N92-2...

Message Handling System Concepts and Services in a Land Mobile Satellite System

S. Barberis (CSELT), **F. Settimo** (=);
A. Giralda (TELESPAZIO), **I. Mistretta** (=);
C. Loisy (ESA); **J.L. Parmentier** (SAIT)

CSELT
Via G. Reiss Romoli , 274
I - 10148 Torino, ITALY
Phone number: +39 11 21691
Fax number: +39 11 2169909

ABSTRACT

A network architecture containing the capabilities offered by the Message Handling System (MHS) to the PRODAT Land Mobile Satellite System (LMSS) is described taking into account the constraints of a preexisting satellite system which is going to become operational. The mapping between MHS services and PRODAT requirements is also reported and shows that the supplied performance can be significantly enhanced to both fixed and mobile users. The impact of the insertion of additional features on the system structure, especially on the centralized control unit, are also addressed.

1. INTRODUCTION

In 1982 the European Space Agency (ESA) started, on behalf of seven of its Member States, an experimental programme aimed at exploring the feasibility of providing satellite communications to mobiles equipped with light and inexpensive terminals. After a two year phase spent to characterize the radio propagation environment between satellite and mobiles, a low data rate satellite communication system named PRODAT was designed [1].

The system is based on data transfer protocols, data encoding and modulation schemes specifically adapted to the features of the land-mobile to satellite radio path. Since different data transfer protocols were to be used on the terrestrial and satellite links, an implementation based on store-and-forward messaging service seemed a natural solution and was therefore selected for PRODAT.

In order to verify both the design performance and the suitability of this telecommunication service to satisfy the potential users needs, a prototype system was built to provide an experimental service between some fifty mobile equipments and a few fixed positions. The connections between fixed users and the Earth Stations, having access to the satellite, were established by means of the available public networks, i.e. the international telex and Packet Switched Data Networks (PSDN) as well as the Public Switched Telephone Network (PSTN).

Over two years of successful field experimentation with various user communities have proved that:

- the achieved level of performance had met the design objective and was significantly above the competing systems;
- the provided service met the requirements of a wide range of potential users.

Therefore, the upgrading of the design towards an operational system was decided.

The following chapters briefly present the upgrading of the satellite link performance and the requirements of an operational service; a typical PRODAT Center and the integration of MHS and PRODAT are then described.

2. THE OPERATIONAL SYSTEM

The evolution of the experimental system towards a product susceptible of providing a commercial and potentially attractive service has commanded adaptations in the areas of the satellite link and the integration with standard messaging services.

2.1 The satellite link

Minimising the impact of the space segment utilization charges to the operating costs is of primary importance in this competitive environment [2]. It is therefore essential that the satellite link design provides an optimal usage of the satellite communication capacity, also when the radio path is interrupted due to obstacles.

For the experimental system, a fixed apportionment of the total communication capacity among all mobiles in session at the same time had been chosen. The operational system, on the contrary, has a dynamically variable channel assignment scheme which limits the real time capacity sharing only to those mobiles which experience good link conditions. Those who are temporarily obstructed are not allowed to transfer data until more favourable conditions are restored. This is achievable in PRODAT owing to the mode of operations of the mobile which, unlike other systems, is full duplex and allows to continuously monitor the link status.

2.2 Integration with standard messaging services

Although the connections with the fixed users in the experimental system use standard protocols on public networks, no attempt could be made at the time of design to comply with the new messaging standards. Today, however, there is a significant incentive in seeking compliance with the new standards, in particular the X.400 CCITT Recs. This because:

- it allows PRODAT to become a ready made product, susceptible of being integrated as an add-on to a messaging network, public or private, when service extension to mobiles, using a satellite connection, is desired;
- the compliance with well accepted standards provides the scope for more economical system implementations; in particular, it is possible to take advantage of the commercial availability of products developed for a wider market than the application considered. A significant economy of scale, when compared with customized developments, is thus achieved.

