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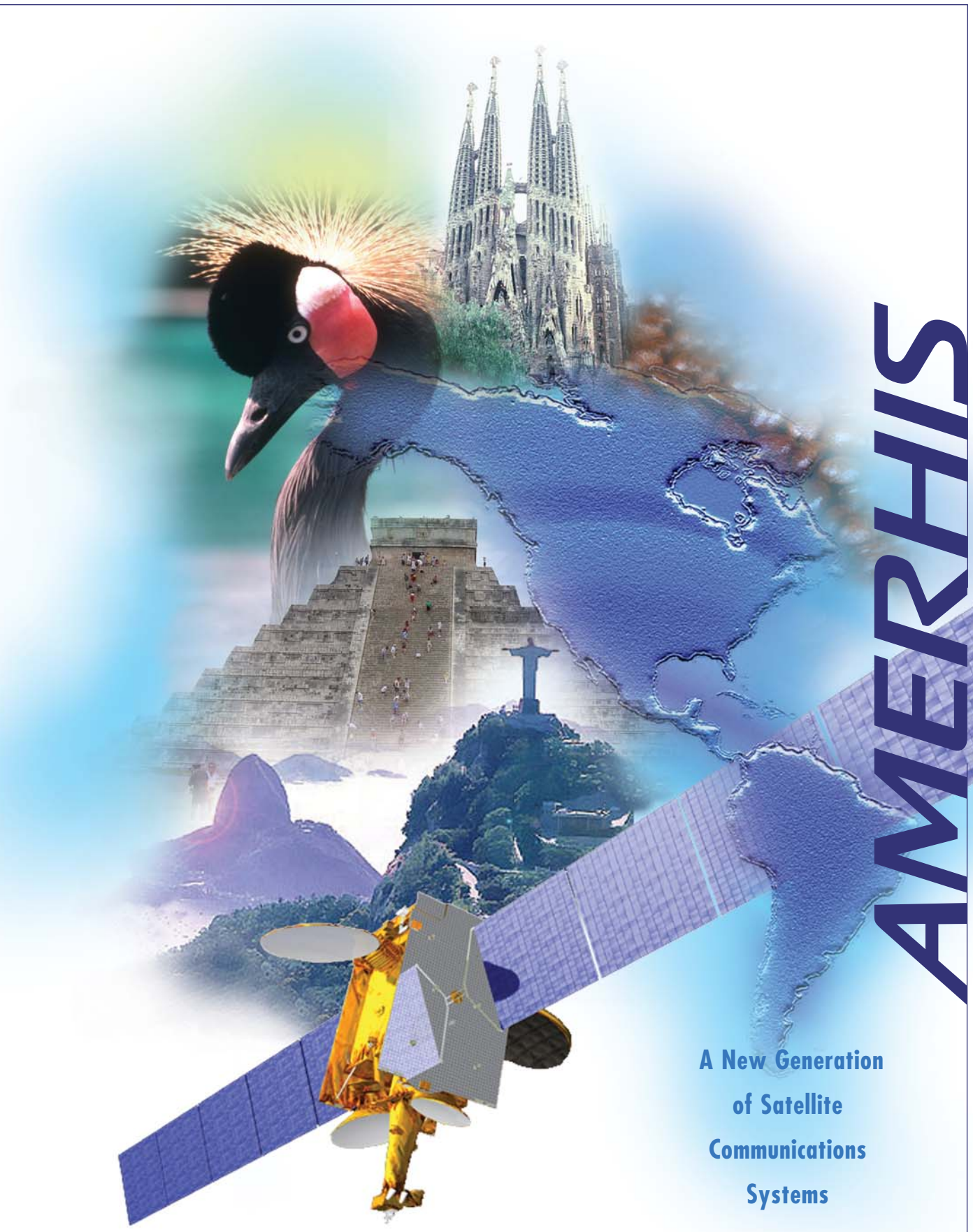

AMERHIS

A New Generation of Satellite Communications Systems

European Space Agency
Agence spatiale européenne

hispasat

CDTI Centro para el Desarrollo Tecnológico Industrial

esa

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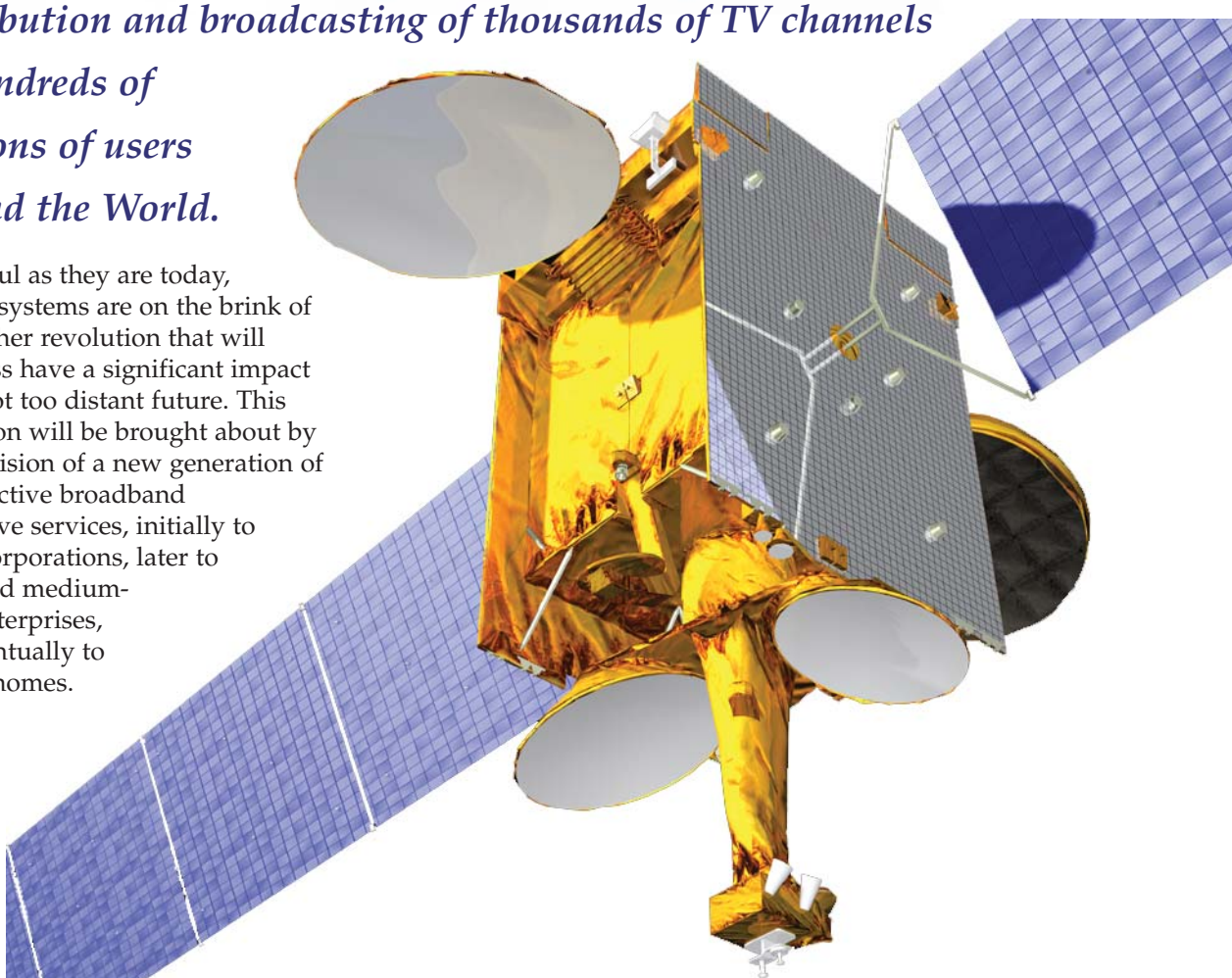
Introduction

