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THE PROCESSING AND DATA COMMUNICATION RESOURCES FOR THE BRAZILIAN COMPLETE SPACE MISSIONS

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14. Abstract/Notes

The objective of this work is to inform about the functional segments that will constitute the processing and data communication resources planned for the Brazilian Complete Space Mission. These segments can be characterized by eight functional parts: 1) Space Control Data Network System - REDACE System; 2) Ground Station Supervision; 3) Payload Ground Data Acquisition and Routing; 4) Distributed Processing in the Earth Stations; 5) Missions Control Center; 6) Mission Operations Center; 7) Mission Center; 8) On Board Data Handling. The development of these resources are significantly based on the application of distributed processing to local systems and networks.

15. Remarks: Paper presented at the "International Workshop on Space Data Systems - InWSDS; Washington D.C., U.S.A. - January 19-21, 1982. A meeting Sponsored by National Aeronautics and Space Administration-NASA.

CONTENTS

LIST OF FIGURES

1. INTRODUCTION

INPE ("Instituto de Pesquisas Espaciais") is the Brazilian civil space agency, subordinated to the National Research Council (CNPq) of Brazil, and directly involved in the Brazilian Complete Space Mission-MECB. INPE is in charge of the development effort for two types of satellite: one for supporting data collection from ground (field) platforms and other for earth observation. This is a pioneering project in the Brazilian context. As a result, the ground support facilites which are to be developed are, in part, specific for these two programs. Other facilities are also planned for missions that will naturally folllow the first two. In order to maximize experience acquisition without, in the long term, increasing costs significantly, many in house standardized developments are taking place for equipments and methods . These resources should cover a fairly extensive list of the processing and data communication systems to be employed in the MECB. The processing and data communication resources for the MECB are distributed in the main segments which will be introduced in the following parts of this paper.

2. SPACE CONTROL DATA NETWORK SYSTEM - REDACE SYSTEM

The star-like network topology represented in Figure 1 is planned to give data communications support to the Brazilian Complete Space Mission. This space control data network system was denominated REDACE System. Two earth stations are planned for the space missions, and are to be located according the map of Figure 2.

The basic functional modules of the REDACE System, i.e., the network nodes, are to be composed by Interface Message Processors - IMPs. The links between the IMPs are planned to utilize a communication protocol based on the NASA/STDN - NASCOM Standards. Presently, the subnetwork baud rates are scheduled to be of 4800 bps, compatible with present data communication baud rates offered by the Brazilian public TRANSDATA (Telebrãs) System. So far, only 1200-bit and 4800 bit message block formats are being considered for the subnetwork.

The REDACE System Control Center is planned to be a special version of the IMP, provided with additional functions for network testing and evaluation. The gateway (s) capability(ies) of the network will be of particular importance not only in the satellite injection phase and in emergency situations of the operational phase of the Brazilian Space Missions, but in eventual support, with similar functions, for foreign space missions, as well. If necessary, a modified, and possibly simplified version, of the REDACE system IMP can be considered for the gateway realization.

Redundancy with doubled data communication links are predicted, and they are to be separately connected to doubled IMPs, located at the center of the network, next to the Mission Control Center. Redundant data communication links are not planned for the Mission Operations Center, to be dedicated to payload data collection.

The Interface Message Processor-IMP is basically composed of two different functional sub-systems, as depicted in Figure 3. The Supervisor Host Computer is planned to test and sense the Network Communication Multiprocessors-NCMs which, in their turn, will realize the data communication links for each node of the network. If messages cannot be routed to any of the operational data links, due to their temporary unavailability, they will be deviated to the supervisor Host Computer which will have, to some extent, buffering capability. The NCM has a distributed processing and multi-port communication architecture, as represented by Figure 4. This organization will permit simultaneous interconnection of data links using, different protocols.

3. GROUND STATION SUPERVISION

The data collection distribution and control of the two planned earth stations are to be performed by their supervisor system. The main interfaces of this system are represented in Figure 5. At some extent, the ground station supervision system is expected to have triple redundancy. One interface of this system will be made with the REDACE

System for routine operational or emergency control data communications with Mission Control Center. A second interface will be implemented with serial data communication buses to connect the station supervision system with some of the ground station instruments or distributed processors, like the telecommand encoders, etc. The third main interface of the supervisor system will utilize the IEEE-488 control bus to communicate with ground station instruments clustered around talker/listener interfaces which will, in their turn, be connected to this control bus.

4. DISTRIBUTED PROCESSING IN THE GROUND STATIONS

The two planned earth stations for the Brazilian Complete Space Mission are expected to make extensive use of dedicated processing in many of the instruments or equipments that will realize their functions, i.e., receivers, transmitters, converters, meters, antenna controllers, ranging processors, etc. With this type of distributed processing, it is expected to achieve a high degree of automation in the operational procedure of the stations, after interfacing the distributed equipments with the supervisor computers, as illustrated in Figure 6.

5. PAYLOAD GROUND DATA ACQUISITION AND ROUTING

The two planned Brazilian Complete Space Missions will have somewhat different needs for payload ground data acquisition and routing. An analysis of the schemes shown in Figures 7 and 8 will make clear some of the different functional treatments to be given to the payload data for each mission, at ground level. Due to the relative low volume of data to be effectively acquired in real time, in the data collection mission, a permanent data link is expected to be available for this purpose, between the earth stations and the mission operations center. In the earth observation mission a cost effective routine medium for payload data transport is expected to be the air mail service. However, depending on the urgency, a real time scheme will possibly be available, for this type of payload data communication.

6. MISSION CONTROL CENTER

The basic scheme for the Mission Control Center processing and data communication resources are represented in Figure 9. The same scheme should be valid for both planned Brazilian space missions. However, it is worth to mention that, in the earth observation mission, the data processing center of INPE ("Instituto de Pesquisas Espaciais") may be insufficient for real-time calculation that will be needed for guidance and control, during the orbit injection phase. This requirement may call for a more powerful dedicated computing facility, to be appended to the mission control computer.

