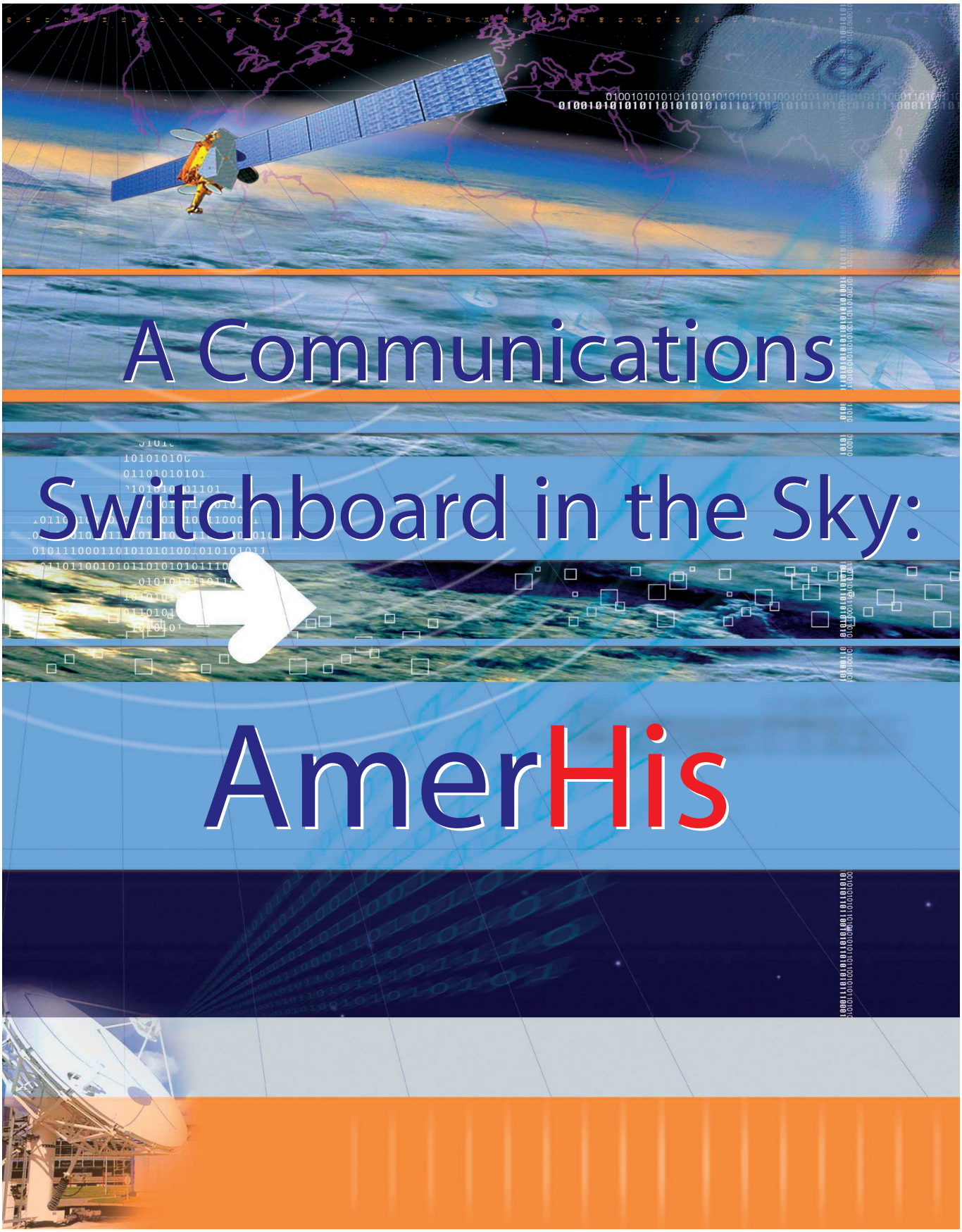