Satellite telecommunications has now reached an advanced stage of maturity, with nearly 40 satellite operators controlling around 250 satellites in geostationary orbit. The services that those operators provide range from backbone trunks in the telephony and data network fields, to the distribution and broadcasting of thousands of TV channels to hundreds of millions of users around the World.

Successful as they are today, satellite systems are on the brink of yet another revolution that will doubtless have a significant impact in the not too distant future. This revolution will be brought about by the provision of a new generation of cost-effective broadband interactive services, initially to larger corporations, later to small and medium-sized enterprises, and eventually to private homes.



The bases for the introduction of these new services are firstly the introduction of multiple spot beams, allowing greater optimisation in the use of satellite resources (power and spectrum), and secondly the consolidation of open standards based on the successful DVB-S/DVB-RCS suite. Designing around open standards guarantees multi-vendor provisioning of terminals and services, which is fundamental to the development of economies of scale and the creation of an open competitive market.

The consolidation of the DVB-based open-standard approach has paved the way for the introduction of a new satellite payload and system architecture, whereby a number of transponders on the satellite can be interconnected by means of an onboard digital switch. In this way, the network topology becomes a star that hinges around the node constituted by the satellite and all its transponders. This architecture allows independent optimisation of the resources assigned to each transponder in terms of coverage, power and bandwidth.

ESA and CDTI, through the Agency's Telecommunications and Spain's national space programmes, together with European and Canadian Industry, have been elaborating these concepts for a number of years. As a consequence, all of the major elements needed for the system - onboard multi-carrier demodulators, switches, modulators, network control centres, gateways and user terminals - are now readily available.

The opportunity to deploy these system concepts on Hispasat's 'Amazonas' satellite therefore came at a very opportune moment. Amazonas combines split coverage of four coverage areas in the Ku-band and could therefore benefit substantially from the new onboard processing system architecture proposed by ESA. As a result, Hispasat SA, Spain's Centro para el Desarrollo Tecnológico e Industrial (CDTI), and ESA reached an agreement concerning the implementation of a DVB-based On-board Processor and complementary terrestrial infrastructure and terminals known as the 'AmerHis System'. The main funding for AmerHis has been provided from the Spanish contribution to ESA's ARTES Programme, with additional support from France, Norway and Canada.

AmerHis is the first operational regenerative, onboard processing, satellite switching system in the World. Its introduction paves the way for the emergence of a new generation of satellite systems that will further enhance the claim that satellite communication is one of the most important applications of space technology.

Beyond its great technological and commercial interest, AmerHis is an excellent example of collaboration between ESA and a European satellite operator, resulting from the Europeanisation of an initiative within Spain's national space programme.

