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The Implementation of ESA's Telecommunications Programme 2002-2006

esa Telecommunications

– Achievements and Perspectives

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Introduction

The ESA Telecommunications Programme has been in place since 1975, i.e. throughout the existence of the European Space Agency. This Programme has been paramount in the consolidation of the competitive position of European Industry, Operators and Service Providers.

It was on ESA's initiative that one of the first major European satellite telecommunications operator, Eutelsat, was set up. Furthermore, ESA's pioneering initiative consolidated the technological capabilities of both the prime and sub-contractors, leading to European Industry capturing between 40 and 50% of the global market for telecommunications satellites. ESA has also been instrumental in the positioning of Industry with respect to mobile satellite systems, i.e. Marecs, EMS, Inmarsat-IV.

In the course of its development, ESA's Telecommunications Programme has experienced many changes that have permitted the adaptation of the support provided by the Agency to different levels of operational and commercial maturity.

The support provided by ESA in the field of space telecommunications is the most important institutional source of funding for orienting and supporting the European capacities. Through the co-funding mechanism in ARTES 3 and 4, a large part of the R&D industrial funding is associated with the ESA activities, giving ARTES a structuring role for the sector.

The rationale and scope of ESA's current Telecommunications Programme is framed in the Telecommunications Long-Term Plan (TLTP) for 2002-2006, which was approved by ESA's Ministerial Council in Edinburgh in November 2001. This publication describes the major activities that have subsequently been carried out by ESA, using the eight 'action lines' defined in the TLTP 2002-2006 as a reference.

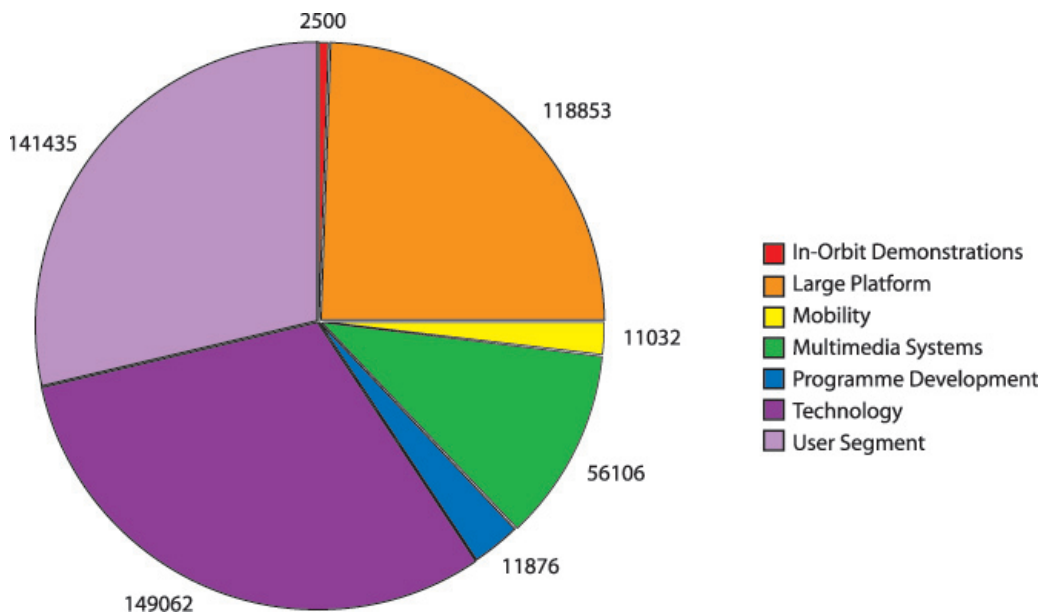
The implementation of TLTP 2002-2006 has taken place against the background of the crisis in the satellite telecommunications sector as described in the document ESA/JCB(2005)18. One of the main consequences of these circumstances has been the lack of readiness of Operators and Industry to co-invest in the deployment of new satellites. This has particularly affected the planned implementation of up to two multimedia systems. The efforts of the ESA Executive have therefore focused on consolidating the technology base and finding opportunities to demonstrate the technologies being developed within the multimedia programme.

An equally important consideration is that only 650 of the 1500 MEuro identified in the declaration for the second period have been made available for implementing the proposed set of activities. This shortfall, combined with the reluctance of Operators and Industry to deploy additional capacity, has limited ESA's ability to implement the provisos of the TLP 2002-2006. Whilst in general terms the competitiveness of European Industry in well-established segments of the market, i.e. in FSS, DBS and MSS, is maintained, the major impact of the shortcomings has been the absence of consolidated European initiatives in emergent new systems, notably broadband and broadcast to mobiles.

In these circumstances the Executive, in close coordination with ESA's Joint Communications Board (JCB) Delegations and with the Industry, has revised the plans for implementation of the TLTP and prioritised those activities that were found to be of immediate relevance to the needs of Industry and were financially supported in conformity with the Programme rules.

The total value of the contracts placed between January 2002 and August 2005 is 490.8 MEuro. The number of contracts placed is 438.

Following the prioritisation resulting from the feedback from Operators, Industry and Delegations, most of the resources have been allocated to the user segment and technology lines. Two programme lines have been left dormant: In-Orbit Demonstration (only Conexpress) and Inter-Satellite Links. In addition, the initial and pre-development activities related to the AlphaBus satellite platform led to the completion of the Phase-B and the preparation for Phase-C/D initiation, which culminated with the signature of the contract for this phase, which took place in June 2005.



The implementation of the 2002-2006 TLTP: Value of contracts per line up to August 2005

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The Programme Lines of the Telecommunications Long-Term Plan

Preparatory Studies

ACHIEVEMENTS

The objective of the 'Preparatory Studies' line of the Telecommunications Programme is to provide the strategic guidelines for and support the strategy of the overall Telecommunications Programme. This is achieved by providing awareness of the market and technology trends, analysing systems by performing various types of feasibility studies, and supporting different aspects of the definition, integration and standardisation of satellite systems.

In the period between 2002 and 2005, a total of 40 activities have been initiated, with a value of 11 MEuro. The major results obtained from these activities can be structured as follows:

i *Support to Telecom Strategy - Market awareness*: Several studies have been performed to analyse trends in demand for satellite telecommunications and opportunities in specific regions or application areas of interest (i.e. Multimedia Market Evolution, Eastern Europe, Telemedicine, HDTV, etc). These studies have allowed the Executive to focus the Programme on specific areas and services of interest.

ii *Support to Telecom Strategy - Technology feasibility analysis*: This is a very wide area of activities that have addressed several innovative concepts and technologies for both ground and space systems, such as high-throughput processors, ultra-fast packet processors, software, etc. Some of these studies have been seminal in terms of the generation of important systems, such as the Very-low-cost Interactive Terminal study, which was precursor to the SatMode system development. Similarly, the Ku-band Mobile study has triggered a potentially very important use of Ku-band satellites in inclined orbits.

iii *Support to Telecom Strategy - DVB enhancement*: The preparatory programme has placed the highest priority on support to Industry for activities related to the European DVB-RCS Standard. These objectives have been targeted by means of a set of projects that have covered the evolution of DVB-RCS systems such as: Quality of Service (QoS) management, QoS at the application layer, terminal performance assessment, protocols for adaptive fade mitigation, control and management planes, inter-operability benchmarking, low-cost installation.

iv *Next Generation Systems*: A particularly important component of the Preparatory Studies line has been dedicated to the exploration and analysis of the feasibility of a wide range of satellite-system concepts and to the support of other lines of the Telecom Programme at system level. Examples of these activities are Scalable Multimedia, Skylan, Stratospheric Platforms, and JADES (in support of the Large Platform Mission), Conexpress, Geodem, DDSO, etc. Further specific studies have been performed on the evolution of mobile services, namely the Preparation of Next-generation S-UMTS, and Satellite Digital Multimedia Broadcasting. From these studies important conclusions have been drawn which have served to decide on the continuation or rejection of these systems, and accordingly their consolidation or not in other lines of the ESA Telecommunications Programme.

