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Satellite Telecommunications – Market Perspectives and Industrial Situation

esa Telecommunications

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Contents

1 Introduction 4

2 Market Perspectives 7

Impact of the Evolution of Terrestrial Services on Satellite Systems: Global Trends 7

Evolution of Commercial Satellite Services 12

- *The evolution of Fixed Satellite Services: From crisis to moderate growth* 12
- *The evolution of Mobile Satellite Services* 19
- *The evolution of Digital Broadcasting to Mobiles: From DARS to SDMB* 20

Satellite Telecommunications and Security 22

Evolution of the Needs for Satellite Telecommunications Platforms 24

3. Industrial Situation 27

Space Segment Industry 27

User Segment and Applications Industry 30

4. The Telecommunications Programme and Relations with the European Union 32

5. Conclusions 33

6. References 34

1

Introduction

Satellite Telecommunications is the most mature and economically most important of the space applications. In Europe it constitutes the core industrial activity for satellite manufacturers. The health of the global Satellite Telecommunications market determines to a great extent the sustainability, and therefore the continuity, of European Space Industry. This is evident from a number of established facts:

- Of the 155 satellites successfully launched by Ariane-4 in the course of its operation, 139 are telecommunications satellites. Of the 39 satellites launched by Ariane-5 by mid-2005, 26 are telecommunication satellites (Ariane-5's capabilities allows the launch of multiple payloads with several small satellites) and it is estimated that 90% of the value of satellite payloads launched by Ariane-5 will be telecommunications-related[1].

- The annual revenue accrued from the lease of the approximately 7500 FSS and DBS (36 MHz equivalent) transponders in orbit is more than 6.6 billion US$, i.e. around 5 billion Euro. The revenue produced by Mobile Satellite Systems exceeds 800 million Euro[2].

- The average number of telecommunication satellites launched per year in the 1990's was 23, while the estimate for the first decade of the 2000's is less than 20. This figure is reflected in the turnovers of satellite manufacturers and launch providers.

- 50-60% of the revenue of European Space Industry (5 billion Euro) stems from the manufacture and launch of communications satellites[3].

- The ground-segment industry has a turnover of 17.8 billion US$ [4,5].

- The revenue produced downstream by satellite-driven services exceeds 50 billion US$[5].

The role of the European Space Agency in Telecommunications is to maintain the competitiveness of European and Canadian Industry in this most important segment of space applications. The activities supported by ESA address the needs of satellite operators, service providers and users in a very complex and competitive marketplace calling for continuous innovation in satellite telecommunications technology.

Launch of an Ariane-4

ESA's actions are multifaceted and intended to cover all elements of the value chain associated with the provision of the various services offered by different types of satellite systems. This effort is driven by both the technology push and the market pull. It ranges from market analysis to applications and service definition, and it includes system design, subsystem design, interface definition, standardisation, equipment definition and specific components and technology developments. The resulting developments may be subject to qualification and they are followed, whenever appropriate, by deployment and experimentation, and pilot operations, for both space and ground systems.

ESA has pursued this 'mission' in one way or another throughout the lifetime of its Telecommunications Programme, starting from its inception nearly 30 years ago. The scope and plans for its pursuit have more recently been incorporated into the Telecommunications Long-Term Plan (TLTP), which is the blueprint with a five-year horizon for ESA's actions.

The current version of the TLTP (TLTP1) was approved by the Edinburgh Council at Ministerial Level in November 2001. The 2002-2006 Long-Term Plan has been partially implemented during the course of the last years with various degrees of success, within the legal framework provided by the rules of the ARTES Programme. An account of the main results of its on-going implementation is provided in the brochure ESA BR-253 (based on document ESA/JCB (2005)19).

In the meantime, the telecommunications sector in general has experienced one of the worst, if not the worst, crisis in its history since the inception of telephony more than 150 years ago. Initially the satellite telecommunications sector proved to be quite resilient, and has not suffered the kind of downturn that affected both dot.com service providers and telecommunications operators, perhaps with the important exception of the LEO constellation initiatives.

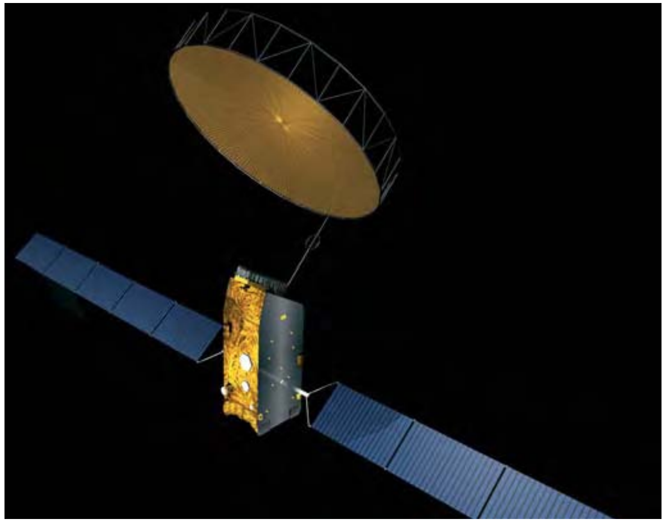
However, the general downturn has eventually been reflected in the satellite market. There is currently an excess of deployed satellite capacity. At the same time, the expectations of continuous growth in the demand for conventional satellite transponders and the emergence of new generations of broadband and mobile services have not materialised, and there is therefore a strong reluctance on the part of investors to deploy new systems. A major consequence of this change of mood has been delays in the implementation of several broadband initiatives that were considered imminent in 2001.

In the USA this downturn in commercial markets has been compensated by increased institutional investments, notably by the US Department of Defense (DOD), in R&D and operational telecommunications systems for the military.

Specific opportunities for the deployment of new commercial systems may be in the making. While conventional C/Ku-band satellites continue their consolidation and remain the mainstay of operators and industry, new advanced satellite systems have been deployed with success for mobile services (Inmarsat IV F1, launched on 11 March 2005, Thuraya) and DARS services have been successful in the USA (XM Radio reached 4.4 million subscribers and Sirius 1.8 million subscribers by mid-2005) [6,7].

In addition, the need for Ka-band systems as a cost-efficient solution to provide broadband access to a large proportion of the population left unserved by the terrestrial systems, offers new opportunities for the consolidation of a new generation of satellite services.

The European satellite industry traditionally relies on the commercial market sector. Until the global markets fully recover, it will have difficulties to finance the R&D associated with new market opportunities. More than in the past, ESA's TLTP will need to cater for institutional R&D support to the Satellite Telecommunications value chain in order to reduce its present vulnerability to the commercial market fluctuations. A significant loss of commercial market share will result in the loss of industrial capabilities, which are essential for the overall space programme in Europe.



Inmarsat-IV

In this light, the partnerships that have been established with the European Union (in a wide range of space-related activities) and with a number of agencies and satellite operators will result in a coherent and convergent policy for the Satellite Telecommunications sector. A key component of this policy will be an R&D programme at European level as manifested in the ESA TLTP.

It is therefore in this context that the new version of the ESA Telecommunications Long-Term Plan (TLTP 2) for the period 2006-2010 is being proposed. In line with previous practice, this update provides firstly an analysis of the situation in the Satellite Telecommunications environment, reviewing market evolution, industry trends, and the relationship between ESA and other interested partners, i.e. the EU and national agencies. This defines the scope of the present document.

Building upon this analysis, the proposed new TLTP 2 (2006-2010), ESA/JCB (2005) 25 Rev. 1, identifies the major lines of action that are proposed by ESA for the period of applicability of the Plan, and proposes a programmatic and financial envelope for their implementation.

The role of ESA in Satellite Telecommunications is to maintain the competitiveness of European and Canadian Industry in the most important segment of commercial space applications.

The global markets are slowly recovering from an unprecedented crisis in the telecommunications sector as a whole.

European satellite industry relies on the commercial market sector. Until the global markets fully recover, it will have difficulties to finance the R&D associated with new market opportunities and to maintain market share.

More than in the past, ESA will need to step up institutional R&D support and services promotion to compensate for the present vulnerability of investments in the European Satellite Telecommunications sector.

This document presents an analysis of the prevailing situation in the Satellite Telecommunications sector, establishing the background scenario for the proposed implementation of a new phase of the Telecommunications Long-Term Plan for the period 2006-2010.

2

Market Perspectives

Impact of the Evolution of Terrestrial Services on Satellite Systems: Global Trends

Satellite Telecommunications is a relatively small but very significant fraction of the global telecommunications activity. It has traditionally developed around terrestrial services: television, telephony, data communication, etc. It is therefore extremely important to review the general trends to identify what their impact will be on future satellite systems.

