GALILEO LAUNCH AND EARLY ORBIT PHASE (LEOP) – A working partnership from two Space Agencies

Claude Audouy [1]
Centre National d'Etudes Spatiales (CNES), Toulouse, France

and

Nigel Head [2]
European Space Agency Operation Centre (ESA / ESOC), Darmstadt, Germany

Since 2001 the teams of ESOC, the ESA operations centre in Darmstadt, and of CNES, the French National Space Agency in Toulouse, had the ambition to build collaborative work on the European flagship programme: Galileo. This working partnership provides a 24h post-launch operations service, founded on the complementary skills of the two teams, aiming at performing the critical "Launch and Early Orbit Phase" - i.e. the period between separation and final orbital positioning - for all satellites of the Galileo constellation. The members of the operational teams are drawn both from ESOC and CNES for both the onboard and ground operations. But there are some specificities, for example the ground Mission Control System software which is delegated to ESOC, or the tracking stations which are taken in charge by CNES. Finally, the Flight Dynamics operations use the skills of both centres. The Galileo LEOP Team has been built through several challenges. Technical challenge in the sense of preparing to handle multiple spacecraft launches at a foreseen tempo of one LEOP every 3 months. Cultural challenge to establish an integrated team between two different centres separated by more than 1000 km. How to establish the best communication possible between two halves of a team in order to bring the "best of both worlds" to an integrated operation concept? The paper presents an overview of the mission and the set up to ensure it. It describes the operational team organisation to cope with the mission needs and the evolutions during the course of the project. The first lessons learnt are then presented as well as their possible ways forward for the subsequent launches.

I. Introduction

The proposed joint approach from ESOC and CNES to perform Galileo LEOP is based on the experience both centres have achieved providing this type of support on many occasions in the past, to both internal and external customers.

A fair partnership has been set up in a long term roadmap to provide this kind of support to European innovative programs such as Galileo, thus allowing the first gathering of satellite operations expertise from two of the largest groups in this domain.

This joint undertaking for LEOP operations has been built on the basis of trade-offs between: risk mitigation, cost effectiveness, and motivation of teams. The proposed solution reflects the necessary compromises while making best use of the institutional experiences of the two organisations.

This solution, based on a common development and qualification process for operational tasks, is also founded on a number of ingoing decisions: the separation of routine/LEOP premises, the use of flight proven facilities wherever possible and a two LEOP control centre approach anticipating the tempo of launches in the deployment phase.

Early Orbit Phase is a set of complex operations involving flight proven, complex and specific facilities as well as highly experienced individuals.

---

[1] Galileo LEOP Service Manager, DCT/OP/AR, 18 Avenue Edouard Belin 31401 Toulouse Cedex 09 - France.
[2] Galileo LEOP Service Manager, D-OPS/HSO, Robert-Bosch-Str. 5 - 64293 Darmstadt - Germany.

Swift reactions of the operational team are mandatory for nominal operation and even more in case of contingencies. The success of operations is depending on reliability given by all the means used for communication.

A LEOP control centre must be able to face and handle very specific operational situations as:

- search spacecraft(s) for 1st contact and 1st contact for communication between satellite and ground
- early orbit determination
- first switch on of the satellite's elements after stress of the the ascent phase
- platform sub systems configuration
- appendages deployment operations step by step
- very short transitions from initialisation sequence to Normal Mode acquisition (with respect to limited power autonomy)
- first calibrations of thrusters and sensors
- rendezvous strategy and execution for final orbit fine positioning, particularly critical in case of cluster launches for a constellation deployment.

Specifically, this requires from the LEOP centre a high level of flexibility, versatility and speed of reaction, both in the operational teams involved and from the systems used to face all the above critical operations and all of the possible contingencies associated with this kind of operations.

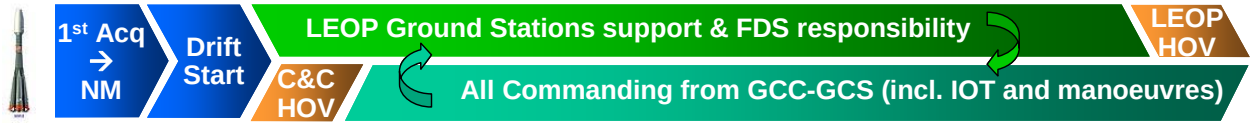
II. Overview of the mission

The Launch and Early Orbit Phase (LEOP) service for GALILEO is provided in close partnership between CNES and ESA/ESOC.