v *Satellite Integration in Terrestrial Systems*: Complementing the system- and technology-driven activities, the Programme has dedicated several studies to supporting the integration

of satellite systems and terrestrial networks and services, i.e. IP Security, Enhanced IETF Encapsulation for DVB-S, Ipv6 and Satellites, Active Networks and Multimedia Satellites, etc. As a result of this effort, systems designers, terminal manufacturers and service providers have been able to improve the performance and enhance the integration of satellite systems in terrestrial networks.

vi *Support to Standards*: This effort has been combined with ESA's direct support to various areas in the standardisation of satellite systems. In this respect, the coordination of the SatLabs group has been crucial in the validation of the interoperability of DVB-RCS terminals produced by different manufacturers, and in the consolidation of the features and functionality of the standard. An equally important activity has been ESA's contribution to the development of the new DVB S2 standard. DVB S2 is considered a fundamental interface to air whose added efficiency will be incorporated into future broadcasting systems, but more significantly into interactive broadband access systems. Yet another interest group supported by the Preparatory Studies line of the Telecommunications Programme has been the Advanced Satellite Mobile Task Force (ASMTF), whose objectives are to coordinate views on the role that advanced mobile satcom systems will play in the future.

All in all, the Preparatory Studies line of ESA's Telecommunications Programme has produced extremely valuable results that have helped in evaluating the technical and economic perspectives of a wide range of satellite system concepts and technologies. Furthermore, this line has been a factor in the emergence of new projects and in the consolidation of the DVB-based standards, which constitute a strategic objective of European Industry.

PERSPECTIVES

As defined above, the Preparatory Studies line, aimed at supporting the elaboration of the strategy, analysing the trends in the sector, and initiating the preliminary studies on advanced concepts, is an indispensable tool for the implementation of the Telecommunications Programme as a whole, and will therefore need to be continued for the period 2006-2010. The major strategic areas of appraisal will continue to be:

- Support to Telecom Strategy
- Continuous monitoring of the sector and identification of its trends
- Initial studies on Next Generation Systems
- Satellite Integration into Terrestrial systems
- User Segment and Terminals.

The flexible implementation of this line of activity through the adoption of yearly work plans allows for a continuous adaptation of its objectives to the prevailing situation.

Multimedia Systems

ACHIEVEMENTS

The Interactive Broadband line of the ARTES Multimedia Programme has maintained an important degree of support to European Industry in preparing for the eventual emergence of a new generation of interactive satellite services. The market has not evolved as predicted, but the activities supported by the 'Multimedia Systems' line have:

- Developed and validated the major system concepts associated with Multimedia Broadband Multispot Beam (mainly Ka-band) systems, including user requirements, service definition, system requirements, system design, equipment development, validation and testing approaches.

- Maintained and developed skills and technical capabilities in European Industry in such system-related areas as: networking, system management, security, QoS management, etc.

- Maintained competence and competitiveness in specific products, equipment and subsystems, for both the space and ground segments, i.e. DVB-S based systems, Ka-band front-end RF equipment, antennas, processors, platform equipment, etc.

- Achieved a high degree of readiness for the eventual surge in demand. This level of readiness will allow solutions to be provided for a wide range of institutional and commercial initiatives.

Enhanced Skyplex

The most significant projects developed under the Multimedia Systems line are:

i *Skyplex*: A total of 24 Skyplex units have been sold commercially. The latest implementation supported by ESA is the so-called 'Enhanced Skyplex', which includes an improved implementation on the Multi Carrier Demodulator (MCD) with improved performance, the use of turbo-coding and a reduction in mass and power. The Skyplex unit is used on Eutelsat's W3A satellite.

ii *Alcatel's Domino*: The major achievement of the Domino programme at system level is the readiness that has allowed Alcatel to address commercial bids for broadband systems. The Domino programme has produced a wide range of critical system elements and equipment items, e.g. Transmit and Receive Multispot Beam Antennas, Onboard Processors (MCD, Packet-Switched Demonstrator, TM/TC and Switch Controller), RF Units (FGUs, Ka-band EQM, DOCON, Ka-band Linearised CAMP, etc.) and other technology-related activities (miniature heat-pipe substrate and ASIC test vehicle). It is one of the onboard processor technologies developed under Domino that has permitted the implementation and deployment of the AmerHis system.

iii *Alenia's Euroskyway*: The development of the original Euroskyway concept is based on an Asynchronous Transfer Mode (ATM)-oriented cell-switching system. These developments have produced the Euroskyway demonstrator, including its payload (processor, front-end, etc.) and ground segment (Network Operation Centre, gateways, SaTSIM, and terminals). Euroskyway adapted the system to make it fully DVB-S/DVB-RCS compliant. Both the ground-segment and space-segment specifications have been developed in full detail, and were the basis for negotiation of potential bids with European Operators.In line with the short-term interest of specific operators, Alenia proposed to reorient a part of the Euroskyway programme to provide short-term solutions for the implementation of an interactive broadband system that could make use of Skyplex Ka-band satellite capacity. This concept, known as SkyplexNet, has been commissioned with Eutelsat and used to initiate services with a number of selected Service Providers.

Italian civil protection authorities in Piedmont, Italy demonstrating SkyplexNet technology

iv *Astrium WeB/West*: The development of WeB has allowed Astrium to achieve a high level of readiness to address the emergent Ka-band market opportunities. Within the WeB project, Astrium has developed a system approach that combines forward-and-return transparent processor architecture with a mesh processor that allows inter-connectivity between beams. The project has produced a system validator in which all system functions are emulated. In addition, the WeB/West project has included the development of antennas, processors, key radio-frequency units, and ground-system units.

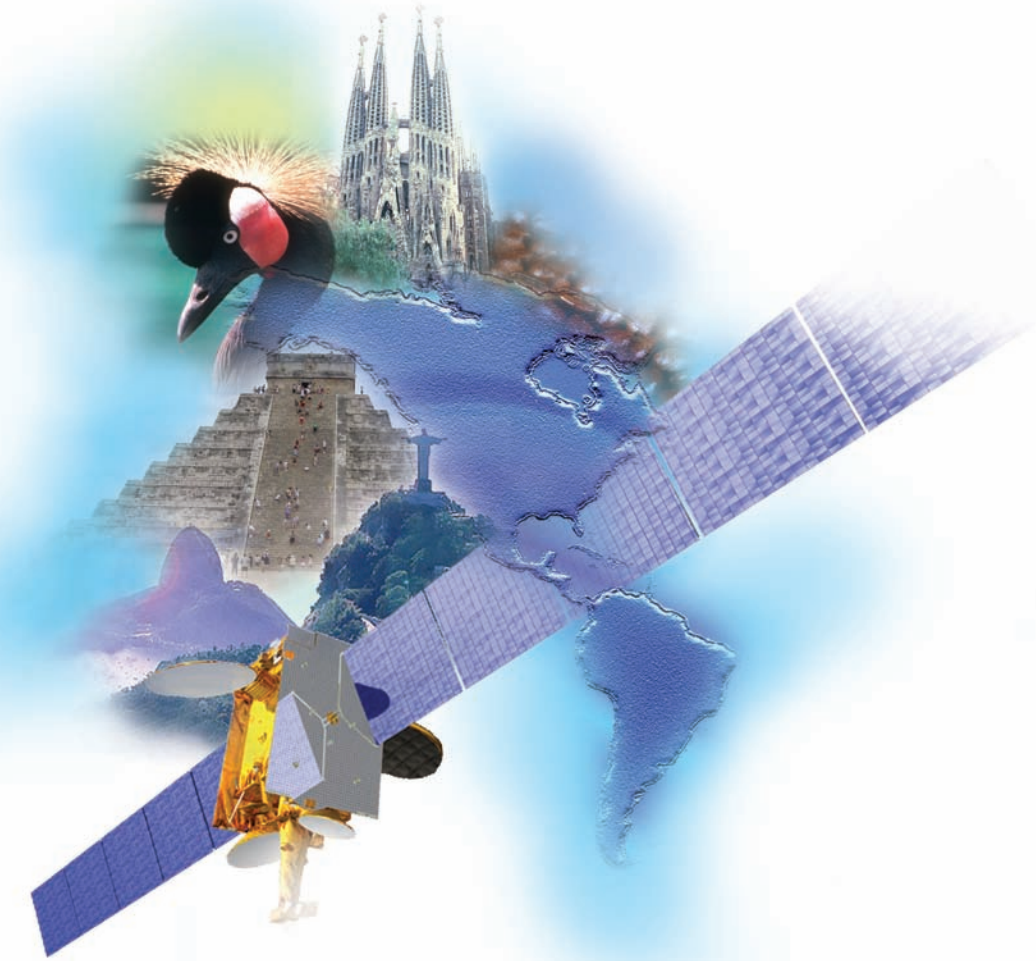
v *AmerHis*: Despite the crisis in the telecommunications market, ESA, with the cooperation of Spain's CDTI, was able to reach an agreement with Hispasat to deploy in orbit some of the core technology developed under the Domino project. This payload, called AmerHis, embarked on the Amazonas satellite, consists of 19 active C-band transponders and 32 active Ku-band transponders. The Ku-band coverage of Amazonas takes in four regions: Brazil, Europe, N. America and S. America.