3. OPERATIONAL REQUIREMENTS

The PRODAT system has the difficult task of facing a market where other systems (Standard C, Qualcomm) provide a similar service. The obtainable performances will thus be compared by both the network operator and the users.

In this competition context, the success of a system will depend not only on the system design quality but also on the fulfilment of several operational requirements, necessary to achieve the target performance degree. Within such requirements, those related to Operations and Maintenance pertain to the System manager, whose choices impact on the achievement of, for example, a high reliability level. Other requirements, described in the following, are more peculiar to the system; among these:

- Service definition
- Network architecture definition
- User requirements.

3.1 Service definition

The services supported by the PRODAT System are divided into four main categories:

- basic services
- supplementary services
- value added services
- emergency messages.

Basic services ensure a message exchange between fixed and mobile users in a store and forward mode. Broadcast and multidestination transmission, as well as request/reply, are particular applications of the first category.

To cope with specific requests coming from the Users community, other optional services like notification delivery, deferred delivery, waiting messages cancellation are also foreseen. More details about the introduction of optional service elements are presented in sect. 5.

3.2 Network architecture definition

The design objectives of the PRODAT network architecture must comply with adequacy and flexibility requirements and can be classified according to the following list:

- to fit into the existing technical standards
- to comply with European regulations
- to allow for future technological changes
- to follow the demand increase with a modular expansion of the radio channels capacity.

The consequent guidelines for the architecture implementation are the following:

- isolation of the satellite access, terrestrial access and message switching functions
- functions location as much as possible in proximity of users and/or network operator
- choice of advanced structures like the CCITT X.400 framework.

3.3 User requirements

In addition to the user interface implementation, some care has been devoted to the security requirements in the areas of:

- access control to the radio link
- privacy of the user related information.

The first problem has been solved with subscriber identity authentication functions which protect the network from the misuse of resources by non authorized people using manipulated or stolen mobile terminals. For the second problem, the network has been equipped with protection functions of the subscriber identity.

4. THE PRODAT CENTER

In the described satellite system configuration, a key role is played by a centralized management unit, the PRODAT Center, which must:

- ensure the connection between fixed and mobile environment linking the satellite segment, accessed by the mobiles, with several terrestrial networks
- to provide an efficient overall network management.

The first requirement consists in ensuring a reliable message transfer between originator and recipient harmonizing the two different communication media involved in a transaction. The satellite subnetwork is the most critical and the PRODAT Center has been equipped with those functions (bidimensional Reed-Solomon coding, CDMA access technique) capable of protecting the transmitted messages at a satisfactory level.

On the fixed network side, the X.400 standard offers a variety of services by means of existing or emerging products provided that the PRODAT Center is interfaced appropriately. In this way, the advantages of an advanced message handling system would be available not only to the users of telematic services such as TELEX but also to OSI Personal Computers.

Two main functional subunits can be identified on the radio side, namely:

- the Satellite Earth Terminal, with the antenna, the frequency converters and the associated facilities;
- the Satellite Access Unit which handles the satellite protocol and interfaces with the store-and-forward part .

More details can be found in the scheme of fig.1 which includes:

- the IF subsystem performing the BPSK/SCPC modulation and, in the opposite way, despreading, QPSK demodulation and vertical decoding. The functions for controlling carrier level and frequency are located here;
- the Satellite Control Unit, responsible not only for the satellite link protocol but also for the other high level protocols. Hence, it provides a reliable transfer service to the Message Transfer Agent (MTA), devoted to message handling;
- the Terrestrial Access Unit, responsible for handling the terrestrial network protocol and the interface with the MTA.

The PRODAT Center also performs the management functions necessary for housekeeping, communication monitoring and customer data handling (configuration, security, billing, accounting, planning etc.). Automatic procedures and powerful User Interfaces are provided as a support to the operator.

A modular concept has been adopted for implementation so that fault recovery, maintainability and further improvements are easier. The needed functionalities are implemented around a communication subsystem based on Ethernet and a Data Base subsystem.

