A GRAPHIC SYSTEM FOR TELEMETRY MONITORING AND PROCEDURE PERFORMING AT THE TELECOM S.C.C.

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Abstract

The increasing amount of telemetry parameters and the increasing complexity of procedures used for the in-orbit satellite follow-up has led to develop new tools for telemetry monitoring and procedures performing.
The name of the system presented here is GRAPHIC SERVER.
It provides an advanced graphic representation of the satellite subsystems, including real-time telemetry and alarm displaying, and a powerful help for decision making with on line contingency procedures.
Used for 2.5 years at the TELECOM S.C.C. for procedure performing, it has become an essential part of the S.C.C.

Key words: Satellite telemetry displaying, on-line procedures, functional graphic mimics.

Introduction

The TELECOM S.C.C. is in charge of the control and the follow-up of the French TELECOM satellites. Three satellites are in orbit today: TELECOM 1C the last model of the TELECOM 1 satellites, TELECOM 2A and 2B the two first models of the TELECOM 2 family.
The main task of the S.C.C. is to perform all operations required for station-keeping and satellite subsystems management.
The increasing complexity of spacecraft subsystems and procedures, and the increasing amount of telemetry (TM) parameters led to develop a new tool called "Graphic Server" providing a friendly man-machine interface to monitor and display all TM parameters, both in routine phase and during procedure performing.
Nowadays, this tool has been used at the TELECOM S.C.C. for 2.5 years.
This paper will first give a brief summary of the architecture and the facilities of the Graphic Server, then present the result of its operational use.

General description

The Graphic Server is a system displaying real-time telemetry on up to five simultaneous graphic displays. It is connected to the S.C.C. telemetry acquisition and monitoring system from which it receives TM parameter values and alarm codes for the selected satellites in order to update all the graphic items on the displayed mimics.
It also manages a graphic interface used by the operator to choose the appropriate mimics among the available ones in the mimic base, and to request the involved TM parameters to the S.C.C. computer.
All the available mimics are previously designed using the off-line application which provides a graphic editor, consistency tests, a simulation tool and storage facilities.