The AmerHis system is a DVB-S/DVB-RCS compatible, onboard-processor payload with the capacity to interconnect four Ku-band transponders, one for each of the Ku-band coverage regions. The payload also includes down-converters and DVB-S modulators. The AmerHis system also includes a Network Management System, which allows the provision of a wide range of Internet-based, corporate-communications and video services. A set of gateways and a representative number of terminals has been included in the project.

Amazonas was launched on 5 August 2004 and the AmerHis payload was successfully tested in September/October 2004. The integration of the Network Control Centre and the rest of the ground segment have taken place. Voice, video (teleconference)

and data services are currently running on the system, involving communications between subnetworks with terminals in North America (Canada), Brazil and Europe. A successful set of demonstrations took place on the occasion of the Le Bourget Air Show in mid-June 2005. A wide range of pilot systems will be using the AmerHis system prior to and in conjunction with its commercial deployment.

Amazonas coverage: zone served by AmerHis in the Ku-band



AmerHis

Ariane 5 delivers! Anik F2 is the largest commercial telecom satellite ever launched

PERSPECTIVES

The analysis of the market trends on the evolution of Fixed Satellite Service (FSS) systems concludes that the bulk of the demand will consist of the replenishment and extension of existing systems, mainly in the Ku- and C-bands.

As Operators enlarge their fleets, develop to the maximum their use of orbital positions and take advantage of the economies of scale brought about by larger and larger satellites, the need for flexibility and reconfigurability of the payload increases. Multiple coverage areas call for optimisation of the coverage, assignment of capacity to particular beams, and cross-strapping between different beams and/or different frequency transponders.

At the same time, Operators require shorter production times and reduced costs. A new approach to the way satellites are engineered and manufactured will therefore have to be considered.

Broadband access systems are finally starting to be implemented: WildBlue now being implemented on ANIK F2, or IP Star, will be providing commercial services in 2005. Other Operators have considered full Ka-band multispot beam systems, albeit in some cases only for local TV distribution, e.g. SES Americom AMC 17, and DirecTV.

Eventually, the proven feasibility of Ka-band systems and the demonstration of their superior cost/performance ratios will generate a new cycle of growth. European Industry must maintain and improve its readiness to address this eventual surge in the demand. ESA must therefore continue to support the development, promotion and implementation of Ka-band systems, in partnership with satellite Operators and Service Providers.

Accordingly, the Interactive Broadband Multimedia Project line should be continued in the new TLTP 2006-2010, with an extended scope to cover all aspects of the evolution of Fixed Satellite Services and Broadcast Satellite Services, and in particular:

- System, Services and Networking Aspects: Review complement of standard system architectures, modulation techniques, MAC systems, encapsulation, protocol an networking aspects of broadcast (contribution, transport, distribution and direct-to-home systems), interactive broadcasting, broadband access, broadband trunking (Internet Service Provider interconnection) telephony and data trunking systems.

- Satellite System Architecture: Review configurations and constraints for various reference systems with transparent regional/zonal coverage, and multispot systems for the above-mentioned services.

- User Segment: Promote the development of low-cost solutions for broadcasting, broadband interactive and iTV user terminals, with low-cost Outdoor Units (ODUs) as a technological target. Consolidate the DVB-S/DVB-S2/DVB-RCS standards and SatMode, incorporate additional functionality, e.g. mesh connectivity or new deployment scenarios (i.e. mobile), and low-cost installation.

- Networking Elements: Promote the development of Hubs, Gateways, Network Control Centres, Service Centres, etc.

- FSS Payloads: Revision of payload architecture, mainly Ku- and C-band. Development test and qualification of critical subsystems: antenna(s), output front-end, flexibility and reconfigurability elements (flex D/Cs IMUXES, switches (analogue and digital) and especially OMUXES).

- Multimedia Payloads: Promote the deployment and operation of multi-spot systems in conditions that will demonstrate the service cost advantage that will be introduced with available technology (Operator partnership and/or AlphaBus). Maintain European Industry's capabilities by improving all elements of multimedia (Ka-band) payloads: antennas, HPAs, O/P MPAs, IF switching, regenerative switching in line with standard air interfaces.

Mobile Systems

ACHIEVEMENTS

The 'Mobile Systems' line of TLTP 2002-2006 is dedicated to maintaining European capabilities in the design and implementation of mobile satellite systems. This has been carried out through a combination of system-oriented activities, geared to planning the evolution of next-generation interactive and broadcast mobile systems, and through a comprehensive set of technology-oriented activities (described in other sections of this document) aimed at ensuring European suppliers for the core elements of future Mobile Satellite Systems. This action has helped to maintain the degree of readiness of European Industry (otherwise very heavily involved in the Inmarsat-IV programme) and in the preparation of future systems (mainly SDMB).

The main projects that have been carried out are:

i *Inmarsat's BGAN Extension*: This project will extend the capabilities of the BGAN system that will be offered by the upcoming Inmarsat I-4 satellite constellation. The BGAN Extension Project establishes the specification and definition for directional as well as omni-directional, truly mobile, BGAN platforms and services for maritime, aeronautical and land mobile applications. In addition, it also aims to diversify the BGAN service portfolio with the development of a multicasting service capability exploiting the advantage of satellite for delivering such services at the global level.

ii *EADS Astrium's Amethyst Programme*: This programme has as its objective the definition of advanced mobile system concepts and new payload architectures dedicated to mobile satellite systems. The Programme was initiated with a Phase-0 focusing on the consolidation of preliminary system and payload concepts and the identification of the necessary technology evolutions. The subsequent Phase-1 has been split into two main lines. The first is devoted to the system and design analysis of GEO-mobile networks, aiming at the integration of satellite networks with ancillary terrestrial components. The second focuses on the adaptation of the Inmarsat-IV spacecraft design to offer higher performance services in the L-band extension regulated at the WRC2003.

iii *Alcatel's SDMB System*: This Satellite Digital Multimedia Broadcasting System is intended to implement a multicasting layer over unicasting terrestrial 3G UMTS mobile networks. The system architecture is based on a combination of high-power GEO satellites, providing several spot beams over Europe, and a terrestrial component composed of terrestrial repeaters. The system will deliver interactive broadcasting/multicasting multimedia services to mobile end-users in outdoor and indoor environments, relying on specific 'caching' ('push and store') mechanisms and local storage capacity in the handset. The SDMB system is an initiative promoted by Alcatel and supported by ESA through its ARTES Programme and the Commission through its IST 6th Framework Programme (MAESTRO project).

iv *Satellite Data Link System for Air-Traffic Management*: This system specifically addresses the air/ground communications of civil aviation for the purpose of air-traffic management. The SDLS service requirement and system studies commissioned in Industry address the specific functionalities and quality of service required for controlling aircraft trajectories. As a result of active cooperation with Eurocontrol with a view to meeting the projected air-traffic capacity requirements over Europe in the future, the Air Navigation Conference (state level) of ICAO held in 2003 decided to specifically address satellite communication technology when studying new systems capable of meeting worldwide requirements in the future.

v *Mobile Ku-band Receive-only System*: This system aims at using end-of-life geostationary satellites, which are still in a good technical state but with limited orbital control, to provide alternative applications that are inherently insensitive to these orbital instabilities. The prime service to be offered by the mobile Ku-band receiver system is digital satellite radio with pan-European coverage.