Broadcast services: television and radio

Broadcast services (mainly radio and television) have continued their evolution from being exclusively FM/UHF terrestrial broadcasting systems to having a larger proportion of the audience being served by cable and satellite systems. The levels of penetration of the different delivery systems vary greatly between countries, in both Western and Eastern Europe.

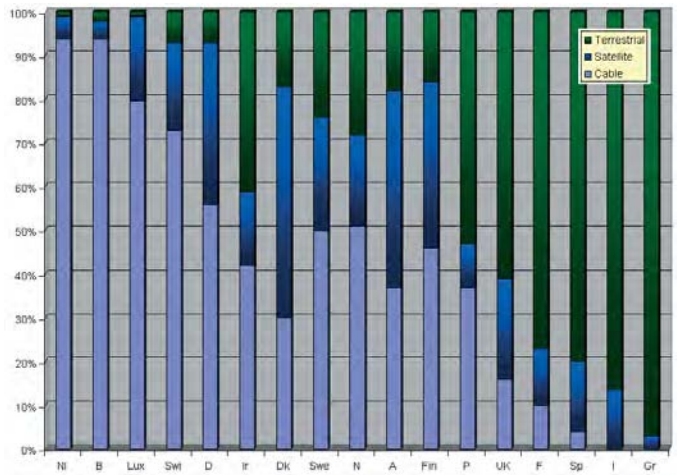
The most rapidly growing segment of the broadcast market is based on multiprogramming subscription services. Public Broadcasters have grown at rate of around 5% per year, while the Private Broadcasters' rate of growth has been 14%. Cable and satellite systems today represent the major alternative means of providing multiprogramme television and maintain a high rate of growth. More significantly, new broadcasting services (Digital Television and more recently HDTV) are likely to be offered by satellite first.

There are still important geographical markets with moderate levels of, or very limited, multiprogramming on offer even in Europe. New EU members and their neighbours constitute potential sources of growth in satellite demand, which are likely to be realised in the next five years. The average penetration of satellite services within the new EU member states is still less than 15%, while cable is well-developed.

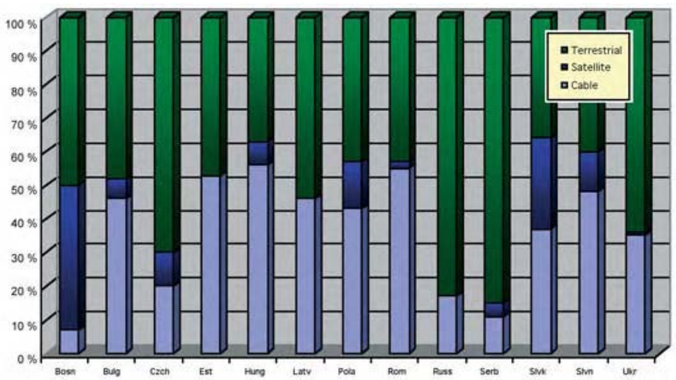
In more mature markets like the USA, the share of satellite systems has continued its robust expansion. In 1994, practically 100% of American homes received their TV signals through cable. Ten years later, only 75% of these homes rely on cable; 22% are served by direct-to-home (DTH) satellite systems, while the other 3% are served by other means.

The long-announced introduction of Digital Terrestrial TV has taken place in a number of countries without having really made a major impact. In fact, in some cases the companies that took this initiative are either in bankruptcy (ITV Digital UK, Quiero Spain) or in disarray. A major change may be produced by the announced replacement of all analogue transmissions by digital ones before 2010/2012.

Another approach, proposed by terrestrial telecommunications operators, is the offer of TV services, on demand, using broadband subscriber access infrastructures. These services are offered in combination with Internet access and telephony in the so-called 'Triple Play'. This is possible with high- performance DSL-based systems (ADSL-2), since the subscriber loop is dedicated. While some operators are already beginning to offer these services, it is not expected that they will generate sufficient demand to justify the necessary major investments across Europe in order to be considered a threat to satellite-delivered services in the period considered here, i.e. 2006-2010. This is, however, a critical development and therefore must be monitored regularly to analyse the threats and opportunities that will emerge for the Satellite Telecommunications sector.



TV delivery systems in Western Europe: EU 15 + Norway and Switzerland



Penetration of TV systems in Eastern Europe

Television has all together been an important success for satellite operators. The unique ability of satellite to broadcast optimally over extended geographical areas will continue to be its greatest asset. Today, almost every TV channel that is produced is either distributed to cable heads or to UHF repeaters by satellite. In other words, the demand for satellite capacity will also grow with the emergence of new TV services that use different broadcasting means.

Other major trends that may affect the demand for satellite capacity for TV will be induced by technological innovation, e.g. new services like Interactive TV, the introduction of additional user-equipment functionality such as Personal Video Recorders, Multimedia Home Platform (MHP) applications, and the definitive emergence of HDTV.

HDTV in particular is expected to provide a significant boost to transponder demand. Several satellite operators have already initiated the deployment of capacity claimed to be HDTV-oriented. In the USA, DirecTV appears to target local markets using four Ka-band satellites and distributing 1500 HD signals to local markets and 150 signals to the national market. The European operators have not yet made public their strategy for extending capacity for the introduction of HD services. Since the key orbital positions are basically saturated, the available options involve either developing new orbital positions in the Ku-band or extending capacity on the existing ones in the Ka-band, or some combination thereof.

On the opposite side, the major threat to demand for satellite capacity will be the eventual implementation of more efficient coding standards: the introduction of MPEG 4 coded signals on broadcasting transponders will allow 20-30 standard-definition TV signals to be distributed on 36 MHz transponders that today transmit just six to eight channels. In such a scenario, the demand for satellite capacity would eventually be reduced, since the reduction in cost of transmission is not likely to increase the number of channels to be transmitted in the same proportion, as the cost of providing the service is dominated by the content production costs.

The potential introduction of new MPEG 4 coders would cause disruption on existing TV platforms, since there are more than 50 million MPEG 2-based set-top boxes currently in use in Europe. It is therefore likely that their eventual adoption will be associated with the introduction of new services or the emergence of new platforms.

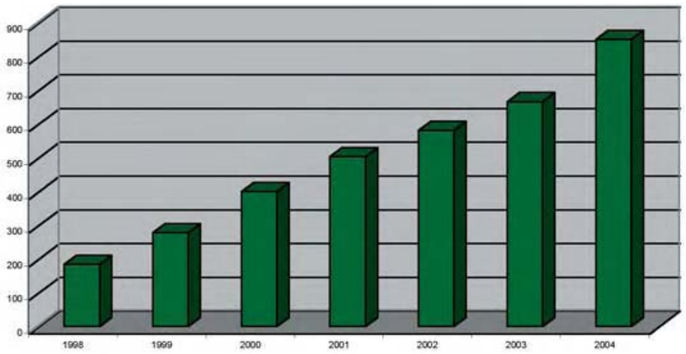
Fixed communication systems: telephony and Internet

Following years of continuous growth in telephony, data and Internet traffic, the main telecommunications operators have deployed a staggering amount of optical-fibre capacity. This capacity remains unused to a large extent and consequently it is unlikely that there will be an equivalent surge in demand for some time. In the main cities of Europe and the USA, usage of the optical-fibre capacity is less than 3% of the actual installed capacity. In general, the pace of new installations has slowed or even halted altogether.

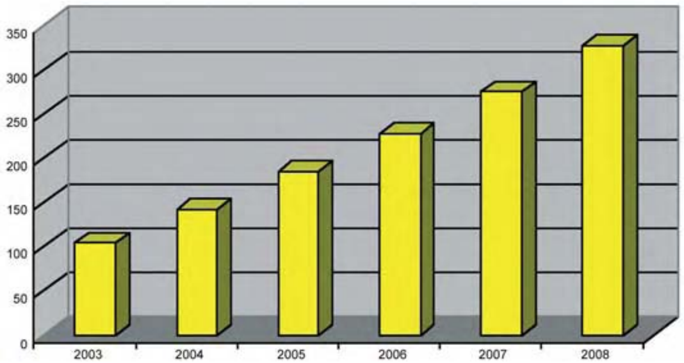
Between 1998 and 2001, the growth in terrestrial international circuit capacity with the USA grew from 234 000 circuits to 6.7 million. In the same period the number of satellite circuits grew from 27 000, or 10% of the total, to 81 000, which still represents only 1.2% of the total trunking capacity installed. In the same period, the level of utilisation of satellite capacity

USA International Circuit Capacity	1995	1996	1997	1998	1999	2000	2001	2002
Terrestrial Circuits (Thousands)	234	299	439	810	1199	3735	5429	6738
Satellite Circuits (Thousands)	28	29	36	35	63	95	84	81
Percentage of Satellite %	10.6	8.7	7.7	4.2	5.	2.5	1.5	1.2

Table 1. International trunking in the USA[2]



Evolution in the demand for Internet access[8] (millions users)



Projections of the growth in demand for broadband access[9] (millions users)

remained between 93 and 97%, while that of terrestrial circuits fell from 58.5 to 41.4%.