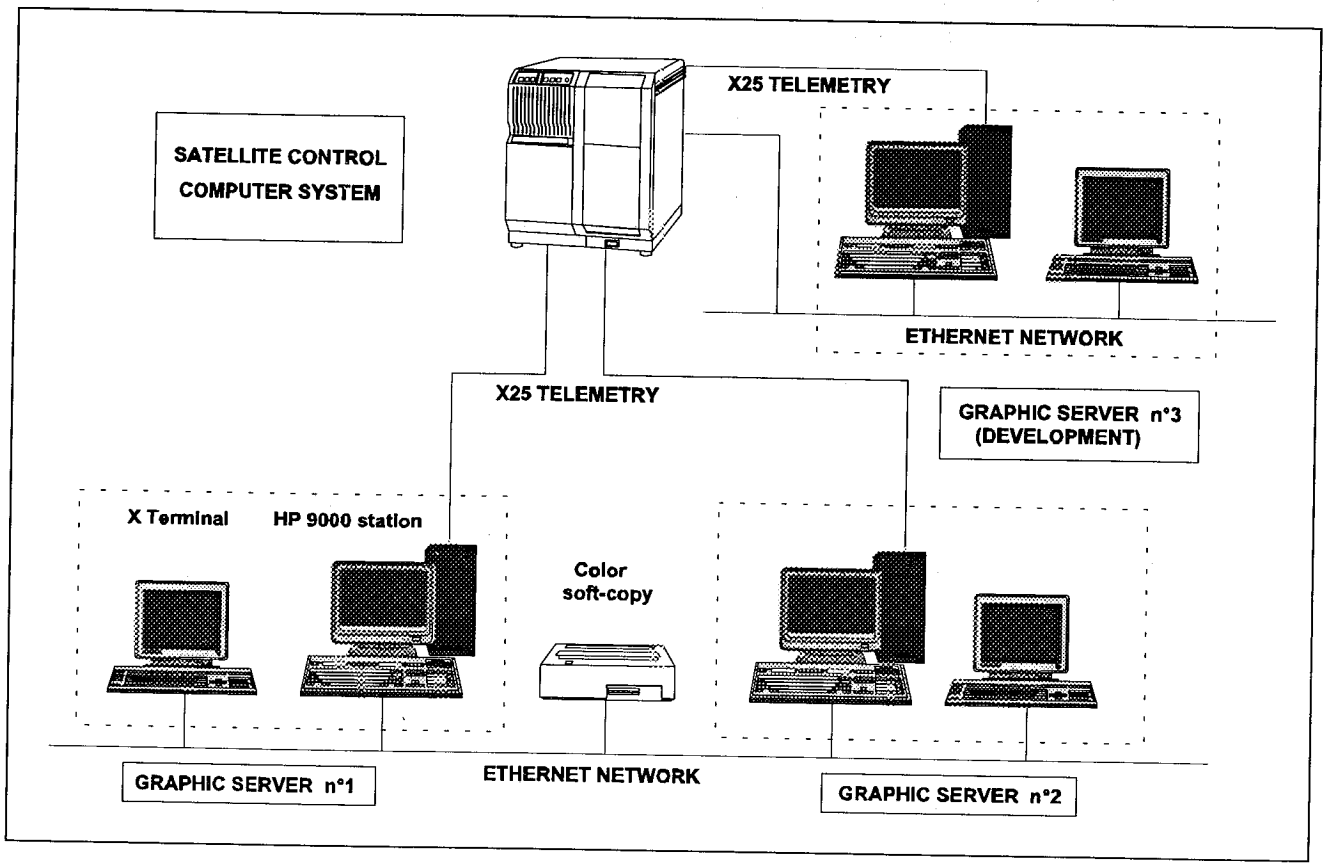

Figure n°1 : Hardware description

Hardware environment

The Graphic Server is supported by a Hewlett Packard configuration (see figure n°1)

- a HP 9000 computer from the 800 series under HP UX with a 335 Mb disk, 24 Mb of RAM memory and a 16 tracks streamer.
- a high resolution 19 inches bit-map display as the master display.
- an X-terminal with a 19 inches display as the slave display.
- an alphanumeric display as the system supervisor terminal.

Communications between the Graphic Server and the S.C.C. telemetry acquisition system are supported by:

- an X25 link for real-time telemetry .
- an ETHERNET link for the development Graphic Server work station

Internal communication between the HP work station and the X-terminal is supported by a local ETHERNET link.

Software environment

The software configuration implies the following items:

- HP UX operating system
- C compilator
- HPGKS, STARBASE, X25, FORTRAN, and X11 environment.
- ANIMATOR, a graphic software package developed and distributed by the SYSECA company
- the Graphic Server application.

Application description

The Graphic Server application provides the off-line mode including all tools for creating, checking, and storing the mimics, and the real-time mode used for TM data acquisition,

mimics updating and operator's requests handling (see figure n°2).

The real-time mode

The real-time application performs the TM parameters acquisition, and using the "graphic real-time environment" developed with the off-line mode, actuates the animation of the telemetry data flows, only data involved in the displayed mimics are sent to the Graphic Server. Each new mimic request will first trigger a telemetry data request before displaying and updating this new mimic. These data are already processed by the S.C.C. telemetry acquisition and monitoring system, and sent to the Graphic Server under a label, a