Furthermore, part of ESA's strategy has focused on the development of mobile 3G services via satellite (S-UMTS). Such activities follow two main lines, namely study and simulation activities intended to identify and assess efficient techniques for 3G service delivery to mobile users, and the development of software/hardware-based test beds capable of validating and demonstrating the S-UMTS concepts in the laboratory as well as over-the-air.

The most relevant activities are the Advanced Test Bed (ATB) and its forerunner 'Robust Modulation and Coding for Personal Satellite Communications Systems' (ROBMOD) focused on the lower layers and the 'Network Simulator for Third-Generation Mobile Satellite Systems' (3GNetSim) aimed at the design,

development and validation of the higher layer protocols involved in the radio-access network for 3G mobile satellite systems. These projects investigate the possibility of integrating a satellite infrastructure within the terrestrial UMTS networks, basing the satellite-system solutions as much as possible on those adopted by 3GPP for UMTS, and making modifications only when needed to best match the particular characteristics of the satellite environment.

PERSPECTIVES

Mobile communications remains a strategic objective for European Industry. It therefore needs to maintain a high level of competitiveness and ensure the development of new competences that will guarntee its participation in new mobile opportunities resulting either from the extension of the Inmarsat system or the emergence of new regional or global systems.

The success of radio broadcasting to mobiles in the USA may herald the emergence of new service providers in Europe or other parts of the World, and therefore European Industry must be able to play any of the various roles required by these systems.

ESA's mobile S-UMTS demonstration van

From a different perspective, mobile communication systems are particularly suited to the provision of security-related infrastructure. In addition, the planned deployment of Galileo will require the development of position-related services and complementary networking systems that will allow the full exploitation of the combined navigation-telecommunications services.

Therefore the main perspectives in terms of development for the Mobile Systems line in the period 2006-2010 are:

- Technology: Development, test and qualification of next-generation mobile payload technology and payload architectures, including: antenna(s) reflectors, multi-spot feeds, processors, MPAs, and front-end optimisation. Development of improved procedures for the integration, measurement and testing of complex payloads.

- Development of system architectures and payloads adaptable to the requirements of Operators.

- System analysis of techniques related to mobile systems: Revision of available air interfaces. Analysis of improved-efficiency physical layer design (ACM, OFDM, etc.). Radio resource-management models. Service-provision models.

- Development of terminals, radio access networks, hubs, management systems, and associated subsystems and equipment.

- Development of the system aspects related to mobile broadcasting. Evolution of SDMB towards system validation. Development of technology suited for implementing contoured beams of regional/national size in S-band. Paralleling of HPAs for very high EIRP. Flexible utilisation of high-power output stages. Support/promotion of the implementation of a European-based Mobile Broadcast system.

- Review of the requirements of integrated navigation-telecommunications systems. System architecture of location-based services. Scenarios for implementation. Requirements on user terminals. Requirements on network functions Requirements on the space segment. Development of related services and applications.

- Review of the requirements of mobile communication systems integrated with security networks: protection of the communication (encryption), interference rejection, protection of the infrastructure, protection and survivability of the networks.

User Segment and Applications

ACHIEVEMENTS

The Applications line is dedicated to developing innovative opportunities for using satellite communications for the benefit of the end-users. Satcom-based applications are key for the competitiveness of the European and Canadian Space Industry and Operators: firstly, because they represent the largest market segment, which exceeds the combination of satellite manufacturing, launch services, lease/sale of capacity and ground segment; and secondly, because applications have proved to be the major engine in generating new demand for satellite telecommunications services, and in turn more demand for satellite capacity.

Espresso is the UK's leading educational broadband content company. Formed in 1997, and with the support of ESA, they were the first company to introduce full-screen video and media-rich content into a browser-based network solution in classrooms

The Agency has been a pioneer in this area with the launching of an Applications line in 1997. Since then the Telecommunications Department has managed 110 projects under the different elements of the ARTES Programme, either providing immediate commercial opportunities, as in the case of Espresso, Inmedia and Avanti, or paving the way for longer term undertakings such SkyPlexNet and TelBios.

Leveraging such experience, in 2001 the Executive introduced the User Segment concept as an evolution of the Applications area. The specific area of User Terminals has been recognised as a critical success factor for Applications, in that it promotes the availability of standardised, interoperable and low-cost user terminals. Results in this area have exceeded all expectations. In addition, the initial focus on the pure development of Applications as an isolated element has migrated to a notion of 'Application as an integral part of an end-to-end system'.

In essence, the successful introduction of an application in the commercial environment can only materialise if a full end-to-end solution is developed. This encompasses not only the application itself (what the users interact with and pay for), but also the other elements in the value chain, such as different services, systems and subsystems, without which the applications cannot be provided in a stable and sustainable way to the world of the end users. Within this end-to-end approach, rather than being just a means of transferring bits between geographical sites, satcom becomes an integral part of a problem-solving solution for the user community. The system has to be developed with clear application requirements in mind. But at the same time, applications are pivotal in achieving market acceptance for a new system technology. This requires the coordinated development of applications and the underlying systems.

Within the framework of the User Segment, the following has been achieved:

Project support

- Creation and operation since 2002 of the User Support Office to assist new entrants and smaller companies (typically 50% of contractors in the User Segment belong to such categories) in dealing with ESA, in becoming familiar with basic technical and regulatory issues relevant for the satcom environment, and overcoming barriers to market entry.
- Since 2001, launch of five rounds of the yearly Start-up Initiative dedicated to new entrants into ESA Telecom, aimed at smaller firms (particularly for those active in the applications field), based on a two-step tender-submission process (outline proposal and full proposal) and executed in close cooperation with national Delegations.
- Provision of a set of Technical Facilities (such as access to satellite capacity, access to DVB uplink stations and to interactive DVB-RCS terminals) in support of applications projects and specific demonstration events.

Standardisation

- Consolidation of the DVB-RCS standard in the VSAT market (DVB-RCS is required in major Requests for Proposals; competes alongside the market leaders; number of commercially deployed DVB-RCS hubs and terminals has increased significantly).
- Launching of the SatLabs Group, today composed of 32 members and covering all elements of the multimedia-service-provision value chain, with the aim of achieving interoperability and terminal-cost reduction.

- Leading of DVB-RCS standardisation group for the final approval of a worldwide standard for multimedia via satellite.
- Decisive contribution to DVB-S2 standard creation for the improvement of satellite efficiency by 30%.

