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# The CDO and SETTERS - Key elements of modernisation of Guiana Space Centre

**JN.Hourcastagnou[a], Sandra Steere [b],Xavier Nérault.[c]**

[b] Sandra.Steere@cnes.fr, Guiana Space Centre , CLRR Project https://centrespatialguyanais.cnes.fr/en
[a] Jean-Noel.Hourcastagnou@cnes.fr, Guiana Space Centre , CLRR Project https://centrespatialguyanais.cnes.fr/en
[c] Xavier.Nerault@cnes.fr, Guiana Space Centre , Telemetry Stations Facilities https://centrespatialguyanais.cnes.fr/en

**Abstract**

Founded in 1964, the Guiana Space Centre, Europe's Spaceport, is facing a rapidly evolving environment. These evolutions concern several aspects of our activities such as the evolution of launchers. In the short term the arrival of new launchers ARIANE6, VEGA-C. but in medium and long-term the arrival of partially reusable launchers and the arrival of "micro-launcher" type systems to meet the needs of "mini" and "micro-satellite" missions. The Guiana Space Centre must also reduce maintenance and operating costs for all users of the launch base, whilst at the same time respond to the needs for improved flexibility and a reduction in operational cycles. This paper presents the French Guiana Space Centre's New Operations Centre, the CDO, a game changer for providing a flexible and open spaceport for existing and upcoming launchers

Keywords: Guiana Space Center, CLRR, CDO, SETTERS, digitalization, automation.

## Acronyms/Abbreviations

| | Meaning | Description |
|---|---|---|
| ***CSG*** | Centre Spatial Guyanais | Guiana Space Center (Europe's Spaceport) |
| ***ACU*** | Antenna Control Unit | System controlling the antenna movement |
| ***DO*** | Désignation d'Objectif | Launcher tracking data for antennas |
| ***MDO*** | Module de Désignation d'Objectif | Telemetry station subsystem |
| ***DODO*** | Dispositif Opérationnel de Désignation d'Objectif | TM subsystem acquiring and relaying launcher tracking data to antennas |
| ***CVI*** | Contrôle Visuel Immédiat | Real-time launcher status data |
| ***CVD*** | Contrôle Visuel Différé | Recorded launcher flight data for post-flight analysis |
| ***SCET*** | Service de Centralisation et d'Evaluation des Télémesures | Central system collecting, validating and transferring received telemetry |
| ***SCS*** | Service de Coordination des Stations Aval Télémesure | System allowing the monitoring of TM stations from Kourou |
| ***CDO*** | Centre des Opérations | Project of digitalization and modernizing of the CSG |
| ***CTTM*** | Centre de Traitement des TéléMesures (Toulouse) | CNES' technical post-flight telemetry data analysis team |
| ***SETTERS*** | Système d'Enregistrement, de Transfert et de Télégestion pour les Essais et la Réception télémesure en Stations | System for remote controlling and monitoring telemetry equipment |
| ***RETA*** | Réseau d'Enregistrement des Télémesures Ariane | System for recording launcher telemetry data |
| ***RTR-PTM*** | Récepteur de Télémesure Radio Processeur de TéléMesure | System for receiving, treating and processing telemetry signals |

## 1. Introduction

Since 2017, CNES and ESA management have been working together to define the concepts for a New Generation of the Core Launch Range. The program, known as the the CLRR (Core Launch Range Renewal), or CSG-NG in French [1]. The CLRR aims for a gradual modernization of the launch support system (managed by CNES), initially covering investments that should contribute to :

- Improving operational efficiency
- Introducing new working methods
- Greater flexibility and modernization of the base
- Increased use of remote control and monitoring capabilities
- Replacement of end-of-life equipment

With of course, a main objective of cost reduction during operations and maintenance. This objective requires fundamental restructuring of the Spaceport's operational concepts. These new operational concepts can only be implemented using investments for dedicated & new infrastructures. Once in place, enforced operator training is planned, for training personnel in these new operational concepts. The CLRR approach is based on three priorities:

- A new operations center, the CDO ("Centre des Opérations"). With its new ground system architecture, the CDO brings the capacity to manage several launch campaigns in parallel. The CDO also promises to reduce the delay in preparing for a new launch, thus reducing costs.
- New digital collaborative tools providing a new way to manage operations
- Improving energy management of the launch base

This article presents the CDO, responsible for core launch range support operations. This article also focuses on the SETTERS system which is the first brick of the CDO project. The goal of SETTERS (Système d'Enregistrement, de Transfert et de Télégestion pour les Essais et la Réception télémesure en Stations) is the modernization and evolution of the telemetry equipment used at the CSG.

## *2.* The CNES at the Guiana Space Center

At the Guiana Space Centre, CNES has many missions; however, this paper focuses on missions regarding launch operations

### *2.1 Before a launch*

Before a launch, CNES is responsible for the analysis of a new launch mission with respect various laws and regulations. The CNES determines the compliancy of the mission with regards to the planned trajectory & flight safety issues. Also, before a launch, CNES must prepare and validate the Core Lanch Range Support systems, that will be activated during a launch.

