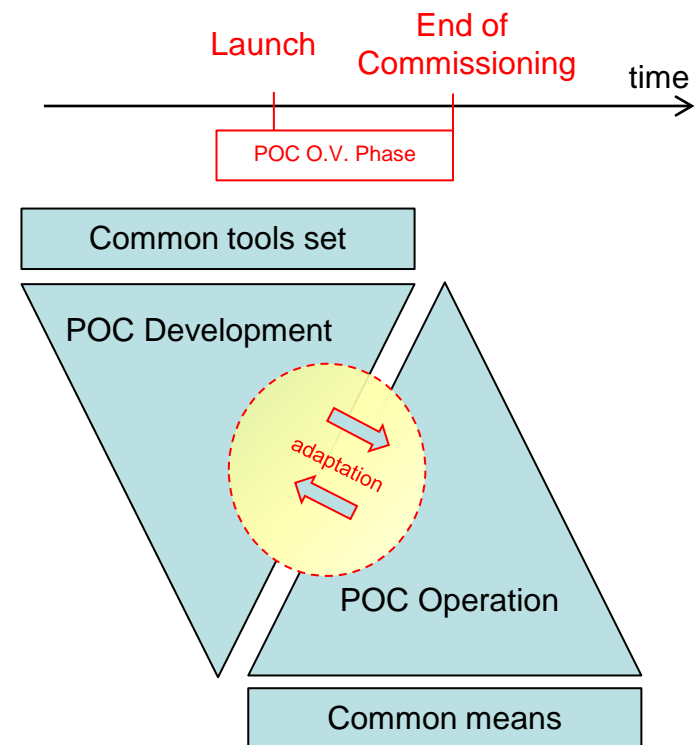
- The figures refers to the present staffing. They do no include the development teams. The needs to prepare, perform and support operations are highly variables with time
- The most critical phase is during Operational Validation
- In house contractors hired in all positions except PM and operation lead

## ◆ Scientists

- The Rosetta SONC will welcome 10 to 15 scientists to support on-Comet operations
- The FIMOC hosts between 4 and 8 persons from different labs at each MSL operation shift
- In the GAIA DPCC approximately 10 scientist have attended the 4 ORs

## Conclusion

- The COMS has been created in order to ensure the operational needs of various scientific Payloads Operational Centres and to reduce the total operating cost
- A common functional design is used for the different POCs within a common operational organization and maintenance support
- Common tools have been developed for the existing POCs and are favoured in the preparation of the next ones
- adaptations are always necessary during the POC operational validation phase
- At the end of a mission, common means can be easily re-used
- Lessons learnt allow teams to better and sooner characterize the right needs of the future missions





# Current life at COMS



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## Current life at COMS



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