Satellite trunks are the favoured solutions when the capacity required by the route is limited. Regions like the Middle East and Africa see 67% of their circuits served by satellite, while in the case of Western Europe this figure is just 0.3%. In addition to more people talking more, the major driver for the growth in international traffic has been the growth of the Internet and the number of people having Internet access, as shown in the accompanying graph. This growth has been reflected in the demand for satellite Internet trunks to connect remote Internet Service Providers (ISPs) to the core network.

An equally important trend has been the introduction of broadband subscriber access, by means of a combination of cable, ADSL and satellite systems. By the end of March 2005 there were 83 million ADSL circuits installed in the World, with the majority being in Asia (50 million in China, Japan and Korea combined). If cable access systems are taken into account, the total number with broadband access today is around 10 million.

This trend is expected to continue in the foreseeable future. Installations of broadband systems (ADSL, Cable) are expected to reach 327 million worldwide by 2008.

A fundamental question for the satellite industry is:
What proportion of the Broadband Access Market will be captured by satellite systems?

The satellite telecommunications industry and other interested parties must ensure that technically sound, commercially attractive, satellite solutions are offered in time to match the growth in demand.

The strong pull for broadband access systems based on cable and ADSL creates a generic applications scenario (Internet access, Internet contents, e-mail and file transfer services being developed independently from satellite systems) whereby satellite systems should thrive. The deployment of ADSL and cable systems in the most developed regions, usually urban areas, will create services and content, and consequently an unsatisfied demand in all of those regions where the provision of terrestrial-based services remains technically or commercially difficult.

Broadband availability is expected to reach 85-90% of the 200 million homes across Europe when left to purely commercial momentum. In January 2005, broadband was available to more than 90% of the urban population, but only to 62% in rural areas. The extrapolation of this case to the whole of Europe leads to the identification of a potential market of 20-30 million homes that could benefit from satellite systems in getting broadband services.

In areas with DSL availability, the take-up rate (i.e. the percentage of homes that subscribe in an area where the service is being offered) has evolved from 6% in mid-2004 to 10% presently. Assuming an equivalent potential take-up in rural areas, the unsatisfied demand would be around 1.5% of the more than 200 million European homes. Today this represents more than 2 million unserved users. Since the take-up rate is increasing with time, it is expected that in the medium term 3-5 million homes may be potential users of satellite-based broadband connectivity. The analysis carried out by the EU[11] makes reference to estimates that 4.7 million would-be broadband users will be excluded by the commercial rollout of ADSL, and could benefit from a public-driven satellite initiative. This report estimates that only 88% of the EU15's population will be accessible by terrestrial means.

Another evaluation of the addressable market carried out in the context of the evaluation of the Digital Divide Satellite Offer[12] concurs with an estimate of around 2 million potential users in 2010 in the base case, where satellites would capture just 33% of the available market. This would rise to around 4 million in 2020. Under reasonably optimistic assumptions, i.e. the absence of alternative solutions and competitive satellite offerings, these figures would double to 4 and 8 million users, respectively. Similarly, around 200 000 Small or Home Office users would be potential users of a satellite system who could subscribe in the base-case analysis, while more than 600 000 would be the target under more optimistic assumptions.

Furthermore, a recent study carried out on behalf of ESA by Price Waterhouse Coopers et al.[13] concludes that while the cost/benefit analysis for the provision of broadband access is extremely positive for Europe as a whole, i.e. the NPV of the benefits is 70% greater than the cost, this figure is much reduced for rural areas, at just 13%. It is therefore unlikely that private investors will be persuaded to take the risk associated with such an investment, and as a result between 4.5 and 7 million potential users of broadband are expected to remain unserved.

Satellites should play an important role in the provision of broadband access not only to European citizens, but also to other regions of the World. Projections of demand from several million satellite users call for several hundred transponders' worth of additional broadband-optimised satellite capacity. However, the barrier to the investment may be so high that this prospect will remain unrealised unless there is a strong push from public initiatives.

In summary, the evolution in demand for terrestrial-based fixed services for telephony and Internet should lead to continuous growth in the demand for additional infrastructure, both in the access and the long-distance networks. In both cases, satellites should be called upon to play a significant role.

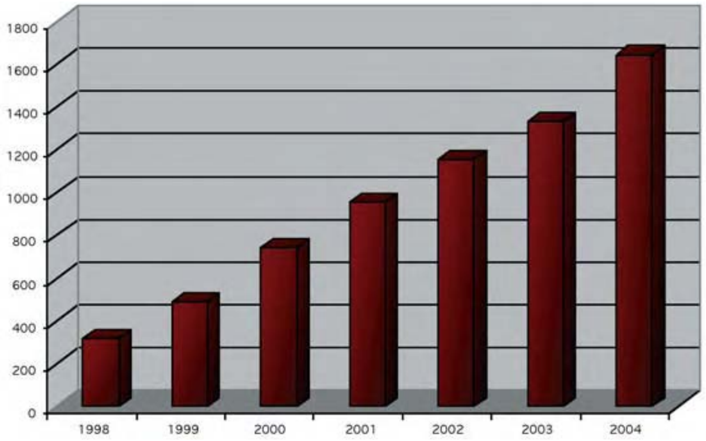
Mobile communication systems

Mobile telephony has been growing faster and achieving higher levels of penetration than any other telecommunications service in history, as shown in the accompanying illustration.

Mobile satellite operators have traditionally based their business models on attending to the needs of specific communities, e.g. maritime and aeronautical, that require services in regions without alternative infrastructures.

However, the emergence of second-generation mobile systems (GSM and the like) created the perception that a satellite service based on similar performance, terminal-size and cost figures would be successful. This led to the development of the global LEO systems. Unfortunately, the perception was wrong. Today Mobile Satellite Systems keep a more modest profile in specific niches, based on the improved performance of such GEO satellites as Inmarsat-III and IV, ACES and Thuraya.

The major drivers that will affect the way in which satellite services are conceived in the future are, on one hand the emergence of third-generation mobile services (UMTS, IMT 2000), and on the other the ubiquity of the Internet. Anything worthwhile communicating with will have an IP address, be it fixed or mobile. In this scenario there must be quite a few instances where satellite will be the best or even the only solution.



Evolution in mobile telephony[10] (millions users)

In spite of their healthy growth, terrestrial mobile systems have experienced a crisis caused by fierce competition, decreasing average revenues per user (ARPU) and the excessive fees paid for the third-generation (UMTS) licences. In the course of the second half of 2003 and the first of 2004, however, no less than 20 European operators rolled out third-generation commercial services[14].

Satellite systems can play a complementary role in the deployment of third-generation mobile systems, either by providing an overlay for the distribution or multicasting of subscription content, or by providing coverage in regions otherwise not sufficiently covered. S-UMTS systems should ideally use the allocated S-UMTS frequency bands that were planned for such a complementary role. Today no mobile satellite operator has any declared intentions with respect to such S-UMTS-type services.

Mobile telecommunications operators have perceived the opportunity to obtain extra sources of revenue by adding an overlay of broadcasting services (particularly low-resolution TV broadcasts) to their basic third-generation mobile offerings. This approach is looking to both terrestrial (DVB-H, pursued by Nokia) and satellite solutions, most notably the Korean-Japanese initiative on Mobsat.

An example of the use of satellites to provide third-generation mobile services, albeit not in the S-UMTS frequency band, is Inmarsat's BGAN (Broadband Global Area Network) system and services on the recently deployed Inmarsat-IV satellite(s). The BGAN system is able to provide high-rate (432 kbps) mobile services in IP mode to small transportable and mobile terminals, thanks to the high performance of the multispot payload and the flexibility provided by the onboard processors of these satellites.

These systems would be able to provide equivalent services (although at a different price) in the regions that will not enjoy UMTS availability for years to come, i.e the largest parts of the rural environments in even the most developed economies.

For various reasons, the Telecommunications sector has not favoured major investments in satellite systems for the last three to four years.

