N94-22789

THE EUROPEAN MOBILE SYSTEM (EMS)

A. JONGEJANS, R. ROGARD
European Space Agency
Postbus 299
2200 AG NOORDWIJK
The Netherlands
TEL: 31 1719 83142
FAX: 31 1719 84598

I. MISTRETTA, F. ANANASSO
Telespazio S.p.a
Via Tiburtina, 965
00156 ROME
ITALY
TEL: 39 640793738
FAX: 39 640793624

Abstract : The European Space Agency is presently procuring an L band payload in order to promote a regional European L band system coping with the specific needs of the European market. The payload, and the two communications systems to be supported, are described below. The potential market for EMS in Europe is discussed.

1 - INTRODUCTION.

The European Space Agency has developed and launched elements of the first generation of Global L-band satellites in the early 80's (MARECS-A launched in 1981 and MARECS-B2 in 1984). From 1983 onwards, in the framework of the PROSAT programme, extensive theoretical and experimental work in the field of mobile satellite communications was carried out, resulting in the design of two Land Mobile Satellite Communication sytems and in the development of the EMS payload to be embarked on the ITALSAT-2 satellite due for launch by mid-1995.

2 - EMS PAYLOAD

The optimisation of the space segment is a key issue for a competitive land mobile voice service as the space segment cost is predominant.This leads to the requirement for efficient use of the radiated power from the correct orbital position over the useful coverage only. For Europe, an edge of coverage gain of about 26 dB can be achieved with a single beam from a 13 deg east orbital position. Another key element is the possibility to reuse the L-Band spectrum from this orbital position through the use of CDMA techniques. A Eurobeam for the feeder link at Ku band offers the possibility of having a VSAT station as Hub. The EMS payload consists of two transponders connecting the Fixed Earth Stations (FESs) at Ku-band with the Mobile Earth Stations (MESs) at L-band and vice versa. The main characteristics of the EMS payload are summarised below:

Feederlink	:	Ku-band
Mobile link	:	L-band
L-band	:	42.5 dBW
L-band G/T	:	-2 dB/K
Ku-band G/T	:	-1.4 dB/K
Useful bandwidth	:	12 MHz
Payload DC power	:	400 W
Payload Mass	:	60 kg

EMS characteristics

In order to facilitate coordination with other L-band satellite networks and to allow flexible handling of the payload capacity, the total useful bandwith has been divided into independent sub-bands. In the forward link the total useful bandwidth consists of three 4 MHz bands.In the return link, where the interference problems are most acute, each of the above three bands has been further divided into four channels each, of 1 Mhz, referred to as "virtual transponders". Each virtual transponder can be remotely and independently switched on or off and its gain adjusted. Channel filtering is achieved by using

SAW technology at an IF frequency of about 140 MHz.

Two separate offset L-band antennas are used for transmit and receive, reusing the ITALSAT F-2 Ka-band elliptical reflectors (projected aperture diameter: 2m) and dedicated L-band four "cup" feeds. RHC and LHC circular polarisations are provided. The typical coverage is shown in Figure 1. Assuming a nominal voice channel EIRP of 19 dBW, 600 channels can be served simultaneously (including voice activation factor).

3 - PROPOSED MOBILE SYSTEMs (see Refs. 1 and 2)

Two baseline systems are foreseen to be operated via EMS:

A-The Low-data-rate PRODAT-2 system.

The PRODAT-2 system is the operationnal evolution of the experimental PRODAT system which has been successfully tested and demonstrated in Europe under the responsibility of the European Space Agency between mid-1987 and end 1992 (Ref 1).The main characteristics are very similar and the experience gained during the trial phase together with the evolution of the market has provided scope for optimisation of the system. The system is an open, centralised and modular system in which the fixed user is connected to the Hub via the public network, either directly or via national or regional concentrators (see Fig. 2). Link characteristics are given below:

- -Store and forward
- -Forward link:BPSK/TDM 1500 bit/s
- -Return link: CDMA/OQPSK 600bit/s
- -Adaptative block coding with ARQ
- -Omnidirectionnal mobile antenna
- -10 W RF power

PRODAT-2 main characteristics

-The basic communication functions are retained (Bi-directional messaging, broadcast, request/reply and polling). The public network access to the Hub is compatible with CCITT X400 recommendations in addition to conventionnal fax/telex links. Several other improvements have been implemented to cope better with users requirements. The PRODAT-2 system is now ready for demonstration, for which a pre-series of fully industrialised MES's (including a GPS card for position determination) are available. The two manufacturers (FIAR-Italy and PESA-Spain) are ready to produce MES's at competitive prices.

