



## New Generation of Satellite Communications

The new generation of standard satellite communication systems, with on board processing and switching, will allow to provide a global solution for the present and future telecommunication services, audio, video, data and multimedia.

The advanced networks of Satellite Communications will become a very important component of the new generation of telecommunications networks, in general, and in many cases, they will be the only solution until the terrestrial network have the required level of development. In particular, the future networks with satellite switching will allow, very quickly, the ideal architecture for the integration and management of end to end multimedia services.

### ► The new Telecommunication Networks

During the long phase for the creation of the broadband Integrated Services Digital Network (B-ISDN), emerged with an unforeseen effect the Internet solution, which has fully conditioned the new public and private network architectures, both for fixed and mobile services.

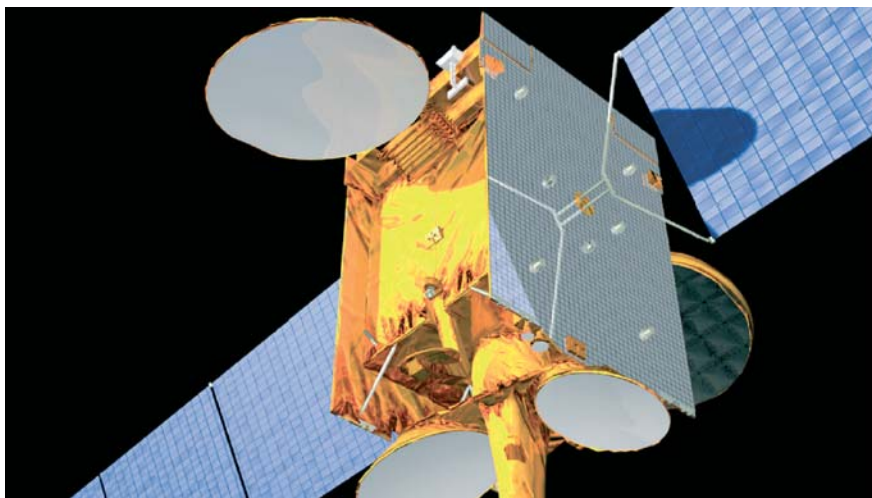
Within that context, the terrestrial network, with integrated architecture, has had important implementation constraints, as point to multipoint connectivity, coverage area, communication symmetry, network interworking, bandwidth management and mobility and management functionalities.

On the other hand, the first Internet generation, which has based its great

development success in the simplification, even removing, of some basic telecommunication functions, has had a set of functional and performance limitations (QoS), which have not allowed to face the new multimedia services and application requirements. Therefore, in the last years from 2000, has emerged a new initiative of global convergence oriented to an

integrated and effective solution, in cost and performances, identified as "Next Generation Network" (NGN), with the objective to provide a final solution to all these issues, at global level, under an industrial suppliers and telecom operators agreement.

The advanced Satellite Communications Networks will be



a very important component for the Telecom NGN in general, and in many cases, it will be the only solution until the terrestrial network has the required level of development. In particular, the future networks with satellite processing and switching, will allow very quickly, the ideal architecture for the integration and management of end to end multimedia services.

## ► On board Satellite Processing System

The functionalities and performances required by the new Telecommunication Satellite Networks will be achieved by means of multibeam architectures, with On Board Processing and Switching (OBP), at low level of information bandwidth management, with full resources flexibility, in such way that it will be possible to comply any distribution, routing and advanced telecom service requirement, for the selective coverage of big extension regions.

In Fig. 1 is shown a block diagram of the payload architecture for a classic transparent satellite, and the differential part of an On Board Processing architecture (OBP), for a switching unit. The differential part functionalities, located between the

low noise receiver and the channel amplifier are as follows:

- Frequency conversion
- Frequency demultiplexing, with signal digital processing
- Digital channel demodulation
- Base band switching
- Digital modulation
- Transmission frequency digital modulation

Within the ground segment topology, the following kind of units are considered: user satellite stations and terminals, service satellite stations and terminals, gateway satellite stations and terminals, and the network control and service centre, that has the overall system view, and will be able to realize the control functions and management of the whole network elements.