Figure 1 – The Amazonas satellite, which is stationed at 61 degW

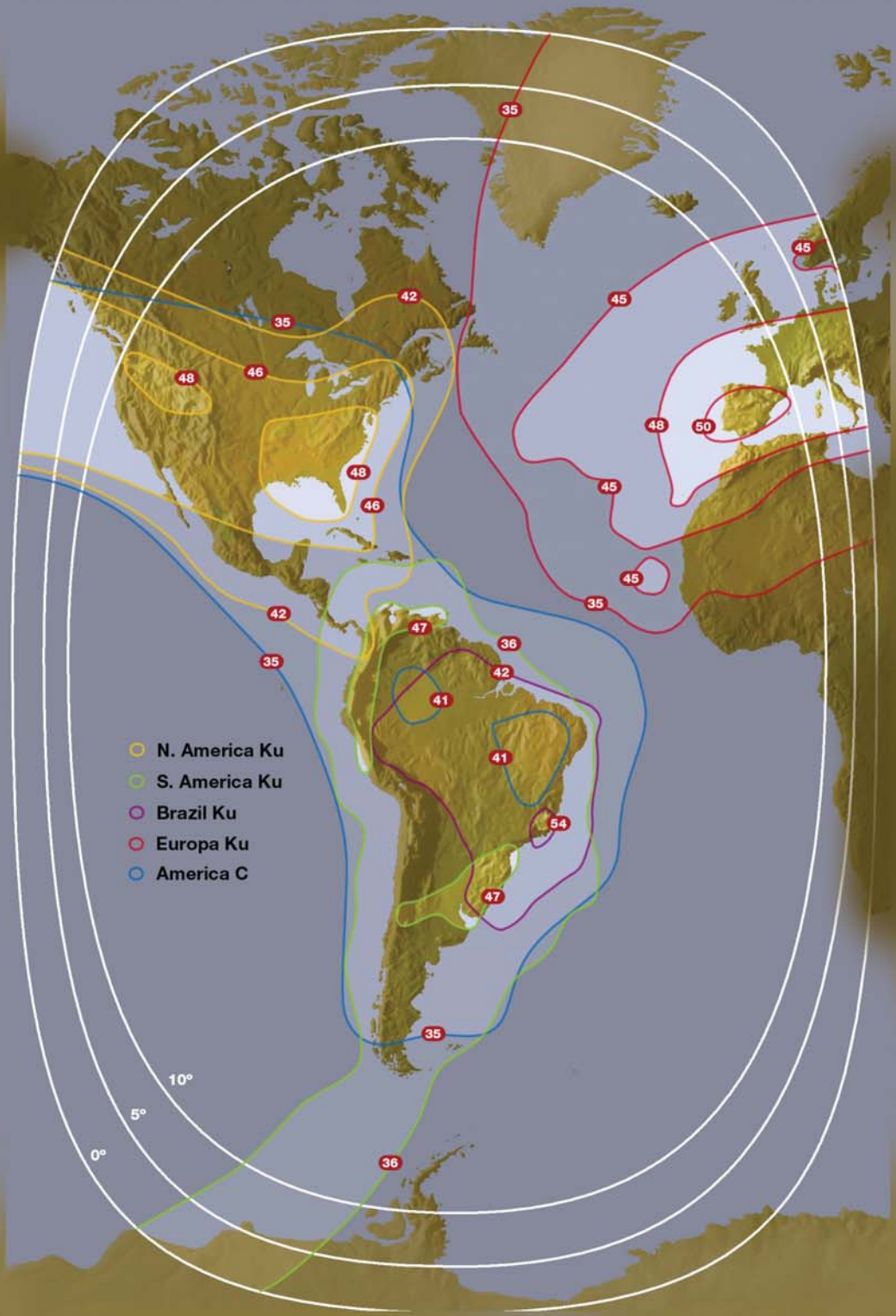


Figure 2 – Amazonas coverage: zones served by AmerHis in the Ku-band

AmerHis – A New Era in Satellite Communications

AmerHis is an advanced communications system, based around the Alcatel 9343 DVB On-Board Processor, carried by Hispasat's Amazonas satellite. This processor has the capacity to provide the demodulation, decoding, switching, encoding and modulation for the four transponders on Amazonas. Each Ku-band transponder covers one of the four geographical regions served by the satellite, namely: Europe, Brazil, and North and South America, as shown in Figure 2.

The AmerHis system provides a fully compatible interface with the DVB Return Channel Satellite (DVB-RCS) open standard.

The initial terrestrial system configuration will include:

- A Management System (MS), consisting of a Network Control Centre (NCC) and associated management control, responsible for managing the onboard resources and user terminals.
- User Terminals (RCSTs) oriented towards the commercial demonstration of new services.
- Gateways (RSGWs) that will provide the system with access to terrestrial networks.

Thanks to AmerHis, Hispasat is able to offer broadband interconnectivity to users anywhere within the four geographical areas covered by Amazonas, with highly efficient usage of the space segment (single hop). It also allows Hispasat to differentiate its portfolio of services from those of its competitors and to position itself as one of the most advanced satellite operators on either side of the Atlantic.