### *2.2 During a launch sequence*

During a launch sequence, CNES carries out missions for two purposes : the launch operator to track the launcher and for the CNES Guiana Space Centre to ensure flight safety. CNES missions for the launch operator are the following :

<u>CNES missions for the launch operator are the following :</u>

| | |
|---|---|
| *Acquisition and recording of Telemetry data:* | Have all the Telemetry data for the entire trajectory available offline, from the beginning of the synchronization sequence to the end of the launcher passivation operations |
| *Monitoring of the end-of-flight sequence:* | Provide the launch operator with real-time information to enable it to assume the mission was successful: i.e., injection, payload separation and order execution. |
| *Immediate Visual Inspection* | Provide real-time information to the operator's display room to enable it to evaluate |

| | |
|---|---|
| *(CVI) of launcher operations & behavior:* | the operation & behavior of the launcher in flight. |
| *Satellite orbit injection diagnosis:* | Provide the launch operator (located in the Jupiter II building) with the satellite orbit injection diagnosis and information about the composite's attitude, no later than 30 min after the separation of the last payload |
| *Optics - video film* | Film the technical launch operations in order to show all or part of the launcher and its interfaces (umbilical connections, nozzle clearance, etc.). |

CNES missions to ensure flight safety:

| | |
|---|---|
| *Anti-collision in orbit* | Provide the Emergency Response Department with an assessment of the risk of a collision in orbit with manned space systems whose orbital parameters are accurately known and available, during the space operations and during the three days following the decommissioning phase (return of the Upper Cryotechnic Stage) |
| *Telemetry* | Provide real-time information to the flight safety room |
| *Trajectography* | Acquire, process and display the launcher location data in real time in the flight safety room, during the entire safety mission (MSI and MSA). |
| *Predictive intervention criterion* | Make it possible for the ground segment to analyze whether the flight is dangerous or not, based on predictive intervention criteria, e.g., the non-injection of the satellite into its orbit, due to insufficient propulsion of a launcher stage |
| *Flight termination* | Implementation of flight termination / neutralization. |
| *Visualization of lift-off* | Display an image of the launcher in the Flight Safety room from lift-off to an altitude of 250 meters |
| *Launcher fallback components in the event of an accident or neutralization* | Provide the necessary information to analyze the area affected following an in-flight accident or the activation of the on-board intervention system. |

Carry out coordination missions

| | |
|---|---|
| *Display in the Jupiter II room* | Project the video images of the trajectory in the Jupiter II control room.<br>Monitoring the progress of the launch sequence<br>Provide real-time information about the technical status of all local systems and the downstream telemetry stations, to enable the following : |
| *Monitoring the progress of the launch sequence* | A decision regarding the readiness of the CNES systems during negative launch sequence<br>Real time knowledge of flight tracking (acquisition, launcher events, antenna positions*)* |

### *2.3 After a launch sequence*

After a launch, the CNES carries out post-launch analyses and assessments on the technical functioning of the various CNES systems, to report to the launch operator and the Guiana Space Centre. The CNES CSG must also provide flight data to various correspondents. This typically involves generating an immediate report at the end of the flight safety activities and the end of the flight. The aim is to quickly identify anything that went wrong during the launch and to provide this information based on reliable and validated indicators. The data is also used to update flight history to enrich the feedback of experience and to improve decision support tools. An optimization of system configuration is also possible, based on post-flight data analysis.

## 3. The New CDO

The new operations center, the CDO, aims to enhance capabilities of the Core Launch Range by

- centralizing operations that are currently distributed across 12 technical buildings
- fostering the automation and the remote operability and maintainability of its resources
- managing multiple launch campaign configurations in parallel

The expected benefits include :

- increased operational capacity for the CSG by parallelizing multiple operations
- flexibility, with quick and safe system reconfiguration
- rationalization and optimization of processes and operations
- decreased energy consumption
- enhanced training & validation of systems via a digital simulator

The new operations center is profoundly renewing all Core Launch Range systems and services, including all the IT and the operational equipment that is necessary to support the execution of the launch campaigns. Examples include : launcher data telemetry acquisition and processing & launcher tracking to determine a real time launcher trajectory for safety purposes, weather forecasting & telecommunications...

This presentation focus into the architecture and the functions of the CDO, but also shows how the new operational concepts are being developed and how the business and the organization will have to evolve and change and what new skills need to be implemented.

The new operations center, the CDO, has been designed to enhance the core launch range support operation capabilities detailed in paragraph 3. The main functions of the CDO are detailed in Figure 1.

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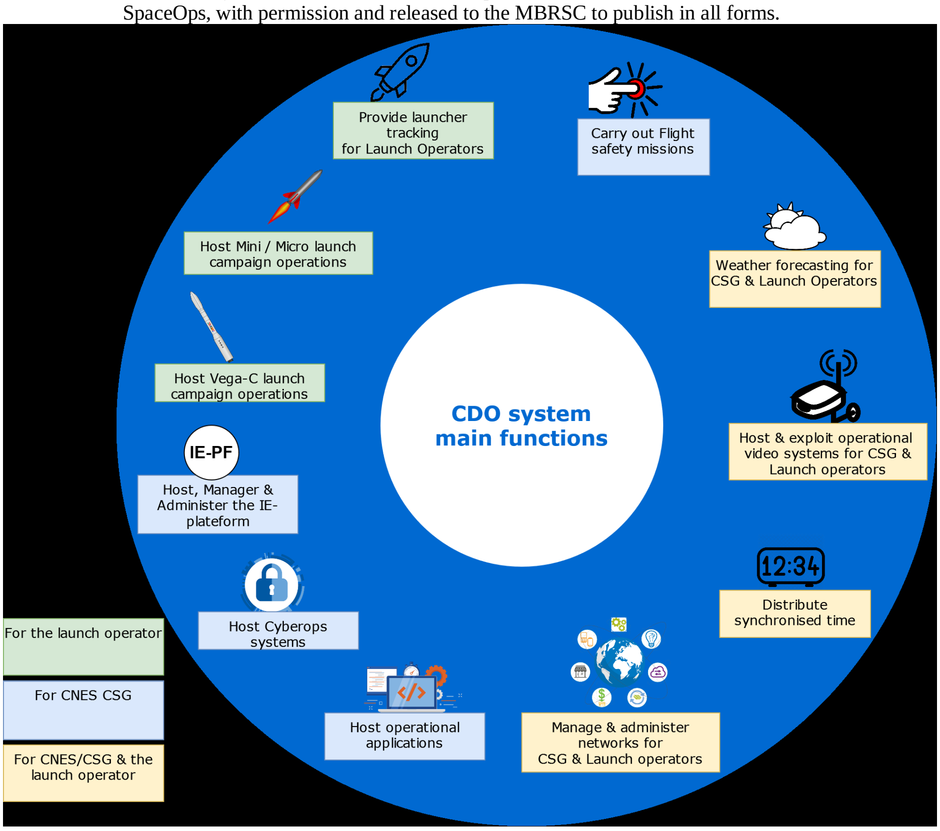