User groups

Applications projects require the direct involvement of the user community. For the more mature areas, it is crucial to build up consensus through a sensible user base, to overcome fragmentation and achieve a reasonable economy of scale. ESA recognises the fundamental role played by the users in the requirements definition and their contribution to the applications projects from the definition phase up to the operational transfer to sustainable service provision. Reciprocally, ESA is recognised in many areas by the users as the right entity to consolidate user-community interests and foster the emergence of an adapted space solution. The following milestones have been achieved in this respect:

- Creation of the *Telemedicine Working Group* to consolidate the lessons learned from Telemedicine pilot projects (ESRIN Symposium in May 2003) and lay the foundation for a way forward (ESRIN Symposium of July 2004), which led to the roadmap for the Telemedicine via Satellite Programme Proposal.
- Creation of a European *Train Operators Group* for elaboration of common requirements and support to Internet-to-train interoperability.
- Federation of the European *Civil Protection* requirements in the Satcom field.
- Initiation of cooperation with the International Atomic Energy Agency (IAEA) in order to demonstrate the relevance of satcom infrastructure for security and safeguard needs.
- Creation of a *Service Providers Advisory Group* for the provision of a 'quality label' for satellite multimedia services, to define minimum requirements to ensure an adequate quality of service to the end users.

Development activities and their main results

- In the traditional 'exploratory' area of applications, 9 projects have led to fully commercial systems, and 11 projects are leading to operational systems that are in the process of commercialisation.
- DVB-RCS is now a serious contender in the broadband satellite market, with close to 70 hubs and over 16 750 DVB-RCS sites online as of late 2004 (source Northern Sky Research). Most worldwide requests for proposals are explicitly requiring DVB-RCS and excluding any proprietary technologies.
- A number of 'Solution Projects' have been launched, aimed at providing scalable turn-key systems in response to the needs of specific user groups:

  - SkyPlexNet, for applications related to emergency management (network for the fire brigades, Italian Civil Protection Agency and the Ministry of Defence) (commercially available).
  - REMSAT, for the provision of Earth-observation images, communications, localisation and coordination of rescue teams and fire brigades in case of forest fires, which is now deployed at operational level (operational, adopted by Canadian fire brigades).
  - SatMode, dedicated to the provision of interactive TV services via very-low-cost interactive user terminals (commercial launch in fourth quarter of 2005).
  - Broadband in the Sky and Pacific Skies, two initiatives providing DVB-RCS networks with shared use of a hub for multiple Internet Service Providers (commercially available).
  - MediaSpace, in the field of capacity building and 'info-poverty', which provides blending of satcom, ICT and content for the creation of development opportunities in disadvantaged areas outside Europe (system sold to

National Fire Agency of Taiwan and commercially available).

Solution Projects have emerged as the best way to bring mature applications projects successfully to market. They have three major characteristics:

- The active involvement of the federated user communities both in the requirement derivation and in the pilot phase, where the application is validated in terms of its operational and business models within the actual target environment of the end users. For credible involvement of the user community, it is crucial to obtain some form of financial contribution and risk sharing from the users themselves.
- The development of Solution Projects in partnership with the user communities, including the development of the end-to-end system, and not just limited to the associated technology and applications, but including also the set of ancillary services, which are indispensable for real service provision (as opposed to what is usually done in technical demos).
- The transfer to a sustainable service-provision organisation.

REMSAT - Real-time Emergency Management via Satellite

SATMODE - interactive television via satellite

PERSPECTIVES

The traditional *Exploratory Applications* activities, which as noted above fulfil a crucial role in the generation and validation of new opportunities and constitute the innovation engine for applications, should be reinforced by a dedicated application line focusing on *Solution Projects*. This new application line should provide the financial and legal framework to execute a number of such projects, with the objective of setting up fully functional systems, characterised by unambiguous and transparent service requirements derived by the users, and of becoming operational in a sustainable environment after the early deployment with the support of ESA. Such Solutions Projects will be addressed according to the technical maturity of the application and the level of user involvement. The potential application areas are:

- Internet on Public Transport
- Broadband Access for Consumer Applications
- Interactive TV Applications
- Location-Based Applications
- Automotive Applications
- Civil-Protection Applications
- Safety/Security Monitoring and Control
- Info-poverty/Capacity Building.

A new legal framework will be required to regulate the participation and financial contributions of user communities in the different phases of the projects, to guarantee compliance with competition/state-aid regulations for the pre-operational services, to regulate access to IPRs to Industry, ESA and users, to verify the possibility of establishing synergies with regional/national/international development programmes with similar or complementary objectives and, last but not least, to provide a stable and appropriate financial envelope.

The *Telemedicine* line appears as the most mature sector for this new application line. This is an area which has been subject of a number of applications activities in the past, and for which a specific, coordinated effort is required to move from the exploratory to the operational phase.

The Telemedicine group of experts has expressed the wish to see ESA setting up a Telemedicine via Satellite programme. Particularly important in this case will be collaboration with other regional/national/international Telemedicine programmes, with the aim of joining forces and enabling the quick achievement of sustainable operations.

Telemedicine - medical care from space

Technology and Equipment Projects

ACHIEVEMENTS

The Technology line has provided significant support to European industry for the development of new designs as well as for upgrading existing designs to meet current market requirements. Equipment prices have fallen in recent years, stressing the need for further reductions in recurring costs, and thus further technology developments. The Technology line has resulted in the following achievements:

- Various equipment items have been updated and improved for the Eurostar and Spacebus platforms such that they are competitive on the World market.
- Payload equipment has been developed for the entire

photo: P. Sebirot

Application areas

frequency range from L-band to Ka-band, including active and passive equipment, low-noise amplifiers and linearised power amplifiers.

- Ground satellite-communication equipment has been developed from a rudimentary basis to complete systems able to support several thousand users. In particular, the DVB-RCS standard has matured and a number of systems and system components have reached the market.

- Components subject to US export restrictions have been replaced in a number of equipment designs with European equivalents, and in several cases new equipment has been developed to replace US-made equipment.

Significant items developed under the Technology line include:

i *Li-ion batteries*: Two technologies have been developed, one based on a large number of small cells and the other based on fewer large cells. The initial developments for Li-ion batteries have been supported in national programmes, while the final developments including qualification have been performed under the co-funded elements of ARTES. Li-ion batteries are now a standard offering on Eurostar and Spacebus, and contribute to Europe being at the forefront of satellite bus technology. The batteries based on a few large cells are used on the large telecom platforms, while the batteries using a large number of small cells are being embarked on small scientific and experimental satellites.

ii *400 N engine*: A 400 N apogee engine has been qualified with components from Europe only. Previously, the valves were procured in the USA, but due to export restrictions it was desirable to have a European alternative. This 400 N engine will be used on the APSTAR satellite being manufactured by Alcatel Space. It has allowed Alcatel Space to submit offers to operators located in Eastern and Asian countries.

iii *Platform central structures*: New central structures have been developed and qualified for growth versions of Eurostar and Spacebus. These structures take advantage of the latest

Artemis solar-array deployment test in the ESA/ESTEC test facilities

developments in carbon-fibre-reinforced materials to achieve high strength and low mass. The production methods are designed for low recurrent costs.

iv *Solar arrays*: In this area, activities have been supported on solar cells ranging from silicium types to triple-junction GaAs cells, on concentrators using small mirrors, special test equipment to verify the quality of the solar cells after mounting on the array, standardisation of solar-array wings for the Eurostar platforms, a thermal knife for hold-down and release, and a high-power solar-array drive mechanism.

v *Output multiplexer*: Higher and higher power levels and more and more channels are being required, which means that the output multiplexer is subject to more and more demanding requirements. Some developments have taken place to accommodate these requirements and at the same time simplify the design, striving for a more competitive product. A technique has been developed to compensate for thermal expansion, allowing the multiplexers to be made from aluminium rather than the heavier and more expensive invar. A high-power low-pass filter has been developed to replace the low-pass filters at each multiplexer input with a single one at the output. Moreover, the layout of the multiplexer has been improved to make the equipment more compact.