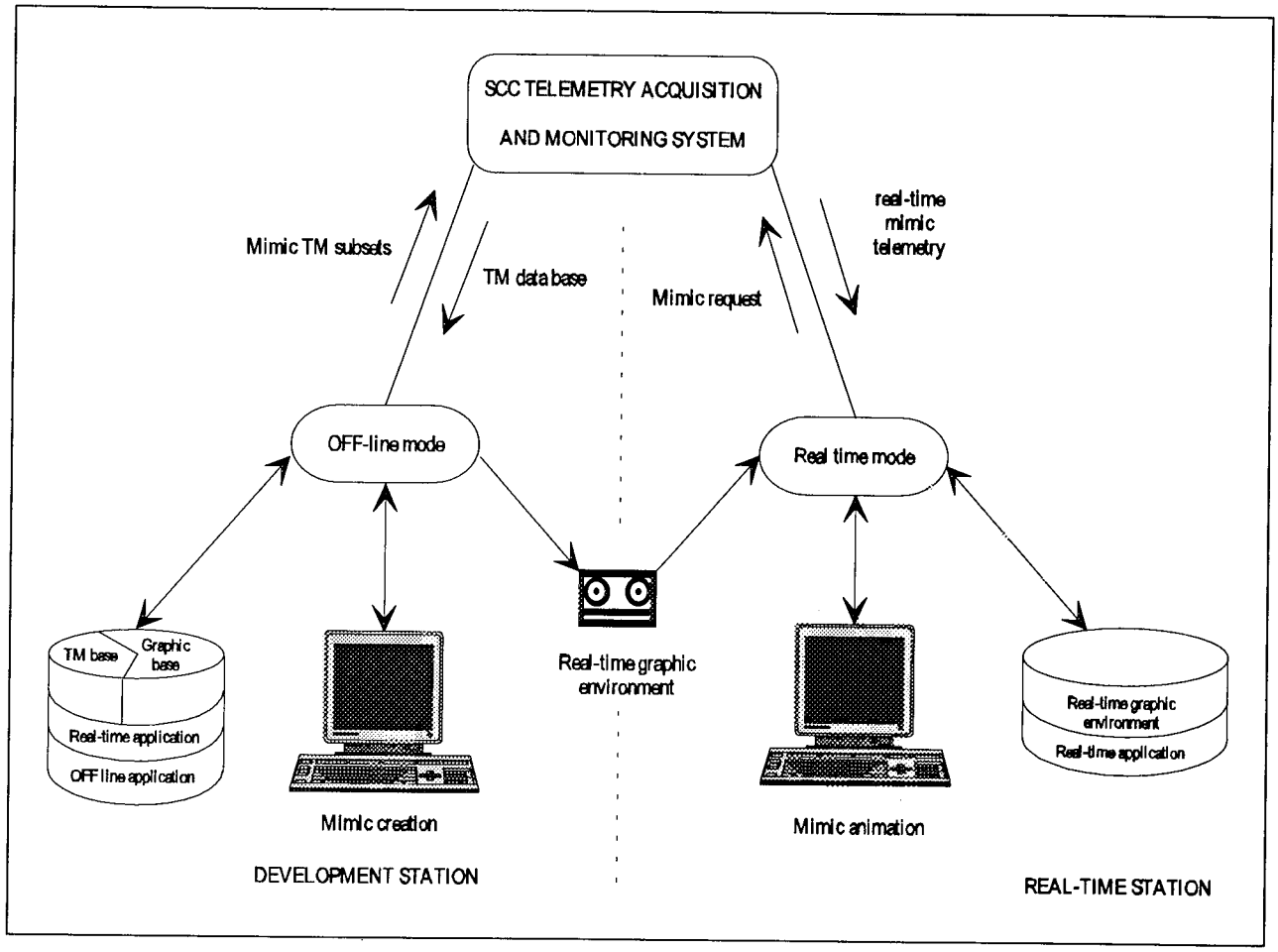

Figure n°2 : Real-time and off-line modes

graphic items used in the displayed mimics. It enables to display and update up to five mimics, one full screen on the bit map display, and one full screen, (or four quartered screen) on the X-terminal display according to its software configuration.
Telemetry data can be real-time or replayed from one or several satellites, or simulated data from a satellite simulator. In order to minimize raw value, an engineered value, and an alarm code. Telemetry data values are used to update all graphic representations , and alarm codes to update their color.
A specific default representation is also used for TM parameters which have never been received.

The off-line mode

The off-line mode, only available on the development work station, is used to create, check, test and store the mimics.
Each mimic can include the following kinds of graphic items: static background drawings, dynamic graphic items (graphic symbols, numeric or alphanumeric values, auto-scrolling curves) used to display the TM parameter values and alarm codes, and clickable areas used to control the displayed mimics.
All these items are created by the system manager and stored into specific libraries, so they can be used again when creating new mimics.
The first action to create a mimic is to define the background drawing with the graphic editor, then to pick up (or create) dynamic items from the libraries, according to the way you want to display each TM parameter (several simultaneous representations are allowed for the same TM parameter).
The second step is to associate those graphic items with the TM parameter labels.
After compilation, consistency tests are performed using the telemetry data base exported from the S.C.C. telemetry acquisition system.
The third step is to export to the S.C.C telemetry acquisition system, the "mimics TM parameter subsets". These subsets will be used by the system to send to the Graphic Server the involved TM parameters after a mimic request.
As a final step, you have to generate and store the "graphic real-time environment" which will be used by the real-time mode.
A simulation tool provides the ability to test created mimics before using them with real time telemetry.

