AGENDA : A TASK ORGANIZER AND SCHEDULER

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ABSTRACT

AGENDA will be the main tool used in running the SPOT 4 Earth Observation Satellite's Operational Control Center. It will reduce the operator's work load and make his task easier.

AGENDA sets up the work plan for a day of operations, automatically puts the day's tasks into sequence and monitors their progress in real time. Monitoring is centralized, while the tasks can be run on different computers in the Center. Being informed of any problems encountered, the operator can intervene at any time while an activity is taking place.

To carry out the various functions, the operator has an advanced, efficient, ergonomic graphic interface based on X11 and OSF/MOTIF.

Since AGENDA is the heart of the Center, it has to satisfy several constraints that have been taken into account during the various development phases.
AGENDA is currently in its final development stages.

Key words: Automatic task sequencing, Scheduling, Monitoring, MMI (Man/Machine Interface), Ergonomics.

1. INTRODUCTION

The Operational Control Centers for Earth Observation Satellites currently in operation (SPOT 1 and SPOT 2) require numerous manual interventions by the operators, who are responsible for:

- the Satellite Control Center for all the real time monitoring and control operations of the satellite while it is within visibility of the receiving stations,
- the Platform and Payload Management Center for all off-line operations: orbit management, configuration control of the satellite's hardware and software, technological monitoring of the satellite, drawing up of the work schedule for payloads on the basis of requests from the Mission Centers.

It was therefore decided to design software that could automate the running of the Center for future observation satellites and thus lighten the operator's work load. The notion of an AGENDA was conceived.

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2. AGENDA'S FUNCTIONS

2.1 Purpose and scope

AGENDA enables the setting up of a day of operations, the automation of the sequencing of the day's tasks, and the real-time monitoring of their progress. Monitoring is centralized although the tasks can be run on different computers in the Center. To make this possible, AGENDA takes account of the distributed nature of the Center's computer architecture. AGENDA informs the operator of any problems and he can intervene to influence the progress of an activity at any time.

All AGENDA's automatic actions and the manual interventions by the operator are recorded in a central log which constitutes the Center's records.

2.2 Notion of work schedule

AGENDA controls the applications through procedures which may be located and run on any

computer it supervises. Thus, AGENDA sees only the procedures and pays no attention to the contents of the applications. To plan all the procedures to be executed during a day of operations, the notion of a work schedule has been introduced.

Daily activity is described in a work schedule defined relative to a reference date. In a given work schedule, all the dates are defined with respect to this reference.

A work schedule is broken down into task sequences, themselves made up of procedures. All task sequences can be run in parallel, the procedures within the same sequence being performed sequentially.

Earliest activation dates and latest completion dates may be assigned to procedures. Procedures may wait for resources being used by other procedures and may depend on completion of procedures from other sequences.

2.3 Description of the functions offered by AGENDA

2.3.1 Setting up the daily work plan

AGENDA helps the operator set up the daily work plan. This preparation may be done in advance.

The daily plan is built up from pre-prepared skeleton plans (including all the operations to be performed during a nominal day) and information provided by the decisions made by the satellite operations control team.
Each day is divided up according to the predicted times when the satellite comes into the field of visibility of the receiving stations.

Standard day skeletons are used to describe nominal days, each skeleton corresponding to a specific sequence of procedures that the operator can reset in time depending on his needs. It is simply necessary to change the reference date to be able to use the same skeleton on another date.

The operator can build a new work schedule or modify an existing one.
For this purpose, AGENDA makes available to the operator:

- the list of existing skeletons,
- the pass forecasts,
- the list of available procedures with their estimated duration and the computers on which they can be run,
- a set of functions enabling an existing work schedule skeleton to be included in the work schedule being built up, procedures or chains of tasks to be added or deleted, and activation conditions to be defined for the various procedures (earliest activation dates, latest completion dates, start depending on completion of one or more other procedures).