Under the overall responsibility of the Operations Prime (Spaceopal), CNES and ESA/ESOC provide a full LEOP service for the Galileo programme. The LEOP service includes:

- Management of the GALILEO LEOP operations activities, including technical management, schedule and cost control of the direct and contracted tasks
- Engineering, procurement and implementation activities, covering: design, development, assembly, integration and test of the LEOP infrastructure
- Operations Engineering, for the engineering definition and support to ground segment, and spacecraft operations during LEOP and handover, and for Flight Dynamics activities until fine positioning of the satellites
- LEOP Operations, for the definition and execution of operations during launch and early orbit phases

The two main phases and responsibility of the LEOP Service during operations are summarised in the following picture.



Operations during each of these phases are conducted according to an agreed Flight Operations Plan, based on the Operations Concept, which reflects the operational capabilities and constraints of the spacecraft, and the associated ground segment.

The distribution of operational tasks amongst the control Centres during these phases has been made after consideration of the capabilities of each control centre and of possible cost and time optimisations.

A. Overall Operation concept

The LEOP Service is fully responsible for spacecraft operations from launch to the completion of drift start manoeuvres. A first stage handover is then performed and the routine Galileo Control Centre is passed the responsibility for all Command and Control tasks. The LEOP service maintains Flight dynamics responsibility for the overall Mission Analysis: planning, calculation, evaluation of manoeuvres ; manoeuvre execution monitoring ; accurate orbit computation based on radiometric data from LEOP Ground Station network ; final LEOP handover after completion of fine positioning. These FDS functions and responsibilities are the same before and after this so called Command & Control handover.

The LEOP service also retains responsibility for the LEOP ground station network support. The routine control centre uses LEOP Ground Station network via the CNES interface during the fine positioning and drift stop phases to support spacecraft manoeuvres. The routine control centre executes localisation sequences according to the LEOP specifications during the drift stop and fine positioning phases. Once the fine positioning manoeuvres are completed a second and final handover transfers all remaining responsibility to the routine control centre and terminates the LEOP phase.

B. Joint organisation

The two agencies prepared two LEOP control centres (LOCC) located at their respective premises of Darmstadt and Toulouse, in order to deal with the rhythm of the deployment of the constellation. The satellites of two consecutives launches will be controlled alternatively from the two LOCCs.

CNES and ESA/ESOC each contribute manpower and expertise for a. "half" team; the two halves are integrated and form a single unit during LEOP operations.

As the teams are not co-located during the early development phases the preparation/implementation team differs from the operation organisation. Team leaders will be responsible of the activities of their respective teams in each centre. The overall responsibilities shared among the centres or allocated to one of the two institutes are as follow:

- Flight Operations preparation - and so the Flight Control Team - are under the overall responsibility of CNES Satellite Operation Manager (SOM) for IOV launches; subsequently for next launches they will be under the responsibility of the SOM of the centre in charge of the operations.
- Quality Management Systems harmonisation and Quality / Products Assurance activities preparation are under ESA/ESOC Product Assurance Representative.
- Data Systems implementation and suppliers contract management are under the overall responsibility of ESA/ESOC Technical Officers / Software Coordinator. Thus the deliveries and maintenance support of suitable configured and validated "re-used" elements such as Monitoring and Control System, Constellation Simulator and Operations Products Preparation tools are ESA/ESOC undertakings towards CNES, CNES being involved in the definition of the local configuration of these tools.
- Ground station network design and operations activities are under CNES responsibility only, so ESA/ESOC do not include similar responsible nor Network Operation service for this project.
- Flight Dynamics: it is foreseen for this activity to have two separate teams from the dedicated local resources, but two representative(s) of the other centre will take part actively in reciprocal operations..
- Local infrastructures: hardware, local area network, facilities and security supports are local to the centre in charge of the launch campaign and comply with the organisation rules of the hosting centre.