Using the system

The Graphic Server tool was implemented in December 1991 as an additional mean for telemetry displaying in the TELECOM S.C.C. and in the TELECOM 2 payload centers.

The graphic environment has been developed for two years by the TELECOM 2 spacecraft analysts according to the operational needs. More than 250 mimics were created, using about 1000 graphic items, enabling to display more than 2000 TM parameters.

Mimic ergonomy definition

Considering the amount of TM parameters and so the number of mimics to create, the first job was to define graphic ergonomy rules for the development of the mimics in order to provide a friendly access to TM parameters and an easy understanding of the satellite subsystems.

Color codes: a specific color code is used to identify each TM parameter alarm status (not received, normal, first level or second level of alarm,), telecommand labels, telemetry labels, static items (without telemetry), wires or links, ON or OFF equipment, clickable areas.

Symbol codes: generic patterns used in numerous mimics were created with standard graphic items (telecommand cartridges, telemetry cartridges, automatic reconfiguration orders, warnings, TOPs, switches...etc.) enabling an easy perception through a whole mimic.

Mimics organisation

Several kinds of mimics were created according to the operational uses:

Alphabetic alphanumeric TM parameter lists:
These mimics displaying both engineered and raw values of TM parameters allow to reach immediately any TM parameter using its label, without knowing the other kinds of mimic where they are involved in. They can be used to check calibration functions of TM parameters with both engineer and row values.

Thematic alphanumeric mimics:
These mimics display groups of TM parameters, sorted according to a satellite subsystem, function, equipment or procedure only in engineered values.

Synoptic mimics:
These kind of mimic can be functional synoptics of satellite subsystems, control panels, monitoring mimics, or on line procedure.
Functional synoptics are organised in a hierarchic way with clickable areas to move through the functional tree from high level synoptics to fully detailed ones. Using all kind of graphic items created by the system user, they display TM parameter values and labels, telecommand labels and expected effects, automatic reconfiguration orders and functional schemes. As they provide an easy understanding of satellites subsystems, they are mainly used to perform complex procedures (see figure n°3).
Control panels are subsystem (or whole spacecraft) syntheses and are used to check satellite configuration (see figure n4).
Monitoring mimics are developed as a guideline for some contingency procedures which require short time reaction. They display the involved TM parameters, decision trees with clickable areas allowing to display on line procedures (see figure n°5).