**Figure 1**

### *3.1 Services & Specific controls centres*

In order to carry out these main functions, the CDO brings together a set of operational centers and systems in a single infrastructure (Figure 2). A center is defined as a group of human resources, technical resources and premises that converge to achieve a given mission. These centers are either:

- created or fully renewed (in red/pink).
- partially renewed (in green).
- existing & will be moved to the new physical infrastructure (the CDO data centers) where they will benefit from modern operations rooms (in blue).

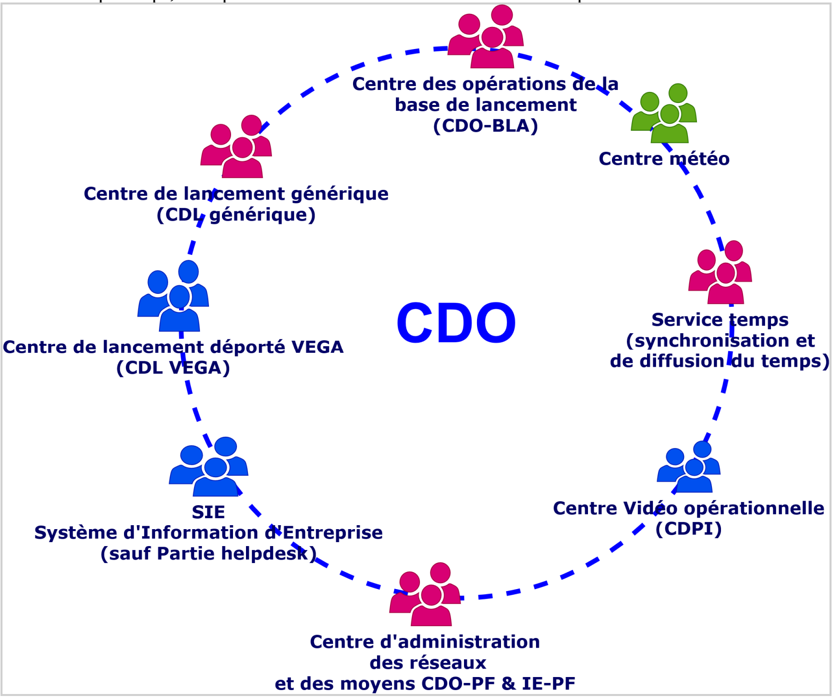


**Figure 2 : CDO services and job-specific Centers**

### *3.2 A layered architecture*

The CDO ground segment has been designed with the following layered architecture (Figure 3). In order to integrate the different centers and job-specific systems, a layered architecture has been defined.

- a A new building will be created. The CDO building has been designed to accommodate all the IT and communication resources required by the various centers within the CDO. It will be connected to the main CSG networks and will have redundant air-conditioning and power supply systems for uninterrupted operations. This infrastructure will be a prerequisite for achieving the objectives of resilience, security and economic efficiency. It will improve overall economic efficiency, notably through the dismantling of obsolete buildings at the CSG that have high in-service maintenance (MCO) costs. This new infrastructure will be complemented by new telecom optical networks that will upgrade and ensure the reliability of the most critical flows.
- b The new CDO building will contain 2 wings. Two new data centers will be created, one per wing. The datacenters will house the "core network" equipment of the BLA's communications networks, the CDO-PF equipment and the IE-PF equipment (supplied by the SNT), as well as the specific equipment of the various centers.
- c Two new digital infrastructures are being developed, the CDO-Platform and IE-platform (the latter supplied by the SNT). The CDO-PF for hosting operations systems and the IE-PF to host the transverse digital base (SNT) and other transverse CNES/CSG systems. These will group together the shared hardware and software resources, such as processing and storage servers, common services (e.g. domain name administration (DNS), directory service, backup/restore services, etc.).
- d A network & telecom infrastructure, consisting of new and existing networks that will be moved to the CDO.
- e New software systems: CDO-BLA, Weather forecasting, etc. to be hosted on the CDO-PF platform and the SNT systems hosted on the IE-PF.
- f A series of operational centers, some of which will be shared by various systems.