Most areas of the telecommunications market, i.e. broadcast, telephony and data, Internet and mobile, experienced in around 2000 a period of excess investment and financial crisis which has limited the readiness of investors to embark on new ventures.

Broadcast services are expected to continue to maintain a moderate pace of growth, leading to the eventual introduction of Terrestrial Digital TV around 2010-2012, even if the experience so far has not been very successful. Multiprogramming will continue, today and for the foreseeable future, on cable and satellite.

HDTV represents the most important growth sector for broadcast services. It is likely to be implemented first on satellite platforms. The strategy for the deployment of HDTV services will require additional Ku-band, and possibly Ka-band, capacity.

On the whole, telephony and Internet trunking demand will continue to grow. While most of it will be met by fibre-optic systems, low-capacity trunks, especially to remote regions, will be more efficiently served by satellite. Therefore, this traditional segment of market utilisation is not expected to produce any surprises.

The most important evolution is expected to take place with the deployment of broadband access systems, with ADSL and cable targeting more than 330 million users by 2008. Clearly, there is an opportunity for satellite systems to meet demand in regions that will otherwise remain unserved.

Third-generation UMTS services are finally taking off, although much more slowly than planned. The slow roll-out is likely to leave substantial regions/segments of the market unsatisfied, therefore representing an opportunity for satellite systems such as Inmarsat's BGAN.

There is an opportunity associated with the perceived need for satellite-based broadcasting to mobile terminals for a wide range of services (mainly low-resolution TV), and user terminals (mainly hand-held third-generation telephone sets).

THE EVOLUTION OF FIXED SATELLITE SERVICES: FROM CRISIS TO MODERATE GROWTH

Fixed Satellite Services have experienced an unprecedented crisis in the last three years. This has been fuelled by the economic downturn, which has affected all areas of the telecommunications business to a greater or lesser extent. In 2001-2003 the demand for transponder capacity ended a growth trend that had lasted for more than twenty years, stabilising at around 5200 36 MHz equivalent transponders. In the meantime, only limited demand for new services has emerged. At the same time, the supply of capacity (based on outstanding orders to industry) has continued to grow well in 2004, totalling more than 7500 36 MHz equivalent transponders in the combined C-, Ku- and Ka-bands. As a consequence, the level of occupancy (fill-in rate), is around 70% rather than the desirable 80-85%. This means that there are more than 1000 transponders in excess of market needs.

Satellite System	Transponders in Operation	Transponders Leased	Unused Capacity %	Revenue M$
SES Global	993	685	31	1352
Intelsat	1842	1123	39	953
Panamsat	882	635	28	831
Eutelsat	601	462	23	886
JSat	330	237	28	371
Loral*	321	231	28	259
NSS	341	184	46	215
Hispasat	65	59	9	105
Others	2156	1655	23	1628
TOTAL	7531	5271	30	6600

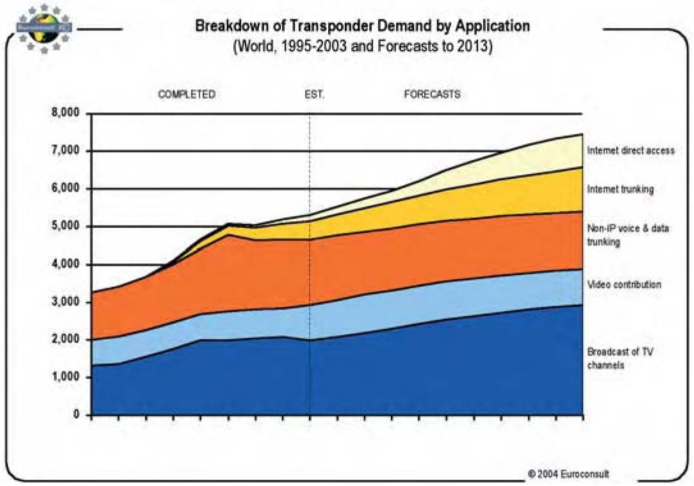
Table 2. Summary figures for operators at the end of 2003[2]

In such a situation of excess supply, prices decrease. Although the cost of capacity to operators is different for the different services, and depends very much from the technical characteristics of the unit, i.e. EIRP, frequency band, coverage, and especially TV neighbourhood, it can be said that in general the average revenue per transponder per year has decreased from 1.7 to 1.2 M$. This is reflected in lower profits or even losses, and generally speaking in a contraction of the market.

The contraction in the sector has led to consolidation. Five years ago there were around 50 FSS operators; today this figure is 35. In addition to the merger of SES and GE Americom, which produced SES Global, other operators, i.e. NSAB, Asiasat, Nahuelsat and StarOne, are all part of the same group.

Loral, after emerging from bankruptcy in mid-2003, sold its North American assets to Intelsat. The control of several major satellite operators has passed into the hands of purely financial investors: Panamsat (Kohlberg, Kravis Roberts & Co), New Skies (Blackstone Group), Intelsat (Zeus Holdings Ltd.), Inmarsat (Apax Partners & Permira), while the major Digital TV platform in the World, DirecTV, has been taken over by News Corporation, which has thereby achieved a privileged position in the satcom market.

Available figures for the present and future utilisation of satellite capacity for the different major segments of the market show an overall growth from 5200 to 7500 transponders by 2013. The TV group, including broadcasting, distribution, and contribution, consume more than half of the projection, while telephony, data and Internet trunking are expected to require around 3000 transponders (i.e. a modest total of 120 Gbit/s).



Actuals and projections of satellite telecommunications transponder demand by service[2]

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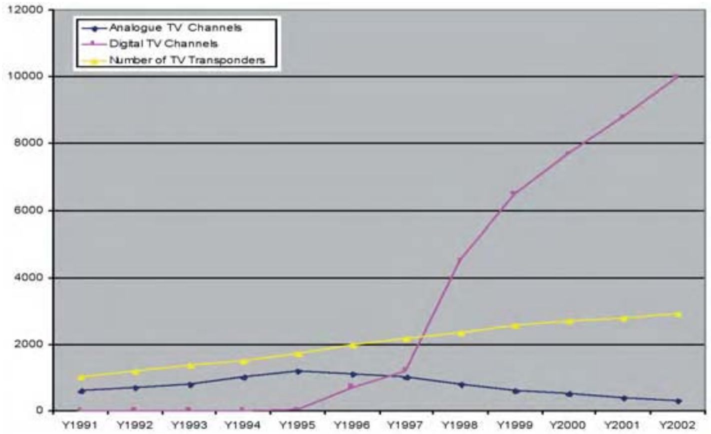


Evolution in demand for analogue and digital TV broadcast channels

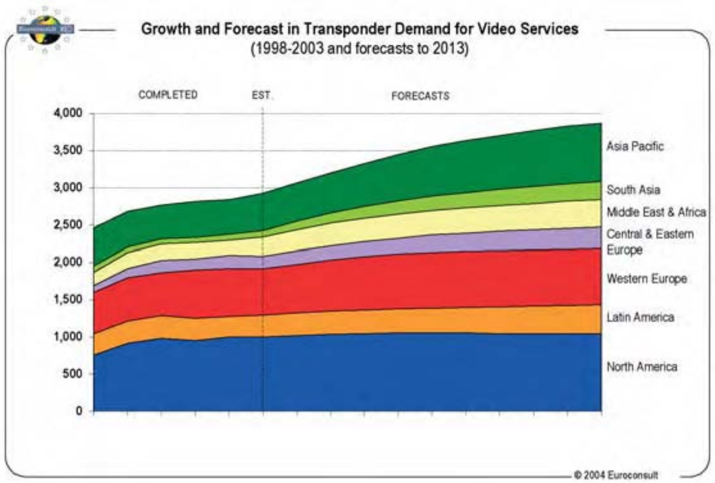
The most significant trend identified by this forecast is the emergence of Internet direct broadband access, which is expected to trigger demand approaching 1000 transponders. The available projections are based on the business models and satellite systems available today. It could be expected that, if Ka-broadband-oriented satellite systems were deployed and economies of scale triggered, this market would be substantially larger.

(i) Video: Broadcast, Distribution and Contribution

TV distribution and broadcasting remains the dominant FSS/DBS service. Globally, nearly 2900 transponders are dedicated to these functions today, representing around 52% of total demand. These services are particularly strong in North America and Europe, and represent the highest-value segment of the FSS/DBS market. Most of this demand has been triggered by the development of digital-television systems, which has been accompanied by the almost universal adoption of the DVB-S Standard (with the very important exception of DirecTV). The growth in the numbers of platforms and TV channels has been staggering, but is, however, not reflected in equal measure by a growth in the number of transponders, as the accompanying figure shows.