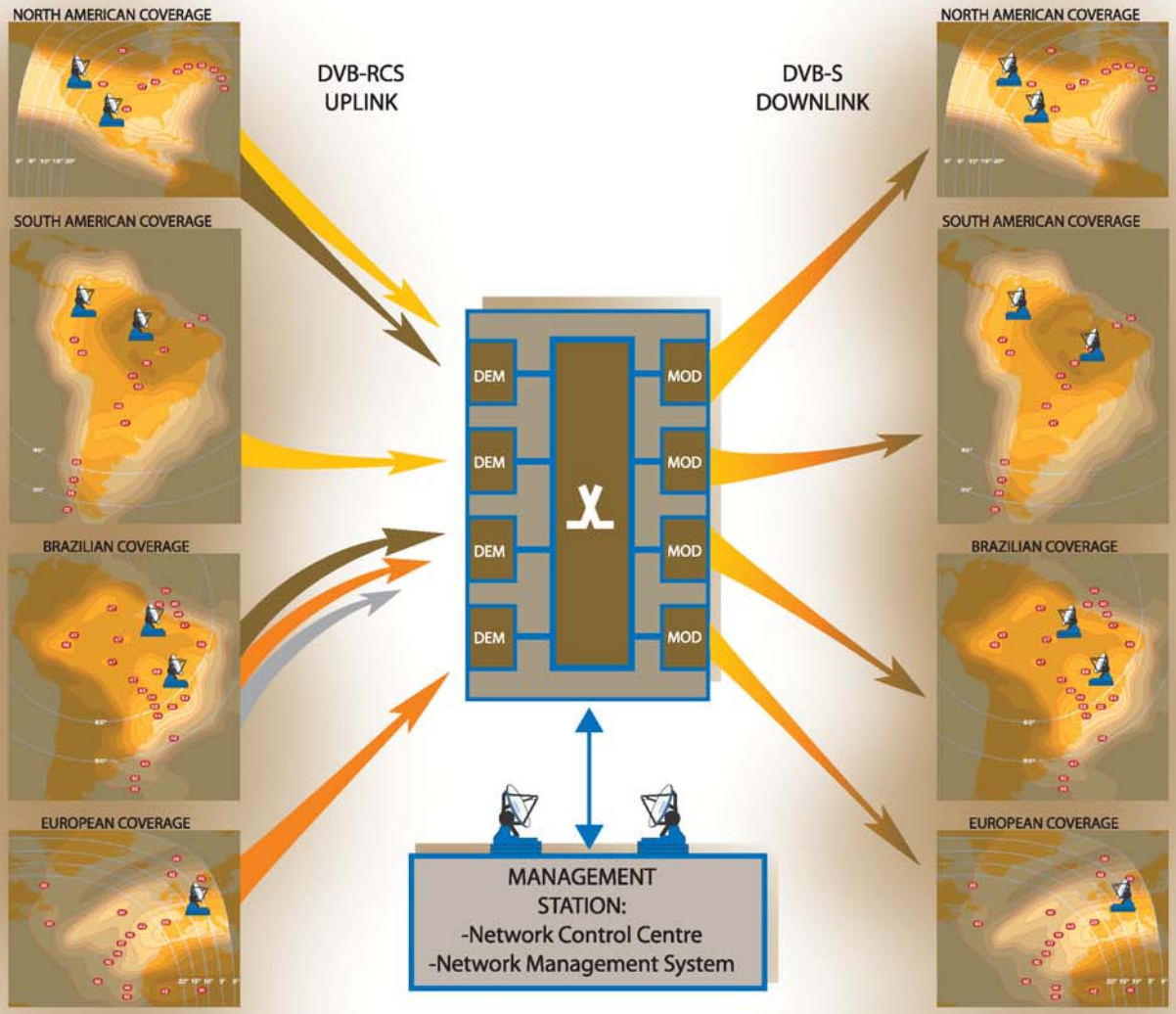


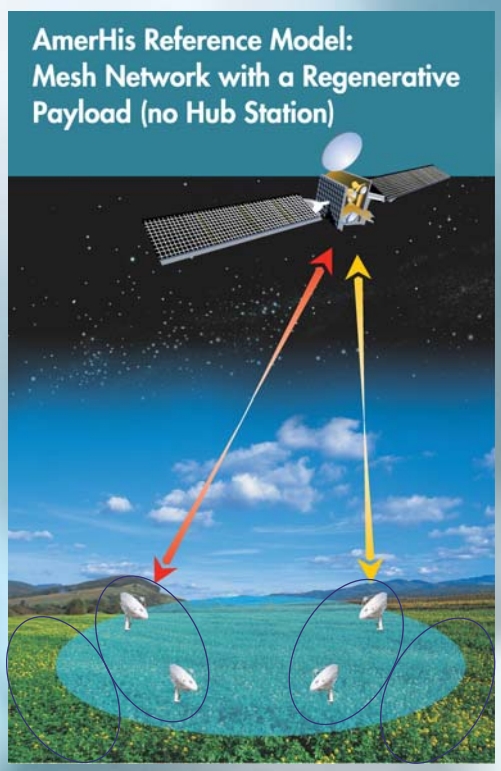
Figure 3 – AmerHis system architecture

Figure 4 – AmerHis provides connectivity between spot-beam coverage areas without the need for double hops between ground and spacecraft

The combination of onboard processing (OBP) and a full compatibility with the open standards of DVB-S (downlink) and DVB-RCS (uplink) gives the telecommunications satellite unprecedented potential compared with the conventional bent-pipe architectures. The AmerHis system architecture is shown in Figure 3. Among the most important advantages provided by the OBP are:

- Provision of direct 'end-to-end' connectivity between any two users in different regions through a single satellite hop. This allows real-time voice and video services, as well reducing bandwidth usage.
- Full flexibility both for the interconnection of coverage areas and payload-capacity management, allowing optimum exploitation of available onboard resources (so-called 'dynamic bandwidth on demand'). The system supports predictable symmetric (up- and downlink) traffic, as well as bursty traffic generated by a large number of users, owing to the dynamic resource-allocation process.
- The regenerative nature of the AmerHis payload and the utilisation of DVB-S saturated carriers on each downlink provide substantial performance improvements when using the AmerHis enabled transponders. These improvements are reflected both in their enhanced throughput capacity and the reduced receive-antenna size requirements for users.

These features, combined with the use of standard low-cost and high-performance user terminals (broadband interactive), will foster a qualitative step forward in the successful development of interactive multimedia services via satellite.



What Services Can AmerHis Offer?

AmerHis is a win-win-win solution for Interactive Network Access Providers (INAPs), service providers and customers. The much greater flexibility for managing and selling capacity is such that all of the main players will benefit from this advanced technology. Real- and non-real-time multimedia services and applications can be provided on readily available DVB-S/DVB-RCS compatible terminals. The system permits the assignment of resources to different subnetworks in a very flexible manner and allows user transmission rates ranging from 512 kbit/s to 8 Mbit/sec. The system supports IP-based as well as native MPEG-based services, with efficient mechanisms for the provision of uni- and multi-cast services, and the possibility to define various quality-of-service (QoS) levels to meet differing user needs.

In terms of connectivity, AmerHis provides interconnections with terrestrial networks (Internet, ISDN, public switched telephone, etc.) through low-cost gateway terminals. It supports both mesh connectivity and star connectivity, in both cases with just one satellite 'hop', with unidirectional or bi-directional point-to-point connections and unidirectional point-to-multipoint connections being possible in both cases. These types of connections can either be established on demand by the terminals and the gateways, or by the Management System. A given connection can be assigned one of three priorities within AmerHis, namely low priority, high priority, or high priority jitter-sensitive, each of which is associated with a specific set of traffic parameters. An admission-control function ensures optimal use of the available capacity and provision of the best possible service for the different types of application.

The physical capacity of AmerHis is distributed over Virtual Private Networks (VPNs). Each VPN can be allocated a dedicated set of logical capacity, reflecting the service provider's needs, or it can share a set with other VPN's. Any VPN can also take advantage of the AmerHis broadcast capability.

AmerHis is therefore creating a new era for relationships between INAPs, service providers and customers by offering much more flexibility than any satellite-based system so far. As a connection-oriented system, it allows full control over the applications crossing the network and the amount of resources allocated to those applications. In this way, over-provisioning can be avoided and billing is triggered only when applications are really using the network. This opens the door for new business models, reflected in turn in the Service-Level Agreement (SLA) between the INAP and service provider or service provider and customer.

Typical examples of AmerHis deployment scenarios are discussed in the following pages.

Internet Service Providers

In this scenario, the Internet Service Providers (ISPs) manage their own low-cost gateway and can provide reliable Internet access to subscribers. Value-added services such as Voice over IP (VoIP) or even video conferencing based on the ITU H.323 standard can be provided to individual customers via a simple configuration. ISPs can choose to offer their own SLAs, be they flat-rate, volume-based or based on a certain quality-of-service profile.

The AmerHis gateways are intended to be low-cost and have minimum infrastructure requirements. The ISPs therefore have the flexibility to locate their gateways in different AmerHis coverage regions and thereby offer more reliable Internet access and/or better tariffs.

A novel feature of AmerHis is the support it provides for multicast services, allowing streaming content to be delivered to a large number of subscribers simultaneously. The AmerHis gateways support all of the necessary functionality for implementing these services according to the latest IETF (Internet Engineering Task Force) standards. The AmerHis network capabilities can support all of the various deployment methods currently used by ISPs, such as private and public IP addressing support, NAT (Network Address Translation), authentication and billing support.