This joint approach is also maintained and reflected in the way the LEOP Service and external contacts are managed:

- LEOP Service points of contact towards the customers for technical and management aspects are symmetrical from CNES or ESA/ESOC
- LEOP Service team leaders (when a team is commonly staffed by the two institute or subco) are interchangeable CNES or ESA/ESOC
- LEOP Service representatives to any Review Boards (Anomaly, Changes, Tests, etc…) are equivalently provided by CNES or ESA/ESOC

LEOP Service reviews are dealt directly by the centre responsible for a given LEOP (if relevant) or commonly and symmetrically by the nominated CNES or ESA/ESOC team members.

C. LOCC infrastructure

The two LEOP Operations Control Centres are built by making extensive use of the existing institutional infrastructure at the two sites. For certain key elements identical facilities are deployed on both sites to ensure transferability of operational procedures and knowledge, as well as subsystem validation status, between the two LOCC's.

Because of schedule constraints on the two first launches both IOV LEOPs are supported from the Toulouse Space Centre premises. In later phases the LOCCs will still be used alternatively for dual launches to cope with the foreseen launch rate. ESOC LOCC-D (Darmstadt) is then currently set up to support the first IOC launch in parallel of the second IOV one.

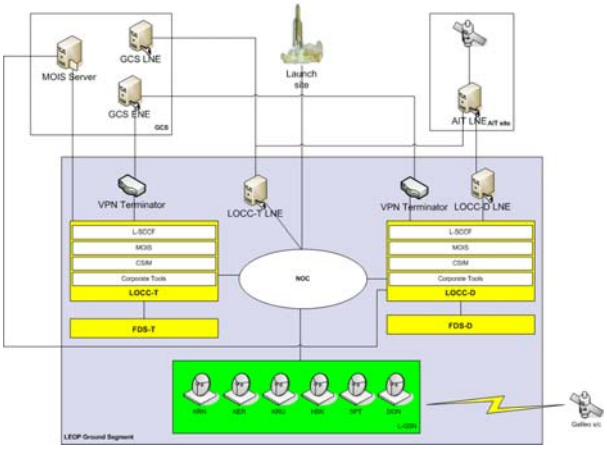


Figure 1 LOCCs infrastructure overview

D. S-band TT&C Facilities

The following network providers have been selected to support LEOP: ESA, CNES, and SSC Prioranet, giving access to a large range of ground stations to provide back up solutions and to ensure extendibility to the deployment phase (different launch sites / trajectories).

Extensive coverage is foreseen for the first several days, to ensure good visibility of all critical operations, also for non-nominal injections, and to allow a rapid response to unforeseen on-orbit anomalies (such as "infant mortality" or erratic behaviour of satellite units).

Sufficient coverage for the subsequent period is ensure to support the final positioning of the satellites in their orbit.

Any S-band tracking stations of these networks are already interfaced and used in both CNES and ESOC centres. A number of S-band TT&C stations are used during the LEOP operations to provide telemetry and command access to the spacecraft as well as to support ranging and tracking measurements.

Due to very accurate orbit determination needs for handover requirements fulfilment (fine positioning phase), the entire network is used to perform tracking measurements (and during long periods, up to 4 orbits).

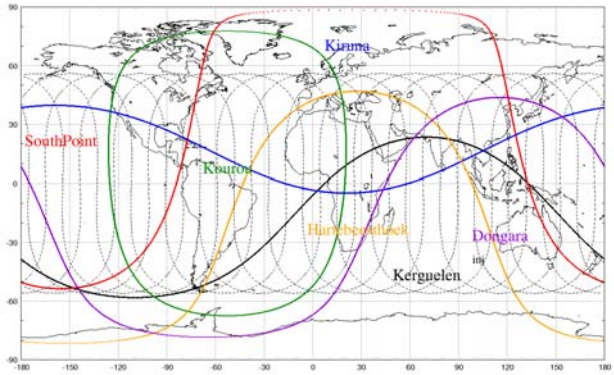


Figure 2 Ground Stations coverage

E. Accommodation for operational teams

These facilities are based on existing local means. Teams and sub-systems composing the LOCC infrastructure are hosted in existing local accommodations such that the LEOP operations are carried out from the Main Control Room (MCR), the Project Support Room (PSR), the Network Operation Centre (NOC), the Dedicated Control Room (DCR) and the Flight Dynamics Room (FDR).