The distribution of free-to-air channels has shown a very modest growth. The sector has been affected by the combined effects of a certain saturation of the demand after years of continuous growth, the cancellation or replacement of analogue transponder leases, liberating a significant amount of capacity, and a certain amount of overprovision that occurred in the late nineties.

While globally the numbers of TV channels and transponders in use have both continued to grow, in Europe this growth has



Transponder demand for video services

been moderated. Several digital TV platforms have sustained substantial losses by being subjected to fierce competition in markets with limited growth potential. The result has been consolidation and therefore reduction of the capacity needs (France, three to two platforms; Italy and Spain, two to one; Latin America, fusion of Sky TV LatinAmerica and DirecTV Latin America. There are also other examples).

Contribution services appear to consume around 900 transponders or 16% of the total demand, having shown an important increase in the course of 2003-2004. In general, the more channels that are produced, the higher the demand on contribution services.

The consolidation of operators tends to accumulate larger amounts of capacity in specific 'hot' orbital locations. 3100 TV channels, or 30% of the total, are located at just six orbital positions. This strategy fosters the trend towards the accumulation of transponders on larger satellites.

In summary, the expectations regarding the demand for satellite transponders for video-broadcasting and contribution services are for a modest compounded yearly growth of 3-5% for the foreseeable future, reaching around 3900 transponders by 2013.

High Definition Television (HDTV) is expected to be the major driver in terms of the demand for satellite capacity for new services. The real growth will be modulated by the fact that new technology will allow additional gains in compression for both HDTV and Standard Definition (SDTV) channels, i.e. the use of MPEG 4 part 10/ H.264 advanced video coding is expected to reduce the requirement for HDTV channels from 18 to 9 Mbps/channel, while SDTV channels will require 1.5 to 3 Mbps/channel instead of the present 4 to 8 Mbps/channel.

Some relatively conservative analysts expect that the number of HDTV channels for the European market will be around 80 by 2011. The number of additional transponders needed as a result of the introduction of HDTV is expected to be 30-40[15,16].

A preliminary announcement by BskyB in April 2005 defines its technology suppliers and the intended commencement of a new HDTV platform by 2006. Premiere has also announced an HDTV channel, Premiere HD, which combines MPEG 4 source coding with DVB S2 channel coding.

Following the takeover by News Corporation of the Hughes Network Systems interests, DirecTV has declared its intention to use Spaceway multispot-beam Ka-band satellites for the distribution of local TV stations. This trend, which could be considered circumstantial, appears to fit with the procurement of two Ka-band DirecTV satellites (DirecTV 8 and 9). Taking this precedent into consideration, the strategy for other operators to provide additional capacity from already saturated hot positions may call for an extension into the Ka-band.

System and Technology Developments Required for the Broadcast Market

The architecture of broadcast satellite systems, based on high-power transponders in the Ku-band covering specific continents or regions, is not expected to undergo any major changes in the short term.

The transmission standards have definitively evolved from analogue FM modulated PAL, SECAM and NTSC signals towards DVB-S, encoded digital multiplex, at bit rates around 40 Mbit/s on 36 MHz transponders. These transponders can therefore each support 6-10 programmes. The recently adopted DVB-S2 standard modifies only the channel coding, introducing mechanisms for adaptive coding and modulation. DVB-S2 introduces additional capacity on each transponder by reducing the link margins. This is particularly important in Ka-band systems, such as the proposed HDTV delivery system for local direct TV via the Spaceway satellite.

The most important developments in the TV broadcasting market will be associated with the emergence of new services, i.e. HDTV, Interactive TV, Digital Cinema, Business TV, etc. Services may be developed around new user configurations, such as the Multimedia Home Platform. Another area of growth, favoured by the reduction in transmission costs, would be Business TV.

The emergence of HDTV services will be one of the most significant developments in the immediate future for Satellite Broadcasting Services. The potential benefits in terms of revenue to producers, broadcasters, satellite operators and equipment manufacturers are undeniable. Although the analyses that have been carried out by ESA-sponsored and independent analysts are not as expansive as could have been assumed, the perception of the ESA Executive is that we are about to experience a major evolution, if not a revolution, in satellite-delivered TV.

The technical characteristics are sufficiently consolidated to confirm that the technology will be MPEG 4-based and the transmission will adopt the DVB-S2 standard.

The impact on the demand for additional satellites and the nature of these satellites will have to be re-assesed. In principle, existing Ku-band capacity may absorb the demand, However, the 'hot' positions are some of the most saturated, and the use of capacity at Ka-band frequencies may be required.

The deployment of new platforms allows the introduction of new technologies, and in some cases new orbital positions, but it looks likely that many platforms will prefer to add HDTV channels as premium subscriptions or pay-per-view (PPV) options to their existing offerings.

Interactive TV services are expected to develop further. In addition to providing Conditional Access control and reconfigurability, they allow one to monitor audiences and provide limited-bandwidth user services: acquisition of programmes, tele-shopping, participation in, for instance, tele-voting, and narrowband access to the Internet. Satellite-based interactive TV (e.g. as provided by the SATMODE system), while consuming very limited capacity, may provide a very flexible and effective alternative.

Yet another area of strategic development that will affect demand for the space segment will be the adoption of more efficient source coding, e.g. MPEG 4 by SDTV platforms. While it is not expected to affect current broadcast platforms, since they have to consider the millions of STBs currently in the field, it may be adopted by new entrants without an existing subscriber base and for specialised applications such as Business TV.

TV broadcasting is expected to continue requiring satellite capacity with performances and characteristics similar to existing systems, i.e. transparent continental or sub-regional coverages in the Ku- and C-bands, with EIRP levels around 47-52 dBw in the Ku-band and 40-45 dBW in the C-band. Additionally, Ka-band broadcast systems, with either regional or local coverage, may be required. Some of this capacity may call for in-orbit multiplexing, as provided by the SkyPlex system.

Satellite operators must adapt their capacity to a very dynamically changing market. Frequently, operational requirements call for additional capacity, the ability to reassign capacity to different regions, or the repositioning of satellites at other orbital locations.

In addition to added capacity and greater flexibility of operation, satellite operators request reduced manufacturing cycles and reduced costs, whilst maintaining or improving overall reliability. These demanding constraints call for a review of the philosophy that is applied in the manufacture of conventional telecommunications satellites. Rather than redesigning each payload module with each order, manufacturers should respond with modular and flexible architectures so that the design can be customised efficiently and reliably.

These general requirements are reflected in the need for the development of larger/modular and more flexible payloads, mainly in the Ku-band, including such items as: high-power amplifiers, linearisers, down converters, beam-forming networks and shaped reflectors, improved flexibility front-ends, etc. New technologies have to be considered for each type of equipment, but especially new modularity and interconnectivity approaches. Furthermore, the industrial approach to the production of telecommunications satellites should be revised and improved.

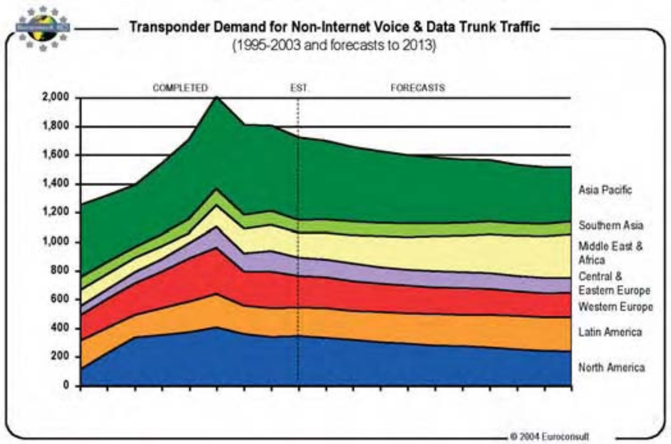
Ka-band broadcasting satellites will probably be dedicated to sub-regional/local targets and are therefore likely to require linguistic or spot-beam systems with medium- to high-power amplifiers. Flexibility will be imperative in these systems.

The accumulation of capacity calls for more powerful and cost-efficient satellite platforms. In the early 1990's the average satellite would carry 20-24 transponders. Today's broadcasting satellites call for capacities of around 40-60 transponders for a given target market (i.e. one quarter of the spectrum available at any Ku-band location). Often these satellites incorporate hybrid payloads covering multiple regions and multiple frequency bands, and therefore demand larger platforms, e.g. NSS 8 carries more than 80 transponders, which implies more than 12 kW of generated power.