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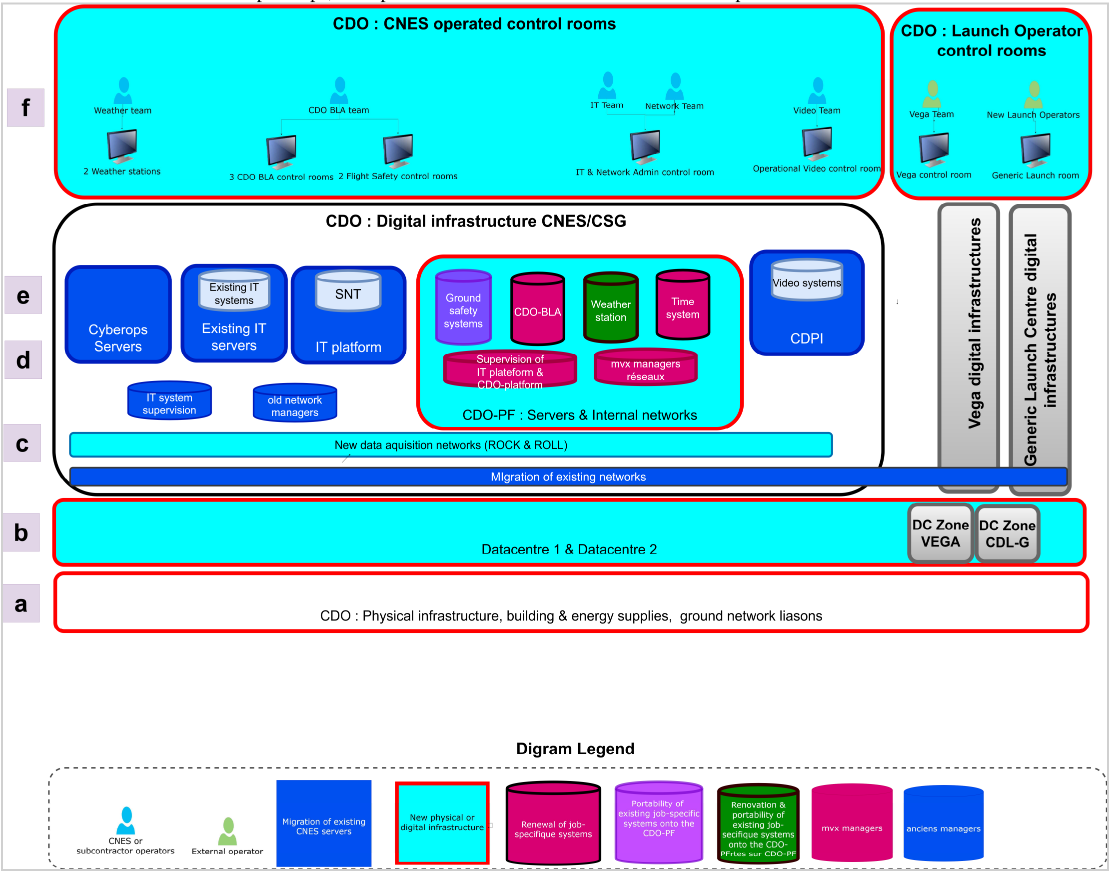


**Figure 3 : Layered software architecture of the CDO**

### *3.3 CDO-BLA: A new ground segment.*

Developed as part of the CLRR program, an entirely new CDO ground system (named hereafter as the CDO-BLA) has been designed. The CDO-BLA is in charge of the most critical missions conducted within the CDO system, i.e: all missions conducted by the CNES CSG for the launch operator as well as for Flight Safety during the launch sequences. The CDO-BLA offers many benefits. Notably, it will :

- Reduce costs in operations and maintenance
- Improve the availability of the core launch range (redundancy within the launch sequence so that it is capable of dealing with major incidents)
- Improve the flexibility of the core launch range
- Increase the availability of the core launch range
- Improve resilience of the systems
- Improve the security of IT systems
- Reduce preparation times
- Increase operational efficiency
- Provide shared system resources and HR teams
- Improve team synergy
- Offer new missions and new services

#### *3.3.1 CDO BLA : Missions*

The CDO BLA has many missions, depending on the current phase of a launch sequence (see paragraph 3). It also has missions that are not specifically related to a launch. These ongoing tasks maintain the CDO-BLA in operational conditions.

- Manage the CDO-BLA's data, catalogues, resources and users
- Provide the hardware, software and test data resources required to carry out maintenance operations within its perimeter
- Provide the resources needed to initially train, then qualify and provide ongoing training to all operating teams working in the CDO-BLA

### *3.3.2 CDO BLA : Means & Resources*

To carry out these missions, the CDO-BLA uses the following resources:

- The French Guiana Spaceport tracking and flanking radars
- The French Guiana Spaceport telemetry stations and flanking telemetry stations
- The downstream stations, for standard East & North launches, with additional stations for a non-standard mission
- The TSAR and TCNF (TCNF3 available soon) neutralization systems
- Optical and video resources for tracking the launcher
- The CDO BLA's operational networks: ROCK, CAIMAN, etc.
- The Launcher Tracking Network (RPL) enabling data exchanges with downstream stations: ROLL

The CDO-BLA is also in contact with the JUPITER 2 coordination room (CDC), to which it sends a status reports to update the synoptic diagrams that will be displayed on the various workstations in the CDC.

### *3.3.3 CDO BLA : Virtual environments*

One of the main concepts of the CDO BLA is the virtualization of working environments. A similar concept has already been implemented in CNES satellite control centers in Toulouse, and notably in the CSO satellite control center, where this concept has proven its worth. An environment should be considered as an independent software environment in which all of the appropriate and requisite data and software is deployed to perform the designated activities to be carried out within that environment. An environment is independent in terms of software, interfaces and data, but can share the same hardware configuration (server, CPU, RAM, hard drive, network, operator workstation). The CDO BLA environments are organized according to various activities that must be carried out and potentially carried out simultaneously:

- Mission & flight safety analyses, preparation
- Campaign configuration & system validation
- Testing and measurement analyses
- Operator Training
- System maintenance
- Launch sequence

### *3.3.4 CDO BLA : Centralized data*

In order to manage the numerous configurations & their updates, data configuration is essential. The CDO BLA offers the possibility to:

- archive all the data received, generated or copied that it processes
- manage all the data (creation, deletion, modification) according to their category (modifiable, not modifiable);
- manage the associated metadata (addition, modification, update);
- manage transfers between the common and local referential databases
-

Two main types of data are managed by the CDO BLA :

- DOPS : System operational data that enables the system to perform its missions. This type of data rarely changed.
- DEXP : Exploitation data, received or produced at a given point in time and whose values are important in relation to that time. This data can be received as streams or files.