The Main Control Room (MCR) is active from the simulation campaign up to the end of LEOP operations. This main room hosts -we are talking here about position and not individuals- the LEOP Service Operations Director (OD), the customer appointed Mission Director (MD), the Spacecraft Operations Manager (SOM) and his / her Flight Control Team (FCT), the Ground Operations Manager (GOM), the Software Coordinator, Product Assurance responsible and Toulouse Space Center Management in the case of LOCC-T. For critical phases, the Network manager is located in this room.

The Project Support Room (PSR) located beside the MCR hosts the Project Support team, composed of spacecraft experts from the spacecraft manufacturers. It is located next to MCR.

The Network Operation Centre (NOC) is in charge of the control of the ground stations, communication network, station and support department scheduling as well as provision of common multi-mission assets to the LOCC-T (video and time). This NOC is common for CNES and ESOC and will therefore be activated for all launches. The Orbit Computation Centre considered here as part of NOC is responsible for the collection and transformation of ranging and tracking parameters into the agreed format for Flight Dynamics and for the extrapolation of orbit data from FDS for station pointing and designation.

The Dedicated Control Room (DCR) is a specific room used for validation and training. During operations themselves, the software support team is nominally located there as well as analyst for offline activities support.

The Flight Dynamics Room (FDR) is the room where the Flight Dynamics Manager and his team are located, in charge of all activities related to the analysis of the dynamical behaviour of the spacecraft, and of the calculation and command generations for the execution of orbital and attitude manoeuvres.

III. Operational team organisation and evolutions during the course of the project.

A. Team Structure

The first layer represents the Decision level formed by the Mission Director assigned by the customer who is the only project decision point for operational organisation. The mission director has the responsibility, in close cooperation with the LEOP Operation Director, to make final decisions on the objectives and conduct of operations in case of non identified major contingencies.

The Operations Director (OD) is assigned from the Galileo LEOP Service Managers group. The OD is responsible for the successful conduct of LEOP including operational readiness of the entire LEOP Service assets. The OD is appointed before the start of the simulations and training program. The OD is responsible for the liaison with the Customer Representative (Mission Director) for technical and operational matters during the period from Operational Validation Readiness Review until the end of LEOP operations.

The Quality Assurance Representative support the OD on configuration aspects verification and Mission Review Board reporting.

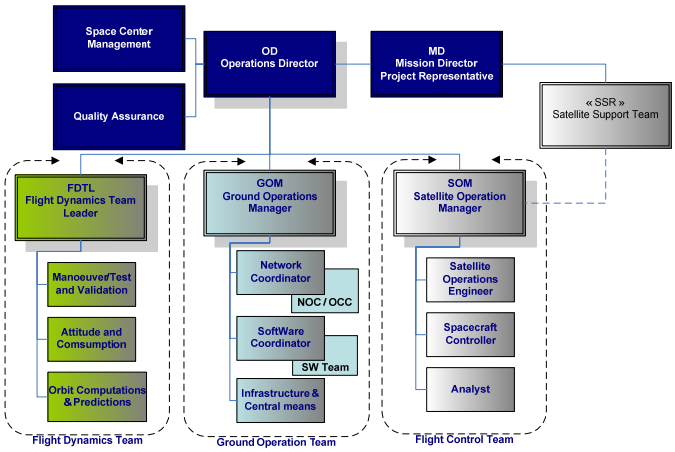


Figure 3 Overall operational organisation

For operations management three teams and their managers directly report to the Operation Director and ensure coordination of all operations.

The Flight Dynamics Manager in charge of Flight dynamics activities is supported by several engineers in charge of orbit determination, manoeuvre strategy, test and validation attitude guidance and propellant consumption management. He/she is directly in interface with GOM for stations or Monitoring and Control aspects, and with SOM for spacecraft related matters.