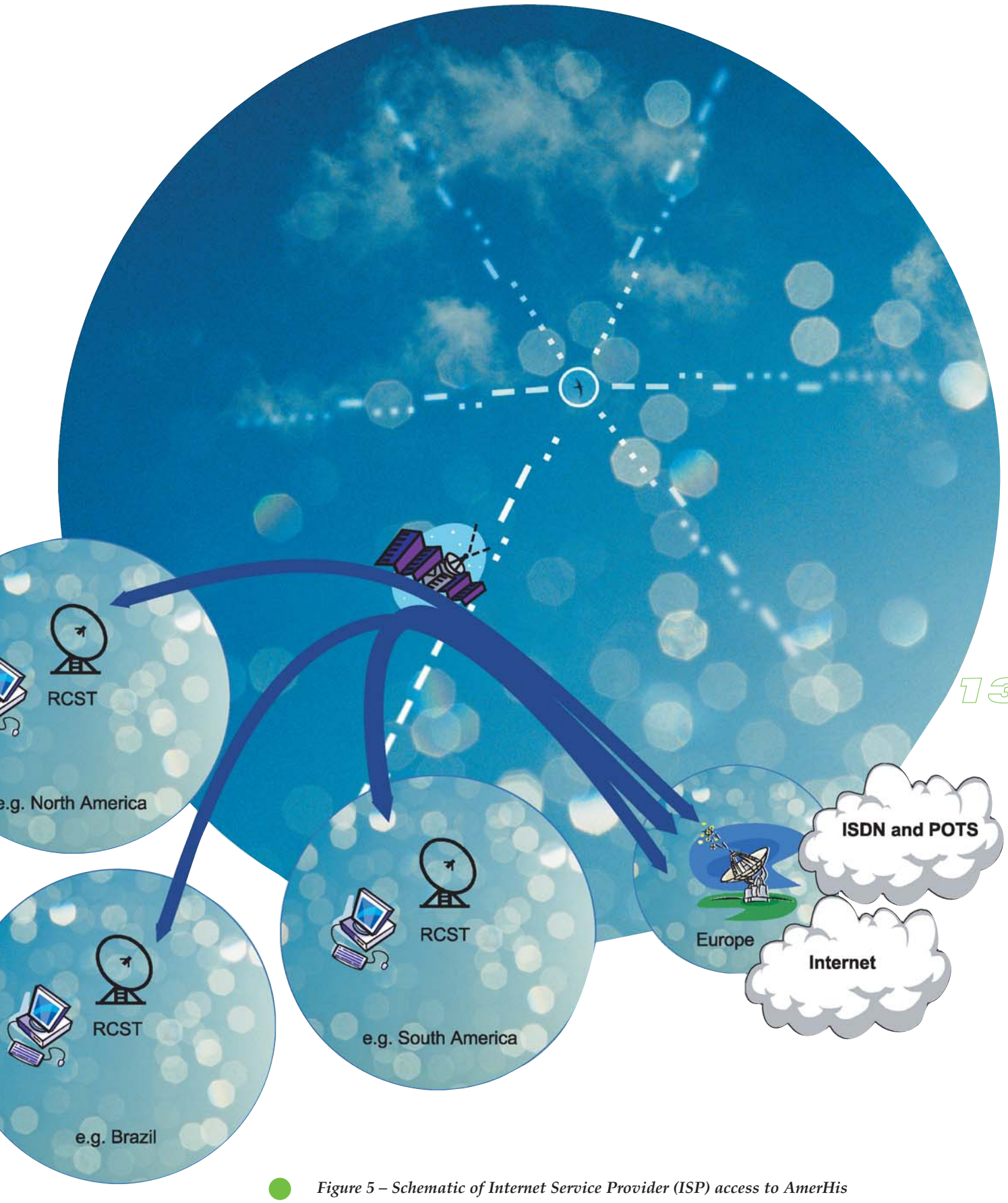


Figure 5 – Schematic of Internet Service Provider (ISP) access to AmerHis

Corporate Services

Companies with multiple branch offices in Europe, Brazil, North and South America can easily set up their own Virtual Private Networks (VPNs) and share their allocated capacity between all branch offices.

An important feature of the AmerHis system for corporate communications is the high quality of service that can be offered for business-grade video and voice conferencing, and the possibility of always reaching every branch office with a single satellite hop. In addition, access to the ISDN and POTS terrestrial networks is provided via the AmerHis gateways.

The AmerHis system allows the scheduling of specific connectivity requirements, such as the daily uploading of newspaper copy to printing facilities in different geographical regions.