### *3.3.5 CDO BLA : State of the art Simulator*

The CDO brings with it, an innovative Simulator (**S**imulator **T**raining **O**perational **N**umerical **E**nvironment **S**ystem, called STONES). The simulator digitally emulates complex external equipment such as the launcher, radars & telemetry antennas, providing operators with a life-like launch environment. For each campaign, operators will be able to perform training but more importantly validate the CDO configuration, ready for a launch, in parallel to different operations, without having to connect to external interfaces

These concepts provide continuous interactive operator training, ensuring operating capacities to perform reliable, timely and resilient operations with a high-level of operator experience. Simulation-based training exploits a simulator integrating the entire set of functionalities, devices and displays of the operational control room. This simulated environment is used, amongst other features, to train operators ensuring qualification before operating the ground segment.


**Figure 4 : A STONES simulator view of launcher tracking by TM antennas and Radars**

## 4. SETTERS : The First Brick of the CDO-BLA system

The first brick of the CDO-BLA system is therefore the modernization and evolution of telemetry equipment used by CSG. This brick is called SETTERS (Système d'Enregistrement, de Transfert et de Télégestion pour les Essais et la Réception télémesure en Stations). The Setters system was decided and developed in advance of the CDO. It brings major improvements in the operations and maintenance of the network of telemetry stations.
In this chapter, we will present the architecture and organization of current telemetry stations operated by CSG and explain the issues these stations are currently facing. We will then present the architecture of the SETTERS project, its goals, how it accomplishes them and today's status of implementation.

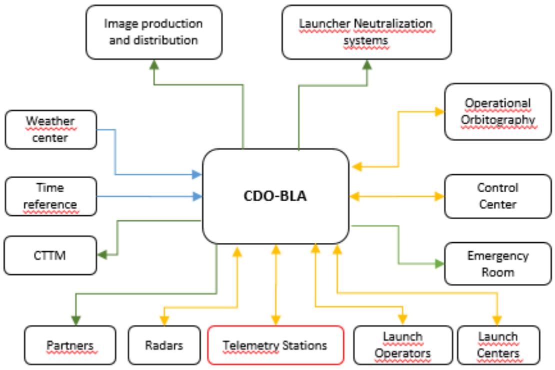

***Figure 5: CDO simplified interfaces diagram***

In order to fully track all launches from French Guiana, a network of telemetry stations has been developed across the globe. With over 1,500 parameters measured, the telemetry antennas receive vital data from the launcher. When the radar in French Guiana can no longer see the launcher, the telemetry antennas become essential. They alone can confirm that the launcher and its passenger(s) are in good condition and on the correct trajectory, but also that it is performing its propulsion phases as planned. Finally, it is the telemetry antennas that confirm the success of the mission.

For launches to the north and north-east of Kourou, French Guiana, the other potentially useful stations are chosen according to their availability. In view of the technical preparations as well as international agreements, the setting up of the network of stations must be planned one year ahead. Located on the Montagne des Pères, in Kourou, the **Galliot station** is the first station to track all the launches, both to the north and to the east. This station is used systematically.

### *4.1 Today's Telemetry Architecture of CNES*

#### *4.1.1 Functions and equipment of a telemetry station*

During a launch sequence a launcher emits an electromagnetic signal using onboard telemetry equipment to inform about the status of its equipment, the status of the satellite onboard, the stages of the launch sequence it has accomplished and other potentially useful information for ground operators. The role of telemetry stations is to acquire this signal and transform it into a readable electrical signal carrying the information the launcher is transmitting.

A single telemetry station is divided in two major systems; the antenna and the reception equipment. The antenna points in the direction of the launcher as closely as possible and collects the emitted electromagnetic waves, converts them into an electrical signal and transfers it to the reception equipment. The reception equipment ensures several other functions such as extracting the data in a readable format, recording the data, replaying it when needed for tests or other operations, transferring real-time data for customer and safety users, and transferring recorded data to the CTTM (Telemetry Processing Center) for post-flight analysis and archiving.

CNES operates several stations in different locations to cover the whole launcher flight path during the mission. Galliot station is located in Kourou near the CSG and is considered the central telemetry station interfacing with the CSG and with all other stations during the mission. Among the specific attributes of Galliot we can mention the fact that it has two antennas pointing to the launcher (Stella 43 and Star 45) that ensure a redundancy in the acquisition of the data especially during the first critical phases of the launch. The Galliot station also has a system called SCET-M installed. SCET-M is the central system responsible for collecting, reading, validating and transferring all telemetry data in real-time and post-flight.

The DODO system is also located in Galliot. DODO receives information regarding the launcher's location and trajectory from the radar teams of CSG and transfers this information to all stations' antennas.

The downstream stations' architecture includes one antenna with its related equipment, and the reception equipment for signal reception, recording and transfer to the Galliot station. Some of these stations are directly owned and operated by CNES which means CNES is also responsible for their maintenance and monitoring during launch campaigns and tests, but CNES also partners with other space agencies to install telemetry equipment on one of their antennas when necessary. This usually happens when a part of the launcher trajectory is not visible by any of CNES's own stations during an important phase of the flight.