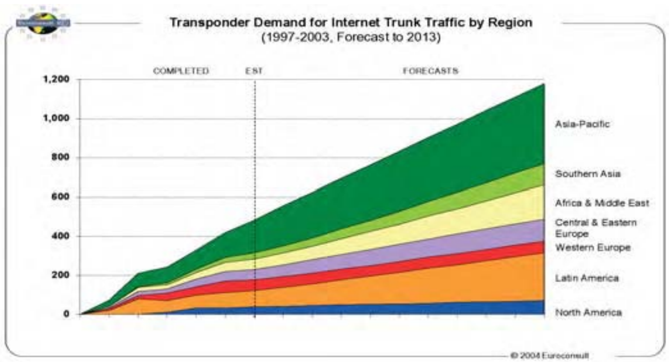
(ii) Trunk Telephony

The demand for traditional non-IP voice and data trunking experienced a clear recession in 2001 after several years of continuous growth. This has now stabilised. Still trunk telephony and data are quite important in lesser-developed areas of the globe, and this demand represents a substantial 1700 equivalent transponders. These transponders are traditionally cheaper, with limited power, often operating in C-band and with a lower EIRP, and are therefore considered a utility rather than a strategic asset by the telecommunications operators.

Given the freeze on investment and the reluctance to add additional fibre-optic capacity to main routes, it is expected that satellites will retain this proportion of the market, especially for lower traffic trunks.



Transponder demand for non-Internet voice and data trunking



Transponder demand for Internet trunking traffic

System and Technology Developments Required for Telephony Trunking

Systems:

Trunk telephony and data have traditionally been implemented on low-power, global-coverage, mainly C-band, transparent transponders. The system architecture is very simple, usually point-to-point, with medium- to high-capacity dedicated carriers between two large stations. In some cases more sophisticated TDMA systems are implemented (i.e Intelsat/ Eutelsat 120 Mbps TDMA standard).

The eventual emergence of satellites with multispot-beam systems may introduce substantial economies in the cost of trunking, which today is dominated by the space segment. This application should therefore be taken into consideration when designing future satellites. Ku-band multispot-beam systems may also be considered for specific regional markets (like IPStar).

Another area of growth will be based on the hybridisation of satellite trunking systems and rural communication systems based on GSM, UMTS, WiFi, etc. The study and resolution of protocol compatibility and efficiency issues must be continued.

Payload:

The changing traffic requirements call for flexibility of interconnection between multiple spot coverage and flexibility in the assignment of capacity. Ideally this flexibility should extend to the antenna subsystem (either through steerable spot beams or reconfigurable beam-forming). Therefore trunking-oriented satellites require the development of more efficient payloads, including front-end flexibility to assign transponders to zones or spots, improved C-, Ku- and Ka-band SSPAs/HPAs, and multispot-beam antennas. Satellite capacities in the region of 50-80 transponders, as for instance on NSS 8, may be required.

Ground segment:

The basic architecture of the trunking network associated with international or national switching nodes is likely to remain as is. Permanently assigned capacity based on digitally switched trunk circuits may be combined with on-demand FDMA or TDMA systems. High-order and adaptative modulation techniques (such as are defined in the DVB-S2 standard) may be adopted by these systems.

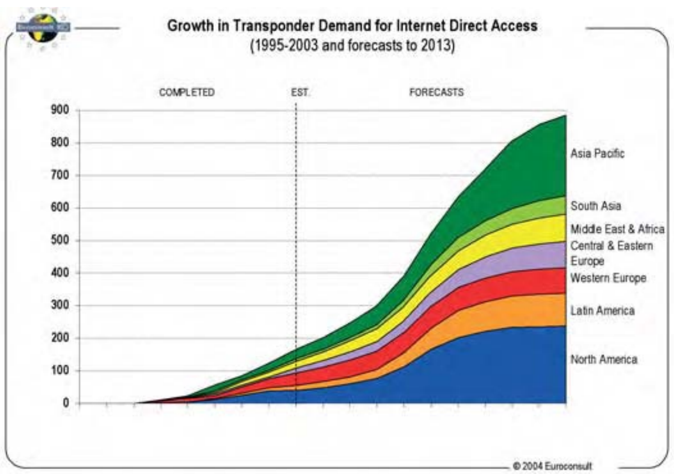
(iii) Internet Trunking

Internet trunking has been the one bright spot in terms of demand for FSS capacity and has saved the day for many a satellite operator. The ability of satellite systems to rapidly provide medium- to high-capacity links connecting remote Internet Service Providers (ISPs) to the core Internet has generated a significant part of the demand, which did not exist at all in 1997.

This demand, which is estimated at around 500 transponders in 2003, is expected to continue growing at moderately high rates, i.e. 10-11%, reaching 1200 transponders in 2013.

System and Technology Developments Required for Internet Trunking

The basic system architecture and physical-layer developments called for by Internet trunking systems are similar to those quoted for non-IP trunking systems. Moreover, the development of caching techniques, edge multicasting, efficiency improvement (e.g. performance enhancement protocols), IP security and IP quality issues will continue to require additional developments.



Projection of demand for capacity for Internet access

(iv) Internet Access, Broadband User, Corporate Communication Systems

This sector of the market constitutes the greatest unrealised potential of the Space Telecommunications sector. Against the promise of a dramatic increase in demand and the planned deployment of an array of new satellites systems (Spaceway, Astrolink, Euroskyway, SkyBridge…) that were forecast in the second half of the 1990's, the reality today is that less than 100 transponders are dedicated to broadband access worldwide.

Some initiatives have been announced for 2004/2005 in the USA and Asia (WildBlue/Anik F2, IPStar). However, perhaps the most emblematic concept, that of Spaceway, has recently been reoriented to broadcasting following the takeover by News Corporation of former Hughes Network Systems interests. More recently, both Echostar and GE Americom have indicated their intention to develop broadband services in the USA. The recent ITT issued by SES- Americom for a full Ka-band multispot-beam system, AMC 17, is particularly significant.

In Europe, most of the effort has concentrated on providing solutions using existing satellite capacity: Aramiska, Tiscali, Satlynx, etc. These initiatives have been partially successful in tapping specific niches in the corporate market, but none of them has achieved the critical mass necessary to trigger large volume demand.

Europe has managed to consolidate an Open Standards approach, based on the DVB-RCS standard, which has been followed up by manufacturers of terminals in the USA, Israel, Korea etc. In this respect, the work of the Satlabs Group, currently participated in by more than 30 organisations and industry, has been a key factor in the drive towards the achievement of interoperability and cost reduction. A major challenge for the European-led effort remains that of overcoming the present dominance of proprietary systems (HNS, Gilat, Viasat), or future DOCSIS-based solutions.

There is no doubt that the emergence and consolidation of broadband access systems constitutes the next frontier in the development of Satellite Telecommunications. This has been reflected in ESA's analysis and in the successive conclusions of Workshops and Symposia the world over. However, substantial barriers remain and it is in this context that the support of public institutions is necessary.

Broadband services are offered today on regular, broadcast-oriented, Ku-band transponders. While this is understandable from the point of view of the satellite operators, who have an excess of Ku-band capacity, the resulting service offering is expensive and not very competitive with terrestrial alternatives. This is clearly demonstrated by the limited take-up in terms of the demand for satellite-based broadband access.

Satellite operators claim that the reason for this slow take-up is the cost of the terminals. However, the latter is only a minor component of the monthly cost of the service, the space segment being the most important factor, especially for genuine broadband, heavy users. While every effort must be made to reduce the costs of user terminals and installation, it is clear that more efficient dedicated space segments should be deployed to enable sustainable solutions.

The provision of non-discriminatory access to broadband services for all regions of Europe is part of institutional EU Policy. It is therefore logical to consider a scenario in which the innovation required to make a success of satellite-based broadband systems will be the result of a public initiative. The successful adoption of a satellite-based solution in Europe is likely to be followed by many other operators and regions around the globe.

Such a scenario is based, in principle, on developing a system dedicated to providing rural subscriber access to Internet

Service Providers, but it can also be used for corporate and small/home office users. The set of user requirements is different in each case.

This initiative has been the subject of an analysis by the European Commission, and the preliminary conclusions are currently being submitted to public consultation[11].

System and Technology Developments Required for Internet Access

Broadband access is the FSS area on which a major proportion of ESA's efforts will have to be focussed, and the Agency has been working in the last few years on practically all of the components of such a system. A major effort is now required to bring these systems to the marketplace. This action has two aspects:

- Promotion of interactive broadband systems and applications on existing satellites. Implementation of advanced solutions: DVB-S2/DVB-RCS with dynamic rate adaptation. Reduction of the cost of the terminals, optimisation of the operations/hub-related costs. Minimising of terminal installation costs. Development of applications.