7. MISSION OPERATIONS CENTER

The Mission Operation Center can be defined as the controller aimed to analyse and qualify the payload data acquisition system, in the operational phase. For instance, malfunction of data collection platforms should be analysed and detected by the computing facility of the respective Mission Operations Center. The functional location of this type of Center, for both planned Brazilian Complete Space Missions, are depicted in Figures 7 and 8.

8. MISSION CENTER

The Mission Center is intended to be the computing facility which will store the data base, originated from the payload acquisition system, from where it is to be available for the mission payload data users. All the payload data available to the mission center is to be validated by the mission operations center, beforehand. The schemes of Figures 7 and 8 illustrate the functional location of the Mission Center among the other ground facilities.

9. ON BOARD DATA HANDLING

On board computers for the Brazilian Complete Space Mission are being designed from standardized basic processing modules. The modules can be classified in two types, as depicted in the on board computer example of Figure 10. One type is the Processing and Communication Unit-UPC, conceived to work as the master unit of the on board computer. The UPC is intended to execute typical taks of on board supervision, including: down and up link data communication using the ground network protocol, data bus-BD communication with the Distributed Processing Units-UPDs, service algorithms execution, etc. The other type of module is the Distributed Processing Unit-UPD, which will be properly interfaced with the other on board sub-systems. Its main tasks will be those of data acquisition, distribution and control for the sub-systems with which it will be interfaced. Service algorithms execution and data bus-BD communication will, among others, be important tasks for the UPDs, as well. Although it is not being considered for the two planned Brazilian Complete Space Missions, the UPC and UPD modules will be capable to be appended with mass storage modules (magnetic tape, bubble memory, CCD, plated wire).

In their turn, the UPD and UPC modules will be passive of variable dimensioning during their specific application design phases. This design flexibility is possible with the use of modular components, as those for: serial data communication, data acquisition and control, memories, etc. All these standardized resources will constitute the components and modules family of the so called INPE Standard for On Board Supervision-PISB.

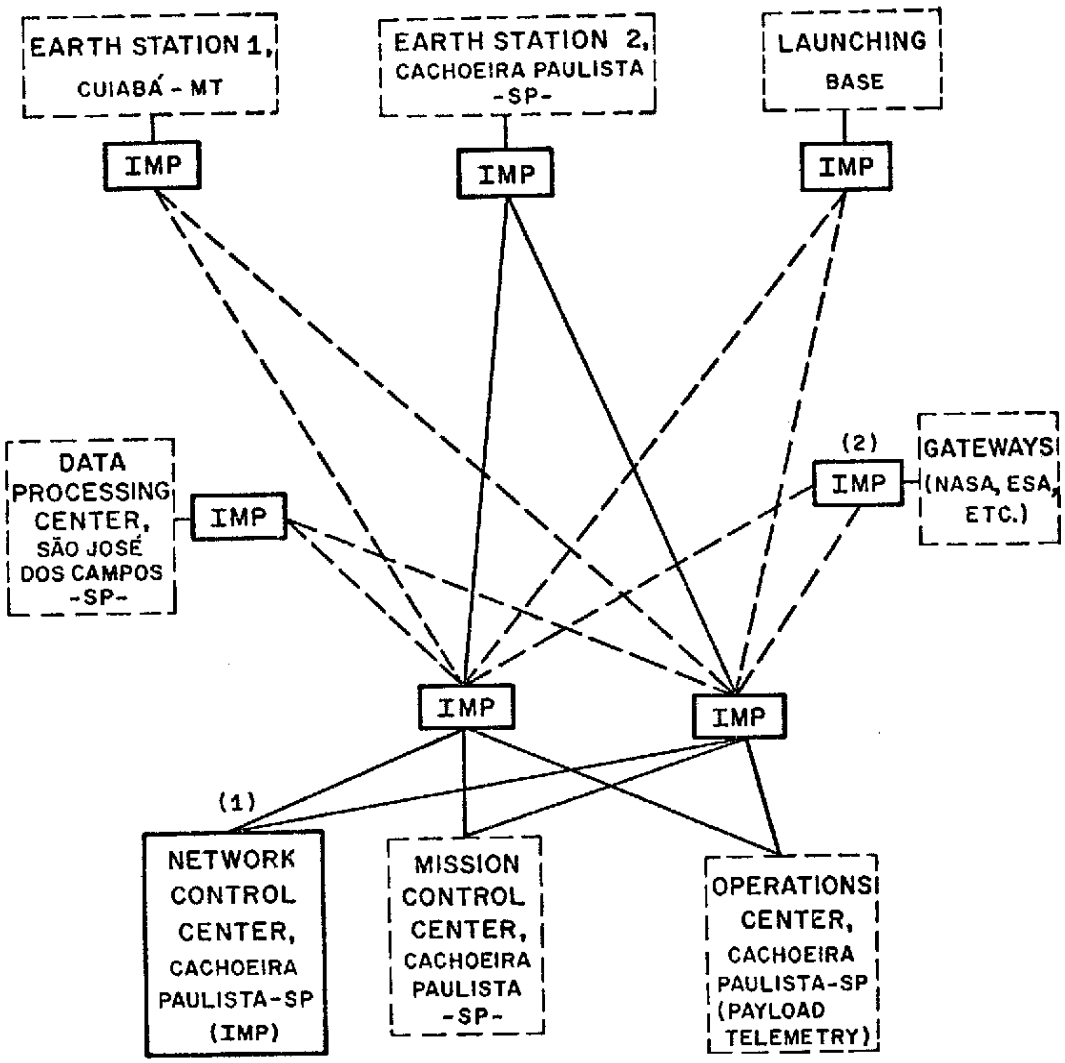
The on board computer system planned for the Brazilian Complete Space Missions will be designed to run a software program denominated Integrated Operational Program - POI. This operational software will be segmented into a couple of main parts: one to run in the on board computer and the other in the ground mission control center, as represented in Figure 10. The management of all other on board

sub-systems will be made from the mission control center by interaction among the POI ground segment and the specific software packages aimed to those other, sub-systems. The basic idea of this POI implementation is already in operational use in the on board ground computer system being utilized by INPE in its stratospheric scientific balloon experiments. The on board and ground segments of the POI are structured to be highly interactive through Telecommand (TC) and Telemetry (TM) data communications.