The Ground Operations Manager is in charge of operations scheduling and, ground operations supervision. For Monitoring and Control aspects, is supported by Software coordinator and the software team. For Ground stations aspects, the GOM directly interfaces with Network Manager and the NOC operators. For infrastructures aspects (power, HW issues, …), the GOM coordinates local infrastructure staff on-call during operations. The GOM closely coordinates with SOM and OD on the availability of the ground systems to allow access to the spacecraft by the Flight Control Team. The GOM develops and manages the mission timeline, and if necessary makes changes to the timeline during LEOP.

The Spacecraft Operation Manager in charge of all spacecraft operations activities is responsible for Spacecraft monitoring and for Flight Control procedures scheduling and execution. The SOM is supported by the Flight Control Team composed of Spacecraft Controllers (SPACONs) in charge of TC sending, by Spacecraft Operation Engineers (SOEs) for spacecraft subsystems monitoring and procedure execution, and by analyst for off-line tasks (DB

management, TM replay …)

B. Teams organisation in Main Control Room

Two kind of shifts are foreseen, "A" shifts (A1 and A2) corresponding to full manning of operation positions occupied by operation team members. They are used to support separation phase, and all critical phases in general (earth acquisition, manoeuvres, any contingency …). Shift B is the minimal team configuration to ensure satellite safety from "baby-sitting" monitoring with no significant operations foreseen.

The shift pattern is built to allow short and efficient shift in order to avoid tiredness and to comply also with French working regulations (not compatible with only two shift scheme organisation). Of course these patterns are slightly modified to reflect the final detailed timeline and need to be reshuffled in case of contingencies.

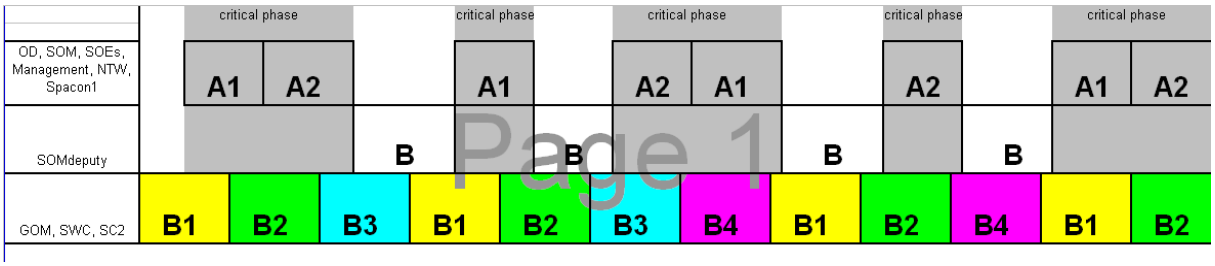


Figure 4 Shifting pattern before C&C hand-over

The following positions are staffed on a permanent 24/7 basis (3 times 8 hours pattern):

- One SOE
- One Spacon
- GOM
- Software support or coordinator
- Operation Director

SOE and Spacon positions in that case represent the "Baby sitting" shift. The GOM and SW support maintain their regular patterns independently of the phase.

For critical phases only, the above positions either handover to the A shift or are re-enforced by additional supports to staff as follow:

- Operation Director
- Management
- Quality Assurance
- SW Coordinator
- SOM
- GOM
- DHS/TTC SOE
- AOCS/PROP SOE
- TCS/ EPS SOE
- Analyst
- 2 Spacons

Whenever possible, the critical operations are scheduled at different time for both spacecraft in order not to overload the team. But during separation and critical phases with contingencies, both S/C enter in critical phase at the same time. The FCT is organised to allow a nominal sequence on one spacecraft while applying contingency procedures on the other spacecraft.

Two Spacecraft Controllers (SPACON) are ready to send commands on two separate and dedicated chains per satellite.

A complete "shift A" Team is on-call during these phases to be on-site within one hour.

C. Flight Dynamics Team shifts

As depicted on figure 4, the organisation for flight dynamics is shifted with respect to the rest of the operation team to cope with different offline activities. For orbit computation and manoeuvre preparation, the flight dynamic team is present well before the manoeuvre, and on the opposite, if a critical phase is not related to a manoeuvre, the team is present for part of the phase only, pending the activities needed.

