TEMISAT

A MICROSATELLITE SYSTEM FOR AUTONOMOUS ENVIRONMENTAL MONITORING SERVICE

Brunella Pavesi (1), Giuseppe Rondinelli (1)
Nikolaos Balteas (2)

(1) TELESPAZIO S.p.a. - Via Tiburtina 965 - 00156 Roma, Italy
(2) KAYSER THREDE GmbH - Wolfratshauser Str.48 - 8000 Munchen, Germany

SUMMARY

TELESPAZIO is developing the first professional system program using TEMISAT micro-satellite.
The service offer will be dedicated to Environmental Monitoring for data collection and distribution from autonomous Networks.
The system is composed by two microsatellite units with low cost satellite based TDMA/SCPC scheme, a Mission Control Center and two different types of terminal; Collection Center terminal and User terminal.
A brief description of the Satelite subsystem is outlined.

1 - INTRODUCTION

The collection of environmental data requires the deployment of many sensors over wide areas usually difficult to be reached or lacking in communications infrastructures.
A satellite system for environmental monitoring services can offer a unique opportunity for an efficient solution.
In particular making use of the existing technology it is possible to provide the required communications capability through a microsatellite based system.

2 - THE TEMISAT PROGRAM

The TEMISAT Program foresees the implementation of a Data Collection and Distribution Service for geophysical environmental monitoring, throught a micro-satellite named TEMISAT (TElespazio MIcro SATellite) and based on Autonomous Managed Network.

This network will adopt very innovative and effective communications technologies to environmental protection service.

The main applications are:

- Basin Level Monitoring
- Oceanographic Monitoring
- Snow Level Monitoring
- Traffic Monitoring
- Monitoring of the structures (Buildings, Dams, ecc..)
- Geological Monitoring
- Seismic Monitoring
- Climatological monitoring

The service shall be provided, at least on a daily basis, to private and public users located on the Italian territory and on the surrounding European and Mediterranean Regions (figure 1).