5. MHS AND PRODAT

5.1 An overview of MHS

The Message Handling System (MHS) is a standard electronic mail store-and-forward system which allows the message exchange between users, humans or computers. Several functional components, i.e. the Message Transfer Agent (MTA), the User Agent (UA), and the Access Unit (AU) interwork with each other to provide MHS services.

The UA allows Users to access the MHS services. The MTAs cooperate with each other to supply a reliable relay and delivery: this feature makes them the fundamental MHS entities. The AU allows the Users of other telematic services to communicate with MHS Users.

In the MHS environment two basic services have been standardized, namely:

- Message Transfer Service (MTS). It is a general store-and-forward and application independent service which involves only MTAs;
- InterPersonal Messaging (IPM). It allows a message exchange between Users in an electronic mail fashion.

The structure of an MHS message has been standardized in two components, an "envelope" and a "content". On the former, all information needed to route the message is written; the latter is the IPM message, i.e. the useful data.

In the following, a mapping between MHS services and PRODAT requirements is attempted for both MTS and IPM, commenting the service elements deemed significant to an LMSS.

5.2 Services and architectures

5.2.1 The MTS service

The MTS is accomplished by means of a set of MTA centres which communicate with each other via a standardized protocol named P1. Every MTA performs the following basic actions:

- **submission:** it allows an originating UA to request the transfer of a message to the MTA directly connected with the UA;
- **delivery:** it allows an MTA to deliver a message to the UA recipient;
- **transfer:** it involves two or more MTA centres. Every MTA routes the message through the network according to the informations written on the envelope;
- **notification:** it informs the originating UA of the message delivery/non delivery to the UA recipients.

The analogy between the basic interactions of an MTA and the main functions of a LMSS is fairly evident and, furthermore, it can be shown that several MTS service elements are already somehow provided by PRODAT.

The entire set of standardized MTS service elements is contained in [3], with a subdivision into basic and optional ones. The former class includes, in particular: Submission and delivery, Non delivery notification, Message identification, Submission and delivery time stamp Indication which do not need further comments.

Among the latter, Probe, Deferred delivery and Deferred Delivery Cancellation seem to be tailored for an environment where the recipient is sometimes unreachable and the information contained in a message is useful only for a limited period. The Probe service element, in particular, consists in sending a short message and reports about the mobile reachability; in this way, useless occupancy of resources can be saved, especially when long messages are transmitted.

Also the Grade of Delivery Selection allows PRODAT users to specify how urgent the relay through the MTS and delivery to the PRODAT Center must be. The chosen urgency level will be afterwards translated into the appropriate transmission priority before accessing the radio link; if necessary, also the retransmission frequency could be increased in order to maximize the probability of reaching the destination mobile in time.

Finally, the Hold for Delivery could be used by an overloaded PRODAT Center as a flow control mechanism when the number of queueing messages exceeds a predefined threshold. The responsibility for a temporary message storage lies in the MTS until the recipient is again ready to accept delivery.

The study of the correspondence between MTS and PRODAT services has been accompanied by the definition of an access network architecture (fig.2). Here, the fixed PRODAT Users are not necessarily regular MHS customers and this allows a simplified terminal equipment. The AU must be designed on purpose: it behaves essentially as a concentration point where all software needed to ensure compatibility between the (PRODAT-like) User generated messages and MTS resides.

Between AU and MHS/PRODAT Interface, the message exchange is fully standardized to the application layer (protocol P1). This is represented by means of the familiar OSI stack without layer 6, not standardized by MHS. The Reliable Transfer Server is a standard layer 7 service element, responsible for the reliable relay between MTAs.

The functional simmetry of the MTS-based access architecture points out that the PRODAT Center is logically equivalent to a fixed User. Hence, it will receive only the content of the P1-messages delivered to the MTA recipient. A suitable MHS/PRODAT Interface provides the necessary adaptation so that changes to the

PRODAT Center internal structure are minimized. The received messages are then stored according to the queuing modality and processed according to the design of the satellite protocol.