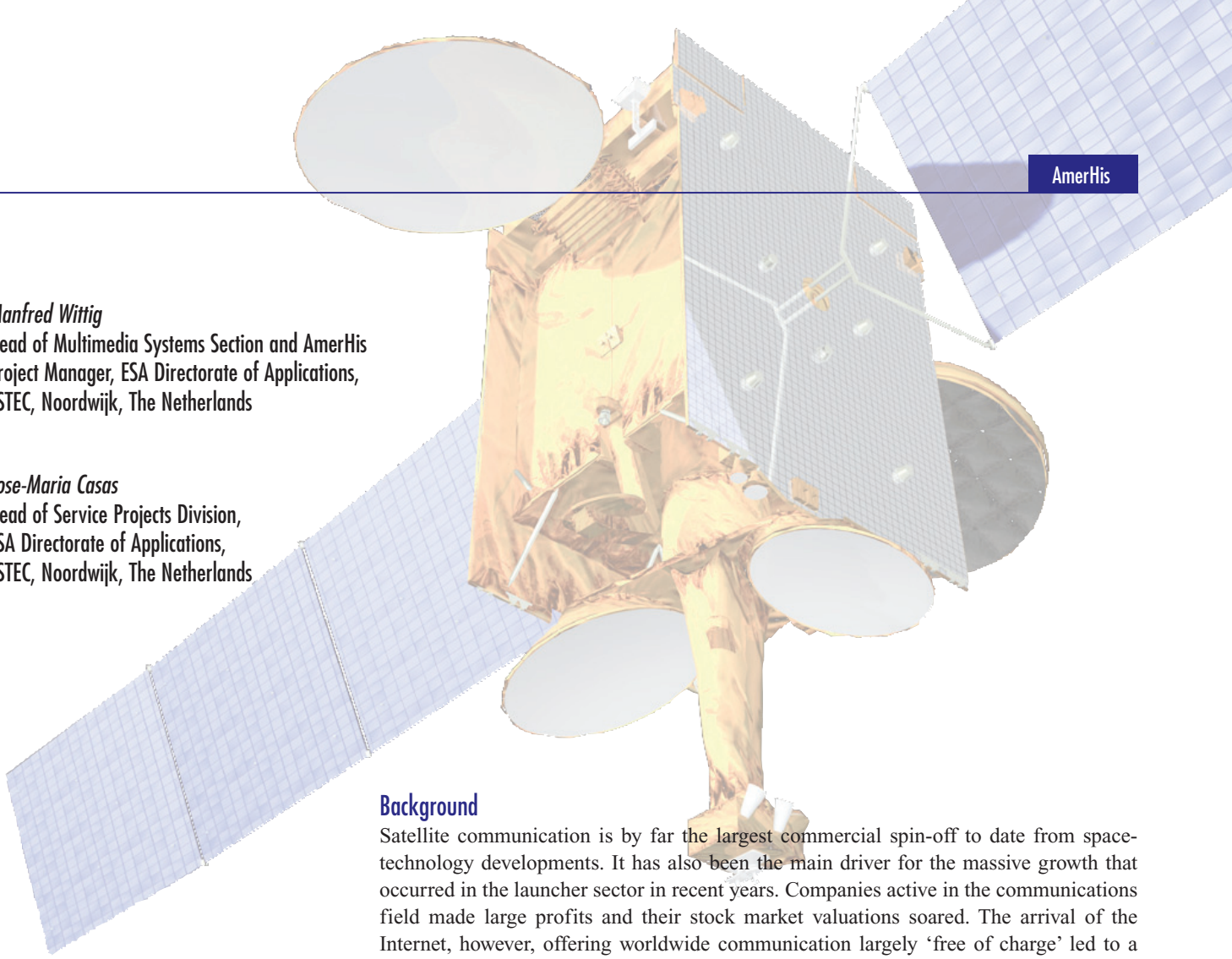