An on board computer replica is expected to be interfaced with the mission control center for on line, possibly real-time, test and diagnosis purposes, as indicated in Figure 11.

10. CONCLUSION

The basic proposal for the processing and data communication resources for the Brazilian Complete Space Mission was submited by INPE/CNPq to the Aeronautic and Space Brazilian Commission-COBAE in November 1979. This Federal Commission approved the proposal terms after extensive analysis. So far, many basic ideas of the proposed plan already evolved toward the aimed realizations. The Brazilian Space Agency - INPE is firmly engaged in the execution of the satellite segment of the approved plan which was, in part, presented in this paper.



OBS. - (1) and (2) : SPECIAL VERSIONS OF THE IMP
— — — TRANSDATA TELEPHONE LINES (TELEBRÁS SYSTEM, BRAZIL)
——— LOCAL LINES

Fig. 1 - Redace System.

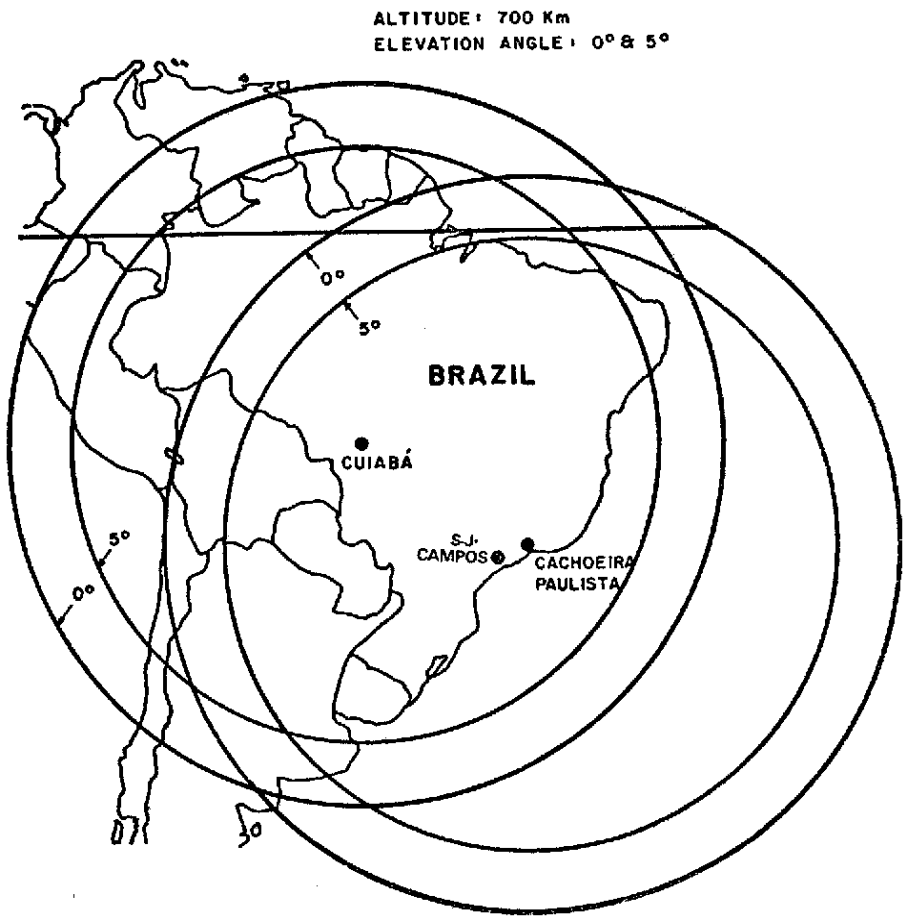
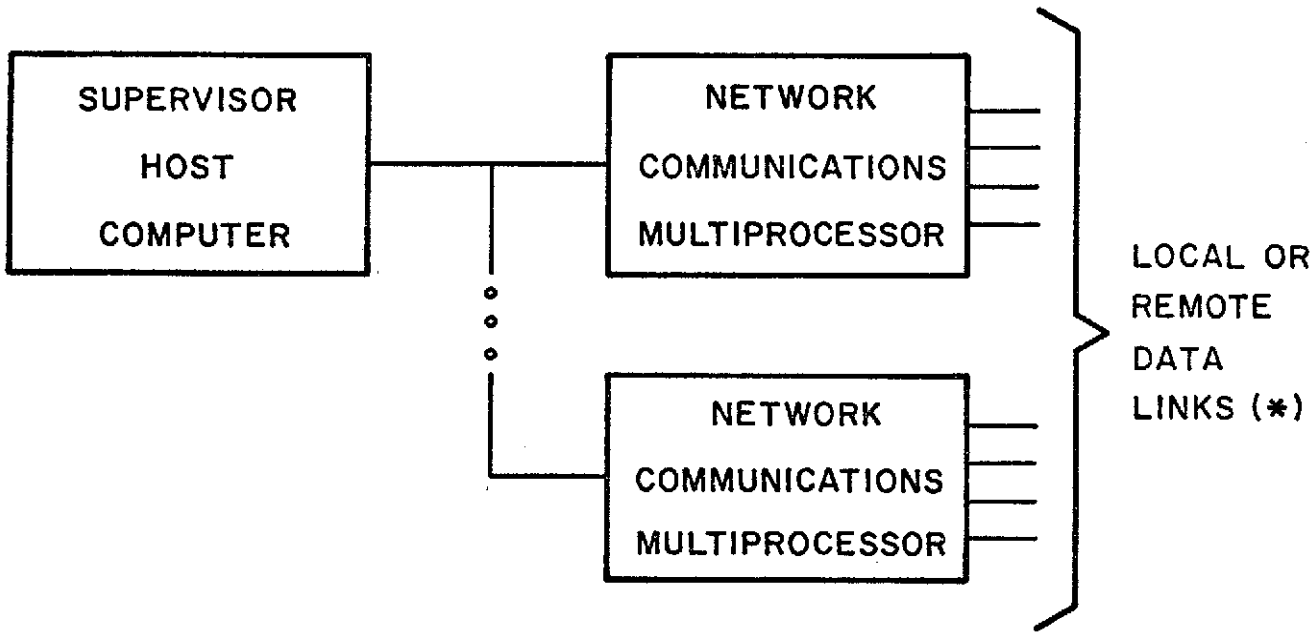


Fig. 2 - Earth station location and their visibility curves (Alt. 700 km).



(*) UP TO 4 DATA LINKS PREDICTED PER NETWORK COMMUNICATIONS MULTIPROCESSOR

Fig. 3 - The Interface Message Processor-IMP for the REDACE system.

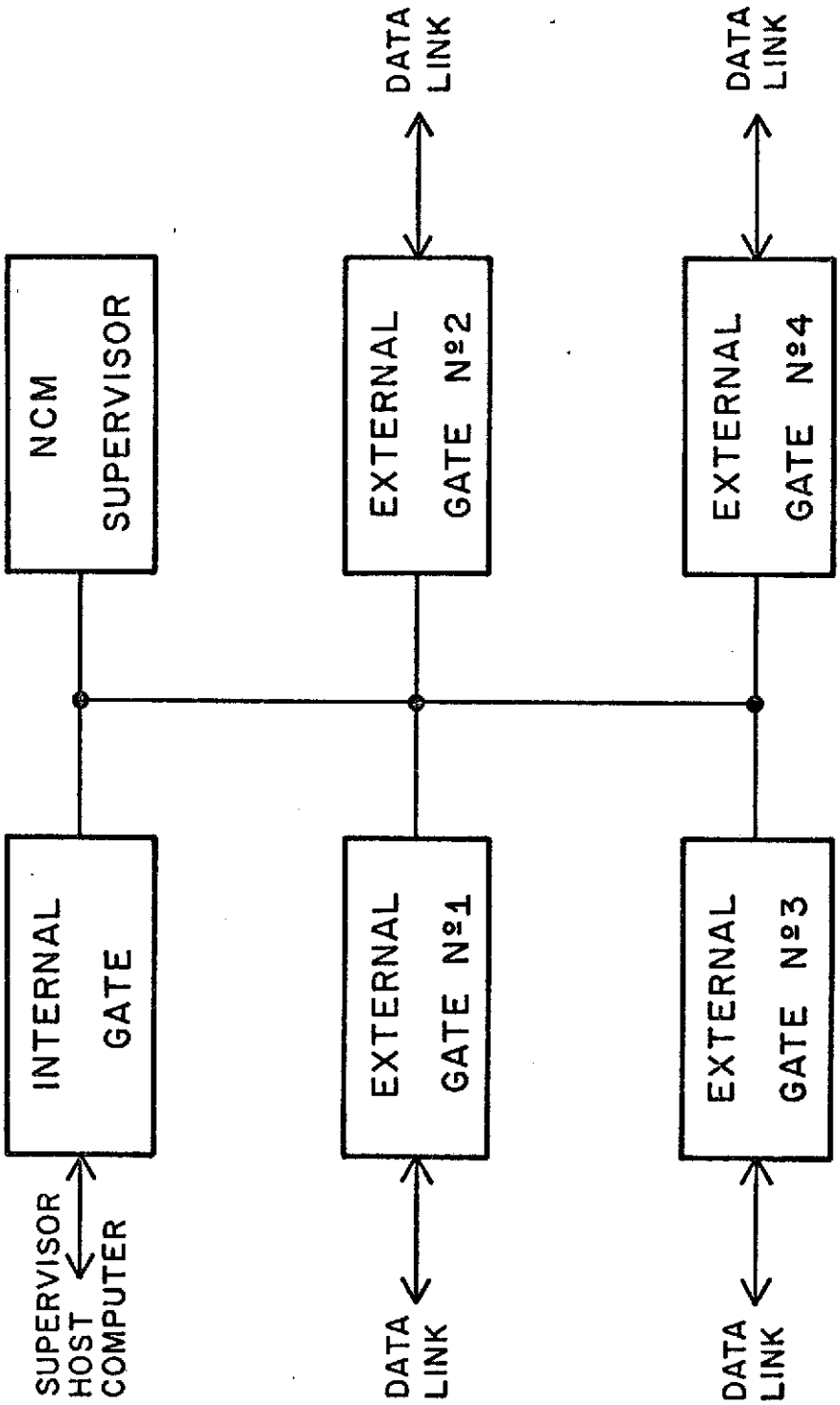


Fig. 4 - The Network Communications Multiprocessor - NCM.

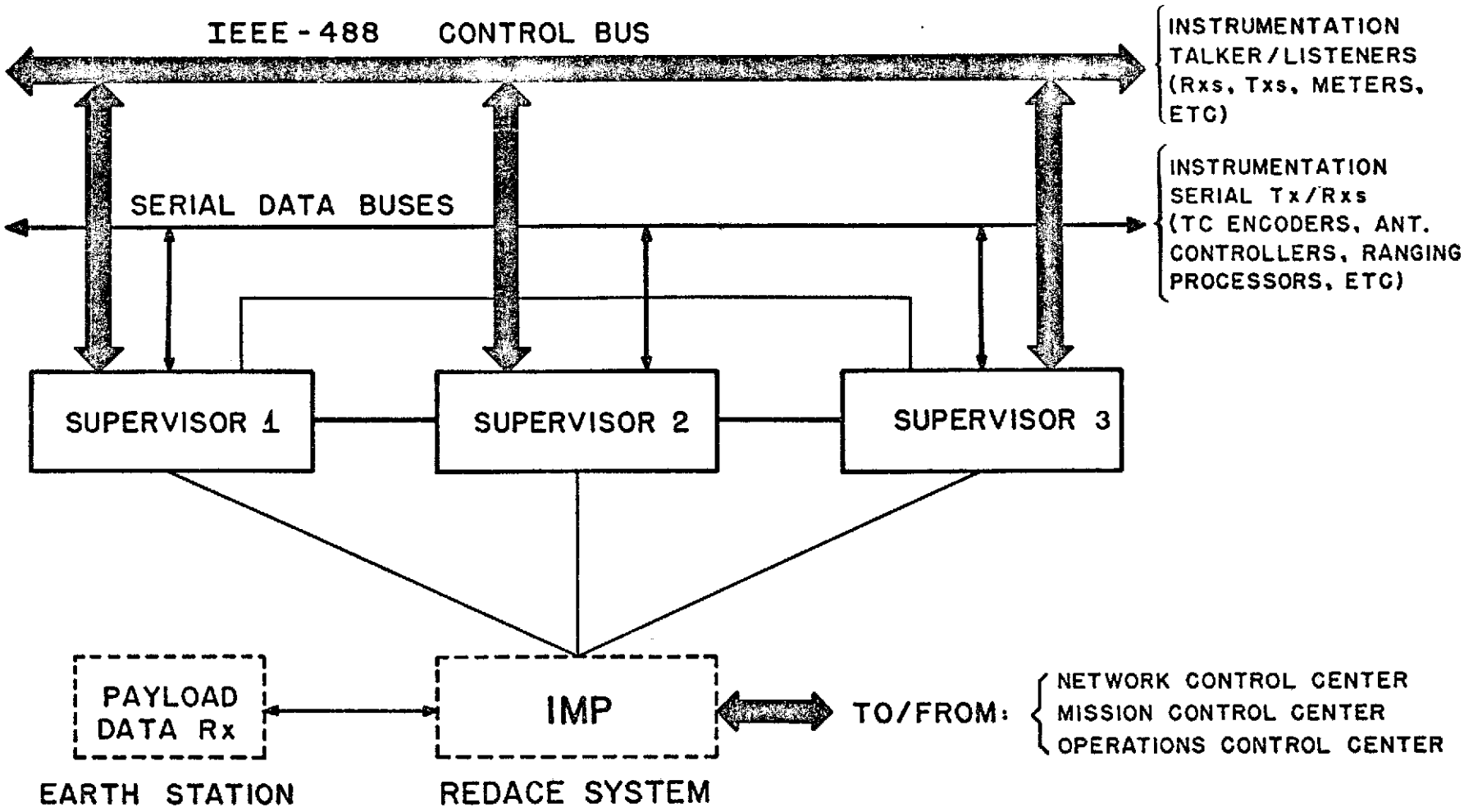


Fig. 5 - Ground Station Supervision Computers.

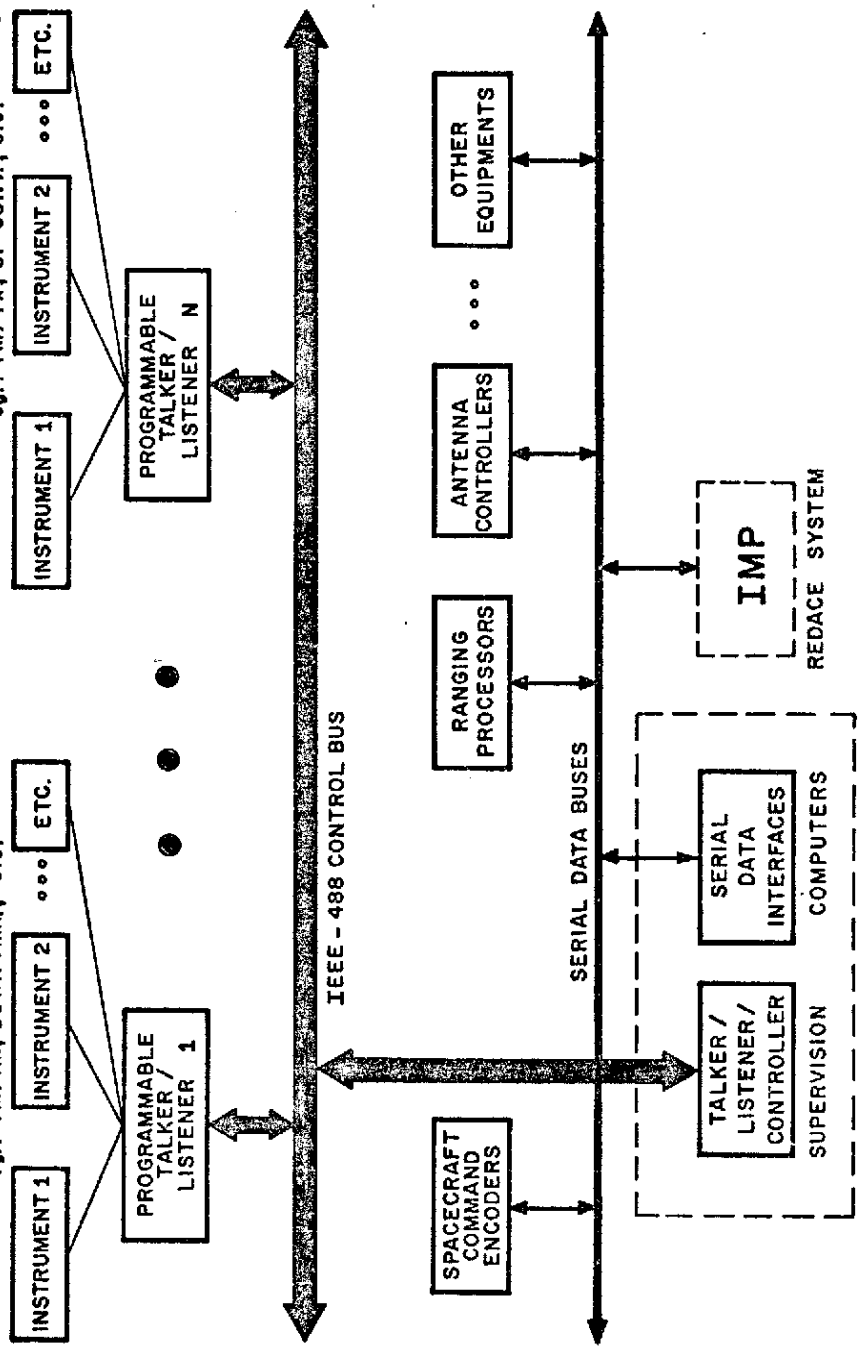


Fig. 6 - Distributed processing in the ground stations.

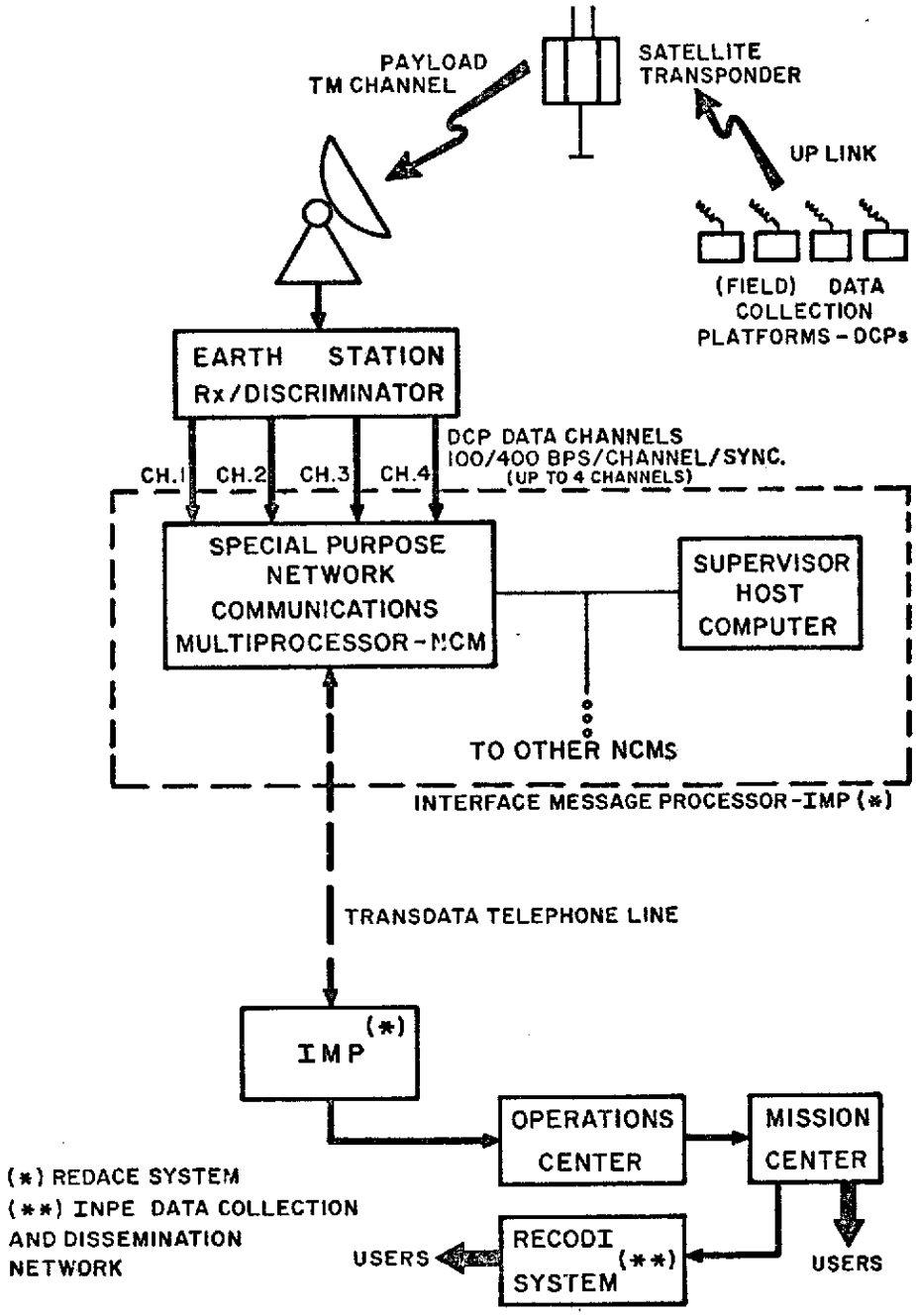


Fig. 7 - Payload ground data acquisition and routing - Data collection mission.

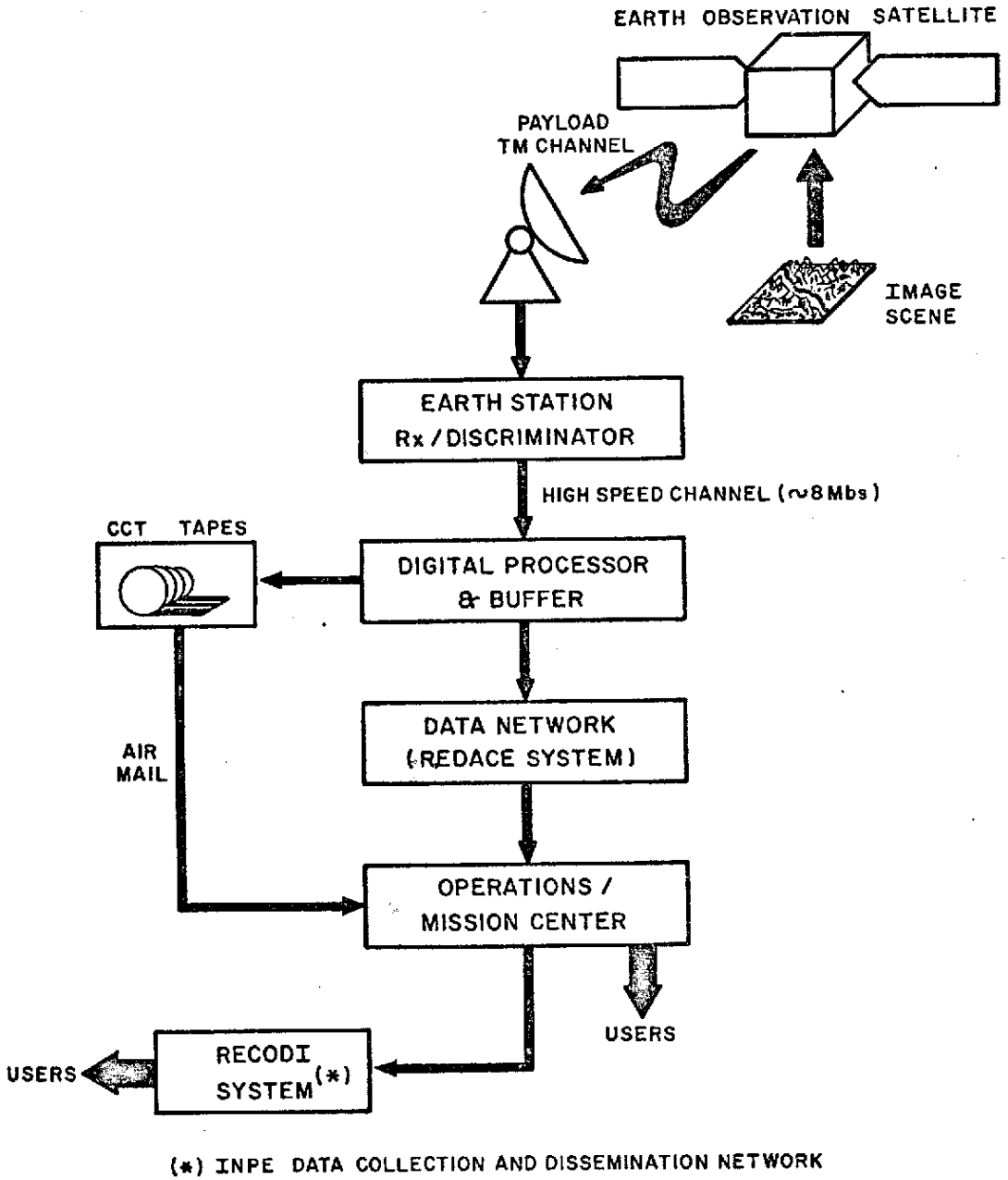


Fig. 8 - Payload ground data acquisition and routing - Earth observation mission.

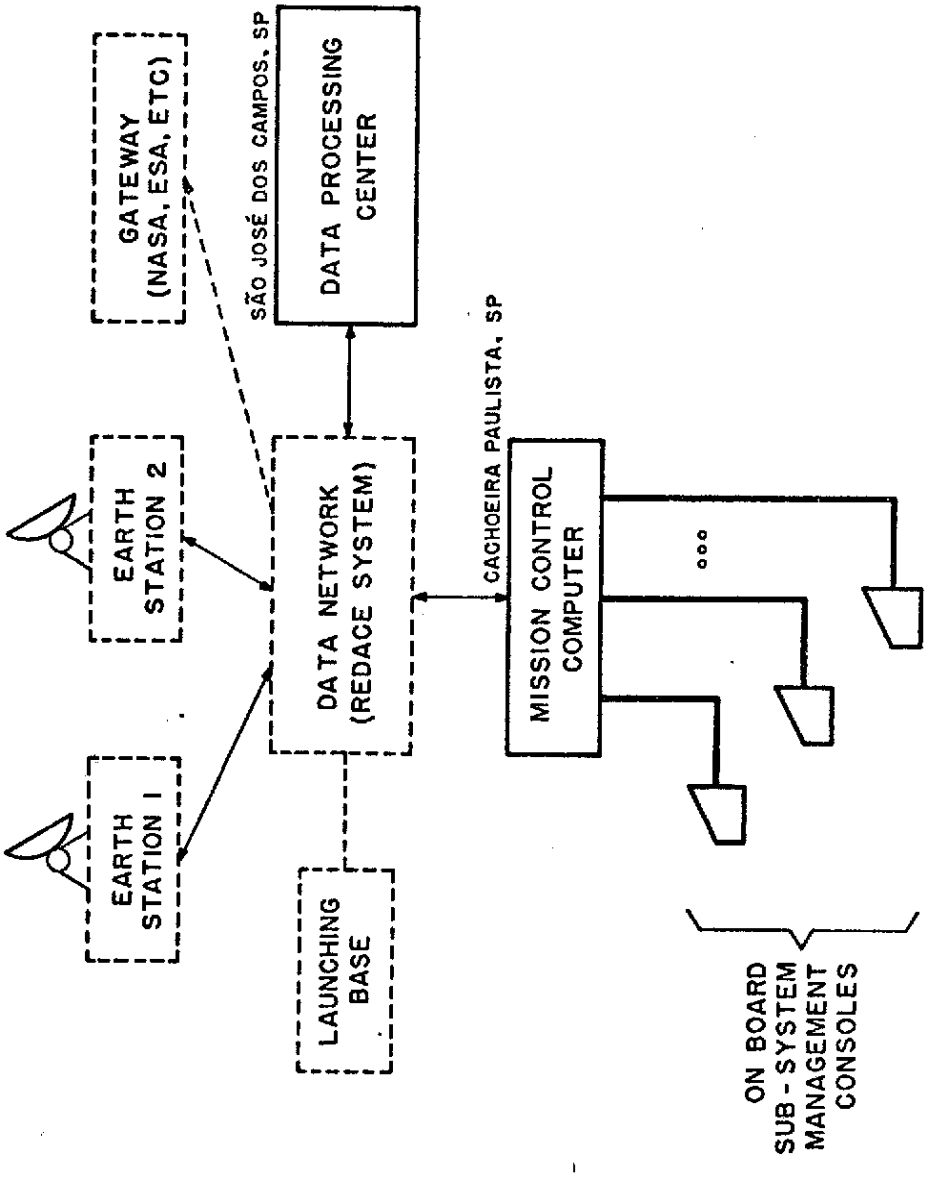


Fig. 9 - Mission Control Center.

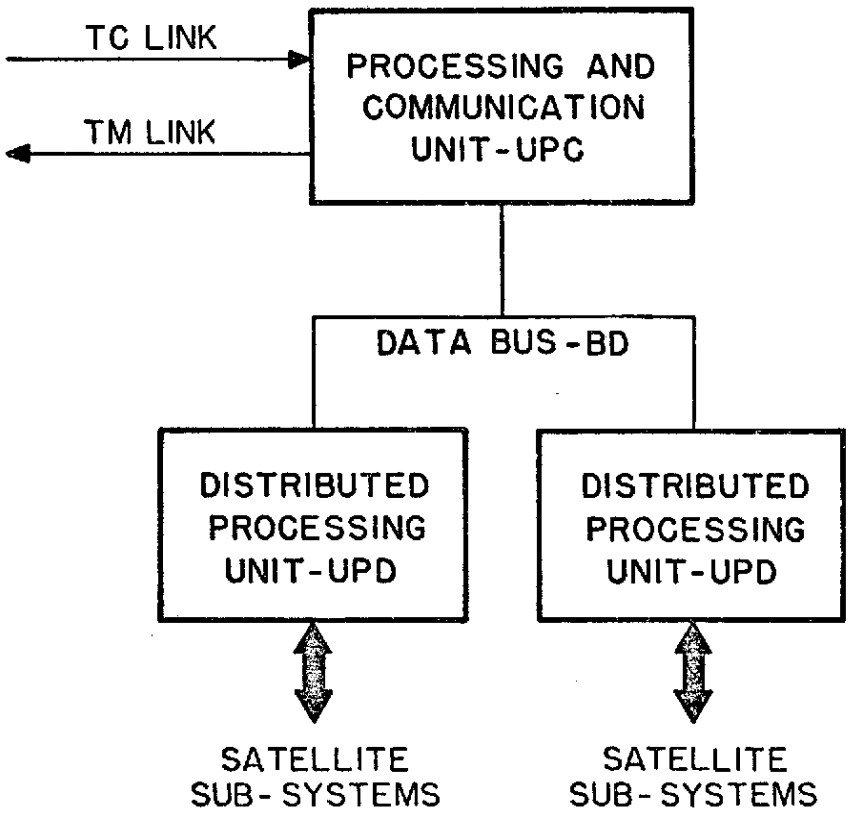


Fig. 10 - On board Computer.

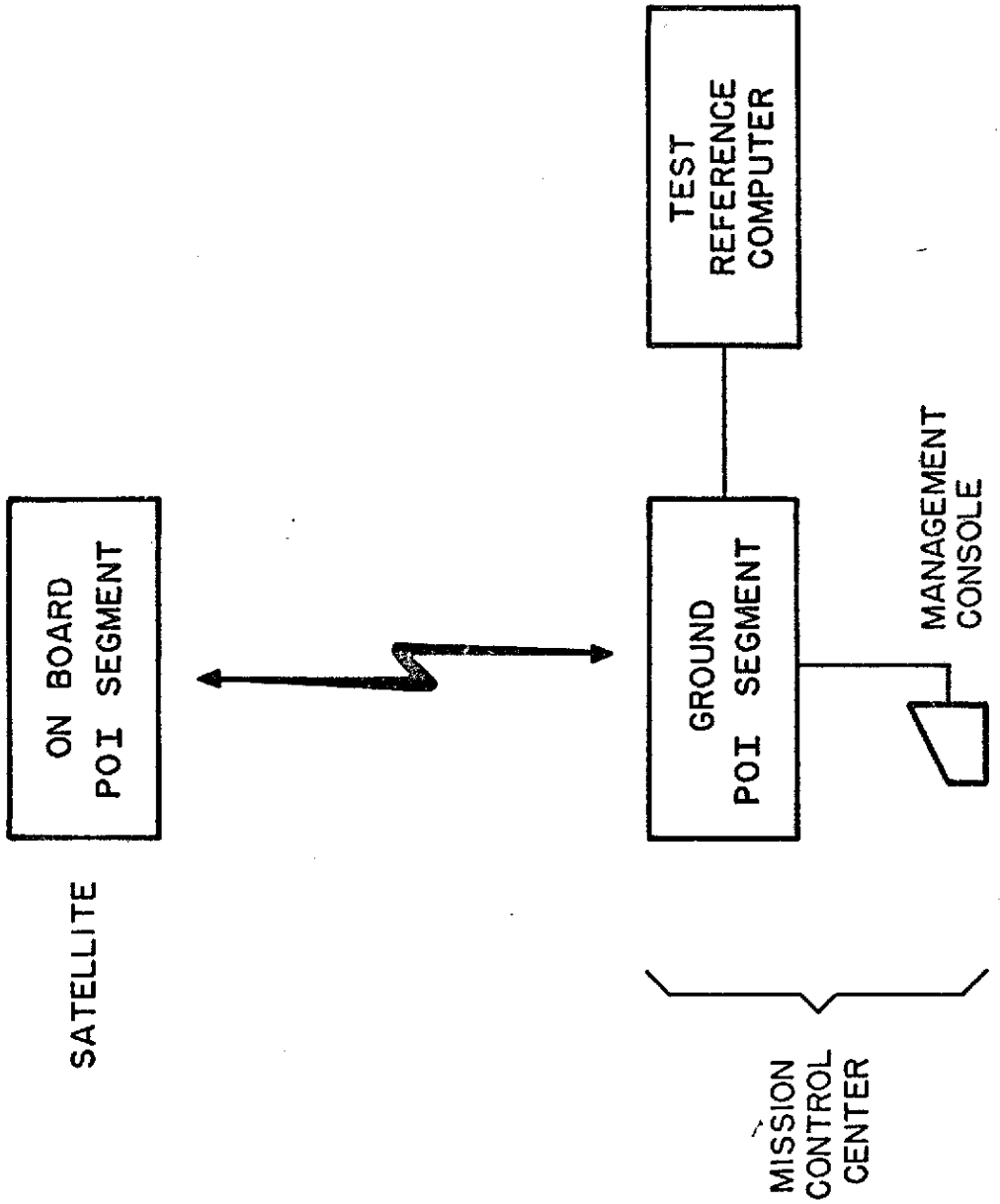


Fig. 11 - Integrated Operational Program-POI.