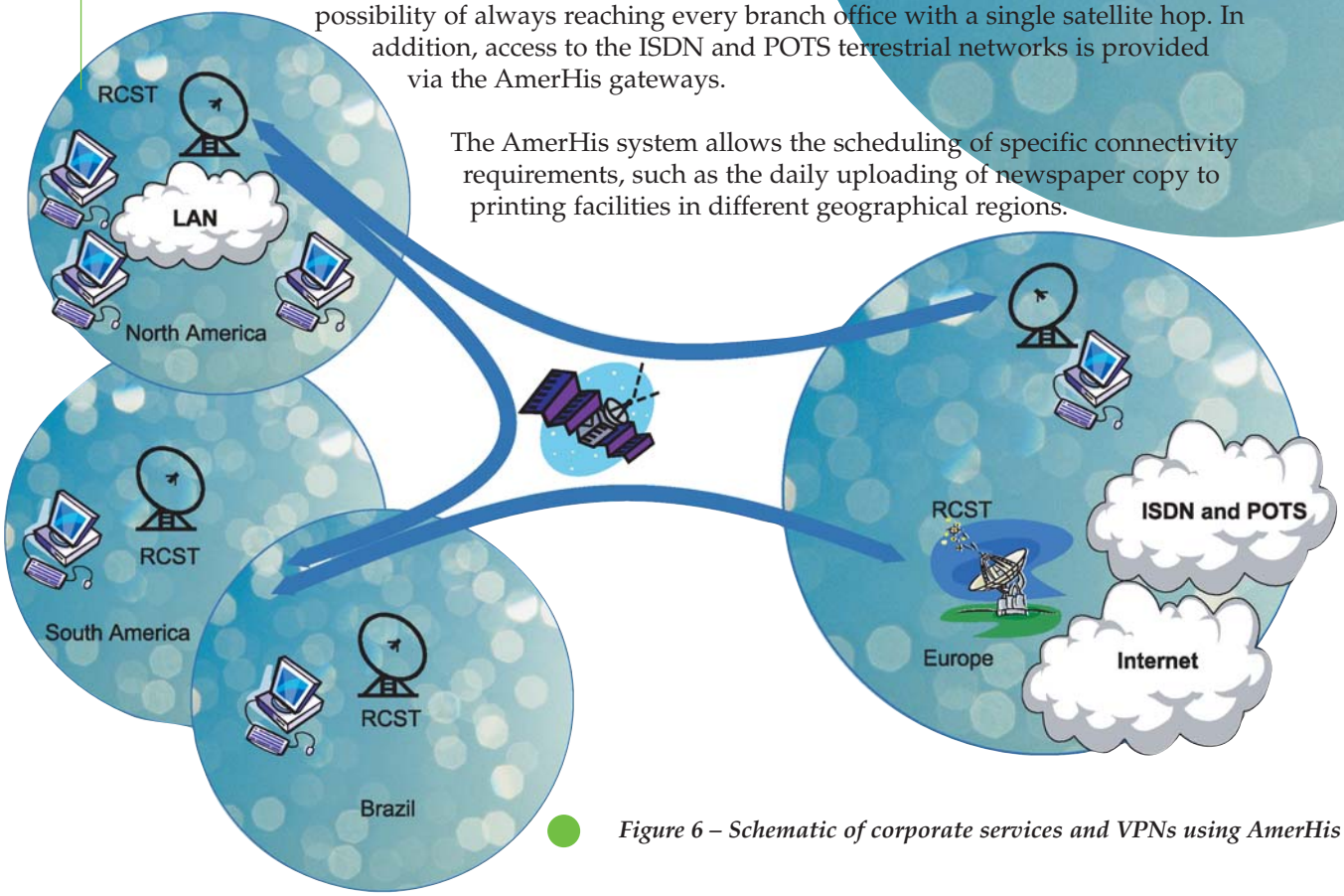


Figure 6 – Schematic of corporate services and VPNs using AmerHis

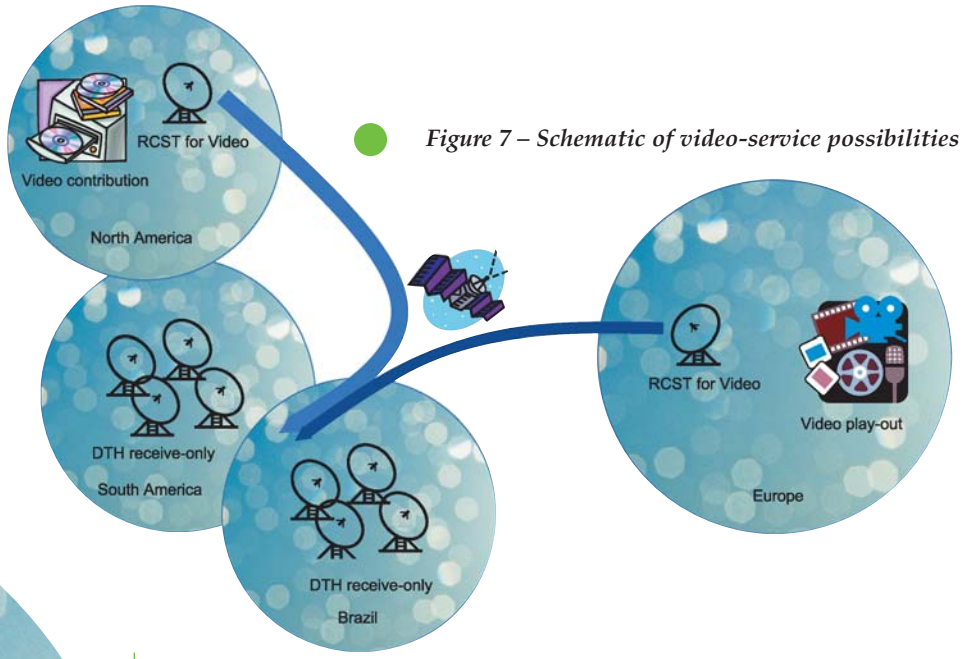


Figure 7 – Schematic of video-service possibilities using AmerHis

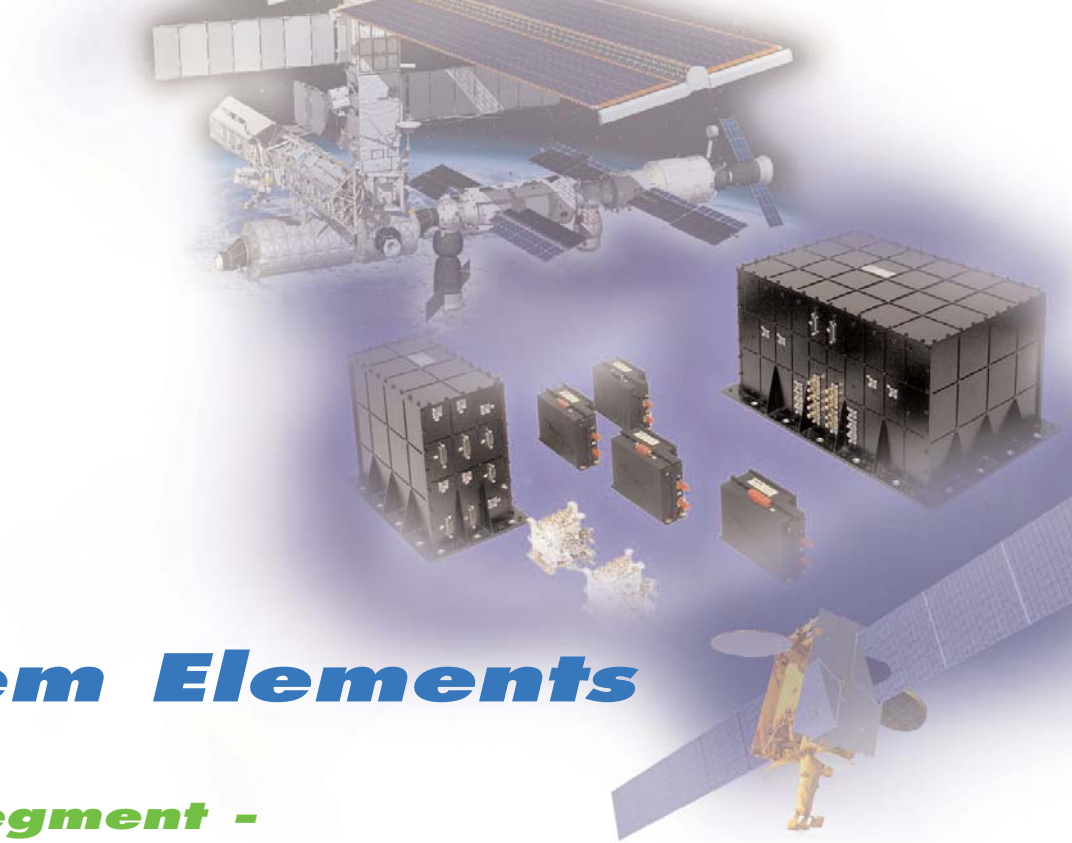
Video Services

The AmerHis payload offers multiplexing and de-multiplexing of MPEG-2 transport streams and is therefore not only capable of offering IP services over MPEG-2, but also allows the routing of video. Contribution links can be made from different uplink stations and, depending on the onboard switch configuration, duplicated and sent to multiple destinations if necessary, using the DVB-S standard for Direct-to-Home (DTH) services. Business television services, occasional-use services and video contributions with smaller terminals can all be supported more easily by exploiting these capabilities.