Illustration Alcatel Espacio



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Background

Satellite communication is by far the largest commercial spin-off to date from space-technology developments. It has also been the main driver for the massive growth that occurred in the launcher sector in recent years. Companies active in the communications field made large profits and their stock market valuations soared. The arrival of the Internet, however, offering worldwide communication largely 'free of charge' led to a collapse in the global telecommunications market, and has ultimately drastically affected the commercial satellite communications sector also. In 2000, for example, about 31 communication satellites were ordered worldwide, in 2001 that dropped to 19, and in 2002 only 3 were ordered. Even more worrying is the fact that in 2000 European satellite manufacturers received 15 satellite-manufacturing contracts, one less than the leading American companies, but in 2001 they got only 3.

The collapse of the satellite communications market, however, is due not only to the general telecommunications melt-down, but also to the advancement of technology. For the last 20 years, communication satellites have been used mainly for TV broadcasting. For analogue TV, the frequency modulation (FM) scheme was established as a standard method of transmission, requiring a bandwith of about 36 MHz per TV channel. Consequently, communication satellites were equipped with several 36 MHz-wide transponders. Modern state of the art satellites have 40 to 50 such transponders. The introduction of digital TV was made possible by the invention of advanced signal-compression algorithms and the progress in digital technology allowed the realisation of cost-effective video encoders and decoders. With the introduction of the Digital Video Broadcast via Satellite (DVB-S) standard, developed in Europe, it is possible to transmit 6 to 10 digital video channels within the bandwidth needed for a single analogue TV channel.

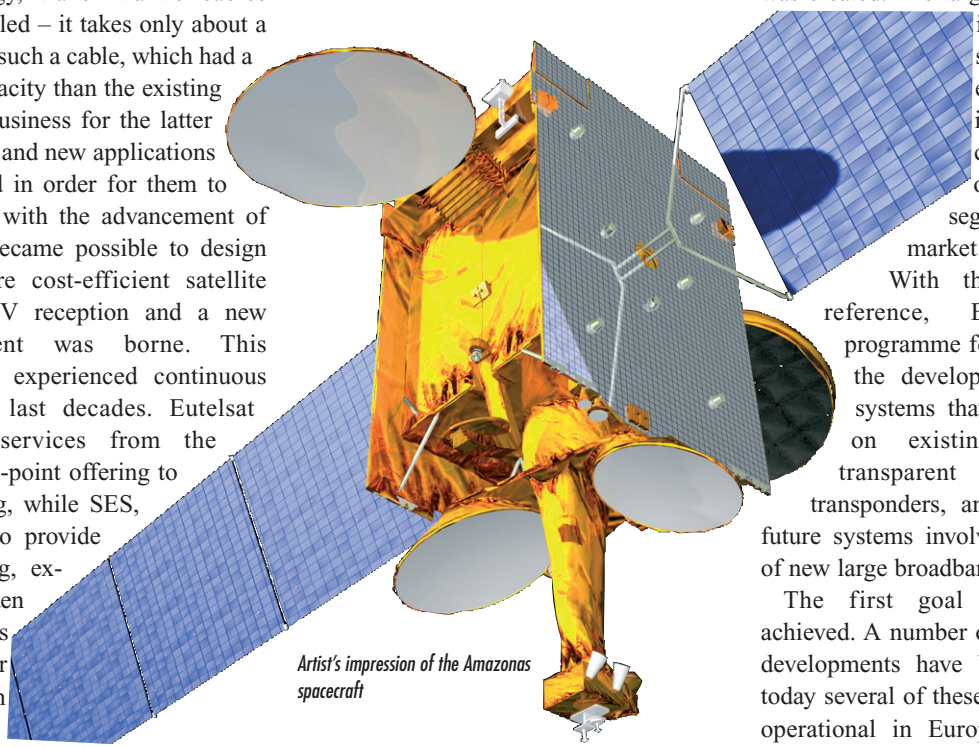
The result is that fewer transponders are needed to provide a large quantity of TV channels. The content providers therefore get cheaper satellite transponders from the satellite operators, who require fewer satellites in their fleets to provide the service. The satellite manufacturers, at the other end of this value chain, then have a hard time to sell more powerful satellites. Basically, only replacements for aging satellites are needed to satisfy the capacity demands for TV broadcasting. With fewer satellites being manufactured in the future, fewer launchers will be needed to deliver them to orbit. Hence, the crisis in which our industry – satellite and launcher manufacturers, satellite operators, and launch providers – currently finds itself will only by resolved when there is a demand for much greater communication capacity in the geostationary orbit. New services in addition to TV broadcasting are therefore needed.