5.2.2 The IPM service

In the access scheme of fig 1, Mobiles are not direct MHS users and the advantages of MHS practically involve only the terrestrial link, i.e. the less critical element of the PRODAT network. A higher service efficiency can be achieved with an access network architecture, based on InterPersonal Messaging, which includes Mobiles in the MHS community.

IPM provides to the individual Users all the communications services typical of electronic mail. Being a higher level application than MTS, it supplies to IPM subscribers several basic and optional additional services. The former allow to:

- send and/or receive messages of the electronic mail system;
- use the capabilities of MTS;
- identify, at user level, the messages submitted to the MTS for transfer;
- recognize the information types contained in the message body. This is obviously not possible to MTS, which only sees the message "envelope".

Some optional services are attractive for PRODAT applications. For example, the Reply Request Indication and the Replying IP-message Indication represent a ready made upgrade to an existing PRODAT service and correlate automatically Original and Reply messages. Non receipt and Receipt Notification Requests are a much more interesting piece of information than the Non Delivery and Delivery Notification supplied by MTS. The former, in fact, indicate if the mobile has been successfully reached; the latter only indicate if the PRODAT Center has been reached via the terrestrial link but nothing can be said about the final destination.

Expiry Date Indication and Obsoleting Indication help to avoid transmitting obsolete messages to a mobile which has been unreachable for some time, when the radio link improves. The saving of radio resources usage is evident.

Fig 3 shows a proposal for integrating IPM into the PRODAT environment. It is evident, first of all, that Fixed and Mobile PRODAT customers are individually considered and that each one has access to a dedicated storage area (UM) of the computers hosting the UA software. This makes it possible to address users in an IPM fashion by means of the standard application protocol P2 (based on protocol P1 for transfer). User Memories are not yet provided in the PRODAT Center design.

Another interesting feature of this second access architecture is the symmetry between the Fixed Users side and the PRODAT Center side: this should allow replicating, or at least reusing with minor modifications, a part of the involved software. It is finally noted that the proposed architecture is particularly favourable to those Users who are already MHS subscribers and want to becom PRODAT customers too: these ones, in fact, need no additional equipment to access PRODAT with the benefits of MHS.

6. CONCLUSIONS

The achieved results allow to state that the disadvantages of a mobile environment (typically on the radio link) can be mitigated not only by a robust access protocol to the space segment but also with reliable message transfer procedures on the terrestrial link. The paper contains some implementation proposals which validate the basic idea showing how the theoretical service elements of CCITT Recs can be integrated in a real system.

Acknowledgement

The authors are grateful to Mr. C. Berrino (CSELT) for his valued suggestions in the access architecture definitions.

REFERENCES

1 **Rogard, R.; Jongejans, A.; Loisy, C.** 1989. Mobile Communications by Satellite - Results of Field Trials conducted in Europe with the PRODAT System. In: *ESA Journal 1989, Vol. 13 pp. 1-12*

2 **Bartholome, P; Rogard, R.** 1988. A Satellite System for Land-Mobile Communications in Europe. In: *Proceedings of the Mobile Satellite Conference, Pasadena Ca. May 3-5 1988 pp. 37-42*