AmerHis Applications

In addition to the scenarios illustrated in the previous pages, AmerHis can support a wide range of applications and tele-services such as:

- *Distributed interactive TV.*
- *Video broadcasting on demand.*
- *Radio/news broadcasting on demand.*
- *Web browsing/news groups/e-mail.*
- *File transfer.*
- *Tele-medicine/tele-teaching.*
- *Video conferencing/video telephony/audio conferencing*
- *Tele-shopping/tele-banking.*
- *Collaborative working.*
- *Push applications.*
- *IP multicast streaming.*
- *LAN interconnection.*
- *Virtual Private Networking (VPN).*



System Elements

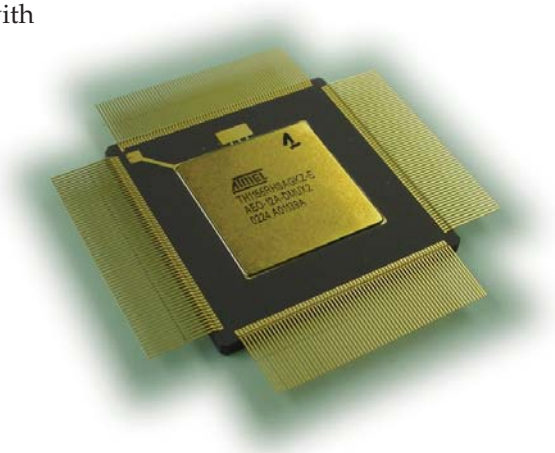
Space Segment - The regenerative payload

The AmerHis payload is a novel set of On-Board Processing (OBP) technologies which is being flown on the Amazonas satellite for the first time. The key feature of AmerHis is that the payload is regenerative and provides unique connectivity possibilities via its 'switchboard in the sky' functionality. A redundancy ring allows switching between transparent and regenerative modes with the four DVB transponders.

The uplink format to the OBP is MF-TDMA according to the DVB-RCS standard (MPEG-2 option) with a granularity of up to 64 carriers per transponder (0.5 Mbps each). Data rates of 0.5, 1, 2, 4 & 8 Mbps are combinable in the same transponder. The coding scheme is Turbo Code with a 3/4 or 4/5 coding rate.

The down-link format is according to the DVB-S standard with a maximum data rate of 54 Mbps (per transponder). The Forward Error Correction (FEC) uses Reed-Solomon and convolutional coding with ratios of 1/2, 2/3, 3/4, 5/6, or 7/8.

The OBP offers full routing flexibility between uplink and downlink channels using dynamic capacity management through a regenerative uplink channel (via the Network Control Centre).



Ground Segment

As already mentioned, the AmerHis ground segment consists of user terminals to access the system, gateway interfaces to terrestrial services, and a management system to configure and manage the network.

Management System

The Management System consists of a Network Control Centre (NCC) and a Network Management Centre (NMC). The NCC controls the interactive network, services satellite access requests from users, and manages the OBP configuration. An NCC Return-Channel Satellite Terminal (RCST) provides terminal access to the satellite. The NMC handles system configuration and manages the AmerHis network elements, supporting remote configuration and monitoring of the NCC, user terminals, gateways and OBP, as well as providing fault, configuration, performance and security features for all elements.

Connection-control management functions both support permanent connection set-ups and handle on-demand connection requests (establishment, modification and release).

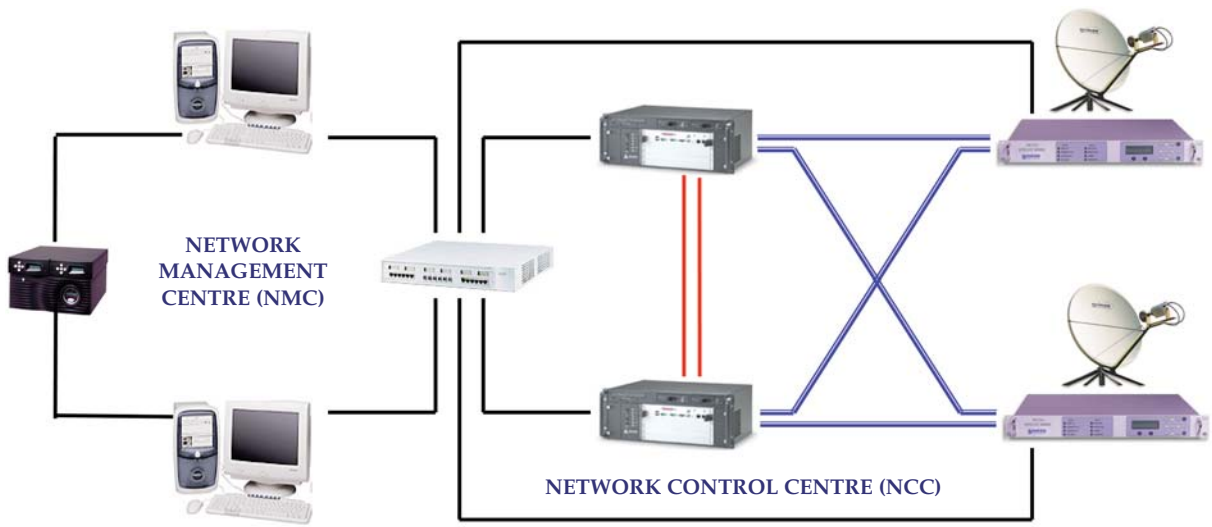


Figure 8 – AmerHis Management System

Gateways

An RSCT Satellite Gateway (RSGW) provides AmerHis users with internetworking capabilities to external networks (PSTN, ISDN, Internet). In effect, the RSGW is the hub in an access network with a star topology. It incorporates a standard low-cost RCST (slightly modified), which is attractive for medium to small service providers. It has been designed to share its satellite and terrestrial bandwidth resources with a large number of simultaneous active subscribers (typically several hundred).

The gateway support commonly used interfaces to the terrestrial networks such as ISDN, Ethernet and ATM. To support the delivery of business-class data services, the RSGW is able to provide service guarantees to subscribers based on different quality-of-service criteria for the different subscription levels.

The peak uplink transmission raw bit rate of the RSGW is at least 8 Mbps (2x4 Mbps terminals). The RSGW maximum downlink throughput at IP level is at least 8 Mbps. In order to offer low-cost RSGWs targeted specifically at small ISPs, a standard RSGW can be simplified by not offering voice/video services and reducing the peak uplink rate to 2 Mbps.