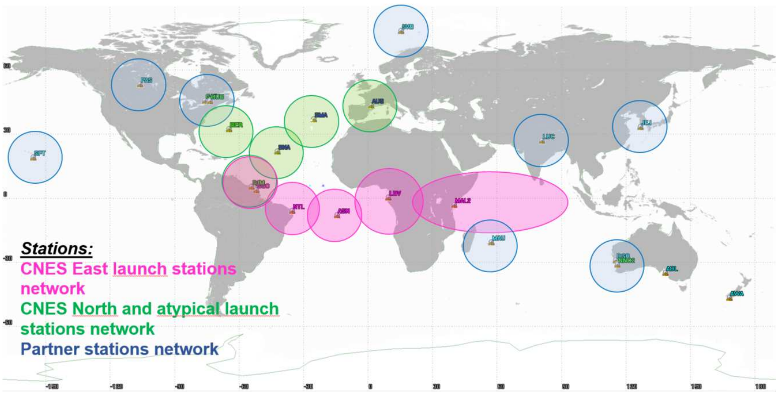

***Figure 6: Map of available telemetry stations for CSG needs***

The architecture of the Galliot station is different. Galliot has a redundancy of antennas and includes DODO and SCET-M systems. It also includes an additional CVI matrix to distribute acquisition paths depending on the configuration needed.

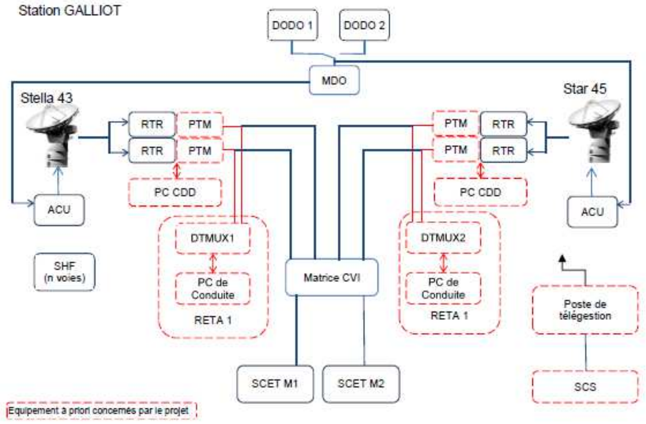


***Figure 7: Galliot station current architecture; Red blocks represent equipment impacted by the SETTERS project***

Downstream stations are usually equipped with one antenna and their architecture is dependent on whether they are fully operated by CNES or equipped with a TM mobile kit in the case of partner stations. Then the station is owned by CNES it is equipped with telemetry reception, processing and telecom systems directly installed in the stations bays. In case the station is external we send a telemetry kit designed to be easily transportable with the necessary embedded equipment. In this case the antenna cannot be operated directly by CSG teams but DO is transferred to the involved partners equipment to position and operate the antenna according to the proper launcher trajectory.

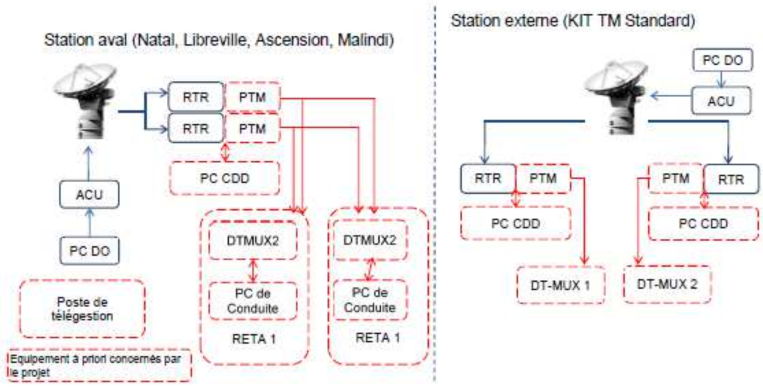


***Figure 8: "Aval" TM stations current architecture; Left represents red blocks represent equipment impacted by the SETTERS project***

To help understand the represented architecture we will provide a brief description of each equipment and their roles:

- RTR-PTM (Récepteur de Télémesure Radio Processeur de TéléMesure) : receives the electromagnetic signal from the antenna and converts it into an electrical signal then converts it into a readable format for other systems.
- ACU (Antenna Control Unit) : Pilots the antenna to make it point towards the launcher path according to DO data
- PC DO: Interfaces with the ACU to provide information on the flight path of the launcher
- DTMUX: Unit responsible for recording and storing the telemetry received
- PC Conduite: Allows to pilot the DTMUX and configure them via the RETA interface.
- PC CDD: Allows to monitor and control RTRs and also to decommission locally the satellisation diagnostic.
- Matrice CVI: This connection matrix can be configured to select the paths of received signals towards storage and transmission systems depending on the need and on the mission
- SCS: Previously used system for remote monitoring of reception systems statuses, this system is obsolete and decommissioned today

- SCET-M: Central system collecting, validating and transferring received telemetry from Galliot to other users.

This distribution of telemetry stations across the globe involves constraining logistics to move equipment for maintenance purposes and staff for operations in case the team is not directly present on site. This logistical complexity is costly both in terms of time and money since replacement operations or stations activation can take a long time.

- Reference station architecture and core subsystems
- Distinction between fixed and mobile stations and differences in architecture
- Functions and equipment related
    - RETA:  Recording, CVD Transfer, Replay
    - PC CDD: Monitoring, controlling RTR, local decom of diagsat
    - SCS: Monitoring status of the telemetry station
    - RTR-PTM:  *Telemetry* receiver.
    - DO: target designation
    - DTMUX : “for ground station" permit to record and play in Real time the essential parameters during a flight test or a launch.