3 **CCITT Recommendation X.400** *Blue Book, Melbourne 1988*

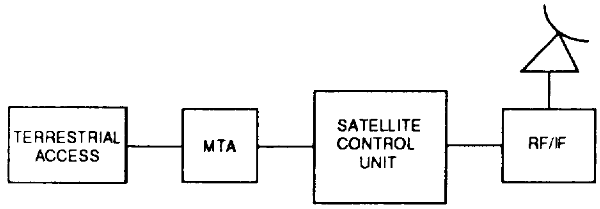

Fig. 1 - PRODAT Centre Architecture

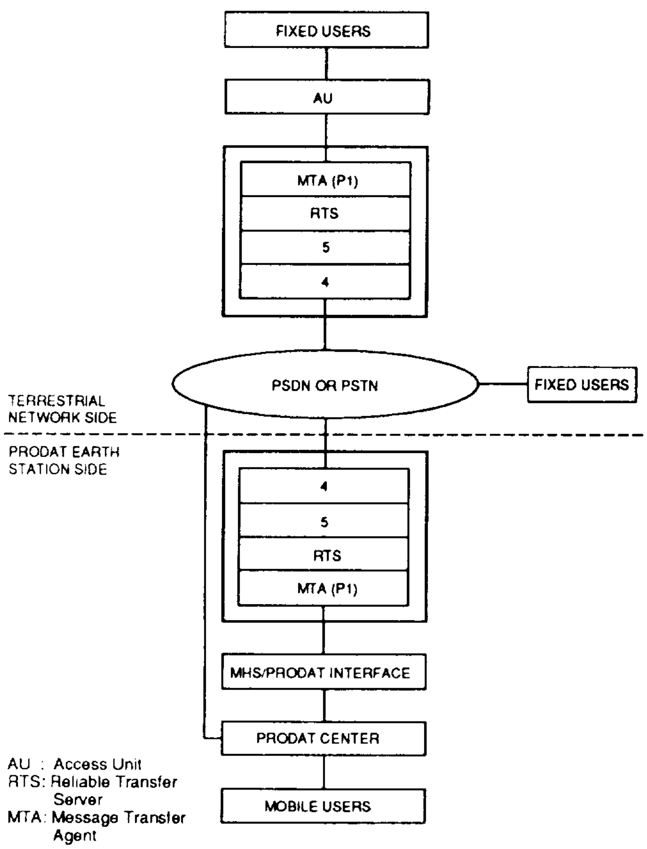

Fig. 2 - MTS based architecture

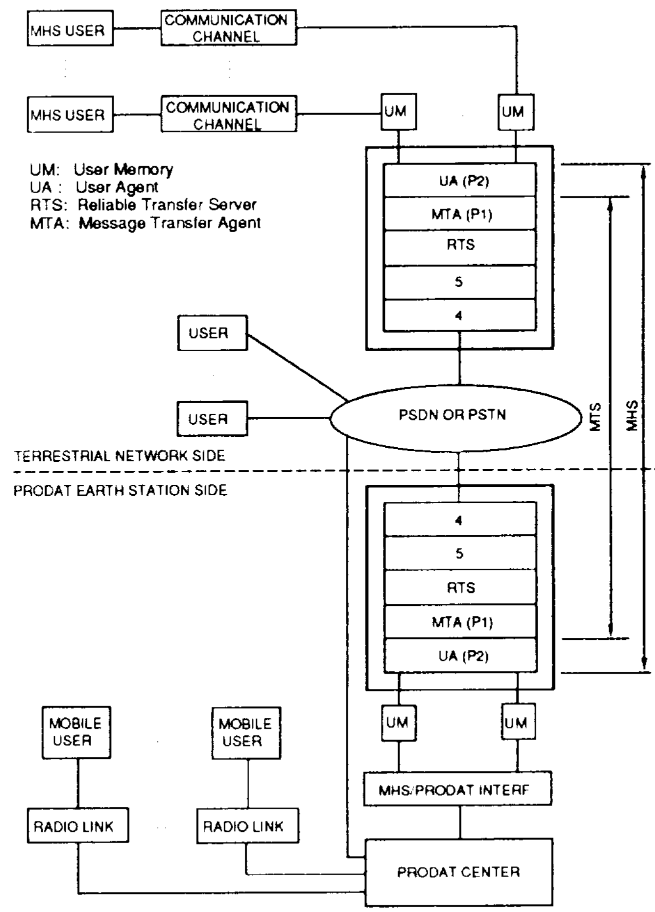

Fig.3 - IPM based architecture