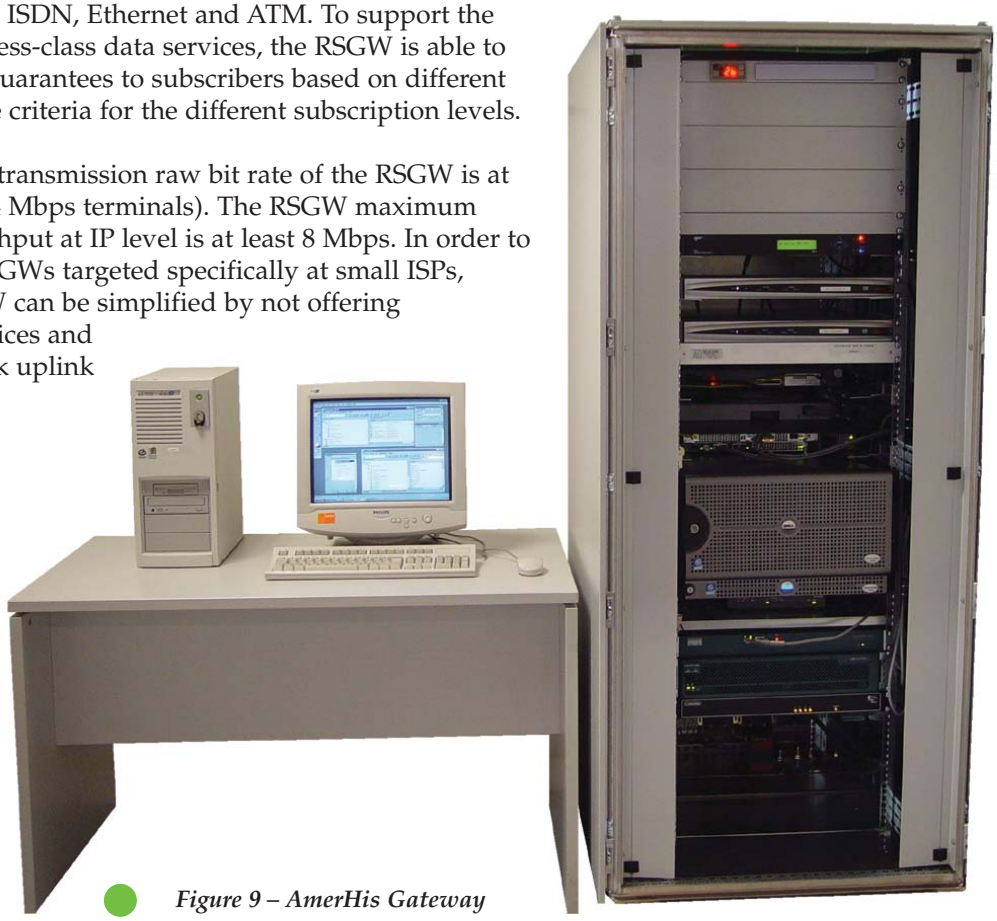


Figure 9 – AmerHis Gateway

User Terminals

A Return Channel Satellite Terminal (RCST) provides access to other users as well as external access to terrestrial networks (via RCST Satellite Gateways, or RSGWs) and Service Providers. The peak uplink raw bit rates for different terminal classes are as follows:

- 518 kbps for Class-1
- 1.036 Mbps for Class-2
- 2.073 Mbps for Class-3
- 4.147 Mbps for Class-4.

The antenna and Solid-State Power Amplifier (SSPA) sizes vary from 1.2 to 3 metres and 2 to 8 Watts, respectively, depending upon the class type and coverage area.

An RCST can support both guaranteed rate and delay and best-effort classes of service. The network quality-of-service mechanism in the RCST performs prioritisation of IP flows and the most suitable transmission parameters for the application in question. This provides priority to mission-critical data transactions or video or voice transmissions, which require faster turnaround, while providing lower priority to less-time-sensitive traffic such as e-mail and web surfing.

These terminals are based on standard DVB-RCS products and are readily available from the companies NERA (Norway) and EMS Technologies (Canada).

Figure 10 – The Return Channel Satellite Terminals (RCSTs) manufactured by NERA (Norway) and EMS Technologies (Canada)

The Industrial Consortium

AmerHis is a very ambitious, commercially oriented project that heralds a new era in satellite communications in the context of the ESA Telecommunications Department's 'Multimedia Programme'. The project is led by Alcatel Espacio of Spain, heading a consortium of companies with long experience, sound reputations and excellent know-how which fosters project success.

The project covers not only the development of the regenerative payload and the ground segment needed for the initial deployment of the system, but also all of the activities needed to support the system's in-orbit validation as well as a first demonstration of services in a real commercial environment.

Prime Contractor

As the Prime Contractor, Alcatel Espacio is also responsible for the On-Board Processor (the A9343) and the integration of the regenerative payload. The company has long experience with ESA in the development of digital processing units and is presently developing the A9343 in the framework of the DOMINO-2 (ARTES) project, and is also leading the IBIS project (5th EU Framework Programme). Alcatel Espacio is strongly supported in these activities by the Spanish Delegation (CDTI), both within ESA and through the National R&D Plan (PNE).

Sub-Contractors

Management Station & Ku Modulators

Alcatel Space, besides being strongly involved in all system-related activities (from design to in-orbit validation), has developed the Management System and the Ku-band modulators for the regenerative payload. It is a leading company in the development and supply of space telecommunications systems, with wide experience of satellite and ground-segment manufacture. It has also led the DOMINO-2 project, aimed at developing advanced satellite communications systems for future multimedia applications.

Gateways
Indra Espacio has been responsible for the development of the AmerHis gateways. It is a Spanish company with broad experience in the development and manufacture of satellite ground-segment systems.

RF Units
MIER Comunicaciones has been responsible for supplying the Ku/IF down-converters for the regenerative payload. An experienced company in the supply of RF units, it has participated in previous activities related to on-board processing.

User Terminals
EMS Technologies has been responsible for the development and manufacture of the DVB-RCS user terminals. With consolidated experience in this field, the company currently also supplies user terminals for the SES-ASTRA BBI service, as well as being the ground-segment supplier for the DVB-RCS experimental system (sponsored by the Canadian Space Agency) being built around the ANIK F2 satellite.

NERA has also been responsible for the development and manufacture of DVB-RCS terminals for AmerHis. It is a well-respected company with more than 20 years of experience in the satellite ground-segment area. NERA is the main supplier for Inmarsat gateways and terminals, is presently involved in the development of the terminals and ground segment for interactive DVB systems, and has been an active contributor to the DVB-RCS standard.

Are you interested in AmerHis?

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