CNES ORGANIZATION FOR STATION POSITIONING OF GEOSTATIONARY SATELLITES

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ABSTRACT

Since 1975, the Toulouse Space Centre (a technical establishment of the French Space Agency, CNES) has successfully brought 15 geostationary satellites on to station.

During these 17 years of experience, an organization of human and material resources has been built up that ensures a very high level of reliability in the execution of these station positioning operations.

The main characteristics of this organization are a rigourous definition of the roles and responsibilities of each person involved, very detailed operations documentation, and methodical preparation of the operations.

Key Words : Geostationary satellite, station positioning, operations documentation, organization

1. INTRODUCTION

It was in December 1974 that CNES and the DFVLR
successfully brought SYMPHONIE-A, the first European geostationary satellite, on to station. This first station acquisition was followed by that of SYMPHONIE-B in August 1975.

This early experience proved very useful when CNES had to make the preparations for bringing the first French telecommunications satellite, TELECOM 1, on to station at the beginning of the '80s.

The technical and human organization set up at that time showed its efficiency when TELECOM 1-A was correctly positioned on station in August 1984.

The principles of this same organization have since been used by CNES to bring 13 successive satellites on to station :

- TELECOM 1B
- TDF 1
- TELE-X
- TELECOM 1C
- TDF 2
- INMARSAT 2 F1
- INMARSAT 2 F2
- TELECOM 2A/INMARSAT2 F3(*)
- ARABSAT 1C
- TELECOM 2B/INMARSAT2 F4(*)
- HISPASAT 1A

(*) brought on to station simultaneously

Although the contractual and technical contexts of these station acquisition operations were very different, the organizational principles stayed the same, demonstrating their capability to adapt and develop.

In this article, we present the three most characteristic aspects of this organization :

- rigourous definition of the responsibilities of those involved in the operations,
- very detailed operations documentation,
- methodical training for operations.

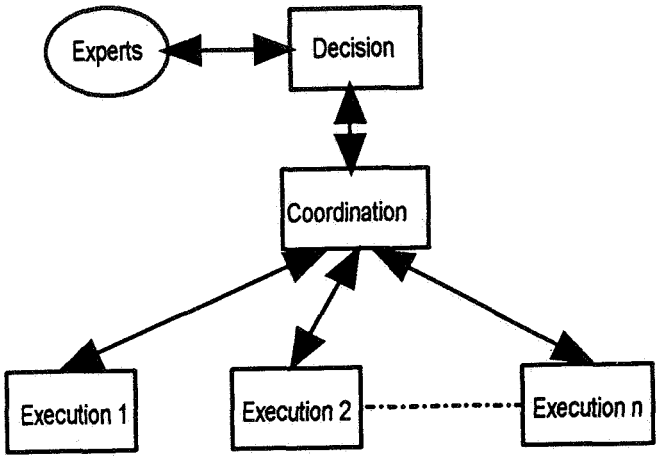
2. OPERATIONAL ORGANIZATION

2.1 Those concerned

There are three levels in the organization :

- Decision
- Coordination
- Execution

as shown diagrammatically below.



At the decision level there is a team of experts (generally from the industrial organization building the satellite) responsible for helping the decision-makers.

2.2 Modes of operation

There are two possible modes of operation while a satellite is being brought on to station:

- *nominal mode* : the satellite behaves as expected; the redundancy in the ground equipment is sufficient to ensure replacements in cases of failure.

- *degraded mode* : the satellite's behaviour is abnormal; the level of failures in ground equipment is such that execution of the operations cannot be ensured with sufficient safety.

In *nominal operating mode* : the operations are performed in accordance with the pre-established plans and procedures under the leadership of the coordination entity, the decision-making entity only intervening to authorize the starts of the most critical phases of the mission (launch, apogee manoeuvres, etc.).

In *degraded operating mode* after the anomaly has been identified, the experts draw up an emergency strategy and the corresponding executable procedures with the heads of the entity concerned.

After authorization by the decision-making entity, the procedures are executed by the entities concerned under the orders of the coordination entity.

2.3 Organization for TELECOM 2 station acquisition

As an example, the figure below gives the organization set up to bring the TELECOM 2 satellites on to station.

The functions of each person concerned are as follows :

- *The Mission Manager* is responsible for how operations progress and keeps the Customer's Representative informed. He sees to the application of degraded case procedures.

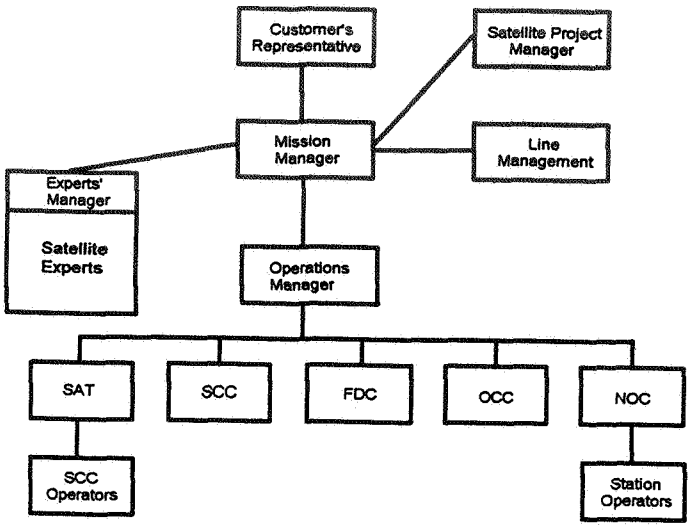
- *The Customer's Representative, the Satellite Project Manager and the line management* participate in decision making for degraded situations.