In Fig. 2 is shown an overall diagram of the Internet Multimedia network architecture, based on the first Standard On Board Satellite Processing and Switching approach.

## ► Multimedia Integrated Systems

The development of interactive systems with on board switching, has had two fundamental problems: a first one due to its technological

complexity, with the associated development costs, and a second one due to be based in proprietary solutions, as a major reason to make so difficult to reach the marketing target for a commercial success.

The first system solution that has been developed, for an Standard Integrated System, today already in operation, within this new generation network, is the one developed in the IBIS Project of the European Commission R&D programme, where it was performed the definition and specification of an integrated system for the interactive Internet Multimedia Network (IBIS System), followed by the design and development of a ground system model, representing the space operational system, today in service. (See IBIS System detailed description in the following Annex).

The IBIS System is a satellite multimedia system, where the Distribution Network is integrated with the Interactive Network, for supporting of interactive Tv, Internet, audio, video, data and multimedia services, within an integrated approach.

The up link is based in the ETSI DVB-RCS standard and the down link is based in the DVB-S standard, the information is transported within MPEG2 packets, and it complies the IP standards for interactive systems.

The System consists of the following operational units: Broadcast- Interactive Payload (in Satellite), User Traffic Stations (UTS) and User Terminals, Service Provider Stations (SPS) and SP Terminals, Content Provider Stations (CPS) y CP Terminals, Gateway Stations (GWS) and GW Terminals, Network Control Centre and Multimedia Service Centre, in Fig.2 is shown the

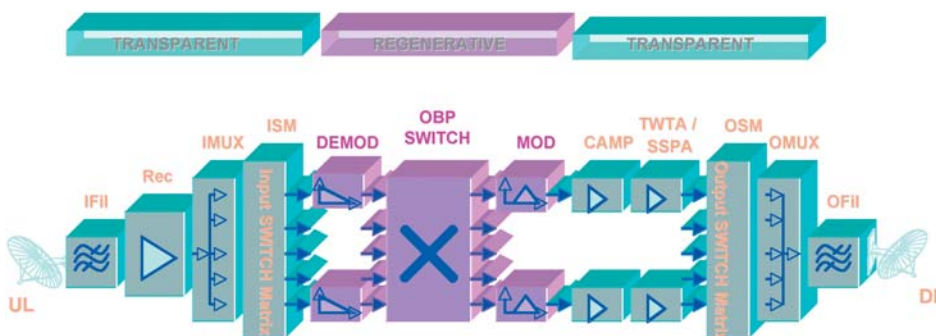


FIG. 1. TRANSPARENT VS ON BOARD PROCESSING PAYLOAD

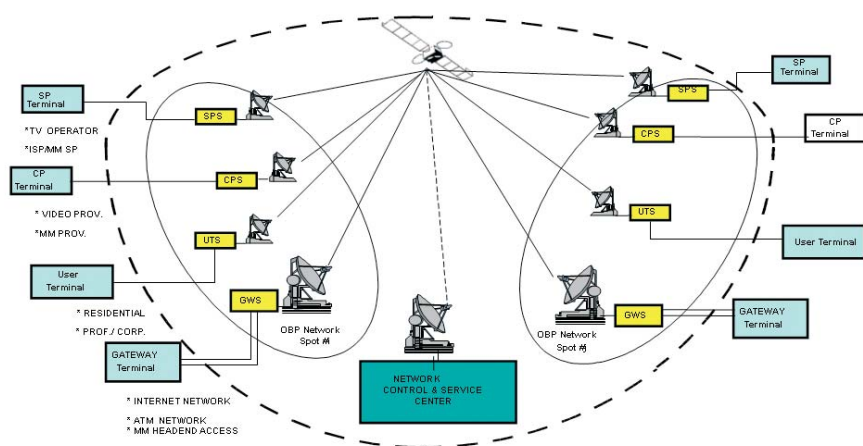


FIG. 2. SATELLITE SWITCHING NETWORK FOR INTERNET MULTIMEDIA SERVICES.

architecture of this new generation Internet Multimedia Network.