There is an interesting analogy with the past. The first communication satellites were used to provide capacity for telephone connections between the continents. Large earth stations were installed and several hundreds, and later several tens of thousands of telephone channels were carried by these communication satellites. This kind of service was the domain of the international Satellite Organization (Intelsat) created in the 1960s. In Europe, ESA's development and launching of the European Orbital Test Satellite for communications led to the birth of the European Telecommunications Satellites Organisation (Eutelsat). OTS and the European Communications Satellite (ECS) family that it spawned were designed for point-to-point applications.

With the later rapid advances in fibre-optic technology, trans-Atlantic cables were soon installed – it takes only about a month to install such a cable, which had a much larger capacity than the existing satellites. The business for the latter was demolished and new applications had to be found in order for them to survive. Again, with the advancement of technology, it became possible to design and manufacture cost-efficient satellite receivers for TV reception and a new market segment was borne. This application has experienced continuous growth in the last decades. Eutelsat extended its services from the original point-to-point offering to TV broadcasting, while SES, created solely to provide TV broadcasting, experienced a sudden growth in its business after the reunification of Germany.

Having this historic lesson in mind, communication satellites have again to find new markets. One such new and very rapidly growing market segment is broadband access for multimedia applications – not only the Internet, but also interactive video, audio and games. With about 100 million satellite receivers already installed in Europe alone, communication satellites have the enormous bandwidth potential required to satisfy such needs. However, the existing satellites are not optimised to provide such services. New architectures are needed in which the satellite payload must be of the regenerative type, providing on-board switching capabilities.

ESA has already been working for more than a decade on such technologies, together with European and Canadian industry. As a result, when in early 2002 the opportunity arose to embark such an advanced on-board processor on a commercial communication satellite known as 'Amazonas', to be built by Astrium for Hispasat, European industry was in a good position to respond. The advanced payload for Amazonas – the only communication spacecraft procured in 2002 from a European satellite manufacturer – is called 'AmerHis', which stands for Advanced Multimedia Enhanced Regenerative Hispasat System. AmerHis is the first commercial communication-satellite payload able, thanks to its very advanced ESA-developed technology, to provide cost-effective in-orbit connectivity services for the above-mentioned applications.



Artist's impression of the Amazonas spacecraft

ESA's Preparations for the Multimedia Revolution

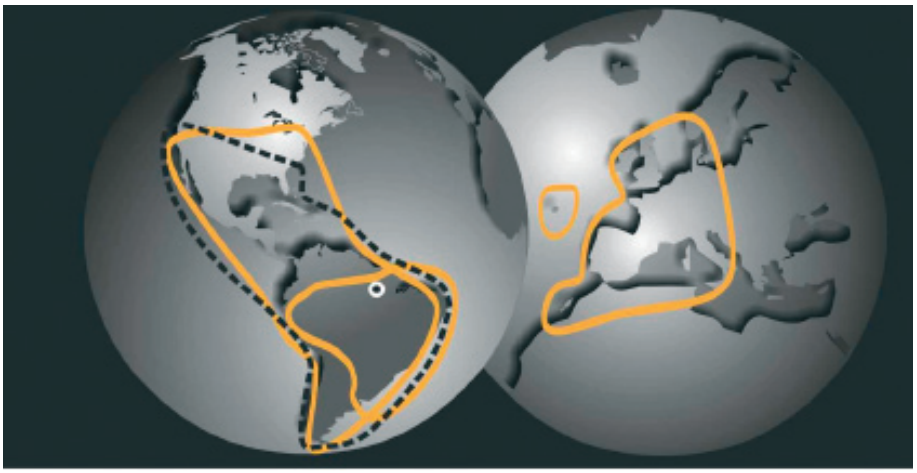
In the late nineties, after consulting with its Delegations, with satellite operators and with industry, ESA initiated a comprehensive programme designed specifically to prepare European industry for the next generation of interactive satellite communications systems.

A fundamental element of this action consisted of supporting the development of an open standard for interactive satellite broadband services, facilitating the open provision of services and open competition between manufacturers. For the delivery of data to the users, therefore, the already well-established DVB-S standard was adopted, while for the return channel from the users the so-called DVB-RCS standard was created. The target customers for this interactive satellite service, which is effectively 'an ADSL in the sky', are corporations, small offices and a certain segment of the domestic market.