AGENDA helps the operator to build his work schedule:
- it completes the information (e.g. by automatically calculating the total time duration of the work schedule, and the real start and finish dates for procedures),
- it updates the information (automatic update of all dates when a procedure is inserted into a work schedule, for example),
- it ensures that the information is consistent at all times (existence of procedures named, dates in increasing chronological order, condition circuits not leading to deadlock, etc.).

Once the work schedule has been built up, the operator can request its execution.

2.3.2 Monitoring the running of a work schedule

When the operator requests the running of a daily activity plan, AGENDA automatically triggers the automatic sequencing of the various tasks planned and monitors their progress in real time. It saves the run-time context and progress status at all times. Monitoring is centralized although the tasks can be run on different computers in the Center. The operator can intervene at any time while this activity is taking place.

All task chains run automatically in parallel. The procedures within a chain run sequentially.
A procedure will be started by AGENDA if the following activation conditions are satisfied:
- the preceding procedure in the same task chain has been completed without error,
- its earliest execution time has been reached or passed,
- all the procedures conditioning its execution

have been completed without error.

The procedures inform AGENDA of their activity status through a run report. AGENDA then informs the operator.
A procedure may be:
- not yet started, because its activation date has not been reached,
- active,
- waiting for resources used by another procedure,
- stopped by the operator while running,
- ignored (the operator has specified that it should not be executed),
- correctly completed,
- stopped with error.

AGENDA signals an anomaly if the latest finish time for a procedure has been reached or exceeded but does not interrupt the automatic task sequencing. If an error occurs in a procedure, AGENDA displays it and stops the automatic sequencing of the corresponding task chain. The other chains continue unaffected. AGENDA warns the operator of anomalies or errors but does not take corrective decisions. These are the responsibility of the operator.

The operator can intervene manually on the automatic task sequencing. The options offered by AGENDA allow him to:
- interrupt a procedure that is running,
- delete an activation condition on a procedure,
- stop and restart a task chain,
- change the progress of a task chain by deciding to rerun or ignore certain procedures, thus jumping backwards or forwards,
- suspend execution of the work schedule. In this case the operator can restart execution where it was interrupted or modify the work schedule before restarting.

2.3.3 Other AGENDA functions

AGENDA also allows the operator to:
- record a message in the log to comment on the day of operations,
- start procedures manually, independently of the work schedule in progress and, if necessary, stop them during execution. He can thus perform a save operation that was not provided for in the daily plan, for example.

3. MAN/MACHINE INTERFACE (MMI)

To perform these various functions, AGENDA offers the operator an advanced, efficient, ergonomic graphic interface based on X11 and OSF/MOTIF.

3.1 Presentation of information

AGENDA gives an overview of the whole work schedule (past, present and future activity) in a single window. The information displayed is refreshed in real time. Information is shown on the screen in the same way whether the operator is preparing a work schedule or checking its execution.

Information is presented in graphic form and displayed versus time. Colors show the different activity statuses. This enables the activity of the whole Center to be assessed at a glance.

For example, a procedure is represented by a rectangle whose length depends on the time estimate, whose position on the screen is relative to planned activation date and whose color represents the activity status of the procedure.

All the following are shown in AGENDA's main window:
- name, start date, total estimated duration, and activity status of the work schedule,
- each task chain with its name, activity status, and the time left until the end of execution of the procedure in progress,
- each procedure, with its name, activity status, estimated duration and an indication of whether it depends on one or more other procedures,
- the satellite passes over the reception stations with the durations of visibility and the station names.

In addition, during running, the current time is given as a reference to situate the progress of the work schedule.

Figure 1 shows how the various information is presented to the operator.

The log messages concerning activity progression and operator actions are displayed in a scrolled window located above AGENDA's window on the same screen.

The operator can act on the portion of work schedule displayed by:
- making changes to the display scale (corresponding to zoom/unzoom),
- traveling in time (i.e. horizontally) using the arrow buttons in order to see past or future activity,
- moving vertically using the scrollbars to see other task chains.