vi *Frequency converters*: Frequency converters have been developed and improved for the C-, Ku- and Ka-bands to produce smaller units that are cheaper to manufacture. This has been achieved in two ways: by using a number of tailor-made MMICs, and by using a standard set of building blocks in hybrid technology. The products developed have resulted in commercial contracts to the companies.

vii *Satellite power amplifiers*: Solid-state amplifiers for the L- and S-bands have been developed, preparing the industry for next-generation Inmarsat and other mobile systems. Several activities have been performed for the linearisation of TWTAs, allowing a higher drive, and thus greater power efficiency, in multi-carrier mode. Recently, promising results have been obtained in the development of a Ka-band TWTA allowing the setting of the maximum output power over a range of 3 dB without sacrificing power efficiency. This feature offers advantages for flexible payloads.

viii *User-terminal power amplifiers*: It is recognised that one of the most expensive components in Ku- and Ka-band user terminals is the power amplifier. Developments have been undertaken to reduce the cost of these components by developing power modules. This will potentially reduce the cost by a factor of five.

ix *User-terminal ODU*: Out-Door Units (ODUs) have been developed for the user terminals, with the emphasis on minimising production costs. ODUs compatible with Ku- and Ka-band DVB-RCS systems have been developed, as well as ODUs compatible with other systems. The effort has been concentrated on integrating the LNB with the transmitter into a single unit and automating the manufacturing and tuning. Several thousand units have already been sold.

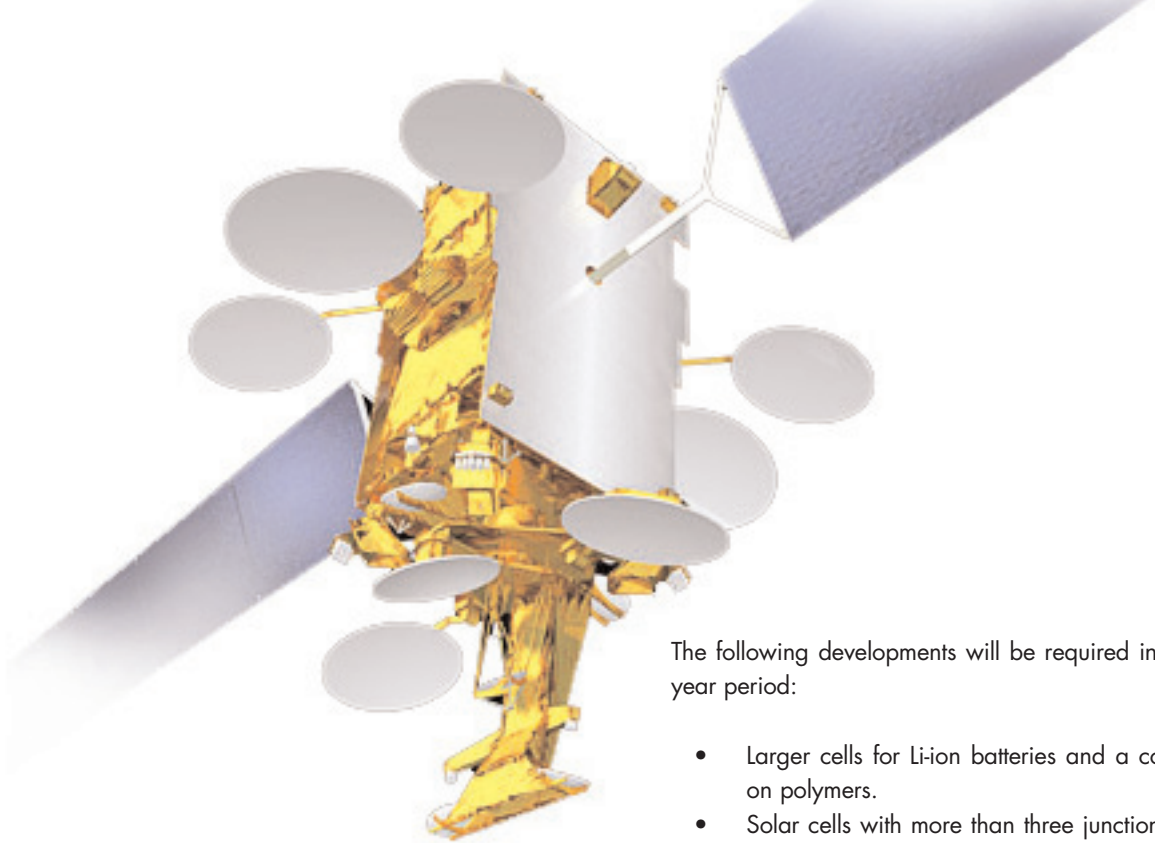
x *User-terminal IDU*: Several activities have been completed to design and add features to the In-Door Unit (IDU) for DVB-RCS-compliant user terminals. These activities have resulted in commercial products being offered in competition on the open market. Again, several thousand have already been sold.

xi *Gateways*: DVB-RCS gateways have been developed allowing easy installation of a DVB-RCS-based network. Versions are available for small as well as large networks. Features are being added to make using the satellite capacity easier and improve the efficiency of usage.

PERSPECTIVES

The commercial satellite communications market is going through a period of uncertainty, resulting in a demand for satellites with a higher degree of flexibility such that they can be used for various services and coverages. The prices of standard satellite equipment are under pressure, and the technology is continuing to make smaller, lighter, cheaper and more performant equipment possible.

Thus, to stay in the market it is necessary to continue the development of satellite-communications equipment for space as well as for ground usage. All areas need revisiting to ensure that the best compromise is reached in terms of investment in new technologies and potential revenue.



AlphaBus

The following developments will be required in the coming five-year period:

- Larger cells for Li-ion batteries and a construction based on polymers.
- Solar cells with more than three junctions to increase the power efficiency, and thin technology.
- Chemical-propulsion systems with all-European components and improved performance, and systems using 'green' propellants.
- High-reliability electric-propulsion systems.
- Earth and Sun sensors with all-European components.
- Carbon-fibre-reinforced materials of European origin.
- Multiple-beam antennas and antennas with in-orbit configurable patterns.
- Flexible-output-power and linearised power amplifiers for all frequency bands, from L-band to Ka-band.
- Miniaturised, low-loss and tunable filters.
- Smaller switches.
- Reliable MEM-based components.
- Flexible frequency converters with low phase noise and high frequency stability.
- Processing transponders for mobile and broadband missions. This requires higher processing power, faster interconnect busses, and ASICs in 90 nm technology.
- Chip sets for mass-produced IDUs for cheaper user terminals.
- Mass production of user-terminal antennas and ODUs.
- Introduction of adaptive coding and modulation in the forward and return links for DVB-RCS systems.

Large Platform: AlphaBus

ACHIEVEMENTS

The main objective of the ARTES large-platform programme is to ensure that European industry is competitive on the World market for large telecommunications satellites.

AlphaBus is the industrial programme for the development of the new product line of large platforms. Pre-developments form part of the large-platform preparatory programme to ensure timely availability of the enabling technology.

Although the technological and development aspects are key elements of any institutional satellite programme, the significance of the ARTES large-platform initiative in terms of industrial restructuring of the European satcom industry should not be underestimated.

The prime contractors Alcatel Space and Astrium reached two major agreements in mid-2003. Firstly, they have converged on a set of commercial agreements covering the terms and conditions for joint marketing of the AlphaBus product line. Secondly, they agreed on their respective responsibilities and work-sharing for the production of AlphaBus.

Within this framework, both partners agreed to maintain the existing Eurostar and Spacebus product-line extensions below 12 kW payload power, making AlphaBus the unique European product for systems above 12 kW.

Considering that the two companies are competitors in the low- to medium-power satcom range, this is a major breakthrough for consolidating European efforts in the commercial sector. The split in production responsibility will tend to consolidate the supplier line not only for AlphaBus, but also for the existing product lines in case of heritage or retrofitting of AlphaBus technology.