D. Network Operation Centre

Operations staff works on 24/7 shifts to ensure correct connection between LOCC (CNES or ESOC) and Ground stations (but also with satellite integration site during Satellite Validation Tests at the satellite integration site or Launch base for pre-launch operations). The planning office is also a part of the NOC providing the reservation for ground stations. OCC part of NOC is in charge of processing pointing data for all stations from Flight dynamics inputs and providing localisation data in the agreed format to the different FDS.

E. Organisation after C&C handover

The organisation after the first (Command & Control) hand-over is reduced with respect to LEOP service full responsibility. It allows both the execution of operations under LEOP service responsibility (flight dynamics and network) and preparation of the second launch in the other LOCC for the future.

In order to perform the activities under LEOP Service responsibility, the following positions are maintained:

- Operation Director (together with QA and management) will retain his decision responsibility. He is in interface with GCC Operation Director. Mission Director from customer and Satellite support Team will move to GCC after C&C hand-over.
- Ground Operation manager will maintain his responsibilities to manage overall operation scheduling for LEOP Service.
- Network Coordinator stay in Toulouse in order to follow the adequate use of LEOP ground station network by the routine control centre and support to Flight dynamics
- The Full flight dynamics team keep its responsibilities.

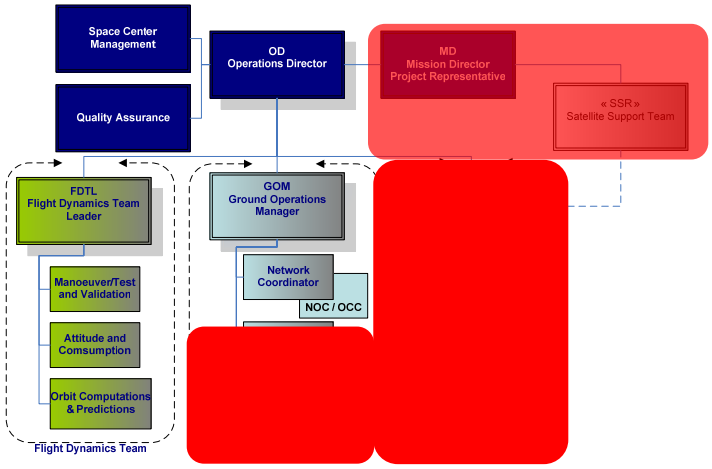


Figure 5 LEOP Service organisation after C&C hand-over

IV. Relationships (or the coffee shop v/s new technologies)

The single largest challenge in building a single team from two different centres keeping activities geographically spread has been the lack of enough meeting opportunities.

Although some of the senior people in the project had the chance to meet and exchange during the long preparatory phase this was not the case for people joining late in the project. It was then difficult to find the necessary time to build solid relationships while preparing the near future activities.

While in some areas, such as Project and top level management, positive relationships have been built from former collaborations on (METOP and ATV), or when the flight dynamics people found rapidly their *modus vivendi* from previous exchanges and workshops, some other teams grew so fast to cope with the very demanding workload that appropriate human interactions failed to develop.

A. Where human interactions failed to develop

When discussing the human issues encountered in the setup of this combined team it should be stressed that the participants from each Centre were all previously highly successful professionals in the environment of their Centre. The problems arose from the environment in which the combined team was required to work and from unrecognised and completely unexpected differences in approach and professional culture in the implementation of what appeared to be almost identical approaches to Operations and its preparation. If fault is to be found with any of the participants then it lies with the LEOP Service Managers (the authors of this paper) rather than the individual engineers, each of whom consistently worked according to the Best Practice of their establishments.

The distance and the time pressure misaligned the objectives of the two centres and prevented consistent vision of the priorities. A different perception of management of responsibilities delegation and reporting schema (insight versus micromanagement of human resources and tasks) created considerable difficulties with in some cases mistrust. Some basic communication behaviours (such as direct phone calls) were lost and e-mail chains of escalation caused unexpected misunderstanding..

From the status of « Unbalanced team » feeling the communication between the two centres reached a critical situation which could have endangered the LEOP Service, affecting each individual wellness and willingness. Instead of building in common we were diverging with the unfortunate and depressing facts that there is always people who did not (and still certainly do not) believe this would work.