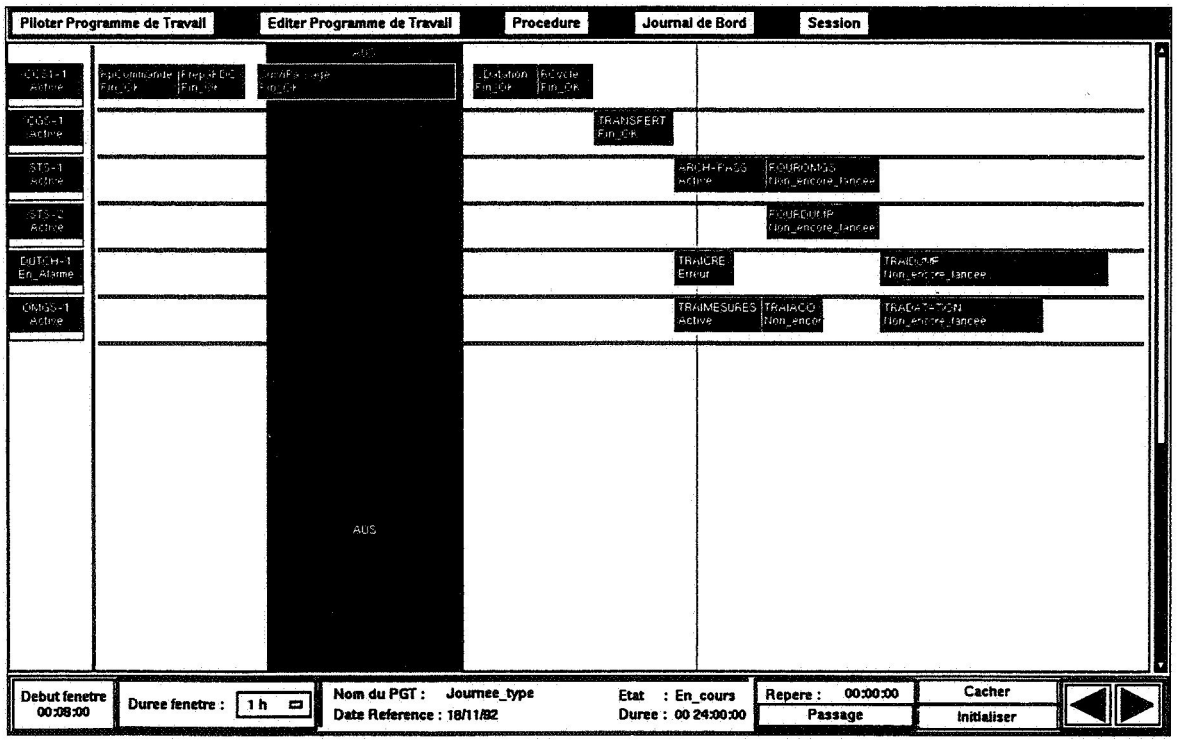
3.2 Operator/AGENDA dialog

The operator controls AGENDA through the buttons, pop-up and pull-down menus, by choosing from the scrolled lists , dialog boxes and other components of the advanced, user-friendly operator interface. AGENDA guides him at all times.

A specialized WYSIWYG graphic editor enables the operator to build up work schedules easily, and directly assess the result on the screen.

The operator can act directly on the chains and procedures or obtain information on passes by clicking on the corresponding graphic objects. He then obtains pop-up menus showing the various possible actions.

Figure 1. AGENDA: Example of presentation of information on the screen.



4. DEVELOPMENT CONCEPTS

4.1 Environment

AGENDA was designed for the SPOT 4 satellite's Operational Control Center, which consists of several HP computers operating under UNIX, together with X11 terminals connected to an Ethernet network.