Within the Agency, a novel approach has been introduced to reconcile the commercial nature of AlphaBus with the geographical return to Member States. For the purposes of the industrial-tendering process, the ESA 'best practices' have been tailored to take into account the competitive aspects of the commercial long-term agreements. Contributions from Member States are aligned a posteriori according to the results of the selection process.

The cooperation between ESA and CNES during the AlphaBus preparatory phase proved exemplary and cumulated in the issue to Industry of a common and uniform Request for Quotation for the AlphaBus main development phase (Phase-C/D) proposal. This action culminated on 16 June 2005 with the signature of the Phase-C/D contract for the procurement of the first AlphaBus platform.

Pre-developments

In preparation for the main AlphaBus development phase, ESA has initiated more than 30 pre-development activities to support enabling technology for the large platform. The following are just a few examples:

- High-thrust electric-propulsion systems are conceived as attractive technologies for improving the competitiveness of commercial platforms. Pre-developments cover both plasma and ion propulsion, including their associated power supplies.
- The development of a 500 N apogee-boost motor will benefit both AlphaBus and existing product lines, and will provide Europe with a competitive edge at both supplier and platform level.
- The development of a European gyroscope as a strategic and ITAR-free alternative to using a US supplier on AlphaBus.
- Large propellant tanks and the core cylinder of the structure are specific to AlphaBus and critical to its timely development.
- High-specific-energy Li-ion cells will improve the competitiveness of AlphaBus and benefit the European space programme in general.

AlphaBus

As part of the preparatory-phase activities, the AlphaBus Phase-B has consolidated the design of the AlphaBus product line to accommodate payload powers of 12 to 18 kW.

The product-line development effort is a commercial and strategic mixture of novel technologies from mature pre-development activities and heritage from the already successfully marketed Eurostar and Spacebus products.

The AlphaBus design surpasses the growth constraints of the existing Eurostar and Spacebus product lines by providing up to 50% greater capabilities in terms of payload mass and power consumption/dissipation. The design benefits from and is compatible with the evolution in launchers towards a 5 metre fairing.

The AlphaBus Preliminary Design Review was successfully concluded at the end of 2004.

The large-platform preparatory programme has achieved its objectives both in terms of pre-development work and AlphaBus core system activities in the framework of Phase-B. A sound technical and contractual baseline has been established, and this resulted in a preliminary Agreement to Proceed in February 2005 in order to start Phase-C system activities. Thereafter, the main AlphaBus Phase-C/D development phase started in July 2005.

The contract for the development of AlphaBus was signed on 16 June 2005 at the Le Bourget Air Show.
From left to right: Giuseppe Viriglio (ESA), Michel Lefévre (CNES), Antoine Bouvier (EADS Astrium), Pascale Sourisse (Alcatel Space)

PERSPECTIVES

AlphaSat

The original ARTES-8 Element as agreed at Edinburgh in 2001 provided a financial envelope of 500 MEuro. In 2004, the element was divided into two specific and self-contained sub-elements:

Sub-element I dedicated to the development of AlphaBus is, as described in the previous paragraphs, well underway. It will provide the flightworthy protoflight model as a deliverable towards the end of 2008. It is sized towards the middle of the AlphaBus product line, with a payload capability of 1000 kg and a payload power of around 16 kW.

Sub-element I AlphaBus activity also covers a preparatory phase in support of selecting a commercial and/or institutional opportunity for an AlphaSat mission scenario. The activities cover a maximum period of 12 months and will enable satellite system-definition activities in support of the mission objectives and adaptation of the protoflight model to accommodate the envisaged payloads. The preparatory work will also propose an alignment of the AlphaBus development and procurement plan within an integrated AlphaSat satellite development plan. It will provide the first steps towards the definition of an AlphaSat mission and will enable a point of merger with the AlphaBus programme.

Sub-element II will build up the institutional mission known as AlphaSat, making use of the AlphaBus protoflight model equipped with advanced payloads (commercial and/or institutional), and launch the resulting satellite. In addition, the ground segment corresponding to selected payloads will be developed and initial operation is included.

Reference missions used as design drivers for AlphaBus include:

- Hybrid C + Ku + Ka missions for broadcast and fixed services.
- Ku + Ka multi-spot multimedia applications.
- S-band multi-spot for the mobile mass market.
- Geo-mobile for mobile application.

The AlphaSat mission will be based on selected payloads covering one or more of these mission types. A possible candidate to focus this preliminary satellite design work is a combined Ku-Ka band mission, where the Ku-payload targets a replenishment mission for an existing commercial service, and the Ka-payload foresees a demonstrator service. This type of mission leaves approximately 2 kW of the protoflight model's 16 kW capability for auxiliary payloads. The latter could cover complementary payload and platform technologies developed under other ARTES lines for flight demonstration on AlphaSat in piggyback mode. Third-party institutional payloads are also presently under discussion.

Other potential core missions for AlphaSat include broadcast payloads for mobile services, advanced DRA or DRS systems.

Through the flight demonstration of the Alphabus protoflight model, AlphaSat will also enhance the marketing prospects for the new AlphaBus product line with commercial customers.

Parallel Technology

In order to sustain the long-term competitiveness of AlphaBus, continued introduction of the latest enabling technology into the product line is required. This parallel line will benefit from ongoing development work within ESA or elsewhere and tailor the technology for application in the AlphaBus product line. In some instances, enabling technology specific to AlphaBus may need to be developed.

A first financial allocation is foreseen in the ARTES-8 Declaration and will evolve within the period of the TLTP to cover:

- Enhancement of the AlphaBus chemical-propulsion subsystem through a 500 N European apogee-boost motor.
- Development of a novel AlphaBus antenna module.
- Improvement of the AlphaBus thermal-control subsystem, covering the introduction of deployable radiators and fluid loops.
- An AlphaBus high-thrust electric-propulsion subsystem covering new high-thrust ion or plasma electric thrusters, associated power electronics and pointing mechanism.
- Introduction of the new spread-spectrum receiver into the AlphaBus telemetry and telecommand system.
- Continued improvement of the AlphaBus power subsystem through the accommodation of a solar-array drive mechanism with improved slip rings, and further enhancement of solar-cell technology (Ga-As, thin film).

Introduction of these technologies into the AlphaBus commercial product line will depend on maturity, as well as the risk perceived by operators, and may require in-orbit time prior to becoming operational. The AlphaSat mission provides a first institutional opportunity for in-flight demonstration.

In-Orbit Demonstration

ACHIEVEMENTS

The initial objective of the 'In-Orbit Demonstration Programme' was to provide a capability to demonstrate new technologies and services in orbit. This line has received a very low level of funding and as a consequence has been focused on a limited set of activities.

Four parallel studies were completed on a platform suitable for technology and services demonstrations from geostationary orbit. Only one of the four designs, namely ConeXpress, received support for a further definition, including a detailed analysis of the economic prospects for such a platform. This analysis indicated market potential for a vehicle recovering geostationary satellites with failing orbit control systems. A study was performed for such a vehicle and its feasibility was established together with initial cost estimates.

PERSPECTIVES

The justification for having in-orbit demonstration missions is still valid insofar as industry has on several occasions expressed a need for obtaining in orbit heritage for newly developed equipment. Today, satellite operators and insurers are extremely cautious about accepting equipment with no in-orbit testing record on new satellites. ESA will endeavour to facilitate In-Orbit Demonstration opportunities either as piggybacks to fully commercial flights or on dedicated missions.

Inter-Satellite Links

ACHIEVEMENTS

The 'Inter-Satellite Links' line has only attracted a low level of funding and has therefore supported only a limited set of activities.

A few activities were performed by Contraves on the development of a family of optical terminals for inter-satellite links, comprising terminals for high and low data rates, and for short- and long-distance links. In addition, activities were undertaken with TESAT addressing various elements within optical terminals.