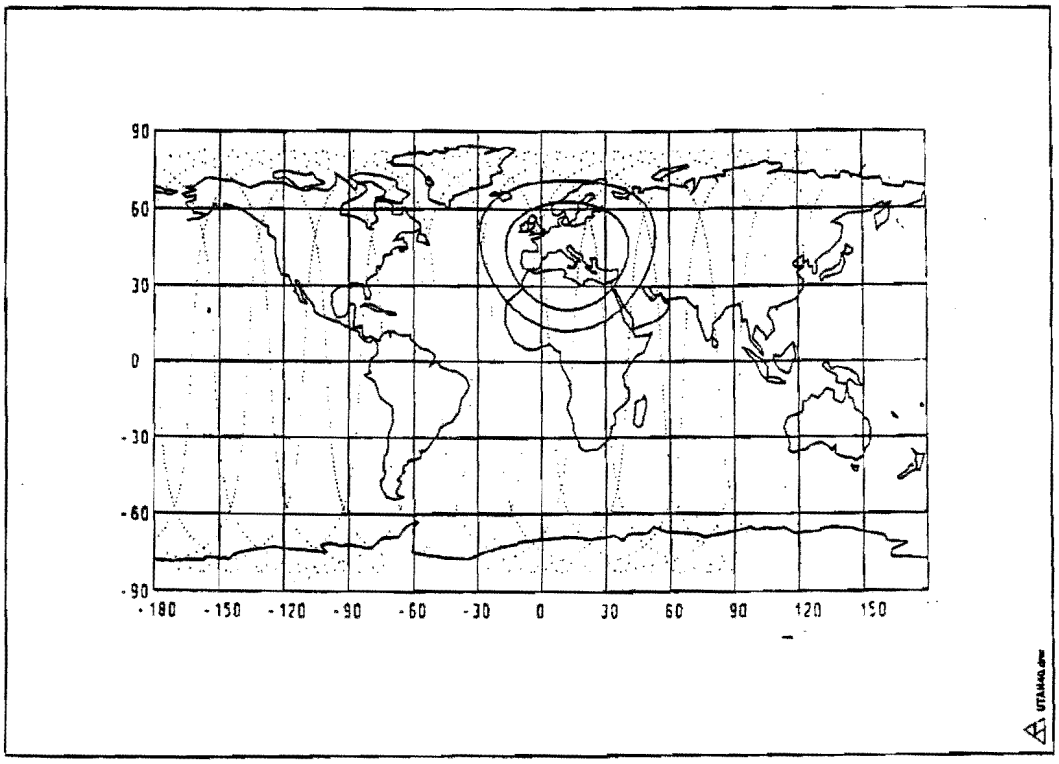

FIGURE 1 - GROUND TRACK OF METEOR ORBIT AND VISIBILITY FOR 0°/10° FROM FUCINO

The environmental data, whose measurements are acquired throught sensor subsystems, are collected, temporarly stored on ground and logged by autonomous and automatic terminal until the uploading request from Temisat. Once the data are received on board, they are trasmitted from Temisat to User Collection Centers.

3 - TEMISAT SYSTEM

The overall scenario for the data collection system application is presented in figure 2.

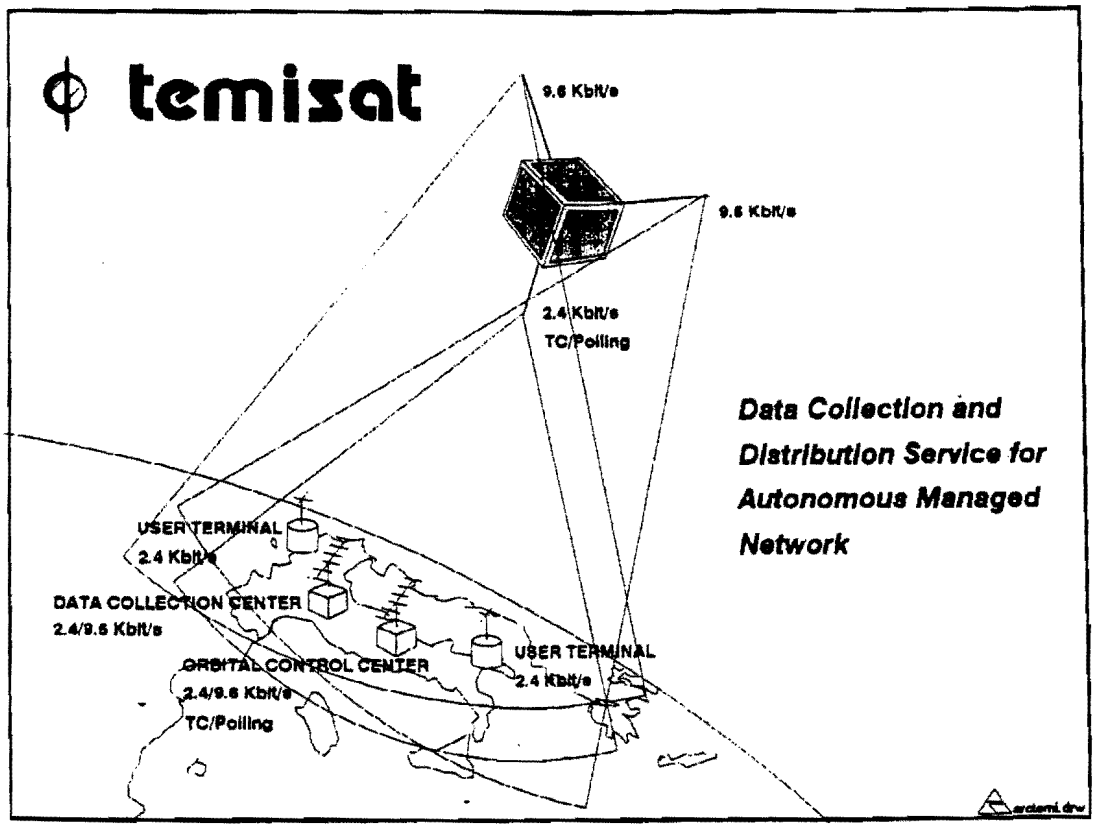

FIGURE 2 - TEMISAT SYSTEM

The system is composed by three main segments:

- A Space Segment consisting of two Micro-Satellites.

These are professional micro-satellites which for the first time introduce a low cost satellite based TDMA/SCPC access scheme.

The expected operational life of each satellite is 5 years, the two satellites are being manufactured by KAYSER and will be put in orbit within three years starting from the first launch.

The major characteristics of the satellites are:

* High Reliability
* Fully Redundancy
* Store and Forward service
* Direct or on Request Access

- A Ground Support Segment consisting of a Mission Control Center.

This Center processes, manages and stores the mission data and prepare the User Routing Matrix that contains the polling sequence, the synchronization and the addressee identification codes.

The Mission Control center is responsible for :

* Mission Planning
* Polling Optimization

- A User Segment Consisting of two different types of terminals:
  * Collection Center Terminal
  * User Terminal.

The User terminal are connected with the block of sensors, which are set for acquiring the measurements and for storing them temporary.

As soon the satellite polls the user terminal, the commands exchange between the interface user terminal equipment and sensor terminal adopting the standard RS232, will make available the data for the packetizations and the transmission, provided by the user terminal equipments.

More than 1000 User terminal coplete Stations are planned to be used in the final Network Configuration.

Of course the standard interface available as I/O of the user terminal can allow to connect the terminal to any type of equipment ready to select, prepare, acquire the data or alphanumeric messages to be transmitted.

The main characteristics of the User Terminal are:

* Standard Interfaces
* Low Power Consumption
* Easy Installation

Data Collection Center is enable to receive the down-link flow data from Temisat corresponding to all the information collected among the User Terminals belonging to its CUG.

It is also possible the transmission from each center of command packet to the satellite: this command will be delivered to the addressed user terminal inside the polling packets.

The main characteristics of the Data Collection Center are:

* High Flexibility
* Closed User Group (CUG) Control
* Low Cost and Low Complexity

Mission aspects

The first Temisat is planned to be launched from Plesetsk as copassenger of METEOR 2 Satellite by the Russian Launcher TSYCLON in May 1993 (figure 3).

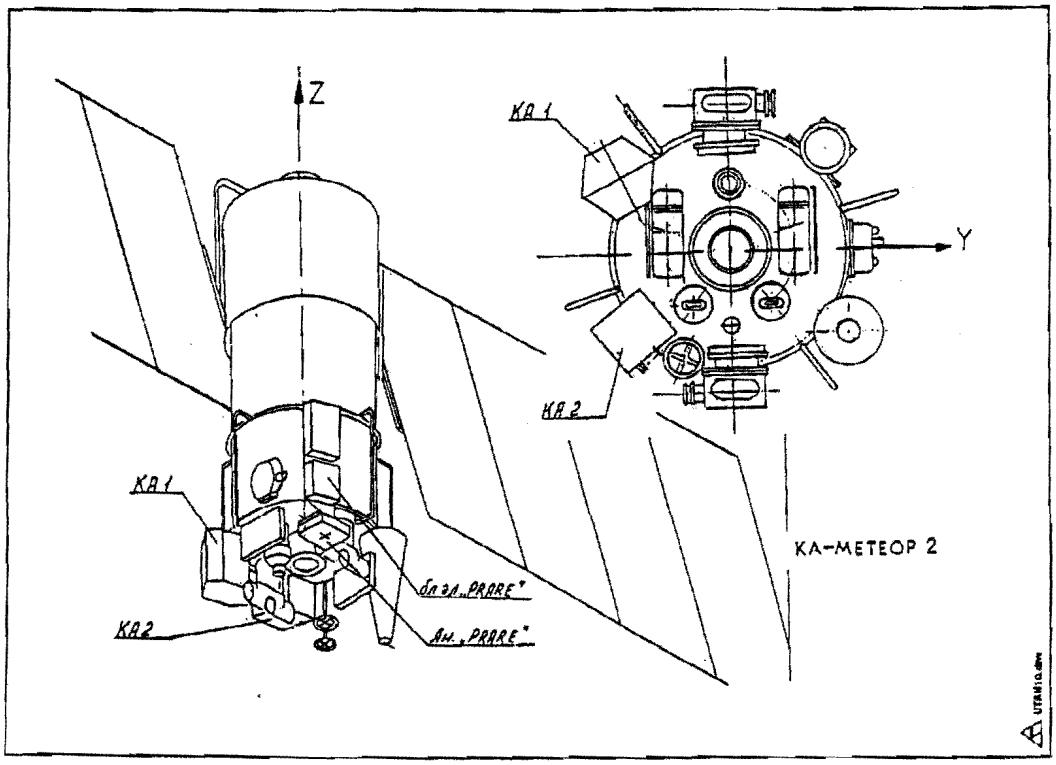

FIGURE 3 - TEMISAT (KA2) ON METEOR 2 (ref. VNIEM-METEOR)

The second Unit is being manifactured together with the first unit; it will be stored on ground for about three years and then will be launched to assure the Service continuity and to increase the in-orbit service capacity.

The nominal altitude of METEOR 2 is 950 Km with an inclination of 82.5°. The eccentricity is less than 0.0001 and the drift of the ascending node of orbital plane is expected to be 0.8°/d westwards.

This means that the worst case condition with maximum eclipse duration is of about 35 minutes and the orbital period is of aproximately 110 minutes.

The following figure 4 shows the Temisat in launch configuration with Meteor 2 and a particular of the separations systems.

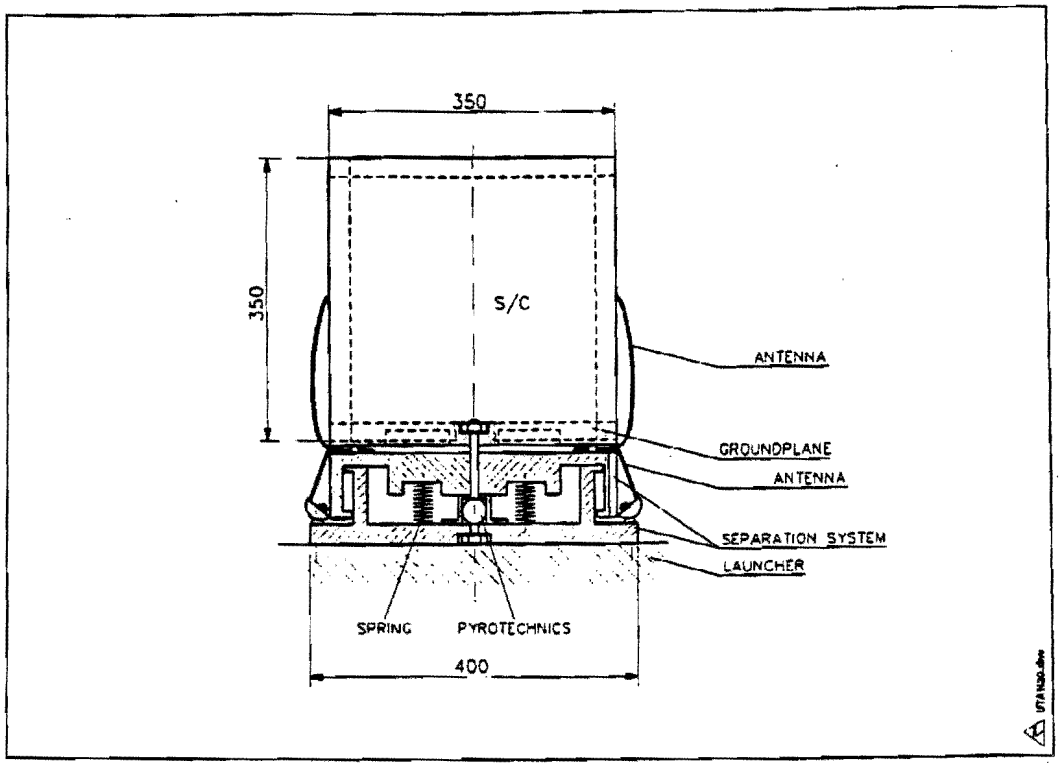

FIGURE 4 - TEMISAT MECHANICS INTERFACE FOR TSYCLON-METEOR MISSION

4 - SATELLITE CONFIGURATION

Payload

The payload architecture has been optimized in terms of balance between the configuration simlicity and the architecture of processing functions required for maximizing the flexibility of the offered service.

In particular the main characteristics can be summarized:

- RX capacity: up to 9 VHF channels plus 1 UHF channel.
- TX capacity: 3 + 3 (redundant) transmitters.
- 3 transmitter antennas plus 2 receiver antennas.
- Redundant data handling module.
- Redundant mass memory.
- Real-time and store-and-forward capacity.
- Data rate: 2.4 Kbps for the user link and 9.6 Kbps for the data collection center down link.
- Fully functional redundancy.

Power Subsystem

The power generation it is assured by 6 panels mounted on the

external spacecraft surface with maximum dimension of 350 x 350 mm corresponding to the spacecraft dimensions.
Each panel contains 96 cells per string, the maximum voltage is about 19 V at 25° and the maximum power generated from the 6 panels is 22 W (BOL).

The battery consists of two fully redundant battery packs with a total nominal capacity of 14 Ah composed by 20 NiCd cells from Saft.
The maximum depth of discharge of the battery is less than 10% on normal operation and less than 20% if a battery pack fails totally, the Charge controller is micro-processor controlled.

The power conditioning and distribution module deliver two voltages 5 V and 9 V, 12 V for unregulated battery bus for RF section Housekeeping signals.
The power distribution is automatically controlled by the payload computer and it can be commanded also from ground.

Attitude Control

A semi-passive attitude control system is foreseen for Temisat using permanent magnets and magnetic coils; the magnetic stabilization system should allow the alignement of the satellite to the local magnetic field of the earth. In figure 5, the nominal attitude versus satellite orbital position is shown.

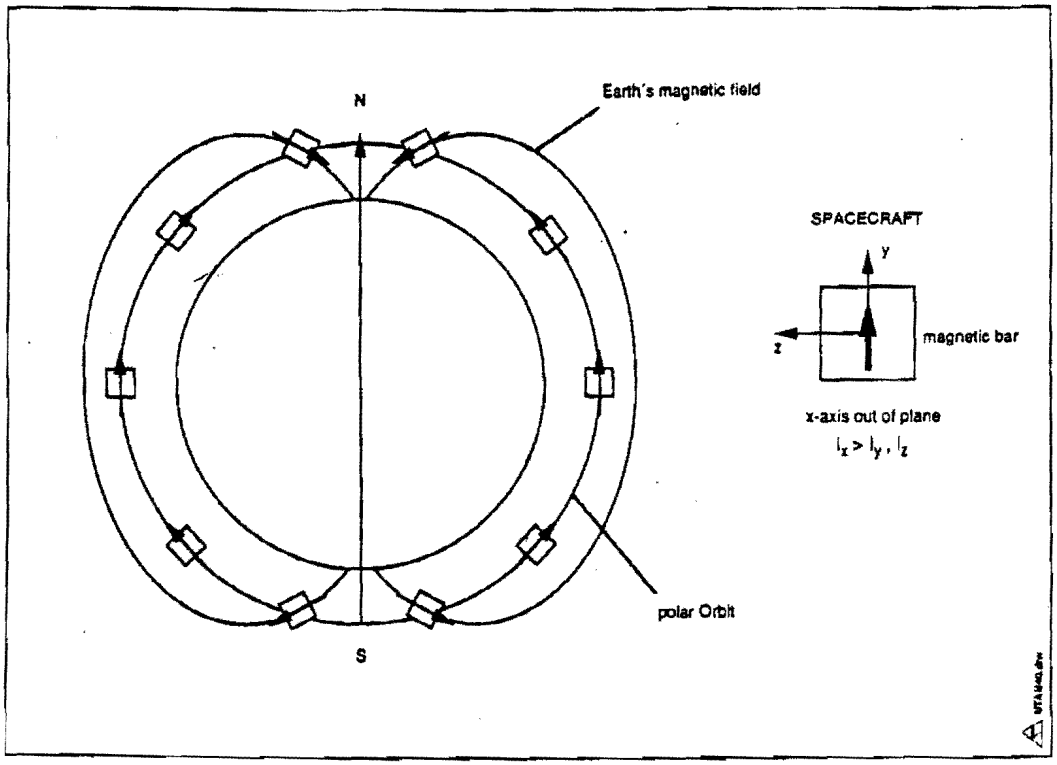

FIGURE 5 - TEMISAT ATTITUDE DURING THE ORBIT

An active coil could be mounted on board to counteract the perturbation effects or anomalous oscillations.
The coils activation is controlled by the on-board computer but can be controlled also via telecommand from ground.

Thermal Control

The Temisat temperature control is a fully passive control obtained from appropriate coating of the surface areas inside the satellite and from the outside spacecraft surfaces exchanging heat with the environment.

5 - CONCLUSIONS

Temisat Program tentative plans to launch the first environmental satellite unit in mid '93. The construction , the manufacture and the overall mission implementation are estimated to cost less than 10M$ and, on the basis of the investment plans, the system seems able to offer promising innovative commercial prospects.