- *The Operations Manager* conducts the station acquisition operations and coordinates the activity of the operational entities

- *The Satellite Engineer* (SAT) is responsible for the execution of actions on the satellite when the situation is nominal.

- *The Head of the SCC* is responsible for the running of the Satellite Control Centre.

- *The FDC Manager* is responsible for the elaboration of orbit and attitude manoeuvres; he supplies the Operations Manager with the data needed for their execution.



The OCC Manager is responsible for the acquisition of localization measurements from the various networks, for orbit restitution and for station designation.

- *The NOC Manager* coordinates the activity of the stations in the network used for bringing the satellite on to station.

- *The Experts* monitor the satellite's behaviour and suggest corrective action if behaviour is abnormal. *The Experts' Manager* coordinates their activity.

The people concerned work in different rooms which may be far apart; communications are provided by a system of interphones and video image transmission.

3. OPERATIONS DOCUMENTATION

3.1 At decision level

The Decision Plan describes the decision-making process during operations, particularly for cases where operations do not progress as expected.

3.2 At coordination level

The General Operations Plan describes the overall operations organization and the ground system configurations. It serves as a reference for drawing up the Specialized Operations Plans (SOPs).

The Control Plan contains the linked chronological sequence of all the procedures needed to successfully bring the satellite on to station. The Operations Manager is in charge of its unfolding throughout the course of operations.

The Flight Plan is a graphic overview of the Control Plan. For each orbit it shows :

- the stations in view
- the manoeuvres to be executed.

3.3 At execution level

The Manoeuvre Operations Procedures (MOP's) precisely define the operations to be carried out on the satellite : telecommands to be sent, telemetry monitoring. The MOP's are executed under the responsibility of the Satellite Engineer.

The Specialized Operations Plans (SOP's) individually define the organization, configuration and, possibly, the timeline specific to each entity.

The Ground Procedures state the implementation procedures for the various equipment or software used for each entity.

3.4 Documentation for Operational Qualification

The Operational Qualification Plan defines the qualification principles for the ground system, the specifications to be verified and the list of exercises to be carried out.

Each exercise is defined in an *Operations Order* and the results of the exercise are recorded in an *Exercise Report*.

4. PREPARATION FOR OPERATIONS

4.1 Technical assembly

Technical assembly consists of linking together the main components of the system and testing that they work properly. This phase starts after acceptance of the components developed specifically for the mission.

The main components to be taken into consideration are, for the case of the TELECOM 1 ground system :

- The Specialized Control Centre (SCC)
- The Flight Dynamics Centre (FDC)
- The 2 GHz Network (CNES and NASA stations)
- The Orbit Computation Centre.

A document called the Technical Assembly Plan defines, for each test :

- the objectives
- the initial conditions
- those involved
- the procedures to be applied
- the planning.

This phase is very important; it checks that the ground system is working properly and allows the operations teams to familiarize themselves with its use.

4.2 Operational Qualification

The purpose of *Operational Qualification* is to demonstrate that the ground system for station acquisition is capable of performing the station acquisition operations.

It has three principle objectives :

- to train all staff,
- to validate the operations documentation,
- to demonstrate the system's capacity to carry out the operations in accordance with the Flight Plan.

The programme is made up of three levels, each level being composed of several exercises having a common aim.

Level 1 :

Training exercises in the implementation of the operational configuration of the ground system with training in :

- diagnosing ground failures
- changing ground configuration

Level 2 :

Exercises in the progression of individual operations procedures for station acquisition manoeuvres, the entities concerned and satellite experts involved in the test being brought into play. The purpose of these exercises is to give the teams overall training in the time sequence, qualify the documentation and demonstrate the ground system's ability to carry out the operations under operational conditions. All the exercises take place in nominal spacecraft and ground operating conditions, although a few degraded cases will also be requested.

Level 3 :

Exercises in the progression of linked sequences of station acquisition under real conditions with the experts present and gradual introduction of degraded cases for the ground and spacecraft, so as to test the teams' capacities to deal with anomalies while respecting the operations procedures.

Each exercise is described in an operations order, which states :

- the test identification number,
- the date and time of the start of the test,
- the aim of the test,
- the duration of the test,
- the configuration requested,
- the simulation facilities required,
- the initialization case to be used by the simulator,
- the entities concerned,
- the documentation used,
- the information specific to the test,
- the staff concerned.

At the start of each test, a short briefing by the Operations Manager confirms the information contained in the operations order and the test conditions.

At the end of each exercise, a debriefing by the Mission Manager brings together the Operations and Entity Managers and the Customer's Representative for an immediate report on how the exercise went. This also allows the Quality Manager to take the anomalies into account.

The decision to accept or rerun the exercise is taken at the debriefings.

Operational Qualification generally lasts two months for the first flight model of a family of satellites and a month or less for the following ones.

During Operational Qualification, great care must be paid to managing the changes made to the operations documentation.

4.3 Waiting in Operational Condition

This phase corresponds to the period of a few weeks (nominally 4 to 2) between the end of Operational Qualification and launch. In principle, the configuration is frozen and only those changes that are absolutely indispensable are made to the system.

A few exercises are performed to enhance team training.

CONCLUSION

The organization set up at CNES for bringing geostationary satellites on to station is the result of long experience. It has proved its capacity to adapt to varied technical contexts (Networks, Satellites, Launcher) and different contractual relationships.