For radio-frequency-based inter-satellite links, developments were undertaken for a pointing mechanism and an RF-tracking system.

So far, European Industry has completed the development of optical inter-satellite terminals to engineering-model level and is ready to start formal qualification.

PERSPECTIVES

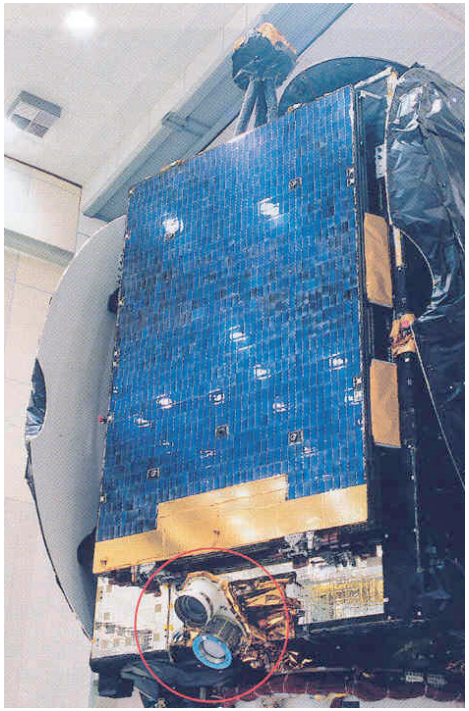
There is a high degree of uncertainty regarding the demand for inter-satellite links between commercial communications satellites. However, future needs may emerge in the field of security applications, which justifies maintaining a strong technology base in Europe for an area of such strategic importance. Developments should therefore be continued for such purposes.

Artemis

ACHIEVEMENTS

Artemis is a technology-demonstration programme providing for the development and in-orbit demonstration of high-risk technologies, as well as the promotion of new operational services.

Following its recovery after its launcher malfunctioned, Artemis began its operations from geostationary orbit in February 2003. After commissioning, the satellite is now successfully providing the planned data-relay, land-mobile and navigation services to its main users on time and with the specified performances. The satellite has an expected propellant-determined lifetime of 10 years.



Two ion thrusters on the south face of Artemis

Artemis

The flightworthiness of a number of the new technologies has been demonstrated, the most significant being the optical inter-satellite data transmission system SILEX, the electric-propulsion system and the integrated control and data-handling system. However, the consolidation of its service functions will be the main focus for the future.

Data relay

In its first 18 months of orbital operations, Artemis has exercised all of the modes and technologies foreseen for data relay, with its S-band, Ka-band and optical links. In the same period, an operational service has been provided to both Envisat (Ka-band) and Spot-4 (optical), allowing Artemis's unique data-relay acquisition features – increased volume of data and real-time delivery – to be exercised. Envisat has recently committed to rely upon Artemis for some 50% of its data collection, including critical services.

Artemis will also support the Automated Transfer Vehicle (ATV) in S-band as prime data source during the attached phase and as backup during the free-flight phases. Despite funding difficulties, a combined Ka-band/S-band data-relay terminal for Columbus (COF) is still under consideration. Using Artemis will give ATV and COF the capability of data acquisition in Europe, with increased availability, security and independence from TDRS.

Artemis has also demonstrated inter-operability in the Ka- and S-bands with JAXA's DRTS and ADEOS-II. JAXA has also recognised the importance of optical-data-relay technology with the development of its test satellite OICETS (launched in August 2005), which will further demonstrate the SILEX capabilities.

Under the Artemis Programme, ESA has also supported the development of an optical ground station in Tenerife (Canary Islands), which has made unique atmospheric attenuation measurements furthering science applications.

Other users planning to make novel uses of Artemis for data relay are EADS-Astrium's LOLA – to demonstrate optical transmissions from an aircraft (UAV) for military observations - and CIRA's unmanned space vehicle.

First image transmitted by means of an optical laser between Spot-4 and Artemis

EGNOS concept

Land mobile services

The Artemis LLM payload provides continuity of service for the European Mobile System (EMS), which was promoted by ESA in conjunction with ASI and Telespazio.

ESA has signed contracts with Telespazio and Eutelsat for the lease of LLM capacity, which provides a modest income for the programme, covering some of the operating costs.

The Artemis LLM payload has also hosted demonstrations for advanced mobile systems promoted by ESA, including air-traffic control (SDLS), a wideband mobile demonstrator (S-UMTS), and travel planning and information services (COMPOSE).

Navigation service

The navigation transponder on Artemis, together with its earth stations at Scanzano (Italy) and Torrejon (Spain), has been successfully integrated into the EGNOS operational system. Artemis will contribute additional redundancy, integrity and accuracy for the operational service planned to start in 2005, complementing similar navigation transponders on Inmarsat satellites

PERSPECTIVES

Current and future scenarios for the use of Artemis allow a steady workload to be predicted for years to come. A cost/benefit analysis will be made before proposing a framework for the extension of the operational phase beyond April 2006.

3

Conclusions

The Telecommunications Long-Term Plan 2002-2006 has been implemented during a period of crisis for the telecommunications sector in general, which has also had a negative impact on the satellite telecommunications environment. As a consequence of the crisis, several of the assumptions made in the Plan, especially those involving the deployment of new broadband systems in partnership with satellite operators, remain unrealised.

The necessary support to implement other project lines, notably In-Orbit Demonstration and Inter-Satellite Links, has not been forthcoming from the Participating Countries, and consequently only preparatory activities have been undertaken so far.

In view of the market situation and the limited readiness of Operators and Industry to embark on high-profile programmes, the Executive decided to re-focus the activities of the Plan on the immediate development of user equipment and technology that would enhance the use of satellite capacity and preserve the competitiveness of European Industry.

In summary, therefore, the TLTP has provided for:

- Development of a European open-standard, DVB-based approach to the provision of interactive broadband services, and the development and promotion of European and Canadian manufacturers' systems.

- Enhancement of the level of readiness of European Industry for the provision of a new generation of interactive broadband satellites, and the development of the capabilities of European primes from satellite manufacturers to broadband system suppliers.

- Implementation and demonstration of AmerHis, the first (DVB-based) broadband switchboard in the sky.

- Support for systems definition and technology development for next-generation mobile systems, and the development of system concepts and technology for future multimedia systems broadcasting to mobile equipment.

- Support for the redevelopment of platform and payload equipment to guarantee strategic independence in the face of the USA's ITAR policy.

- Strategic development of key payload and platform technology items: antennas, HPAs, SSPAs, MMICs, regenerative and non-regenerative onboard processors, batteries, propulsion systems, onboard computers, etc.

- Consolidation and pre-development of the AlphaBus large platform.

- Development of a wide range of applications and pilot demonstrations covering both public (institutional) and commercially orientated systems.

- In addition, it is important to report the excellent results that have followed the successful recovery of Artemis, allowing the regular utiliation of its four payloads.

PERSPECTIVES

In the satcom sector, continuous commercial success cannot be maintained without a permanent push for innovation. ESA's Telecommunications Programme has been the mainstay of the R&D effort of European Industry for many years. In the present situation, this support is more needed than ever before.

The market analysis and evaluation of the achievements of and perspectives for the Telecommunications Programme led to the conclusion that the activities described here should be extended for the next five years (2006-2010).

The existing core of the Programme i.e. the project lines dedicated to the enhancement of technology, equipment, and systems related to the major market areas (FSS, DBS, broadband, mobile, mobile broadcasting, platforms, user terminals, data relay, etc) must be extended. Additional efforts in the field of space applications through partnerships with the user communities are also envisaged.

The deployment of new missions that will either allow reduction of the risk associated with the deployment of new services, and/or allow the validation and qualification of new systems and technologies, is a key tool with which to federate the efforts at European level. In this respect, the development of the AlphaBus platform and its extension into the deployment of AlphaSat constitutes an excellent opportunity for achieving these objectives.