B- The Mobile Satellite Business Network (MSBN) voice and data system

The present MSBN definition is the result of many detailed studies including market surveys, and in-depth technical evaluation. The basic MSBN concept represented in figure 3. shows that a fixed user has direct access to his fleet of mobiles through his own VSAT station installed on his premises and pointed towards EMS. The VSAT station operates at Ku-band and the mobile station at L-band. The MSBN system uses quasi-synchronised CDMA access techniques in both directions over the satellite link.(see Ref 3). The choice of CDMA eases the coordination with other satellite systems and is particularly suited to the PMR (Private Mobile Radio) concept where all the independant networks share a common bandwidth resource without the need for network coordination. The synchronisation of the transmissions in both directions allows a greater number of simultaneous users due to the drastic reduction in the self-noise level. Also,the mobile receiver acquisition is eased as a synchronisation signal is continuously transmitted providing chip, code and carrier synchronisation. In the basic configuration, a pair of channels (codes) are allocated to each business network in a star configuration, and those channels are shared between the MES's under the VSAT station control to handle up to about 125 trucks under average traffic conditions. It should be noted that the system allows for a modular growth of the communication capabilities of the VSAT station according to the growing needs of the transport company. On the other hand, a VSAT station may be shared by more than one company to reduce costs to smaller companies. The link characteristics of MSBN are given below:

- -L-band mobile link
- -Both link uses CDMA Quasi Synchronised
- -QPSK at 867 KChip/s
- -Voice at 6.4 Kbit/s
- -Data at 2.4 Kbit/s
- -Convolutional and block coding
- -Steered mobile antenna with 11 dB gain (see refs. 4 and 5)
- -10 W RF in transmit

MSBN main characteristics.

An experimental MSBN network is presently under procurement by the Agency, and one FES manufactured by SAIT (Belgium) and 14 MES's from Fiar (Italy) and PESA (Spain) will be available for tests and demonstration by the end of 1993, using the Marecs-A satellite.

4 -SERVICES AND COMPETITION

Market surveys have revealed an urgent need in Europe for specialised mobile services for the business world, as distinct from public services offered by Public Telecommunications Operators (PTO's). In the international road-transport sector, for instance, the needs are particularly pressing. Companies that operate fleets of vehicles transporting goods across Europe are very anxious to maintain instant communications with their vehicles wherever they are.

With the opening of borders towards Central and Eastern Europe, the satellite now appears as the only practical way to provide mobile services to those countries on a significant scale.
The poor telecommunication infrastructure of eastern European countries also justifies the need for portable terminals either for data and/or voice services to help interactive businesses.

The actual mobile satellite services being introduced mainly by the PTO's in Europe are Inmarsat's standard-C and Eutelsat's Euteltracs. It is clear that even if the trans-border communication services offered are unique in Europe, their market penetration rate is rather slow. The reasons for this might be marketing, too high tarifs, inadequacy of performances vis-a-vis user requirements or simply an immature market.Both systems have a centralised approach imposing the use of public networks to connect the fixed user to the satellite system. The start of these services ahead of EMS is not considered as a handicap but rather a preparation of the market for satellite services. Other competition will come from the digital European cellular system GSM which is presently being introduced. The prices of mobile terminals will certainly be lower than satellite terminals due to the economies of scale, but the flexibility and the service prices can easily be challenged by a well-designed regional satellite system.

5 - ASSESSMENT OF POTENTIAL SUBSCRIBERS

Awareness of the addressable market and definition of the potential user profiles are fundamental if a successful and profitable Land Mobile Satellite System is to be implemented. A correct market segmentation allows both the definition of systems/products/services that suit the various user requirements and the formulation of appropriate marketing messages directed to the various segments, aiming at differentiating the system/service/product with respect to the various competitors. A study performed by Telespazio for the Agency (see Ref. 6) has evaluated the potential subscribers to EMS, limiting the analysis to the addressable potential terrestrial user. The methodology persued included the following steps:

(a) Assessment of present population of the various user segments.
(b) Assessment of the future population (1995 to 2005)
(c) Assessment of the potential users (interested in mobile communication services irrespective of the telecommunication system, terrestrial or satellite).
(d) Assesment of the addressable users (interested in LMSS communication services).
(e) Assessment of the potential subscribers for EMS specifically.