With this background as reference, ESA's multimedia programme focused on two goals: the development of interactive systems that could be deployed on existing satellites with transparent Ku or Ka-band transponders, and the definition of future systems involving the deployment of new large broadband satellites.

The first goal has largely been achieved. A number of DVB-S/DVB-RCS developments have been supported and today several of these systems are already operational in European and American satellite systems. However, the cost of the terminals and the charges for the service are not yet at a level affordable by home users. Further efforts are therefore being devoted to reducing the cost of the terminals, providing additional functionality and ensuring compatibility between the different systems.

ESA has also addressed the medium/long-term horizon by awarding



The coverages of the Amazonas satellite's three spot beams

major contracts to three consortiums, led by each of the European prime contractors, for preparation of the key technologies needed for future broadband satellite systems. These projects - Domino led by Alcatel, EuroSkyWay led by Alenia and WeB/West of Astrium - have resulted in the thorough analysis and validation of the critical aspects and equipment involved in each of the systems.

The next step is to demonstrate their technical and operational performances. The ESA Multimedia Programme, approved at the Edinburgh Ministerial Council in November 2001, therefore foresees support to projects in which the multimedia technology developed will be deployed on in-orbit satellite systems in partnership with commercial satellite operators. AmerHis is the first such payload.

The AmerHis Industrial Consortium

The AmerHis system is being developed by an industrial team of Spanish, French, Canadian and Norwegian companies led by Alcatel Espacio.

As prime contractor, Alcatel Espacio (Madrid) is responsible for developing and delivering the complete AmerHis communication system, including the Base Band Processor (BBP). Alcatel Space (Toulouse) is responsible for development of the Network Control Centre (NCC), for validation of the AmerHis system and for developing the Ku-band modulators. Mier Communications (Barcelona) is developing the Ku-to Base Band Downconverter. Indra Espacio (Barcelona) will deliver the Gateway Stations. EMS (Montreal) and Nera (Oslo) will deliver the User Stations.

The Amazonas Satellite

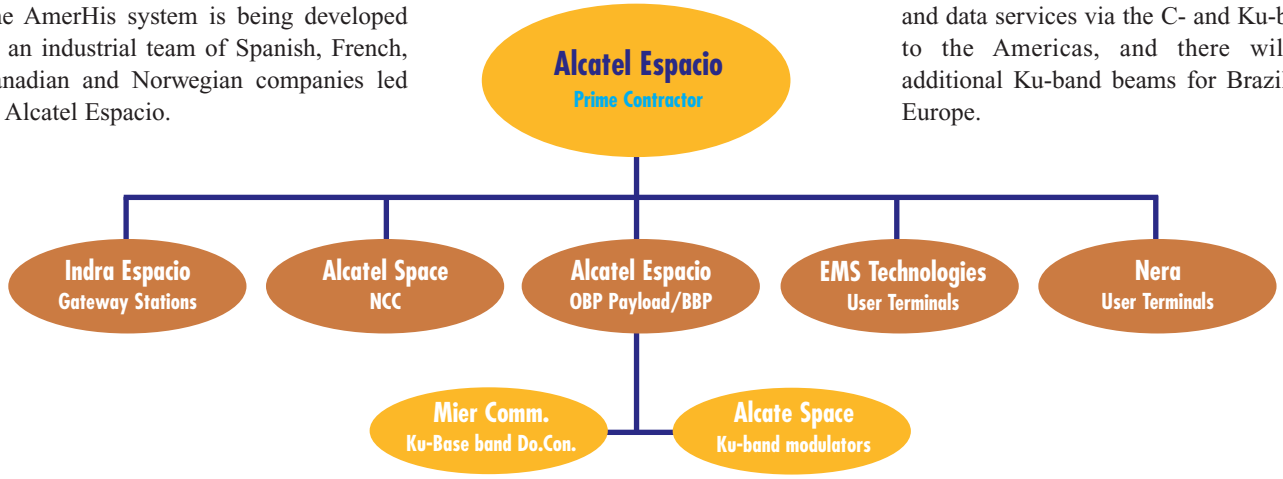
The Amazonas satellite has been ordered by Hispamar, a daughter company of Hispasat operating in South America, from Astrium for a launch in April/May 2004. Based on the generic Eurostar 3000 spacecraft platform, it carries 19 C-band and 32 Ku-band transponders. It will be located at 61 degW above the equator, just north of the Amazonas river.