- Implementation, deployment and operation of a new generation of multispot-beam satellite systems, reduction of the cost of the service, and especially of the space segment.

System definition should be based on identified user requirements, i.e. services (Internet access, IP-based services, LAN interconnection, unicasting, reliable multicasting, etc.), performance (user and network bit rates, availability, QoS differentiation, resource management, throughput control and enhancement, delays) and on operators/system characteristics, i.e. system dimensioning, scalability, multiple ISPs architecture, control of Service Level Agreements at each level, access control, security, etc.

All of these aspects have been considered in the preparatory projects that ESA has carried out: Euroskyway, Domino, AmerHis, Web/West, and DSL in the Sky. All of them are based on Open Standard DVB-S, DVB-S2 and DVB-RCS.

Payload: New capacity based on a multispot-beam system with flexible Ka-band payloads, frequency reuse with and without onboard switching. Major technological developments associated with antennas, front-end HPAs and processors.

Ground segment: Network Control Centre, gateways and DVB-compliant user terminals.

The demand for FSS services is expected to show moderate growth over the next few years. Since there is an excess of capacity, it is unlikely that this demand will be reflected to the same extent in new orders to industry.

In the medium term, the demand cycle will resume and new satellites will be ordered. It is fundamental to maintain the competitiveness of European industry: improved performance, higher reliability, and especially more flexible C- and Ku-band payloads will be necessary. Larger platforms will be needed. Additional efforts on system aspects and ground-segment developments are also necessary.

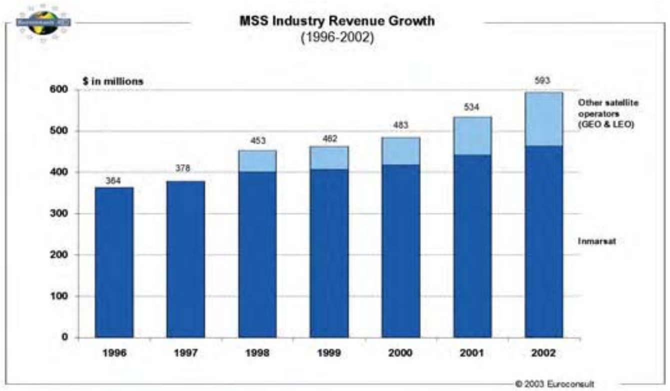
The industrial process associated with the production of telecommunications satellites should be reviewed to improve flexibility, reliability and efficiency and to reduce non-recurrent costs and delivery times.

Broadband services in general, and broadband access to the Internet for private customers in particular, offer the most promising opportunity to reinvigorate the Satellite Telecommunications sector. The evolution in the demand for broadband access expects 327 million homes to be reached by 2008. Present penetration (mid-2004) is around 100 million homes. There is an important opportunity to ensure that satellite-based solutions take a significant proportion of this market, and at the same time satisfy a social need: namely, the provision of broadband access to the Internet and corporate communications for rural communities in a sustainable manner.

To achieve this goal, the cost of all components of the broadband access service must be substantially reduced, i.e. terminals, hubs, installation, customer support, and especially the space segment. The most important component, and where ESA action would be more justified, would be in facilitating the introduction of a new generation of Ka-band multispot-beam, large-capacity satellite systems.

Given the general economic outlook, a public-led action is required to facilitate the deployment of such multispot-beam Ka-band systems. Such an initiative should be based on an Open Standards approach, i.e. the DVB-based family. This effort would open the way for a new cycle of growth in the Satellite Telecommunications sector.

A potential scenario for this initiative could combine the use of the AlphaBus platform with payloads provided by the satellite operators. This infrastructure could be combined with a public action to address the resolution of the Digital Divide in Europe.



Mobile Satellite Service industry revenue

THE EVOLUTION OF MOBILE SATELLITE SERVICES

Mobile Satellite Services (MSS) have moved from the hype and then the crisis created by the fiasco subsequent to the deployment of the LEO constellations (Iridium, Globalstar) into an epoch of realism, which is not in contradiction with the introduction of new services with better performance.

On the whole, the reference Mobile Satellite Service operator, Inmarsat, has consolidated its dominant position. The revenue of the whole MSS sector is close to 700 M$, which is approximately one tenth of the revenue produced by the FSS market. Of this, 75% is accrued by Inmarsat (504 M$ in 2003), the rest being regional systems: Aces, Thuraya and what remains of the LEO constellations.

Today, there are more than 1 million satellite mobile terminals, while in 1995 there were just 200 000, which represents a cumulative 26% growth rate.

Inmarsat, Aces and Thuraya have evolved slightly differently in terms of services. While Aces and Thuraya have so far concentrated on the provision of GSM-like hand-held telephony services in their specific regions, Inmarsat has pushed for higher performance data services by means of their so-called Broadband Global Area Network (BGAN) service mentioned above. In the meantime, Thuraya has announced a higher rate service at 384 kbps called M2Sat.

The required improvement in service performance in terms of user bit rate, terminal size, quality of service and total system capacity has led in all cases to GEO multispot-beam satellites operating at L-band, with spectrum switching and onboard connectivity.

ESA has supported some of the developments that have made Inmarsat IV a reality, e.g. front-end multibeam design, routing and beam-forming processor, air interface, ion-propulsion evolution for Eurostar 3000, etc. Furthermore, ESA is actively supporting the development of Inmarsat IV-based services, i.e. the enhanced BGAN project, which addresses the provision of services to maritime aeronautical and land mobile vehicles and develops additional features.

An interesting initiative originated in the USA is that of Mobile Satellite Venture (MSV), which has received FCC authorisation to deploy a system allowing the reuse of satellite frequencies by terrestrial repeaters. The vision of MSV is to make the satellite system so powerful that it would be resilient to the successive generations of services and user terminals.

There are also other initiatives taken by regional FSS operators to incorporate limited L-band capacity into their satellites to complement their service offerings (Loral's Solidaridad, Koreasat and possibly Eutelsat).

The development of UMTS-compatible services via satellite remains an unrealised promise. No operator has indicated, up to now, their interest in providing an overlay that would allow the extension of UMTS services beyond the coverage provided by the terrestrial deployment. This should be a source of concern for the satellite community. The loss of the UMTS contiguous frequency bands (Core S-UMTS, 1980-2010 kHz and 2170-2200 MHz) will represent a serious opportunity that can be missed by the satellite community. Recent CEPT decisions reassigning the Extended S-UMTS band (2500-2520 MHz, 2670-2690 MHz) to other services are extremely negative for satellites. For the time being, the Core S-UMTS band assignment remains, but for how long?

A possible approach to preserve these assignments would be to facilitate the deployment of S-UMTS-compatible systems using a piggyback payload on an already planned commercial satellite.

Other mobile initiatives worth mentioning address the provision of contents and interactivity to various forms of public vehicles: ships, trains and airplanes. Of these, the most advertised is Boeing's Connexion, which is designed to provide some form of broadband connectivity to passengers using capacity on Ku-band satellites. EADS appears to be developing a similar system called 'On Air'.

In general, mobile services have now consolidated around traditional GEO satellites. Future systems are likely to require more capacity and higher throughput, reducing the overall cost of the service. In this respect, the deployment and eventual success of Inmarsat IV will pave the way for a new generation of multispot-beam systems.

Although the deployment of non-GEO solutions is currently not envisaged by most commercial operators, there are regions of the World where the reception from GEO systems results in unsatisfactorily low elevation angles. Highly inclined orbits as used by the Russian Molniya system should be evaluated as a function of the potential user's requirements.

System and Technology Developments Required for MSS

Analysis of the requirements of the different services, and their impact on the design of the air interface, particularly the physical layer, should receive major attention. These developments should be carried out in the context of multilateral relationships with operators, space industry and terminal manufacturers. Support to standardisation should also continue.

System requirements, in terms of performance and capacity, drive the technology requirements, which call for larger antennas, additional frequency reuse and greater satellite capacity, which in turn demands larger onboard processors. Flexibility of configuration is a key requirement, while it would also be desirable to incorporate UMTS services compatibility into the design. This is to be complemented with core technologies applicable to the user terminals: ASIC development, L-band, and S-band RF front-end optimisation, receiver optimisation, protocol stack and associated ancillary developments such as memory and power management.

In addition, the programme should support specific developments required by niche markets. Examples of these are the aeronautical community for Air Traffic Management and Control, search and rescue packages, or messaging systems.