Estimates of potential users interested in mobile communications services in Europe in 1995 and 2005 are given below:

Year	Potential Users (x1000)	
	1995	2005
Trucks [1]	2000	2687
Railways Passenger coaches Goods wagons	 69 962	 76 1231
Professional Travels	9000	9460
Data collection & Monitoring Appl.	840	1023
Car Rental [2]	34	46
Rescue Users	tbd	tbd
Buses [2]	92	107
Total	12997	14630

[1] Trucks >3t

[2] Only Italian users

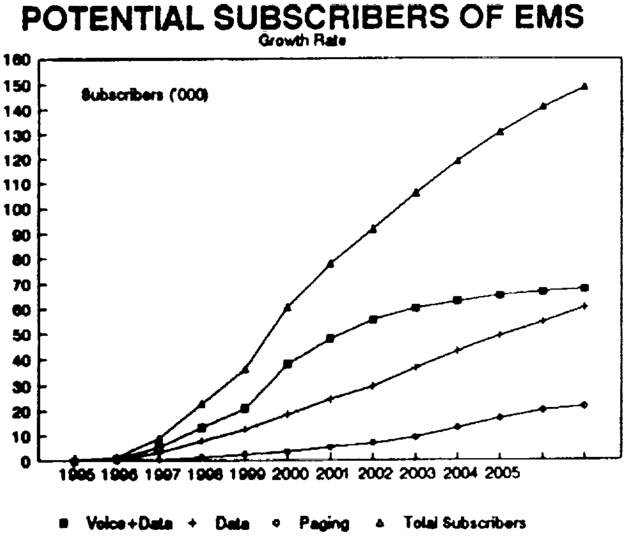
The potential truck user include only those having capacities greater than 3 tons. For the other user groups, the entire future population of users has been assumed (data regarding rescue users were not available). It is worth noting that the end-user prices assumed in the baseline forecast for the voice and data service on EMS, have been determined on the basis of the end-user prices of terrestrial cellular systems with the addition of a price for the satellite services. The prices considered have been :

Terminal Prices ($) :	
data	:2200
voice	:3500
End-User Prices ($)	:
Subscription charege	:32
Data charge	:0.28$kbit
Voice charge	:1$/min.

Finally, the potential EMS subscribers have been determined on the basis of service introduction time in the market and competition from other LMSS system.

The figure below shows the growth curves for EMS potential subscribers per basic service.

POTENTIAL SUBSCRIBERS OF EMS



6 -IMPLEMENTATION SCENARIO

The deployment of any telecommunication system generally involves answering at least two major questions:
-How will the system be implemented ?
-How will the system be operated ?
Key points of the physical implementation of any LMSS are :

- Space segment. Identification of its characteristics and availability of the in-orbit capacity and backup capacity.

- Network deployment. Determination of various phases to make the system operative.

In order to prepare the market,an interim PRODAT-2 low data rate service will be provided using Marecs-A residual capacity. Then, the EMS payload embarked on Italsat F-2 will be available in orbit by mid-1995. Backup capacity will be provided by the LLM (L-band Land Mobile) payload to be embarked on ARTEMIS, with a launch in 1996.

As far as network deployment is concerned, it depends primarily on constraints dictated by the technical and marketing/commercial analysis. In particular, three main stages have been highlighted with reference to technical and operational considerations:

a) Test and demonstration of the system. This is aimed at validating the system from the both performance and operational capability standpoints.

b) Pilot project (Pre-operational phase). This is aimed at refining the system. In addition, it is directed primarily at promoting the system and validating it from an operational viewpoint.

c) Operational Phase. This phase is divided into two steps :

(1st) Private Network
(2nd) Public Network

The rationale for this choice is based on to both market analysis and operational considerations. A reasonable date for Public Service introduction might be 1996.

7 - CONCLUSIONS

The future European Mobile system making use of a piggy-backed payload on a fixed communication satellite has been presented and the various inherent elements described. The design selected has been carefuly matched to the requirements of the main potential user groups that have been identified. The chosen options allow problems related to the coordination with other satellite systems to be overcome from an interference point of view. Moreover, the regional system described can compete with other mobile telecommunication services and can be profitable for the system operator. Even if modest in size, EMS also will open a new market for the European mobile and VSAT stations manufacturers and the associated value-added service providers.