The main role of Amazonas will be to provide spot-beam services covering North and South America and Europe for a minimum of 15 years. It will provide TV and data services via the C- and Ku-bands to the Americas, and there will be additional Ku-band beams for Brazil and Europe.

AmerHis – A Model of Institutional Cooperation

Following the approval of ESA's Telecommunications Long-Term Plan, the Agency entered into discussions with several satellite operators with a view to finding flight opportunities for the systems being developed within its multimedia communications programme. Hispasat SA reacted positively, expressing interest in the potential inclusion of a regenerative payload on the Amazonas satellite.

The commitment to the realisation of AmerHis is reflected in a formal trilateral Agreement between ESA, Centro de Desarrollo Technologico e Industrial (CDTI), and Hispasat, which defines the terms and obligations of the parties with respect to the implementation, accommodation, launch and exploitation of the AmerHis system. The ESA commitment is reflected in the contract awarded on 11 October 2002 to an industrial consortium led by Alcatel Espacio.



The AmerHis Payload

The AmerHis payload will be a 'switch-board in space' providing connectivity between the Amazonas satellite's different coverage areas and making a wide range of interactive services possible over the Atlantic. It will be the first such 'regenerative' switching payload to be flown on a commercial communications satellite. Based on novel on-board processing technology, it can provide high-speed Internet access and broadband data services to subscribers using the DVB/MPEG-2 standard. It also provides access to terrestrial networks through various gateways. These gateways provide such services as Internet access, voice over IP to ISDN/PSTN, and videoconferencing.

The AmerHis payload will connect small, cost-efficient user stations, built to meet the DVB-RCS and DVB-S standards. The link from the user station to AmerHis will work at a medium data rate, allowing low-cost transmitting stations to be used. The AmerHis payload then converts these medium-rate signals, received from many different user stations, into one high-rate data stream, which is transmitted by the Amazonas satellite. The user stations can receive the AmerHis signals with standard digital TV receivers based on the DVB-S standard. By combining the DVB-S and DVB-RCS capabilities into one unique regenerative and multi-spot satellite system, AmerHis integrates a broadcasting multi-media network with an interactive network.

The AmerHis Services and Connectivity

The AmerHis operational system will be an ideal platform from which to provide a wide selection of real-time and non-real-time multimedia services and applications, including:

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

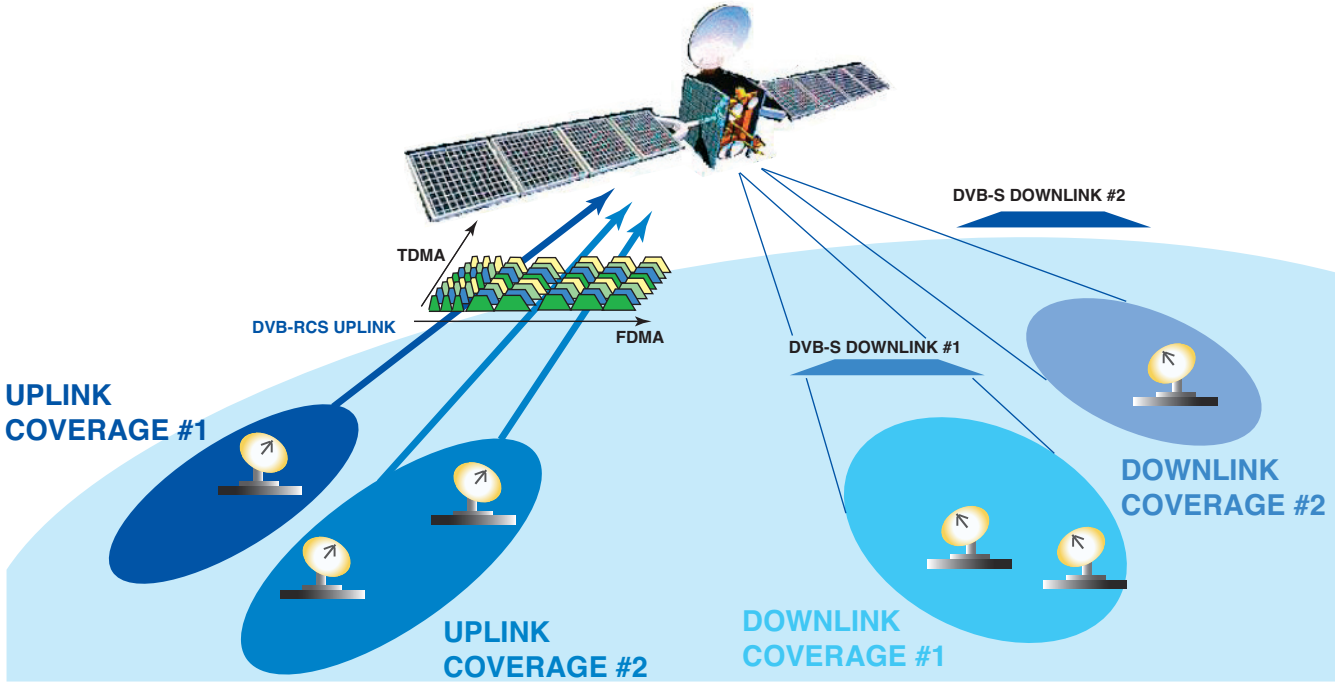
The AmerHis operational system will support IP services as well as native MPEG-based services with efficient multicast and quality-of-service support. Interconnection with terrestrial networks – ISDN and public switch telephone networks – is also supported through gateways.