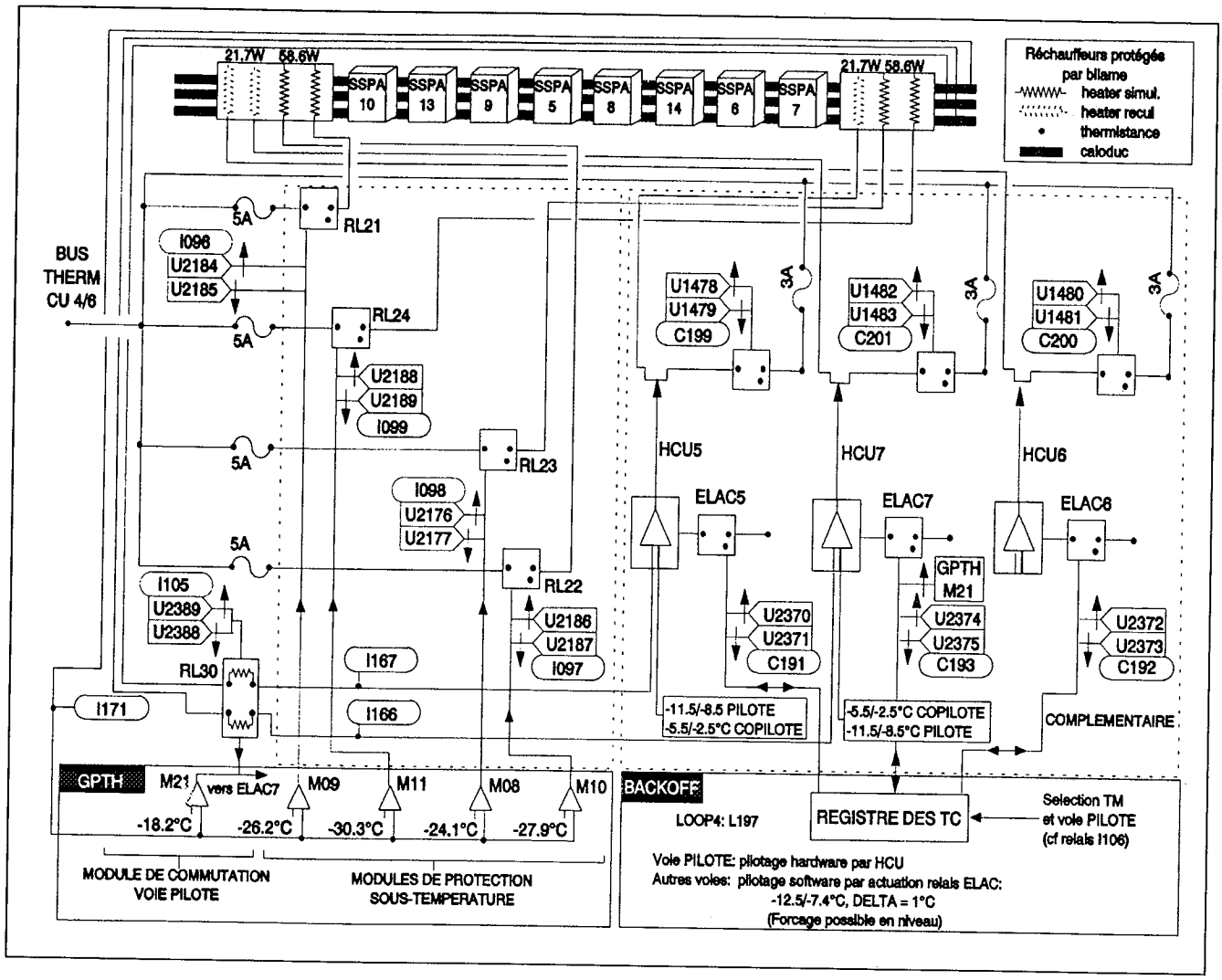

Figure n°3 : Functional synoptic mimic

Curves mimics
These mimics display auto-scrolling curves of TM parameters, and are mainly used to monitor

some specific operations such as manoeuvers or eclipses and as routine displays.

Procedures mimics
These mimics include procedure schemes, explanations, and involved TM parameters. They are designed to minimise the operator's response time for the procedure application (see figure n°6).

Real-time man-machine interface

The MMI is used to display any mimic, on any of the five screens using any satellite real-time (or replayed) telemetry data flow. This dialog is enabled by several kinds of clickable areas (identified by their color) on the mimic displayed on the master screen.

