

## The European Mobile System Payloads for Personal and Mobile Communications

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**Abstract :** *This paper describes the characteristics of the Alenia Spazio payloads providing L-band personal and mobile communications services. The characteristics of a satellite under study for mobile communications at Ka and EHF band are described too. The payloads are: EMS, LLM and SECOMS.*

*EMS ( European Mobile System ) is an ESA Payload embarked on the Italian satellite ITALSAT F2. It will be the first in orbit element of an European Land Mobile Satellite Communication System .*

*LLM ( L - band Land Mobile ) is a payload that will be embarked on the European Spacecraft ARTEMIS and will be used to increase the EMS payload capabilities.*

*SECOMS ( Satellite EHF Communications for Multimedia-mobile Services ) is a satellite under study for future mobile and personal communications at Ka and EHF band.*

### 1) Introduction

Wireless personal communications has attracted considerable interest over the past several years. Some of them , such as ground cellular telephony, providing voice and data services have already been implemented. Multimedia services (combined voice, fax, music, data and video ) are expected to be largely required by the year 2000.

In the future Personal Communications will require personal services (PCS), independently from the type and the number of networks. Any user, in a PCS contest will be accessed through different networks by means of different types of terminals ( either fixed, transportable or mobile).

In this scenario the satellites will play an important role to support and complement terrestrial systems to answer the demand of mobility, interactivity and large bandwidth.

Some market analyses show that by the year 2010 personal and mobile services will represent the 20 % of the total revenues of the European telecommunications market.

In order to face the considerable growth of Mobile communication demand, the European Space Agency (ESA) planned for the second half of the 1990's the in orbit infrastructure of an European Land Mobile Communication System. The development of two L band mobile payloads was approved:

- the European Mobile System (EMS) payload embarked on board the Italian satellite Italsat F2.
- the L band Land Mobile (LLM) payload embarked on board Artemis (planned to be launched in 1998) which will be the in - orbit back-up of EMS.

In order to support multimedia services, multiple beam mobile satellite systems servicing a wide range of mobile terminals such as brief case, lap-top, palm top terminals etc. are foreseen for the next generation of personal communication systems.

Alenia Spazio, in co-operation with other European partners, is currently studying a satellite system (SECOMS) whose main target is to address the ubiquitous and mobile user market with multimedia services up to 2 mbps.

In the following sections the characteristics of above mentioned payloads for mobile and personal communications will be briefly described .

WE  
2D

## 2 L-band Payloads

### 2.1 European Mobile System (EMS) Payload

EMS will provide a Global service over all the western part of Europe and most of Eastern Europe, North Africa and Turkey. The L-band coverage areas are shown in figure 1.

The Payload consists of two transponders, one for the Forward Link from Fixed Earth Stations (FES) to Mobile Terminals and one for the Return Link from Mobile Terminals to FES.

The feeder link from FES to the Satellite is performed at Ku-Band while the link from Mobile Terminals to the Satellite is performed at L-band. The major performance characteristics are summarized in the following table 1:

Coverage	Global European
Number of Users	300
L-band EIRP	42.5 dBW
L-band G/T	-2 dB/K
L-band Polarization	RHCP
Forward Transponder Channellization	3 channels 4 MHz each (12 MHz U.B.)
Return Transponder Channellization	12 channels 0.9 MHz each (10.8 MHz U.B.)
Ku-band EIRP	32 dBW
Ku-Band G/T	-1.4 dB/K

**Table 1 EMS Main Performances**

### 2.2 L-band Land Mobile P/L (LLM)

The L-band Land Mobile payload will allow up to 445 users to simultaneously access the satellite at L-band to be connected, via the Ku band feeder link, to the earth stations. LLM will experience also the frequency reuse by polarization discrimination on the same beam and spatial diversity.

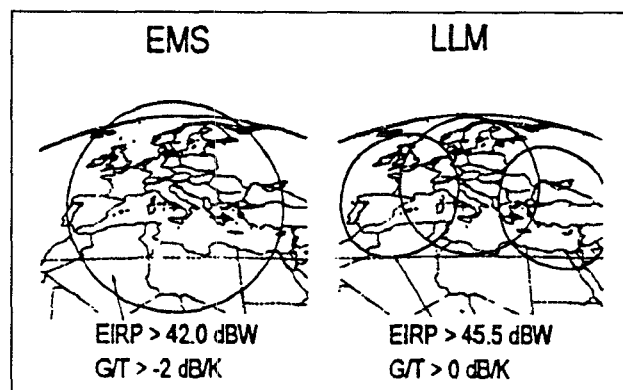
Four different coverages are provided: one Global beam covering a large portion of Europe and North Africa and three spot beams (A,B,C) together covering the 90 % of the Global coverage as shown in figure 1.