#### *4.1.2 Obsolescence, costs, and technical issues*

To renovate in a global way the equipment of the avals stations and Telemetry kits by meeting the needs expressed by the CNES/CSG:

- Dealing with the obsolescence of means of registration (RETA).
- Address medium-term obsolescence of TM receptors/processors (RTR-PTM) .
- Enable use of “standard” telemetry receivers by moving specific functions in a dedicated medium
- By the development of remote management and the implementation of remote actions:
- Increase control of station configuration (fixed and external)
- Address remote management system obsolescence (SCS and PTG)
- Improve station simulation and validation means
- Reduce operational time
- Reduce the service time volume.

With SETTERS, operations logistics difficulties such as delays and waiting durations for maintenance and operation logistics decreases.

### *4.2 The Objectives of Setters*

SETTERS aims to replace the previously mentioned obsolete equipment while allowing to fully and uniformly monitor, configure and operate all telemetry stations; this includes both the signal acquisition segment and the antenna system when the station is under CNES responsibility (some stations are property of partners and the antennas are directly operated by their team). This new approach simplifies campaign and maintenance operations and therefore reduces logistics, and human costs. The system was designed to accomplish the following main functions:

| Functions of the SETTERS system | |
|---|---|
| **Fs1** | Record raw data for CTTM (CVD) |
| **Fs2** | Post launch transfer of recorded and formatted telemetry data for CTTM (CVD) |
| **Fs3** | Replay telemetry data for launch base operators |
| **Fs4** | Extract telemetry data in real-time for the SET |
| **Fs5** | Switch-off telemetry data in real-time for station operators (local CVI) and provide calculate satellite |

| | |
|---|---|
| **Fs6** | Ensure remote monitoring of equipment for launch base operators |
| **Fs7** | Ensure remote control of equipment for launch base operators |

***Table 1. Main functions of the SETTERS system***

The high-level requirements of the SETTERS project are:

- Replacement of obsolete equipment
- Simplify operations and maintenance
    - Monitoring operations,
    - Remote control of equipment,
- Reducing costs (operating and maintenance).

*4.3 Architecture of SETTERS*

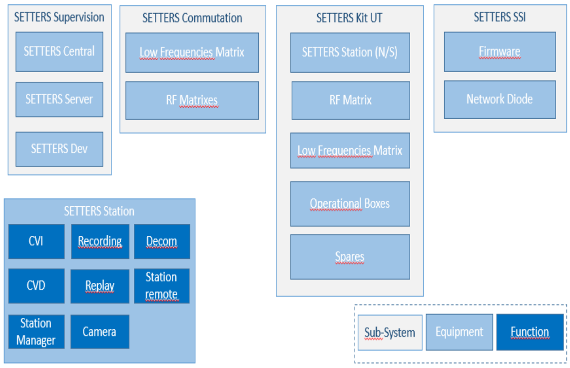


***Figure 9: Architecture of SETTERS subsystems functions and equipment***

*4.4 SETTERS impact and status of implementation*

The current operational processes involve for each active station for a launch campaign and its testing sessions at least two operators and one CNES supervisor. The operators are responsible for the configuration, preparation and operation of both the antenna and the reception equipment. These operations aim to calibrate the antenna (sun tracking, DO verification, link budget, etc.) and to ensure the proper activity of reception subsystems. Operators also need to be available to react properly in case of any anomaly during the countdown preceding the flight. It would not be possible to accomplish operations for both the antenna and reception equipment as it requires not only a long time to prepare the equipment (sometimes campaigns can last 10 hours continuously) but also it requires operators to stay focused on monitoring the systems behavior and reacting in case of manageable anomalies. Operators also stay in contact with CSG supervisors during the whole mission, that means that apart from their technical supervision and operations their attention is also on the communication aspect with the other members of the telemetry team. It would simply be unrealistic to expect one operator to accomplish all these tasks by himself for campaigns this long. We will also add that the presence of a CNES supervisor is required as CNES is technically responsible for the administration of these stations and, in case of anomalies, CNES needs to validate technical modifications decisions and trace events that are considered abnormal.

With the introduction of SETTERS configuration, monitoring and operations can be automated and remotely managed by the SETTERS Supervision module at Galliot. This module is connected to the CDC directly via a KVM which means the telemetry CNES supervisor for the given mission can view and operate all stations from his position at the control center. The presence of operators becomes limited to only physical maintenance operations (changing an equipment, disconnecting and connecting links, etc.) This implies a significant cost reduction since it is no longer necessary to transport two operators for each launch campaign and for each station but now only one is needed. It also reduces the complexity of the operations as all information is centralized in a single system available for CNES supervisors.

The level of digitalization of SETTERS will significantly change the current type of maintenance operations and information security constraints. Current systems include multiple equipment that need batteries to be changed, cooling fans to be cleaned or recording supports to be changed regularly. Since SETTERS is strongly implemented digitally in the current architecture a considerable part of maintenance operations will no longer be necessary. Our first estimate is that the amount of information safety tasks that will be required will largely be compensated by the number of maintenance operations cancelled. IT Security requirements will have the following estimated maintenance requirements:

- IT security administration
- Log recovery
- System updates
- Antivirus patches
- Complementary integrity controls
- Antivirus scanning

The estimated workload associated with these activities for the different stations are the following :

- Kourou Galliot Station: 200h / year
- Kourou Galliot Supervision: 400h / year
- Fixed stations : 96h / year
- Mobile Kits: 32h / year (one intervention per month)

Depending on each station these operations will represent 1/3 to 2/3 of the current workload dedicated to preventive maintenance. Therefore the benefits of SETTERS in terms of time saving are considerable and with the possibility of increased automation for information safety operations the workload can be reduced even more.

## 5. CDO : A new building

The new CDO building (see Figure 5) will host systems and operational personnel that are currently dispatched throughout 10 buildings at the Guiana Space Centre, spanning a distance of over 30KM.