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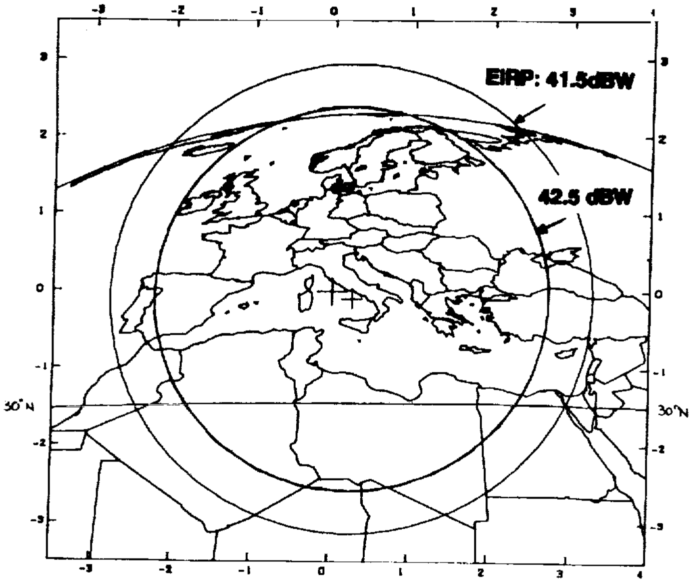

FIG.1: EMS TRANSMIT COVERAGE

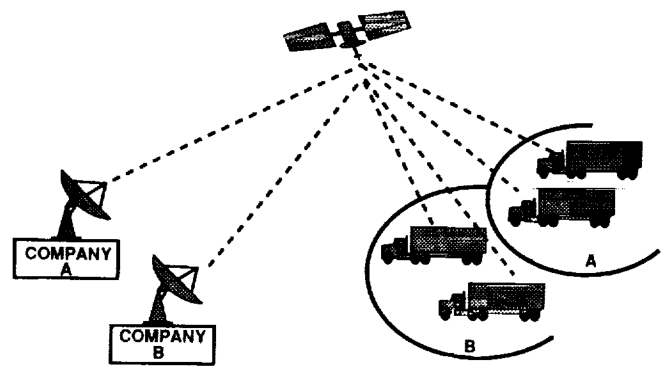

FIG 3: MSBN NETWORK

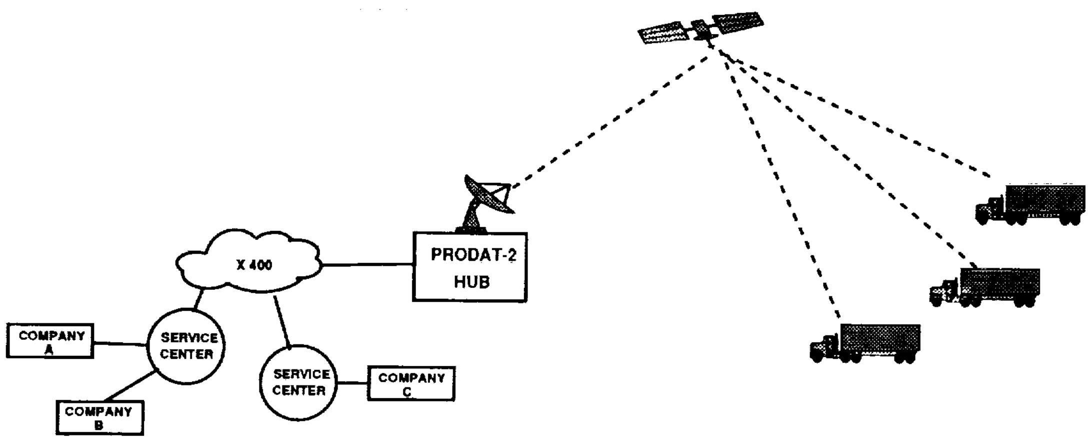

FIG:2 PRODAT2 NETWORK CONCEPT

FIG 4: PRODAT MOBILE STATIONS
OLD (LEFT) AND NEW (RIGHT)

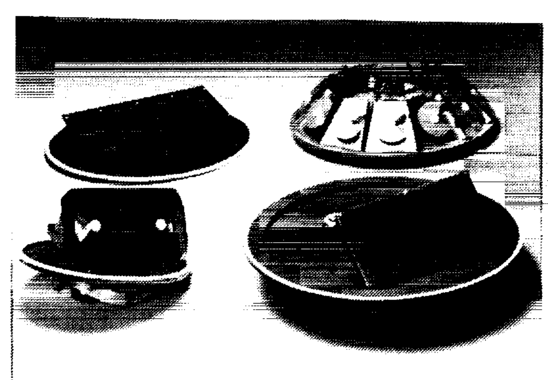

FIG 5: PROTOTYPE MOBILE ANTENNAS
DEVELOPPED FOR MSBN

Session 8
Propagation

Session Chair—*Barry G. Evans,* University of Surrey, England
Session Organizer—*David Rogers,* Communications Research Centre, Canada

(continued)