This became such a self fulfilling expectation that people even stopped trying to communicate, furthermore it became obvious that the tiredness and stress periods with sometime complete exhaustion had their part in increasing what were just only little issues in the beginning.

New technologies are not enough to fill the gap of the geographical distance and do not help to create the necessary exchange forum that can be found when people are co-located and where they can benefit of some neutral areas (the coffee-shop "effect") to break and release the nervous strain.

Nevertheless the challenge and (one of) the objective was clear: we would succeed or fail only together. The clear need to repair the situation in the best professional manner we always demonstrated in each establishment was necessary. This cooperation within this very specific programme environment bound by small latitude (technical, financial, programmatic,…) and unstable environment (mainly schedule), requires much more of the art of compromise than we all were used to. People were invited to come back to a "Tough but Competent" behaviour in a rational and non-emotional manner in order to maintain or sometime demonstrate the professionalism of the two centres.

Sets of what are considered obvious and basic communication behaviours have been recalled and closely monitored in order to fix the situation: no public dispute; communication improvement; personnel exchanges.

B. Public disputes

Everyone has been invited to take particular care of the tone and word used in public in order to clearly forbid any public disputes and or sarcasms when other parties are present as the result of this would only bethe weakening of the LEOP Service position of any kind and the possible temptation for some "divide and conquer" approaches.

In the same way the human relationships lead to a temptation to "consolidate" in front of common "opponent" (anyone not part of the LEOP team).

It was then clarified that "centres" internal issues are to be solved by the appropriate CNES or ESOC processes and management without the involvement of the other half of the team. The LEOP Service issues are to be solved by the CNESOC processes and management with no need to publicise towards other Agencies or customers. This applied with particular attention to verbal communication during teleconference, meetings, and presentations as well as written communications (no email "wars").

C. Communication improvement

Then the LEOP Service management needed to define the conflict resolution process better. The aim was to (re) build a decision making process by "consensus", inviting the team members to reach agreement with their counterpart before publishing and escalating immediately to the LEOP service project management if they could not agree.

This was driven as well from a further cultural difference not anticipated between the two agencies. While one centre was starting to draft technical documentation as proposed inputs to discussions, the other was more used to "brainstorm" on a topic before writing things down. The second party was then left with the impression that the written material was rather imposed statements than actual proposals.

Another communication improvement was put on the need for proper information distribution and processing by "restricting" e-mail chains on technical discussions, providing feedback to the received correspondences (or at least acknowledge receipt) and maximizing co-writing of documents.

This was of major importance during important milestones like reviews where "book captains" where nominated with the job to (mainly) coordinate the inputs rather than to write the complete documents. It was important during this intensive documentation process to "restrict" the e-mail chains but to require feedback to the work (but only from small groups) in practicing highly iterative document writing and exchange.

The set of coordination meetings already in place was re-arranged reminding people that these were their forum. Eventually the need to enforce verbal communication has been recalled in a "Pick up your PHONES!" motto.

D. Personnel « exchanges »

To improve visibility and coordination among the two LEOP sites the augmentation of co-location periods and exchanges was seen as mandatory despite the obvious impacts on private life and to a certain extent on travel budgets.

In order to balance the travel burden it was chosen to co-locate alternately at the other LOCC the team leaders or

operations engineers for "normal" work, meaning not for special workshops or meeting. The co-location for ground system has been increased as well for sub-system deliveries, site acceptance tests and different deployments or integration activities. This was done in addition to the usual co-location during operational milestones such as Satellite Validation Tests and of course to the already planned and obviously co-located Simulation Campaign.

For the next launches preparation new comers (turn-over and recruitment) need to discover the other site. In order to do so some "get together day" sessions have been organized and need to be rescheduled. Particular attention shall be paid to encourage people to attend training sessions convened in the other location sometime in place of remote attendance by videoconference. The improvement in mixing the teams is more than considered for next launches.

V. Lessons learnt and ways forward for the subsequent launches

A. The commonality "dogma"

1. The ground systems

As explained before in this paper it was agreed at the very beginning of this cooperation to use on both centres a common infrastructure for the Mission Control System based on SCOS2000 the ESOC generic TM/TC infrastructure.