In summary, the CDO building will replace approximately 6,500 m² of old premises spread over 10 sites with approximately 5,000 m² of new premises, while offering new services (flight safety systems, generic launch center, etc.). The CDO also introduces dedicated workshops for the telecommunication, video optics and weather forecasting technicians and an area to stock replacement parts.

The main objectives of the CDO building are as follows and are necessary in order to host the CDO BLA system :

- Gather all operational teams in a modern and environmentally friendly building. Creation of ~10 operational centers.
- Construct a building that fits and integrated within the Technical Center of the Guiana Space Center
- Propose a modern architectural design, that positively represents the CSG whilst integrating with existing buildings of the Space Centre
- Enable future developments. Organize the building so that future extensions are possible, while ensuring long term overall coherence
- Be compliant with a QEA (Amazonian Environmental Quality). This approach is intended to support the application of sustainable development to Amazonian environmental construction.
- Lower the global cost of the core launch range support systems
- Upgrade current outdated systems.

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**Figure 10: Artists impression of the new CDO building**


**Figure 11: Artist's impression of the new hall of the CDO building**

*5.1 Ergonomically designed control rooms*

The main CNES operated control centers were analyzed by an ergonomist during conception. The centers are based on generic interchangeable positions. The idea is that operators can choose where they wish to work. The basic design with identical workstations, aims to reduce maintenance costs. All the power supply and the HVAC is designed with redundancy for the operational rooms.

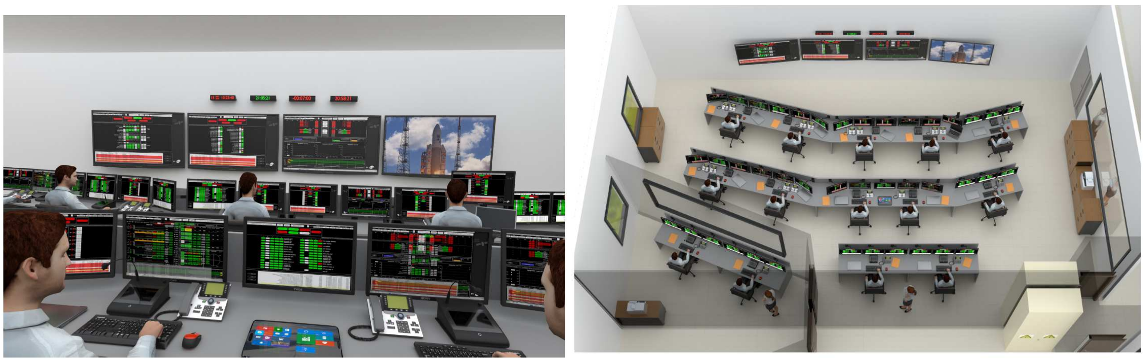

**Fig 12 : Views of Operational Rooms**

## 6. NEW OPERATIONAL CONCEPTS

One means of increasing flexibility and reducing costs of the launch base, is to optimize the human resources. Many of the current manual configuration & validation phases will be automated with the arrival of the CDO. Workflows have been designed to assist operators in mission analysis, flight safety analysis, and in the progress of a launch sequence.

### *6.1 Optimizing Flight safety operational concepts*

The flight safety team is particularly active in optimizing its current operational concepts [2]. Today, the flight safety team is composed of at least four officers. A telemetry officer analyses the launcher's on-board parameters to detect any potential abnormality. Two officers monitor the launcher's trajectory, given by two different tracking means in order to respect the Fail Operational criterion during the mission. The third officer deals with the meteorological issues and the in-orbit collision risk at launch. This third officer can replace the two Flight Safety officers if needed.

With the arrival of the CDO, team reactivity will be the center of attention, by eliminating the dialogue between officers, enabling them to focus on the evaluation of the flight criticality.

To do so, the team will be reduced to two officers: one main flight safety officer and one officer to confirm the neutralization decision and ensure the backup function of the main flight officer. The main officer's screen will display information formerly analyzed by the telemetry officer and the launcher trajectory. The latter automatically calculated using the best data available. This configuration eliminates the telemetry officer and a trajectory monitoring officer.

### *6.2 Synthesized flight trajectory*

The notion of a synthesized flight trajectory has been designed by CNES in order to reduce the Flight Safety team from 4 to 2. The requirement is to be able to display a single trajectory, called the synthesized trajectory, for the Flight Safety Officer in which he can have sufficient confidence to make his decision to neutralize alone. This single trajectory is generated via an algorithm, based on a continuous stream triplet (Position/Velocity/Time) that selects the best tracking means. The synthesized trajectory is displayed on the Flight Safety Officer's single screen. Using flight tracking data, the CDO BLA must compute in real time one or several projected trajectories.

During the development of the synthesized trajectory, the CDO-BLA will have to make the choice to keep, attenuate or reject each of the incoming flight tracking data. This choice will be made according to the determined level of consistency, predefined flight safety rules or principles and the nature of the sensors.

For future operational concepts, requiring tracking of a return launcher or tracking of return launcher parts, the CDO BLA has been designed and will provide a synthetized trajectory for each of the tracked elements.

## *7. CONCLUSIONS*

The new CNES operations center, the CDO, will be the heartbeat of CNES operations at the Guiana Space Centre, Europe's Spaceport.

A real game changer for our European spaceport, the CDO brings with it flexibility, automation, innovation and a reduction in exploitation and maintenance costs. The CDO has been designed to host new launch operators, opening the launch base to the mini/micro launch operator market.

A redesigned ground segment, a dedicated building and new operational concepts will change the way CNES operates tomorrow !