A double circular polarization (LHCP and RHCP) is used in the Global beam and spot B beam coverage allowing frequency reuse by discrimination of polarization. Spot A and spot C will be used to experience the frequency reuse by means of spatial diversity.

The main RF characteristics are summarized in the following table 2:

	L band		Ku band
	Global Cover.	Spot Coverage	European Coverage
EIRP/carrier (dBW)	19	19	7
G/T ( dB/K)	-2	0	-1.4
N. of carriers	280	445	445
Polarization	RHCP , LHCP	RHCP : Spot B LHCP : A,B,C	Linear H, V

**Table 2: LLM Payload key features**



**Figure 1 EMS and LLM Coverage**

### 2.3 The European Mobile Satellite Service (EMSS)

The fixed earth stations of EMSS are VSATs with 1.8 m. The EMSS is implemented using CDMA multiple access scheme. Service demonstrations will be based on two different communication systems developed by ESA: PRODAT and MSBN.

#### 2.3.1 PRODAT

Prodat has been conceived as low data rate messaging system which operates through a compact and low cost mobile terminal. A

printed antenna of 90 mm diameter and 20 mm thickness with an isotropic coverage is used.

Main Characteristics are:

- 10 W RF Power
- TDM/BPSK 1500 b/s receive
- CDMA/OQPSK 600 b/s transmit
- Adaptive ARQ base block coding

### 2.3.2 Mobile Sat. Business Network (MBSN)

MBSN has been designed for vocoded voice and real time data transmission services and allow for a wide range of network architectures.

Its main design feature is the possibility of decentralized satellite access from the fixed side, while maintaining overall efficiency even in low traffic networks. It is based on the use of low cost VSAT stations operating at Ku band (1.8 m of diameter) and a CDMA multiple access scheme.

## 3 Ka-band Systems: SECOMS

The SECOMS system presently under study is being designed to support mobile-multimedia services at Ka and EHF bands.

The following evolutionary approach will be adopted:

- *Phase I*: Ka-band system component.
- *Phase II*: EHF band system component to be added and integrated with the Ka-band component to increase capacity, expand set of services and enhance mobility and interactivity over the same coverage area.

*Phase I* Ka-band system component is intended to be operational before year 2000 to provide multimedia-mobile services to medium-sized portable/mobile terminals from few kbit/s (about 32 kbit/s) to 384 kbit/s, and to low-cost direct-to-user fixed terminals up to 2 Mbit/s.

*Phase II* EHF system component, operational after year 2000, will complement service

provision in terms of data rates down to 4.8 kbit/s for telephony and data services (and possibly down to a lower rate for paging/messaging) with palm top terminals. Both system components are intended as a unique integrated system, and connections will be allowed between terminals of different size operating at Ka-band and/or EHF.

Transportable and mobile terminals (assumed installed on board of airplanes, ships, trains, cars) have been grouped within three main categories:

- low-medium throughput terminals: from few Kbps up to 128 kbit/s (personal mobile and transportable terminal, with little power autonomy)
- medium-high throughput terminals: from few Kbps up to 512 kbit/s.
- high capacity terminals: few kbps up to 2.048 Mbit/s.

The present system architecture has been defined according to the following concepts :

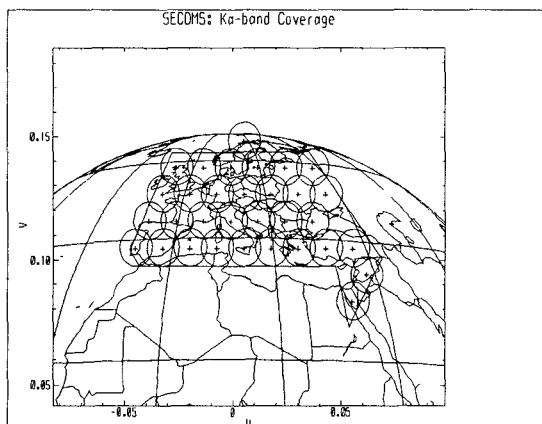
- use of multiple satellites connected through Inter-Satellite Links (ISLs);
- use of High-Gain Spot Beams (HGSB) generated on-board the satellite and allowing multi-spot coverage of extended Europe;
- implementation of on-board fast digital processing (OFDP);
- use of the most appropriate multiple access/distribution (MA/D) technique. (Presently the MF-TDMA/TDM and CDMA/CDM techniques seems to be the most suitable ones);
- use of intelligent terminals with limited EIRP and G/T;
- implementation of a “dual-band” integrated service.