Dual-use technology needs to be considered, including RF or optical-relay systems to aeronautical or maritime vehicles. The emergence of security- driven mobile communication systems requires special attention, as well as broadband access from airplanes to satellites using higher frequencies, Q/V/Optics.

THE EVOLUTION OF DIGITAL BROADCASTING TO MOBILES: FROM DARS TO SDMB

So far, the most successful satellite communications story of the 21st Century is Digital Radio Broadcasting. By offering about 100 channels of high-fidelity, CD-quality sound, via subscription services to receivers mounted on cars across the USA, XM Radio topped 4.4 million subscribers in June 2005, which in principle should produce revenues of more than 500 M$ per year. The rival system, Sirius, which basically targets the same market although with a different approach to the satellite

MSS is an important sector of the Satellite Telecommunications market. The competitiveness of European industry, which has been well established, must be reinforced by continuous support to the development of existing and future services. ESA must therefore continue its strategic support to the industry in all segments of the business: space, ground, and operations and applications.

This action should be mainly reflected in the continuation of key technological developments both in space - MMICs, onboard processors, antennas, etc. - and on the ground - ground infrastructure such as terrestrial repeaters, and user-terminal technology, RF front-ends, receiver ASICs, etc.

In a competitive and mature mobile market, it is probably not up to ESA to propose operational system deployments, i.e. new system initiatives should be framed in the context of user/market-driven demand, with consensuses achieved in appropriate forums. ESA should nevertheless continue to support industry-led initiatives on the development and eventual qualification of mobile system concepts, for both GEO and non-GEO systems, and specific technology-related items such as large antennas, SSPAs, beam-forming networks, processors, etc. and the associated user terminals.

In addition, ESA should review the applicability and synergy that would result from the employment of dual-use technology.

system, had achieved more than 1.8 million subscribers by June 2005. The market, developed in cooperation with car manufacturers, is far from being saturated as the healthy quarterly growth figures show (1.2 million new XM subscribers in the first half of 2005).

On the other hand, following a very different business model, World Space initially relied on a free-to-air service to Asia, Europe, the Middle East and Africa through two geostationary satellites, AfriStar and Asia Star. Revenues generated by the radio broadcasters came from advertising, public subsidies or a combination of the two. Late in 2002, World Space decided to launch a subscription-based business model.

It is important to emphasise that World Space, besides being the pioneer in the conception of the services, is also responsible for the proprietary technology that is part of XM Satellite Radio. Furthermore, the linkage of Alcatel to both WorldSpace and XM has guaranteed that the very powerful payloads that are intrinsic to DARS systems are delivered by Alcatel Space, i.e. to a large extent it is European technology that is powering the success of Digital Radio by Satellite.

The success of the DARS systems, especially in the USA, clearly defines two main avenues of evolution:

- Geographical extension: i.e. exporting the same or equivalent business models to say Europe. Unfortunately, the only company that announced its intention to provide such services in Europe, Luxembourg-based Global Radio did not manage to attract sufficient interest from investors, in a difficult economic environment, and filed for bankruptcy in April 2003.

- Service extension: i.e. incorporating a combination of multimedia products in the delivered streams. This extension may be conceived in combination with the possibility of adding hand-held third-generation UMTS terminals to the car-mounted receivers. This concept has been given the generic name 'Satellite Digital Multimedia Broadcasting, or SDMB'.

The SDMB concept has been proposed in Europe by an Alcatel-led team of companies, with the necessary preparation in terms of the optimisation of the main system trade-offs: capacity vs. availability, direct reception vs. terrestrial repeaters, and hand-held vs. car-installed terminals. These activities are taking place under several ESA and EU contracts.

In the meantime, a joint Korean and Japanese initiative has taken a step forward with the launch of a dedicated SDMB satellite, MBSAT, in March 2004. A service consisting of 11 video channels, 25 audio channels and three data channels has been initiated in Korea, while the Japanese offering consists of 30 audio, 7 video and 60 data channels. As far as terminal providers are concerned, Samsung and Toshiba form part of the venture.

System and Technology Developments Required for Broadcasting to Mobiles

System: Continuation of major system trade-offs around the canonical Contents Delivery Architecture. Identification of major parameters: Service-provision model, system capacity, target markets, service categories, user-terminal configuration, propagation analysis tools, network planning tools, etc.

Payload: High-power payload to address the lack of user-receiver antenna gain and penetration margins. Shaped contoured-beam antenna to discriminate various linguistic markets, with onboard multiplexing to allow independent contributions from broadcasters.

User terminal: The main scenario assumes the delivery of contents to satellite-enabled UMTS terminals. Other models of reception, i.e. private cars and collective transport, will be considered.

Terrestrial-repeater development will be required to complement the coverage mainly in urban areas.

SDMB constitutes a very promising area of growth. European industry has been involved in the success of the USA initiatives (mainly XM Radio), but so far there is no similarly successful European initiative.

The evolution of these services towards multimedia broadcasting in a European context should constitute a major area of innovation to be supported by the ESA R&D programme.

ESA should continue the necessary preparation of the SDMB system in partnership with the European Union, involving system analysis, technology developments and eventual support to in-orbit demonstration of these services.

Satellite Telecommunications and Security

The Satellite Telecommunications market has another important component, which is the utilisation for security and defence purposes. The distinction between civil and military systems becomes ever more blurred. We can distinguish two components of this market: the use of civil satellite capacity by the different security and defence institutions and, at a different level, the deployment and use by the different strategic groups of a dedicated infrastructure of military telecommunications satellites.

(i) The use of civil capacity by the military has grown dramatically during the last five years. Bandwidth usage tends to multiply with each new intervention. The Iraq campaign in 2003 used 800 times more bandwidth than Operation Desert Storm in 1991. All available capacity on military networks has essentially been used, and substitute commercial capacity has been sold at record rates.

Of course, the requirements of these systems are akin to equivalent civil system architectures. IP trunking is much used, while VSAT networks are employed in a number of configurations. The utilisation of mobile systems (Inmarsat, Iridium, Globalstar and Thuraya) has also increased many fold.

It is not easy to infer specific requirements from the security utilisation of commercial satellite systems, other than the introduction of added security features in the earth stations, e.g. encryption. In as much as the satellites have been deployed with civil applications in mind, their features are determined by these requirements.

Normally it is not easy to move satellites from their assigned orbital positions in order to address security/defence crises. However, the availability in some systems of steerable spot beams with programmable interconnectivity to the main feeder links provides an efficient solution to the problem of assigning capacity to hotspots.

(ii) A more important quantitative and qualitative component of the defence market is the specific capacity dedicated to military systems. This segment is usually differentiated by its special requirements involving the use of the X, UHF, SHF and EHF frequency bands. However, some initiatives have been directed towards the provision of satellite capacity in the X-band to defence institutions on a commercial basis (e.g. XStar launched 12 February 2005). The requirements for these systems call for the ability to deploy the satellites in different theatres of operation, i.e. repointing antennas or even repositioning the satellites. TTC systems have to be protected and their components must usually be radiation-hardened.

The trends in the architectures of these systems are not very different from those applying to commercial systems: smaller user antennas, combined with higher bandwidth requirements, call for multiple spot beams. The ability to reject enemy-induced interference calls for sophisticated nulling antennas. Onboard processors of various sorts allow dynamic allocation of connectivity/bandwidth between the different spot beams. More specifically, various types of ISL are required.

In 2003 the US DoD announced[17] the concept of a networked military infrastructure called the Global Information Grid (GIG). The objective of this grid is provide dynamic communications with any object/element that may have either strategic or tactical value. The stated purpose is to bring the power of the Internet to the defence forces. In other words, every piece of material, every soldier or agent must have its own IP address. If an object is not addressable, it is probably not relevant. This philosophy is reflected in the allocation by the US DoD of 17 B$ for the so-called Transformation Programme. The major part of this Programme will be a new generation of communication satellites, with a budget of 8.7 B$. This policy has also transpired to the European allies of the USA.

This large and sustained effort, and the continuation of already initiated programmes (DSCS 3, WideBand Gapfiller, Advanced EHF and related SBIRS High and Navsat), will further reinforce the technological advantage that US manufacturers enjoy with respect to their European competitors.

The use of space-based systems to complement and enhance security systems is fully consistent with European Policy, as stated in the resolution of the European Council of November 2004. Security applications will have greater relevance in the forthcoming cooperation between ESA and the EU. This need has been highlighted in the Report of the Panel of Experts on Space and Security (SPASEC)[18]. The assessment by this Panel calls for a set of high-level requirements in the telecommunications area, namely:

- Worldwide coverage
- Secure connectivity
- High-data-rate connections
- