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OPTIONS FOR INPE-CNES DATA COMMUNICATION INTERFACING - PRELIMINARY VERSION

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14. Abstract/Notes

This report presents the result of the initial data collecting phase (Preliminary Phase) to determine interconnection options between the REDACE System ("Rede de Dados para Controle Espacial") of INPE and the "Reseau de Stations 2 GHz" of CNES. The final objective to be attained is to permit the cross-support for Space Missions between CNES and INPE.

15. Remarks
This report is based on the work executed with collaboration between CNES and INPE technical personnel, in Toulouse, France during the Fall of 1984.

SUMÁRIO

Este relatório apresenta o resultado da fase inicial de levantamento de dados (Fase Preliminar), que tem como objetivo a determinação das opções de interconexão entre o Sistema REDACE ("Rede de Dados para Controle Espacial"), do INPE, e a "Rede de Estações 2 GHz" do CNES. O objetivo final, em vista, é o de viabilizar o apoio cruzado entre o CNES e o INPE em Missões Espaciais.

CONTENTS

LIST OF FIGURES

1. INTRODUCTION

The Brazilian Institute for Space Research - INPE ("Instituto de Pesquisas Espaciais") develops its Data Network for Space Control, the so called REDACE System ("Sistema de Rede de Dados para Controle Espacial"). Gateways for data communications with external data networks are being considered in the development of the REDACE System. These gataways are expected to provide cross-support in space missions between INPE and other space agencies (Bergamini 1984). Each data communication network of these space agencies will be referred to as External Network - RE ("Rede Externa").

In particular, this project presents the various options for RE connections between the "Réseau de Station 2 GHz" (CNES 1984a) of the Centre National d'Études Spatiales - CNES and the REDACE System of INPE. The facilities of the "Réseau de Stations 2 GHz" are composed of: earth stations, several centers (CSS, COO, CIMTT and SGT) and a data communications network, the so called "Système de Transmission de Données Digitales - STDD" (CNES 1984a).

The effective implementation of this project is expected to observe the following five phases: 1) Preliminary Phase; 2) Evalution Phase; 3) Decision Phase; 4) Development Phase; 5) Operation Phase.

The Preliminary Phase of this project comprises the study of the characteristics of both data networks (INPE and CNES) and their options for data communication interfacing. This report represents the result of this phase of the project. Each option for interfacing is presented with a technical analysis.

Three options for data communication interfacing were identified. The first option does not properly characterize a gateway between INPE and CNES networks, considering that it would implement a *Direct Connection* between a CNES earth station and the REDACE

System. This option would be solely intended for support, by CNES, to INPE's space missions.

The second and third options characterize data conections between the network of both agencies and could be utilized for cross-support in space missions of the two agencies.

The second option is the *Connection by ETTD*, which is characterized by the local connection of a CNES network ETTD ("Equipement Terminal de Transmission de Donnees") equipment with the computer of the External Network node (PAM/RE) of the REDACE System, to be located in Brazil.

The third option is the *Connection by MCR*, which is characterized by connecting, a Multiprocessor for Network Communications - MCR ("Multiprocessador de Comunicação em Rede") of the REDACE System to a CNES network ETTD terminal equipment, to be located in France.

2. INTERFACING OPTIONS

2.1 - DIRECT CONNECTION

2.1.1 - GENERAL DESCRIPTION

This option would be implented by means of a direct connection between the so called "External Network" node of the REDACE System and the CNES (ground) Station, bypassing the CNES Digital Data Transmission System - STDD ("Systeme de Transmission de Donnees Digitales"). This option would only support the use of CNES Stations by INPE.

2.1.2 - DETAILED DESCRIPTION

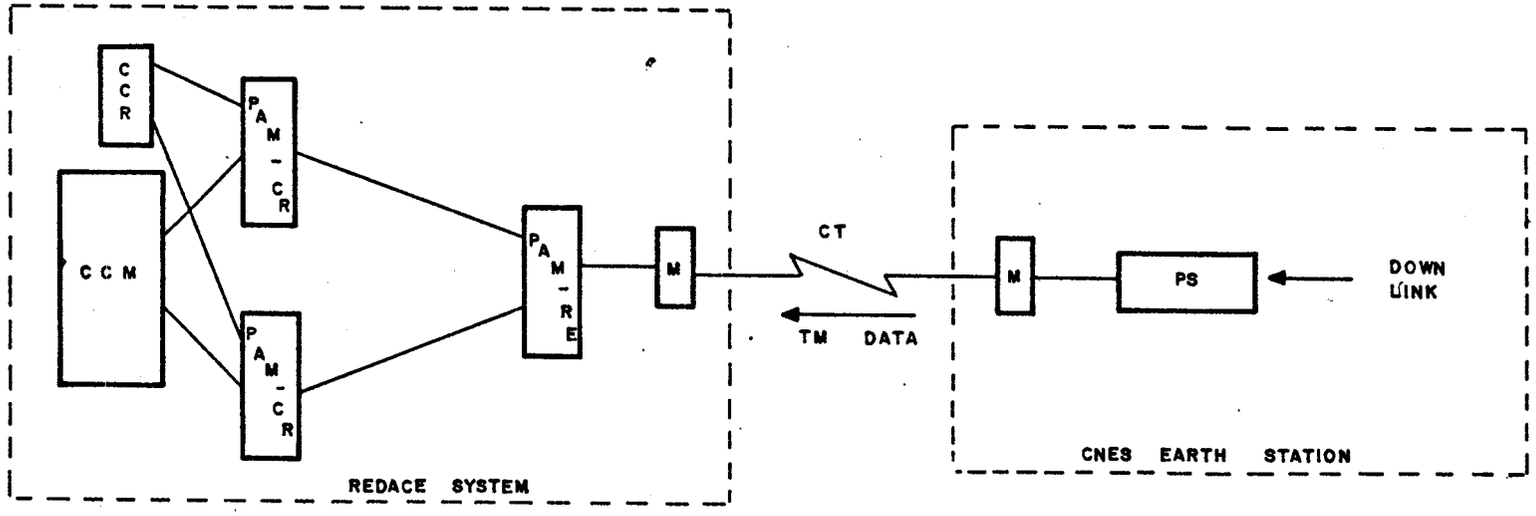
This option considers the direct connection of the Message Processor and Logger/External Network - PAM/RE ("Processador Armazenador de Mensagens / Rede Externa") node of the REDACE System with the Primary (bit) Synchronizer of the CNES Station telemetry channel. This option permits the direct transmission of the string of telemetry - TM bits, received by the CNES Station, to the Mission Control Center - CCM ("Centro de Controle de Missão") of INPE, as represented in Figure 1. A modem is to be connected to the Primary Synchronizer in order to transmit the string of TM bits. The data rate at the modem output must be, at least, twice the rate received at the output of the Primary Synchronizer. Desirably, in this case, the data rate should be increased fourfold. This modem will be connected to a corresponding one at the PAM/RE (see Figure 1). The modem at the PAM/RE will have to recover the clock of the transmitting modem connected to the Primary Synchronizer. The PAM/RE will have, then, by means of software, to recover the original bit string obtained at the output of the Primary Synchronizer. After the recovery of this bit stream, the PAM/RE will search for the frame synchronizer in order to recover the original data frames transmitted by the satellites. These data frames are to be transmitted to the Mission Control Center through the REDACE System.

This option does not support other space data systems services, like telecommand,ranging, etc.

2.1.3 - REQUIREMENTS FOR IMPLEMENTATION

a) Detailed study of the Primary Synchronizer characteristics. In particular, special attention should be given to the Primary Synchronizer and Modem interface.

b) Contracting of international,private data communication link.



CCM — MISSION CONTROL CENTER
PAM — MESSAGE PROCESSOR AND LOGGER
CR — REDACE SYSTEM CENTER
RE — EXTERNAL NETWORK
M — MODEM
PS — PRIMARY SYNCHRONIZER
CT — TELEPHONIC CHANNEL
TM — TELEMETRY
CCR — REDACE CONTROL CENTER

Figure 1 - INPE-CNES interface: Direct Connection.

c) Specification and development of the pertinent software to be resident in the PAM/RE.

d) Evaluation of up and down link telecommunications (frequency, modulation, etc) compatibility for cross-support.

e) Memorandum of Understanding between both agencies, which establishes the services to be supported by CNES to INPE.

2.1.4 - TECHNICAL ANALYSIS

This option would support only the TM service. It does not provide support, by CNES, to Ranging and Telecommand services, which could, otherwise, be essential services for INPE.

Another critical aspect is the fact that INPE's satellite is expected to have a down-link data rate of 2.000 bits/sec., which would require a data transmission rate of 9600 bits/sec. at the output of the Modem to be connected to the Primary Synchronizer, at the CNES station. Considering that no protocol is to be used in the long distance data link between the modems (one at INPE and the other in CNES) for such a fairly high data rate (9600 bits/sec.), this communication channel would present a high error data rate, without possibilities of error recovering.

It is worthwhile to mention that this option presents an implementation alternative of notable technical simplicity and low cost.

2.2 - CONNECTION BY ETTD

2.2.1 - GENERAL DESCRIPTION

In this option, a Data Transmission Terminal Equipment - ETTD ("Equipment Terminal de Transmission de Donnés") would be utilized to connect the REDACE System to the STDD ("Systême de

Transmission de Données Digitales"), providing a fully compatible connection with the STDD.

2.2.2 - DETAILED DESCRIPTION

This option proposes a connection between the REDACE System and the Digital Data Transmition System - STDD through the ETTD equipment. Presently, all the access to the STDD is performed by means of the ETTD. This solution requires an access compatibility with the STDD, by the REDACE System. Therefore the PAM/RE of the REDACE System must perform the protocol mapping for observing the required compatibility with the ETTD.

From the point of view of the STDD, the REDACE System would represent a unique address, which would be characterized in the CNES data block by the "destination" field and by another field for a specific subaddress (of a set), depending on the specific service. From the point of view of PAM/RE, routing of a data would be guaranteed within the REDACE System for the STDD as a unique host, based on a reference table previously loaded, in the same PAM/RE, by the REDACE Control Center - CCR.

An aspect of compatibility that should be observed concerns the cross-support of the Ranging service. In this case,all the communication with the station should observe the data formatting recommended by the owner space agency. Therefore, the control center of the user space agency should comply with this Ranging related data formats (CNES 1984c), excluding any processing of this type by the PAM/RE.

The ETTD considered in this option could be located close to the PAM/RE (in Brazil) or close to the STDD Central equipment (in France) considering that the CNES data communication protocol does not incorporate any resource for data link error recovery. Due to the fact that the ETTD already provides built-in testing

capabilities with the STDD, these same testing resources would be of great convenience if utilized for validation of the long distance data link that would be characterized if the ETTD is placed close to the PAM/RE.

The interface between the PAM/RE and the ETTD would be capable of supporting a data frame exchange within the limits as estabilished by CNES documentation (CNES 1984a), which would transmit up to 9600 bits/sec., in full-duplex mode.

The scheme of Figure 2 represents the connection proposed for this option. This proposal would permit the simultaneous utilization of diversified services such as telemetry, telecommand, ranging,etc.

2.2.3 - REQUIREMENTS FOR IMPLEMENTATION

a) Acquisition of two ETTDs (one for spare) compatible with the STDD, by INPE;

b) Development of software to be resident in the PAM/RE for proper implementation of this option;

c) Development of software to be resident in the Mission Control Center computer for proper implementation of the data formats to be utilized in some of the predicted services, such as ranging, doppler, ephemeris,etc;

d) Contracting of international private data communication link;

e) Evaluation of up and down link telecommunications (frequency, modulation, etc.) compatibility for cross-support;

f) Memorandum of Understanding between both agencies, which establishes the services to be supported by CNES and INPE.

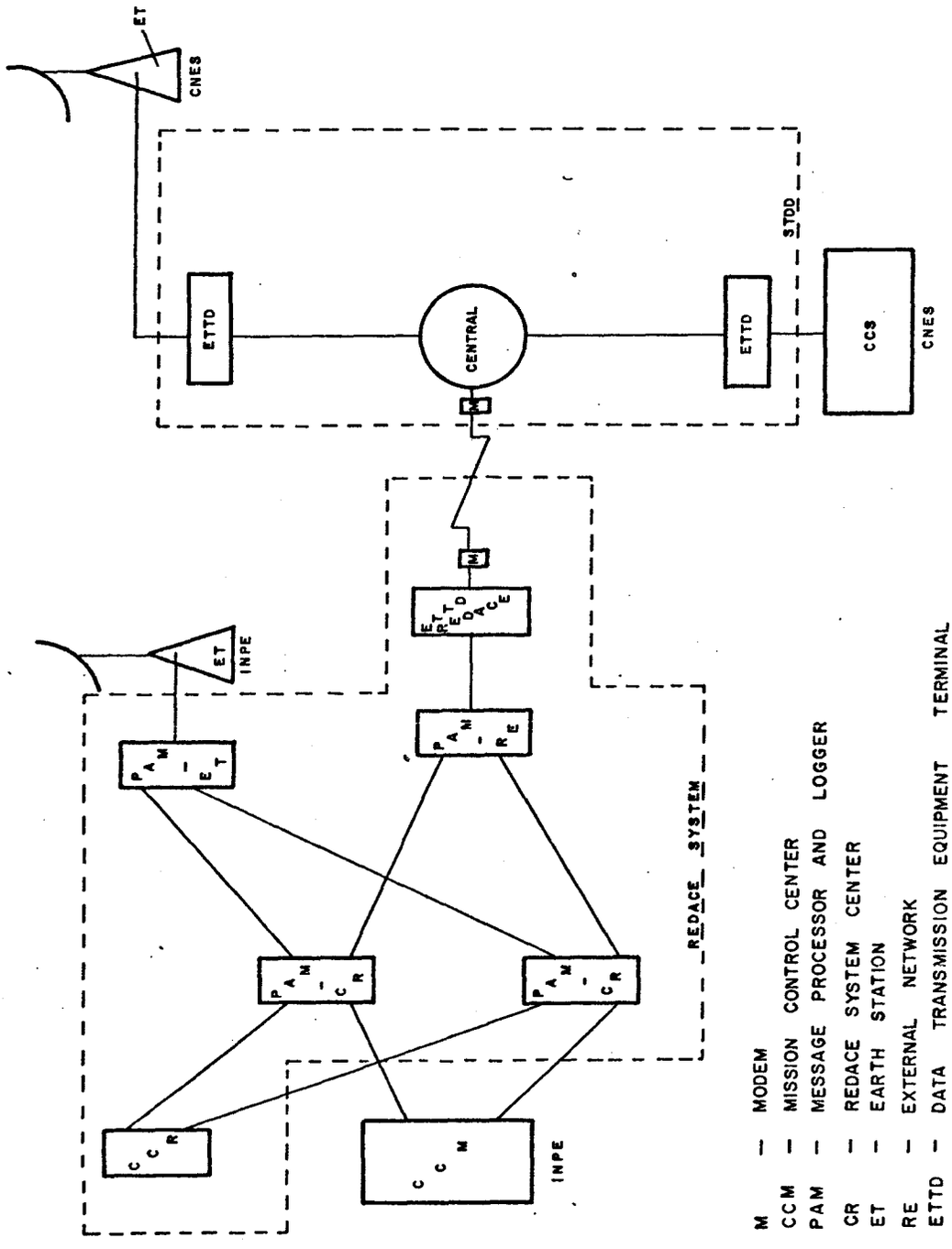


Figure 2 - INPE-CNES interface: Connection by ETTD.

2.2.4 - TECHNICAL ANALYSIS

This option would enable the concurrent and reciprocal execution of all the predicted service (telemetry, telecommand, etc.) that could be requested by INPE or CNES. It has also the advantage of minimizing the software development, considering that the compatibility of the ETTD with the STDD would already be guaranteed and that a relatively simple software would have to be implemented in the PAM/RE.

2.3 - CONNECTION BY MCR

2.3.1 - GENERAL DESCRIPTION

This option characterizes a connection of the REDACE System to the STDD ("Systême de transmission de Données Digitales") through its "GATEWAY/CPA" node (Bergamini 1984), by means of a Multiprocessor for Network Communications - MCR, connected to a "Equipement Terminal de Transmission de Données - ETTD", denominated ETTD/REDACE and integrated to the STDD. A MCR located at CNES and connected to the ETTD/REDACE would be remotely connected to PAM/RE, in Brazil. In this case, a long distance data link with error recovery capability would be provided between the PAM/RE (in Brazil) and the MCR (in France).

2.3.2 - DETAILED DESCRIPTION

It can be observed in Figure 3 that the MCR as well as the ETTD/REDACE would remain in the CNES facilities, such that the MCR - ETTD/REDACE and the ETTD/REDACE - STDD (Central) connections would be in short distance, therefore minimizing the possibility of data error occurence in these short distance links.

The data communication in PAM/RE - MCR- ETTD/REDACE connections would be in a full-duplex mode, with data rates up to 9600 bits/sec. The MCR - ETTD/REDACE connection would have to observe the maximum data block flow permitted by the ETTD/REDACE, as established by CNES documentation (CNES 1984).

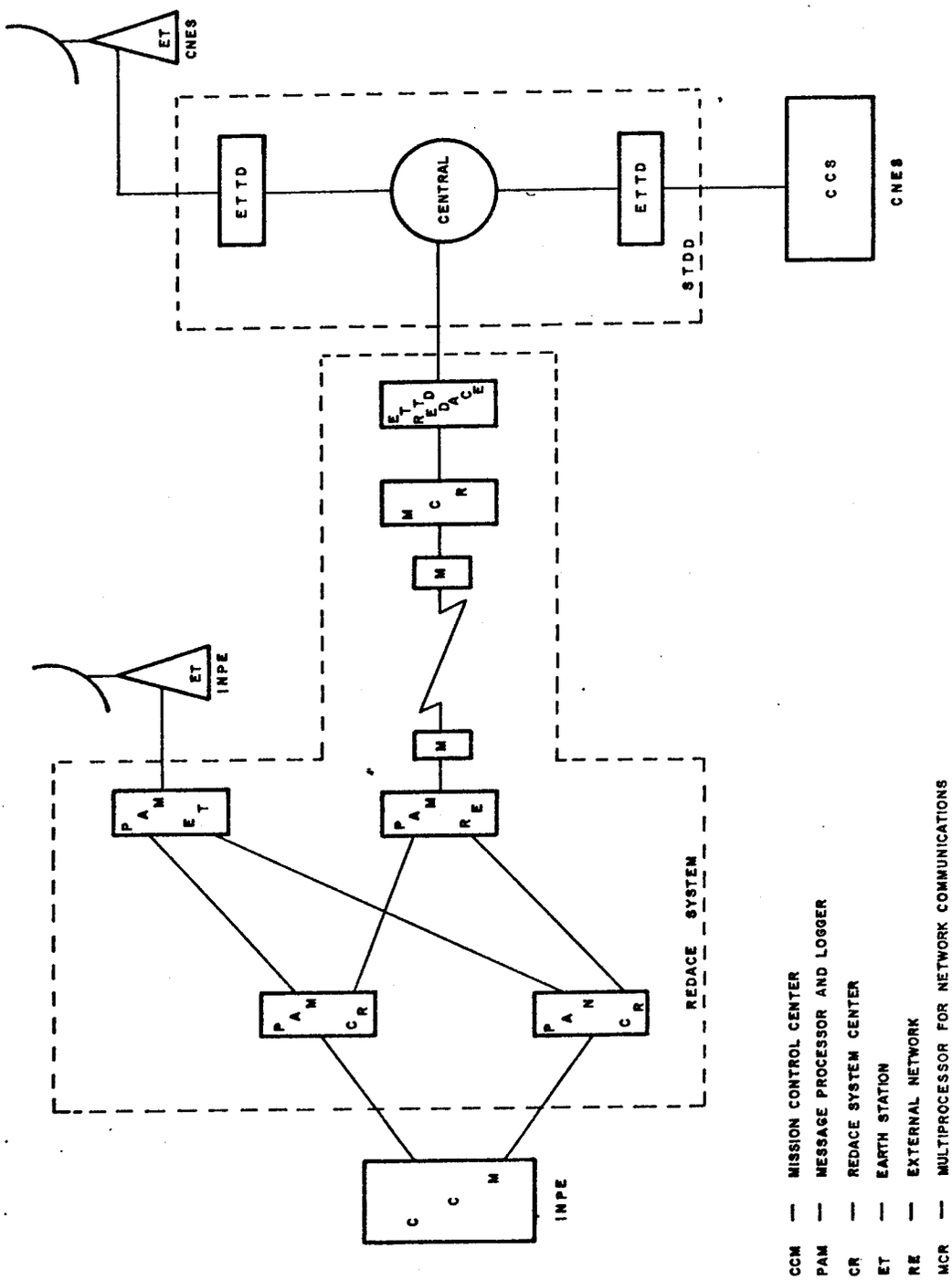


Figure 3 - INPE-CNES interface: Connection by MCR.

In the PAM/RE (in Brazil)-MCR (in France) long distance international data link, a link protocol (in the ISO/OSI reference model sense) would be implemented. In this case, the data field of the link protocol would carry a CNES block, excluding the original HDLC envelope. This link protocol will be based on the INPE Protocol for Space Mission-PRIME.

In the MCR-ETTD/REDACE and ETTD/REDACE-STDD (central) link segments the data would naturally flow in the CNES HDLC protocol, carrying the CNES data blocks.

This option would permit the simultaneous utilization of the data link by various services (telemetry, telecommand, ranging, et.) predicted for the cross-support.

In this case, the REDACE System, which includes the MCR, would be represented by a unique address of the ETTD/REDACE to the STDD. The format field of the CNES block would differentiate a set of subaddresses to be associated to the different services, in the output of the ETTD/REDACE connected to the MCR. On the other hand, the STDD would represent a host to the REDACE System, so that the PAM/RE would guarantee the proper routing of data for both networks by means of a mapping table previously loaded in it by the REDACE Control Center - CCR.

The Control Center of the user space agency will have to observe the data formats of the cross-supporting station for its local services (like ranging, etc.) (CNES 1984c). The PAM/RE would not support any data-processing for these services.

2.3.3 - REQUIREMENTS FOR IMPLEMENTATION

a) Acquisition of two ETTDs (one for spare) compatible with the STDD ;

b) Development of the specific software to be resident in the PAM/RE for proper implementation of this option;

c) Develpment of software to be resident in the MCR solely for implementation of the link level of the PRIME protocol;

d) Development of software to be resident in the Mission Control Center computer for proper implementation of the data formats to be utilized in some of the predicted services, sucha as: ranging, doppler, ephemeris, etc;

e) Evaluation of up and down link telecommunications (frequency, modulation, etc.) compatibility for cross-support;

f) Contracting of international private data communication link;

g) Memorandum of Understanding between both agencies to establish the services to be supported.

2.3.4 - TECHNICAL ANALYSIS

This option permits the simultaneous utilization of all the services (telemetry, telecommand, etc.) that could be cross-supported by both agencies.

This options would aim at an increase in the data transport reliability by using a data communication protocol with error recovery capability in its long distance international data link segment. This goal would not be globally assured, because the data link segments which are more susceptible of errors, are those of the urban, short distance type, implemented in the STTD, which do not support error recovery protocol in their data links.

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