During the course of the project this has been further enforced with the mandatory use of the ground infrastructure inherited from the routine control centre development.

It shall be noted here that at that time it was of usual practice in CNES to develop bespoke mission control centre for new missions (missions being platform family dependant).

It has been very challenging to reach the common understanding of the actual meaning of commonality though and to agree on the boundaries of it, trying to maximise the re-use of existing infrastructures of the centres while minimising the impact on the development of the kernel functions avoiding too many configuration "branching" especially in the software part.

The same is true for complementary tools such as off line trend analysis and telemetry post processing. Time pressure on one hand, made impossible the completion of all possible trade-off on different candidate tools from both centres but, on the other hand, forced the decisions usually it is true in favour of the centre hosting because of the mastered environment. Eventually both centres will be "upgraded" with existing in house supporting tools exchanged between centres.

2. Operational products

It has been recognised that the commonality of Operational Products was carried too far during this first launch preparation.

The effort spent on fully common operational products to both routine and LEOP sites and the lack of appropriate time to allow deviations induced on all parties:

- delays in the availability of final products because of sequential nature of this process even if it first allowed to decrease some team members workload
- lack of flexibility with respect to different schedule needs between routine and LEOP centres preparation
- lack of flexibility in the management process (change boards, configuration freeze,…) in extremely tight period before launch where the necessary priority given to one party has blocked the other
- necessary rework on several common parts because the aims and needs between routine and LEOP cannot be identical

This results during the last months of preparation in the necessary split management of two lines of products which were phases/centres dependant. It seems obvious that the problem listed above will become even more significant during the parallel preparation of multiple launches while managing the growing satellite constellation.

Nevertheless commonality remains to be kept and ensured for the deliverables from which the operational products are derived (e.g. MIB resulting from SRDB extract, relevant attendance of operational people in the SRDB process, engineering workshops,…). Of course, all final products are available to all relevant parties.

B. Management of simulations and rehearsals

In order to lower the travel frequency from the "second" LOCC site attendance (but this also applies to Project Support Team) the set of formal simulation campaign with full attendance (LEOP team and Project Support Team) is reduced.

In addition a number of "nano sims" is set at each LEOP centres on a weekly basis to allow smaller groups of teams to work together as well as team exchanges (e.g. Flight Dynamics "nano sim" with reduced Flight Control Team participation). Attendance to these "nano sims" is opened to everybody from both centres but can be reduced to minimise LEOP team and Project Support Team travels.

These "nano sims" are also very good opportunities in order to start newcomers training. They are not formal at all and the slots can be cancelled if needed.

Some recommendation towards project support teams have been proposed. People who already participated to the previous launch campaign should join as a minimum for contingency simulations. New people in this team should join one day to train on the different tools possibly a day before one of the simulation they may attend and attend 4 nominal simulations in order to practice the nominal LEOP timeline operations before participating to the contingency simulations. Of course, Project Support people can additionally join during any simulations during the whole campaign (15 simulations concentrated over 5 non consecutive weeks).

VI. Conclusion

Challenging by nature, spacecraft operations and Launch and Early Orbit Phase in particular provide to highly dedicated people composing the various operational teams its amount of adrenaline and spice their life.

New missions always have their interest in new technical challenges, this one was not necessarily about discovering a new spacecraft or equipment family but more on the way to manage two vehicles in parallel and to pave the way to possibly manage four in the future coping with a demanding deployment tempo.

Being part of an European flagship programme, the very first one for space project added its own complexity in the management of the different segments and their interfaces, introducing as well difficulties in managing necessary contractual and organization changes occurring during the course of the project.

But, among all others the largest one is the cultural challenge. To master the efficient communication level between two "miles away" centres in order to integrate the best of both operations concept to guarantee the fulfilment of the LEOP Service responsibility has certainly not been as smooth as expected.

The first launch milestone has been passed, successfully with no doubt, but this is just the beginning. The people shall prepare to deal with difficulties and unexpected events and we are not talking here about operational contingencies. However, as during operations we also learn by doing and then capitalised the lessons to do better the next time!

"To be continued…"