4.2 Use of de facto standards

AGENDA's Man/Machine interface is based on the OSF/MOTIF environment and the X window System Version 11.
An interface builder (HP Architect) was used to design the Man/Machine Interface.

The use of the de facto standards (UNIX, X11, OSF/MOTIF) found in industry makes the software portable and thus usable in other Operational Control Centers.

4.3 Development constraints

As we have seen, AGENDA is the operator's main tool, starting and monitoring all the Center applications. This led us to take several constraints into consideration which had a strong influence on AGENDA's design and its different development phases.

4.3.1 MMI ergonomics

Great care was taken with AGENDA's ergonomics.
Ergonomics specifications applicable to the whole Center were drawn up to ensure that the screens presented to the operator were of uniform design (e.g. concerning the presentation of information, error messages, use of colors, etc.). These specifications were based on the OSF/MOTIF style guide.
The principle is to present simple screens that are easy to interpret (a single window gives an overview of all Center's activity) and easy and quick to use. Therefore it has been decided to reduce the input to a minimum by proposing choices from lists or using graphic representations of objects, and use only one level of menus. The risk of error is limited by always asking for confirmation for "dangerous" actions.
A mock-up was made of the AGENDA MMI and the prototype was criticised by the future Center users.

4.3.2 Efficiency

A special effort was made so that the AGENDA software would be efficient. As it is just a tool used to start the "useful" applications of the Center, it must not perturb the execution of these tasks.
On the other hand, being the operator's main tool, it must provide excellent response times both for responses to operator actions and for display refreshment and real time graphics animation.
A mock-up was also made for this constraint so as to validate the implementation choices.

4.3.3 Security

It is vital that correct execution of the daily planning be ensured at all times.
The "sensitive" functions (work schedule preparation and control of their execution) are accessible from a single work station under operator responsibility, whereas activity display functions are accessible by the various users from all the stations of the Center. Operator actions are checked, e.g. by requests for confirmation. The consistency of the work plan drawn up by the operator is continually checked. Progression of the activities and operator actions are recorded in a centralized log, which constitutes the Center records. This log is kept in a data bank and can be consulted at any time.

4.3.4 Taking cases of degraded operation into consideration

If a work schedule stops before time, it must be possible to restart the activity at the point where it was interrupted. Therefore, the consistency of procedure statuses must be ensured, including in the case of failure of one of the computers supervised by AGENDA or in the case of absence or malfunction of the software resources needed by AGENDA. The execution context of a work schedule is saved at all times, which enables the activity to be taken over by a backup computer, for example. Should a procedure be stopped early, restart points defined within the procedure mean that processing does not have to restart from the beginning but only from the last

point that was passed correctly.

4.3.5 Robust software

Being the "backbone" of the Center, AGENDA has to be robust. As the software is complex, because of its functions, the distributed computer architecture and the constraints described above, we attached great importance to development quality and having very complete tests.

4.3.6 Maintainability

The capacity of the Center was set to exploit SPOT 4 and its successor, SPOT 5. The software will be run for about 10 years, whence the importance of aptitude for corrective maintenance.
Furthermore, evolutive maintenance should also be possible and easy so as to be able to respond quickly and cheaply to future needs, for example to make an English version of the MMI.
The maintenance criterion is satisfied through quality development and the design and development methods chosen: separation of the "motor" and MMI codes, use of an interface builder allowing the MMI to be altered easily without touching the software "motor".

5. AGENDA TODAY AND TOMORROW

AGENDA is currently in its final stages of development.
A preliminary version is already available and is presently being used to prepare the skeletons that will serve for acceptance testing and the integration phases for the various subsystems composing the Center.
The final version will be available in May 1993. It will be used from 1993 onwards for the SPOT 4 Center's operational qualification phases.

Later, it will be possible to re-use AGENDA for other projects having similar needs in terms of daily activity planning and automatic centralized monitoring of multiple tasks.