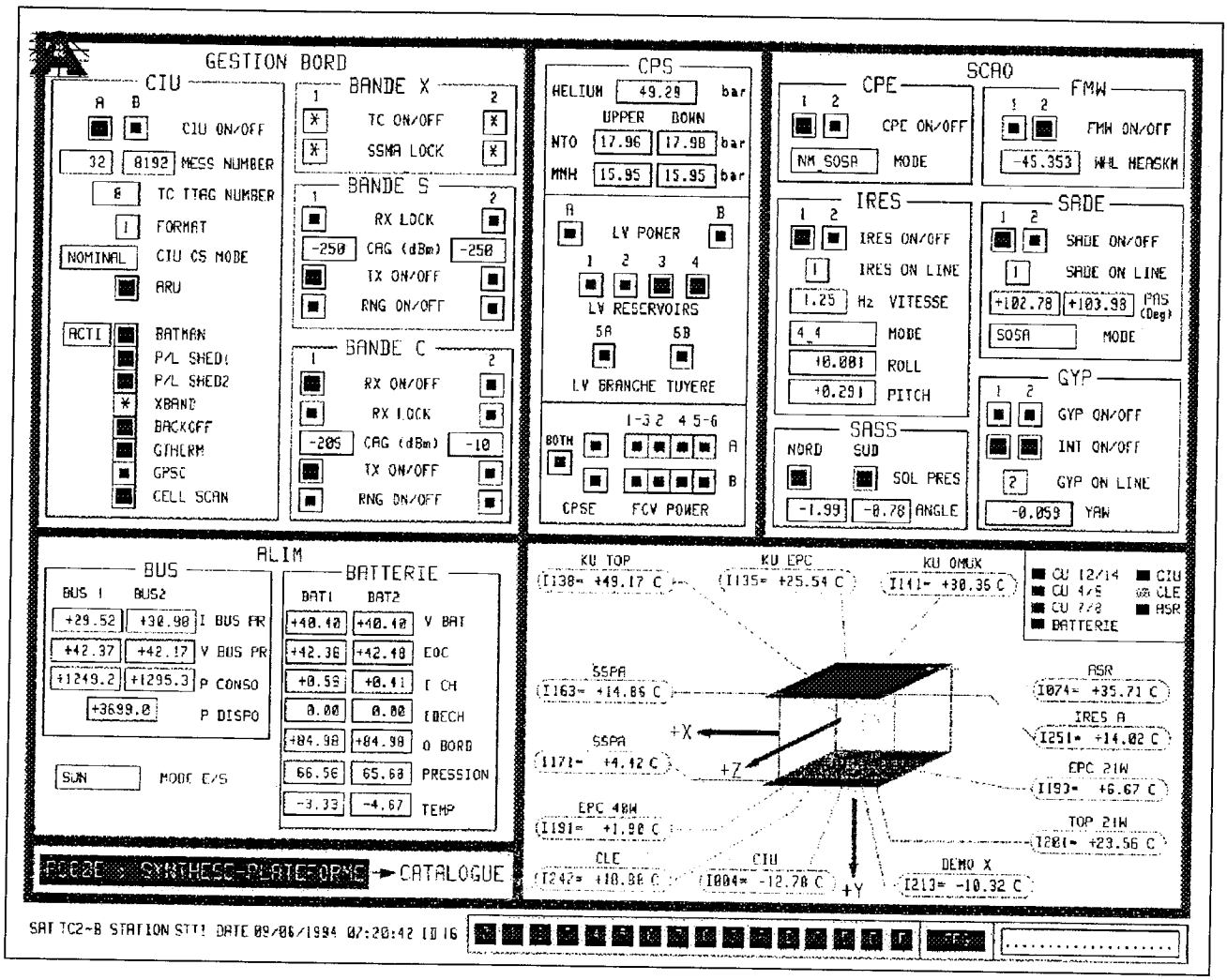

Figure n°4 : Control panel mimic

Directory mimics
This type of mimic is used to display directories of each kind of mimic.
It display the mimics titles and labels and provides an immediate display of the requested mimic clicking on its label.

Keyboard requests through a dialog box
This is the generic mean to create a request. The operator has to define the following items : (mimic label / satellite / real-time or replayed telemetry / screen number) with the keyboard using first the clickable dialog box available in any mimic. It requires to know the mimic label.

Mimic request through clickable graphic items
These items (created by the system user), identified by their color, are included in the mimics according to the logical links between them. They are mainly used to move through functional synoptics and to reach any mimic from specific displays providing mimic directories. They allow to display a new mimic only on the master screen.

Dynamic buttons
A graphic interface enables to program 16 buttons choosing a combination of the following items for each of them (mimic label / satellite / real-time or replayed / screen number).These buttons are the only way to request for a mimic on the slave screen whitout using the keyboard.
As these buttons are displayed at the bottom of any mimic, they provide the ability to create temporary links between mimics used for a particular procedure.To improve this selection, the system allows to store 15 programs of the 16 buttons.These programs are defined, named stored and selected by the operator according to particular procedures or phases(exemple : "Manoeuver" or "Eclipse" program).
By this way, the operator has the ability to display imediatly any mimic of the involved ones, (without knowing its name) when he performs a procedure.