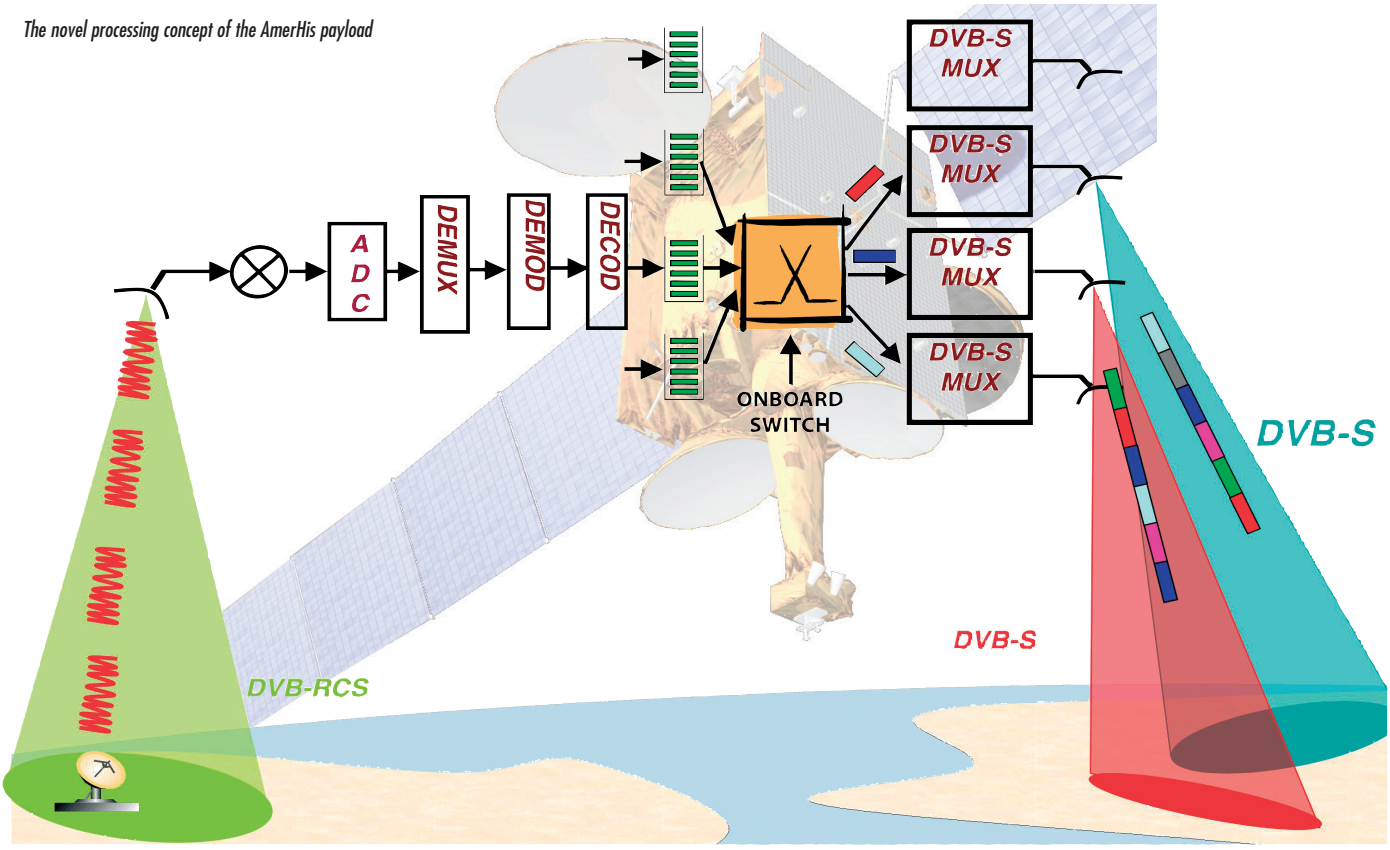
A variety of different connectivities are possible for the various applications:

- Point-to-point: 'unicasting'
- Point-to-multipoint: 'multicasting'
- Point-to-multipoint: 'broadcasting', which differs from multicasting in that the network has no knowledge of, or control over the user.
- Multipoint-to-point: concentration/ multiplexing.
- Multipoint-to-multipoint: mesh or some-to-many.

The AmerHis Development Schedule

The AmerHis development schedule is very demanding. The procurement contract for the Amazonas satellite was signed in January 2002 and the possibility of embarking a piggyback payload only became known the following month. The





The novel processing concept of the AmerHis payload

industrial consortium, led by Alcatel Espacio, quickly prepared a proposal based on the work they had already done under the Domino 2 contract within the framework of the ESA Directorate of Applications ARTES-3 programme. The contract for the AmerHis payload's development was subsequently formally signed in October 2002. However, to meet the Amazonas satellite's tight development schedule, the industrial consortium had already started work. One of the schedule-critical items was the procurement of the ASICs (Application-Specific Integrated Circuits) for the baseband processor.

The Engineering and Qualification Model (EQM) of the On-Board Processor has been completed and was delivered to Astrium the end of May 2003 for integration and testing with the Amazonas spacecraft. It is thermally and mechanically representative of the final Flight Model (FM), which is scheduled to be delivered to Astrium in September 2003.

In parallel with the work on the space segment, development of the ground segment has also been taking shape, fortunately under less stringent schedule constraints. Before delivery of the payload Flight Model for integration on Amazonas, however, a complete end-to-end test of AmerHis including the ground segment needs to be performed to identify any potential incompatibility between the payload and the user stations. The AmerHis Multimedia System Validation Testbed (AMSVT) has been developed for this purpose. The AmerHis Operational System Validation Testbed (AOSVT) will facilitate the pre-launch and in-orbit acceptance tests and the final validation of the AmerHis system before delivery to Hispasat. The integration, testing and pilot operations will be performed during 2004. Delivery of the complete AmerHis communication network to Hispasat is currently scheduled for January 2005.

Conclusion

The AmerHis system is to be flown and demonstrated at a critical point in time for the whole communication satellite community, for whom it will hopefully open a new window of opportunity by providing very cost-effective, interactive broadband services to a very large user community. Of particular interest is the system's ability to provide these services simultaneously to the whole American continent and Western Europe under the auspices of a European satellite operator.

Thanks to AmerHis, Hispasat will be able to offer more and better services to its customers in Europe and North and South America without resorting to today's costly and cumbersome double satellite hops. These services include high-speed Internet access, digital audio and video broadcasting, and multi-casting services. With its two-spot-beam coverage of the Americas and one European beam, the AmerHis payload is an ideal vehicle with which to promote the use of European and Canadian communications equipment and services in other regions of the World.