A payload architecture based on a regeneration stage including demodulators, CS-PS switching stages and modulators has been addressed .

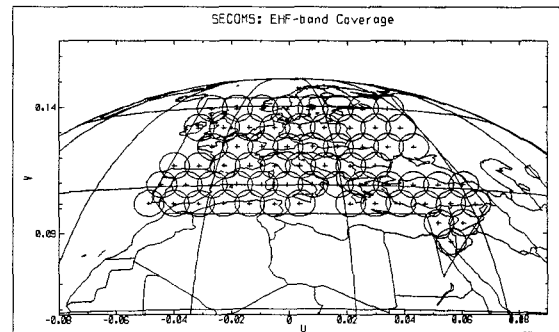
The main SECOMS system characteristics are summarized in table 3:

Parameter	Ka-band	EHF-band
Max Sat. Traffic Capacity	> 4000 Mbit/s	> 200 Mbit/s
Numb. of Spot Beams	32	64
Type of Satellite Terminals	3 ( SatT-A, SatT-B and SatT-C)	1 ( SatT-D)
Type of FES	1 (GaT-K)	1 (GaT-E)
SatT-A uplink information rate	from 32 to 128 kbit/s	--
SatT-B uplink information rate	from 32 to 512 kbit/s	--
SatT-C uplink inform. rate	from 32 to 2048 kbit/s	--
SatT-A,B and C Downlink inform. rate	2.048 Mbit/s	--
SatT-D uplink inf. rate	--	from 4 to 64 kbit/s
SatT-D downlink information rate	--	64 kbit/s
Frequency : Uplink Downlink	30 - 30.68 GHz 20 - 20.91 GHz	45GHz 40 GHz
Coverage	extended European figure 2	extended European figure 3
Spot Beamwidth	0.7 ° ( at -3 dB)	0.49° (at -3 dB)
Polarisation	Circular	Circular
Satellite G/T	16.3 dB/K	19.7 dB/K
Satellite EIRP	53.6 dBW	50.3 dBW
User terminals G/T	7.7 dB/K ( SatT-A) 10.7 dB/K ( SatT-B) 10.7 dB/K ( SatT-C)	8.2 dB/K (SatT-D)
User terminals EIRP	32.7 dBW ( SatT-A) 38.7 dBW ( SatT-B) 44.7 dBW ( SatT-C)	28.8 dBW (SatT-D)
Link Quality	BER < 10 <sup>-10</sup>	BER < 10 <sup>-10</sup>

**Table 3 SECOMS main system param.**



**Figure 2:SECOMS Ka-band coverage**



**Figure 3: SECOMS EHF-band coverage**

## 7) Conclusions

The characteristics of the Alenia Spazio payloads for personal and mobile communication services have been briefly described. EMS (ready for launch) and LLM (under integration and test) will be the in orbit elements of the EMSS system, providing voice and data service.

The characteristics of a new satellite system for future Ka band and EHF band mobile communications, studied by European companies, leaded by Alenia Spazio, has been described too. The preliminary results of the study demonstrate the feasibility of multimedia services provided by a wide set of mobile and ubiquitous terminals with data rate ranging from few kbps up to 2 Mbps.

## Bibliography

- [1] A. Pullara, S. Fagioli : "EMS : System Key Aspects and Technological Experiments". 15th International Communications Satellite Systems Conference, San Diego California, AIAA 1994.
- [2] R. Giubilei, M. Marinelli, A. Sbardellati, T. Sassorossi : " The Communication Payload of the Artemis European Satellite ".15th International Communications Satellite Systems Conference, San Diego California, AIAA 1994.
- [3] F. Ananasso, F. Delli Priscoli: " The role of Satellites in Personal Communication Services" IEEE Journal on Selected Areas in Communications Vol.13 No2 Feb 1995.
- [4] G. Losquadro, J. Medard, I. Mistretta and F. Vatalaro: " Developments in the 20/30 GHz Satellite Mobile System in the ACTS Project " EPMCC ' 95 , Bologna, Italy 28 - 30 Nov. 1995
- [5] C. Loisy, P. Edin, F. J. Benedicto: «European Mobile Satellite Services (EMSS) a Regional System for Europe » ESTEC, 1995.