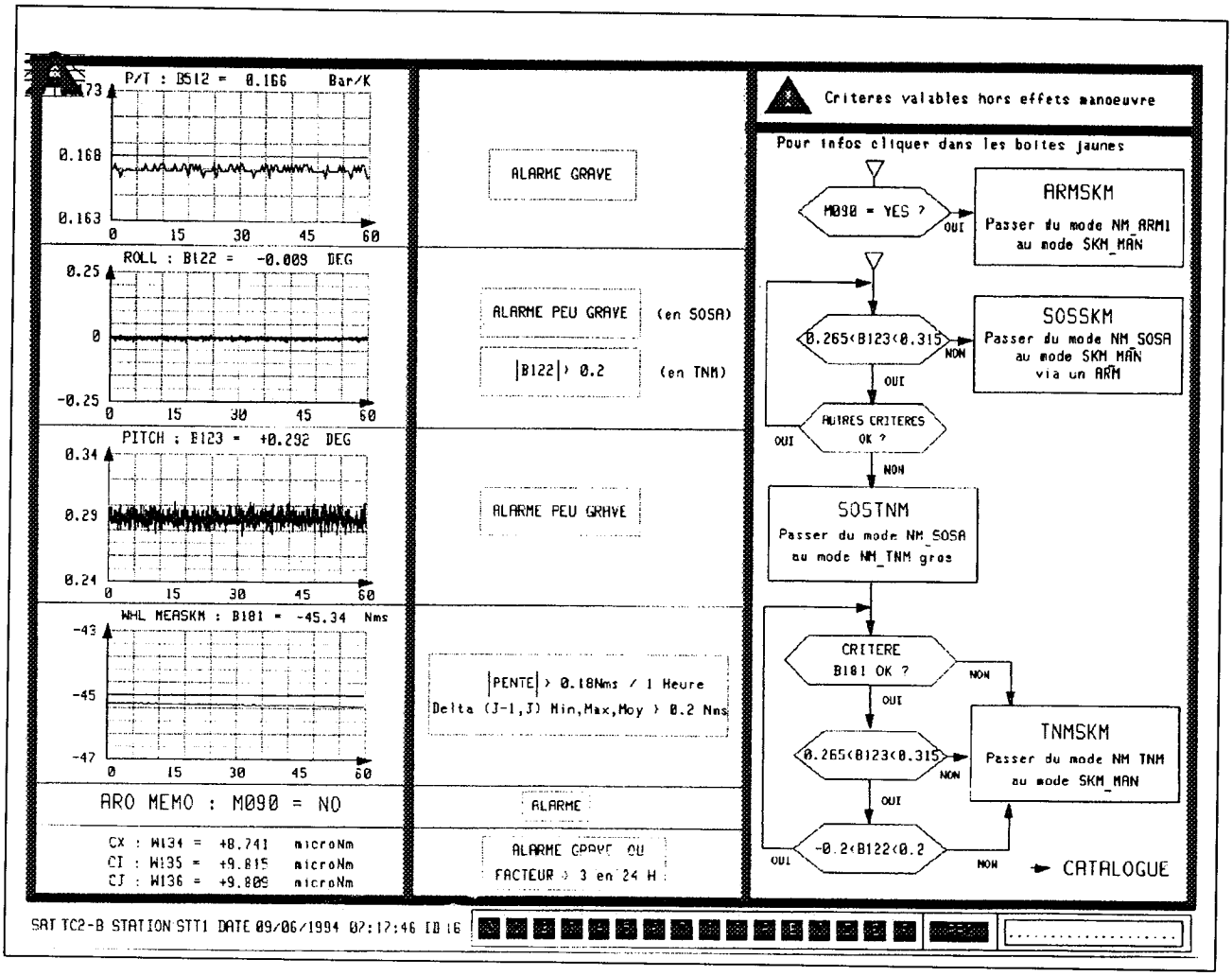

Figure n°5 : Monitoring mimic

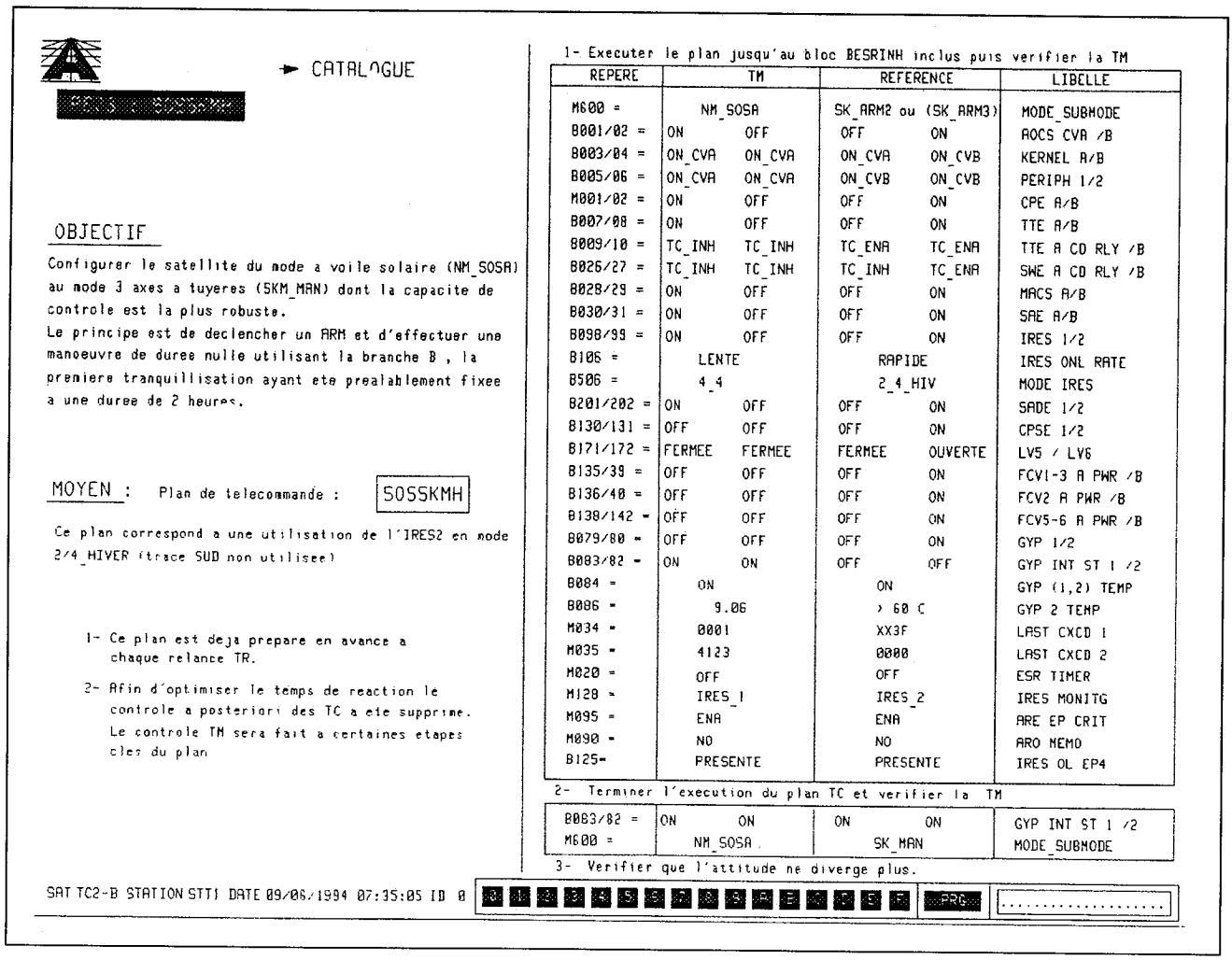

Figure n°6 : Contingency procedure mimic

Conclusion

Initially designed to display telemetry mimics in the Payload Control Centers, the Graphic Server tool has become a powerful tool to perform procedures.
Its great flexibility, the numerous graphic facilities provided, and its friendly man-machine interface have allowed the users themselves to develop a fully detailed representation of the satellites subsystems, as well as on line contingency procedures, in order to improve operations safety.
Designed with very few TELECOM 2 specific software modules, it could be easily adapted for any Satellite Control Center and more generally speaking to any monitoring system with the development of a new interface between the Graphic Server application and data sources.