The IBIS System is actually the Reference Model of a New Generation of Satellite Communications.

## Services and applications

The present New Standard Satellite Communication System with on board processing and switching, as it allows the up link and down speed rates to be adapted to the operator traffic information requirements, service provider and user, is able to support the following kind of services:

- Audio services : Digital audio distribution, broadcast and multicast, on demand audio and interactive audio, in different modes.
- Video services : Video broadcast, typically digital Tv, interactive video, interactive digital Tv and on demand video.
- Data Services: LAN interconnection and data services by Internet access or through private networks, in interactive, broadcast,

multicast and caching modes.

- Multimedia services: Videotelephony, videoconference, multi-point service is required in this case, audio, video, image and data integrated services.

The progressive implementation of the above services will allow to support all type of multimedia applications, which are foreseen in a near future, for the various sectors as:

Digital Tv operator providers, content providers in general, software providers, electronic mail and teleworking for the various activity sectors, electronic commerce , teleducation sector, tourism, entertainment, corporate networks,...

## Development Programmes

Within the ATM cell switching development lines, or similar, there have been developed, during the 95 to 2005 decade, a set of initiatives in Europe, United States and Japan for the implementation of different kind of systems, with satellite on

board processing, to find a global solution for the present and future multimedia service requirements.

In this sense, the European Space Agency (ESA) initiated by the 90's a programme of advanced GEO satellite communications, such programme was initially based in Ku band for supporting of ISDN switching services, then evolved to Ka band, packet services, ATM cells and to MPEG2 packets under the ETSI DVB Standard. Finally the IP/MPEG2 over DVB was considered as the most realistic and effective, both in the European Commission programmes as in the ESA Telecom programme, and it has become the Reference model for the new operational systems, actually in service or in manufacturing.

The IBIS system, as described previously, has determined the reference model for this New Generation of Satellite Communications, and it has been the first integrated Internet Multimedia System in compliance with the ETSI Standards. The specification, design and development of the first ground operational model has been developed within the R&D Workframe programme of the European Commission.

The Amerhis system is the first operational system embarked in satellite, within the Amazonas-1 of the Satellite Operator Hispasat. It is constituted by a space configuration of the IBIS reference model, and based on its multibeam architecture is giving service to South America, Brasil (specific), North America and Europe. There is a new system in the last phase of manufacturing, also within the Amazonas series, with a bigger configuration of the IBIS reference system.

## On board switching system performances

Due to the variety of potential services and the big extension of the geographic area that can be covered by the presented solution, the market requirements shall be defined for each specific case, in order to specify the adequate system requirements and performances. However, the basic performances of this new generation system are as follows:

1. Regenerative Multispot architecture, in a single hop configuration
2. Up Link – Down Link decoupling, with half communication delay
3. Direct end to end connection of Standard User Terminals
4. Selective distribution of Information, in multicast and multipoint connectivity
5. Symmetrical and asymmetrical traffic handling, with high bandwidth management performances
6. National, regional and global coverage, with excellent link budget
7. Separated Transport Network and Service domains
8. Supporting of different services within an integrated and standard architecture
9. System and network architecture oriented to Multimedia services, with easy evolution to new service requirements
10. Public and private network applications
11. Terrestrial network emulation by single Node direct end to end connectivity
12. Interworking with digital terrestrial networks, either fixed or mobile
13. Performance quality similar to terrestrial networks
14. Scalable dimensioning up to tens of gigabits per second
15. Bearer services from 64 kbps up to 4 Mbps as baseline
16. Audio, video and data distribution, contribution (i.e. news gathering) and caching services
17. Advanced audio, video and data Interactive services: Digital Tv, Internet mail Internet web,...
18. Multimedia integrated services
19. Selected set of mobile services, with portable or mechanical transport terminals
20. High functional flexibility of the on board Payload
21. Integration of all existing satellite telecom services, in transparent, multiplexed and switched modes
22. Easy end to end service creation

Spain, by means of Alcatel Espacio, today Thales-Alenia Space, has played a leadership role along the ESA and European Commission programmes, from the definition and development of the first OBP ISDN Laboratory model, until the design and development of the first operational satellite system, for the actual Internet Multimedia Network.

Personally, I have had the honour for the direction and coordination

of all the design and development projects of this ambitious programme, throughout 12 years, being the creator of the IBIS System. I would like to thank from here the extraordinary technological initiative, the big effort and the professional delivery to the participants, from more than 30 companies and R&D centres, which have contributed to the various projects of the programme, as well as to European Commission and

ESA who have made possible that this system, pioneer of a New Generation of Satellite Communications, would become a reality. ♦

Note: A description of the " Integrated Broadcast-Interactive System " ( IBIS System ) is provided in the following ANNEX, as presented in the **Ka Band Utilization World Conference 2001**.

## ANNEX INTEGRATED BROADCAST- INTERACTIVE SYSTEM (IBIS)

### 1. INTRODUCTION

The IBIS is a Satellite Multimedia System, where the Broadcast Network part is integrated with the Interaction Network part, for supporting Interactive Tv, Internet and Multimedia

services. The up link is based on the DVB-RCS standard and the down link is compliant with the DVB-S standard. The information and data is transported according to the MPEG-2 and IP Standards, and the system is implemented by following the ETSI

Reference Model for Interactive Systems.

By means of the present approach, the Forward Interaction path and the downlink Return Interaction path, are integrated on the Broadcast downlink.

The present solution makes possible a simple implementation of the DVB-ETSI Interaction Network part, and it represents a big advance with respect to the current Return Channel solutions, which are provided today, either by the terrestrial or satellite infrastructures.

Such an advanced Interaction System is able to support a big set of the emerging Commercial Applications, for a great variety of Interactive Digital TV, Internet and Multimedia services, within an interaction network, in compliance with the major flexibility and interoperability requirements. The referred integrated Return Link is defined for an on board regenerative architecture, in a satellite multi-spot configuration environment, by using the most advanced on board processing techniques.

The referred set of advanced digital services is made available directly to the end users by means of a satellite infrastructure able of supporting point to point, point to multi-point, multicast and broadcast configurations.

It is a major feature to implement the interaction service performances, on the basis of the current standards, and to achieve the interaction architecture in line with such requirements, by getting a maximum service integration result.

## 2. SYSTEM OVERVIEW

The System consists of the following kind of units:

- Broadcast- Interactive Payload
- Satellite User Stations
- Satellite Service Provider Stations
- Satellite Content Provider Stations
- Satellite Gateway Stations

- Network Control Center

The IBIS Broadcast Interactive Payload is the core of the system, and it performs the following network functionalities :

- Frequency Demultiplexing
- Signal Demodulation
- On Board Decoding
- On Board Routing
- Down Link Multiplexing
- Down Link Modulation

In the Ground Segment, 4 types of Ground Stations are provided :

- User Station Unit: This kind of unit is able of receiving the downlink multiplex (DVB-S) and uplinking via an Interaction channel (DVB-RCS). These units are typically used for accessing multimedia traffic, either directly or via a home or corporate network.

Within this classification, different types of users can be distinguished: consumer, prosumer and corporate users, but the prosumer and corporate ones are considered as more promising in the short term.

- Service/Content Provider Unit: These units will be capable of receiving the downlink multiplex and uplinking via a broadcast-interaction channel. They are typically used to contribute broadcast and multicast channels to the Satellite System.
- Gateway Station Unit: This unit provides the adaptation between the satellite environment and the terrestrial network environment, and it allows to interface either terrestrial nodes or terrestrial head-ends.
- Network Control Center: This is a very complex unit in charge of performing the whole Network

synchronisation, control and management. It will be able to receive the DVB-S down link and it will transmit by means of the DVB-RCS up link.

In FIG 1 it is shown a Basic Network System Architecture.

## 3. PAYLOAD ARCHITECTURE

The Payload Unit consists of three main subunits :

- The RF subunit, for input and output sides .
- The IF subunit, for input side.
- The BBP subunit, following the IF subunit.

The key part of the Payload is the Base-Band Processor ( BBP ), which inputs are the IF signals coming from each input transponder. From now on we will concentrate on one BBP, for simplification, but a set of BBPs can be equipped for a multibeam network configuration.

First, the analogue IF input is sampled in the Analogue to Digital Converter ( ADC ). This input signal contains information in different frequency slots, each one will be treated in a different demodulation/decoding chain.

After the ADC, the now digital signal is filtered in the DEMUX module to obtain the frequency slots. We can have up to 6 TDMA users per carrier of different bit rate, therefore a mix of configurations are possible to be made. The FFT is performed for each slot, so that the signal will be treated in the frequency domain from then on.

Each one of the DEMOD modules performs the demodulation of the QPSK signals of each channel in

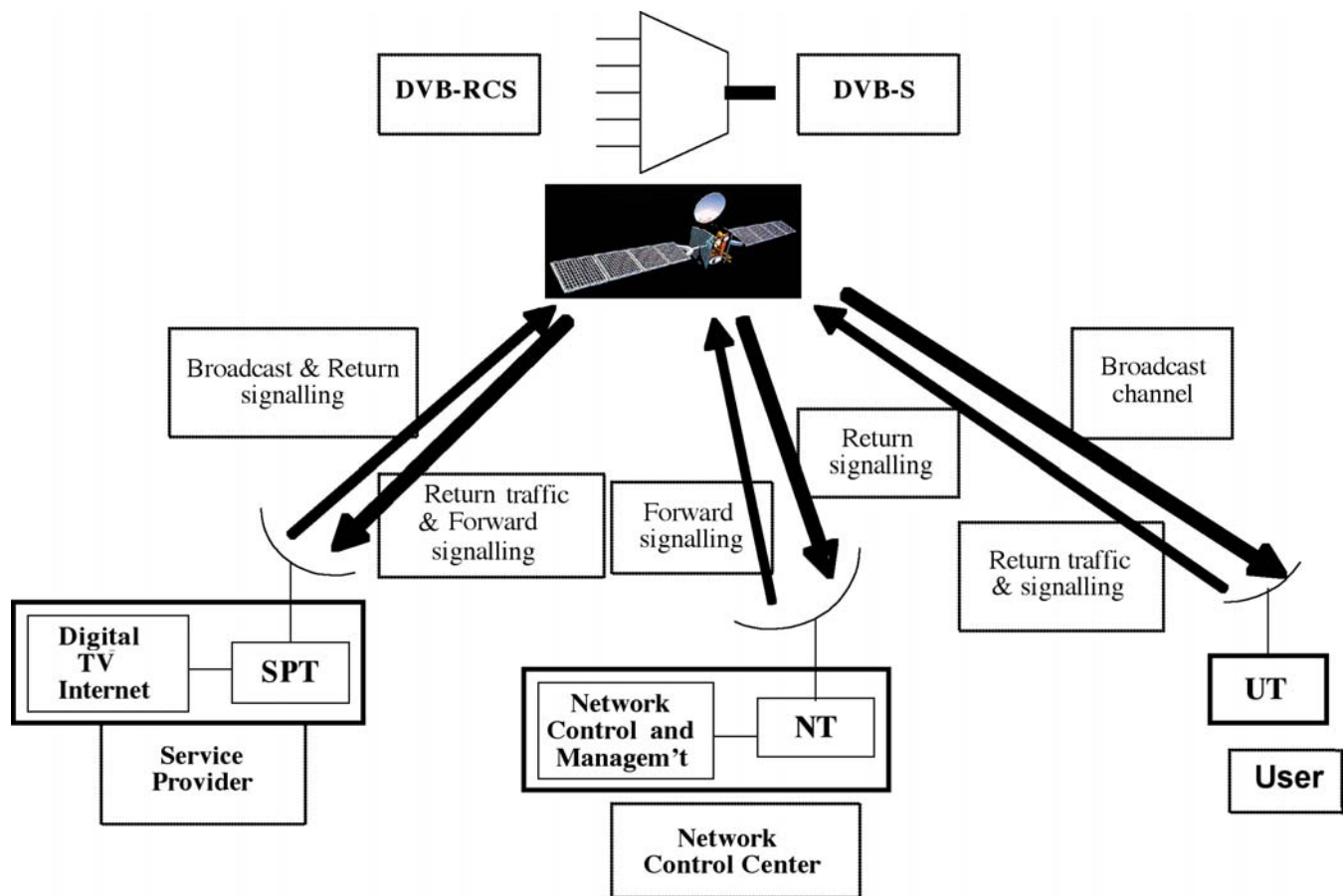


FIG 1 - IBIS NETWORK

parallel, which involves the necessary synchronisation processes, that is, the appropriate sampling point and phase and frequency corrections are obtained in order to reduce the demodulation losses.

The demodulated output channels are formatted into packets, according to DECOD module needs.

The raw data obtained in the demodulation stage is decoded in order to obtain the QEF packets. The DECOD module main tasks are the Turbo Code and Reed-Salomon decoding and the monitoring of packets.

The DECOD is also in charge of the packet buffering for the interface with the SWITCH / MUX modules.

The ADC and the DEMUX module together with the sets of DEMOD/DECOD modules form an unit that is needed for each input transponder. This element will be called MC3D (MultiCarrier Demultiplexer Demodulator and Decoder).

To allow the requested flexibility, data coming from any transponder should be routed to any output transponder. That is, the QEF packets from one MC3D stage can be combined with packets of other MC3Ds to build a high rate multiplex of packets. This Fast Circuit Switching, at packet level, is fully controlled by the Network control Center, through the signalling channel, that allows fast re-configuration, and also it is possible by telecommands.

In case an input packet should be sent in multicast to several downlinks, the DECOD module will indicate that to the involved MUX modules and it will also be in charge of the on-board packet multiplication for each downlink. Inside the downlink coverage, the multicast delivery must be handled at IGMP protocol level, which is transparent to the BBP or achieved through alternative methods, such as the Conditional Access mechanisms provided by the DVB standards.

The MUX module is in charge of multiplexing outputs from several data sources (transponders) supporting multicast as well, and to build the DVB-S compliant packets for the downlink.

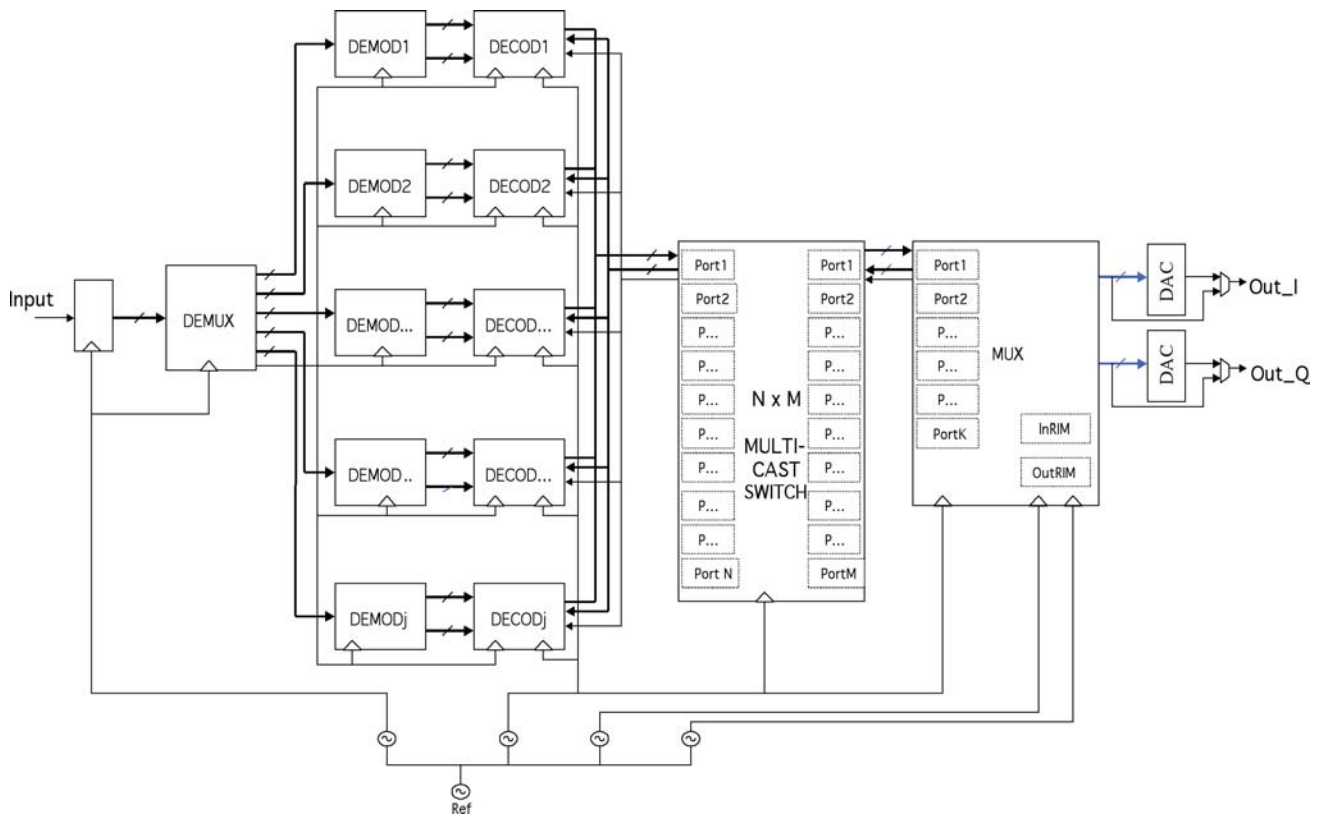


FIG 2 - DVB BASE BAND PROCESSOR – Functional Block Diagram

To support the interconnection of spots, a Multicast SWITCH-MUX module will be used.

The output of each MUX is analogue converted as final stage in the processor, following this stage the modulator and RF step are needed, to send the stream on the convenient downlink.

In Fig. 2. it is shown a BBP diagram, where the interconnection between different spots, related to the corresponding demodulators and providing multicast performances, is carried out by means of the Multicast Switch-Mux.

#### 4. KEY FEATURES

The key features provided by the IBIS System are :

- Up link OBP Payload implementation, on the basis of DVB-RCS standard
- Integration of the forward and return link functionalities
- On board turbo decoding implementation
- On board routing and multiplexing over multispot configuration
- Payload mass and power requirements

#### 5. CONCLUSIONS

The present Satellite System approach provides a very cost effective solution for the integration of the Broadcast and Interactive service and application requirements, which are imposed by the advanced Multimedia

Networks, allowing a direct end to end communication between Users and Service / Content Providers, with optimised link access, very low data granularity and excellent flexibility and reconfigurability features.

The major performances of the present satellite system are in summary the following :

- Cost effective integration of Broadcast and Interactive Networks
- DVB-MPEG2 multispot interconnection
- Open access to Interactive and Multimedia services
- Applicability of DVB-RCS standard to OBP satellite systems
- Essential contribution to the new satellite networks generation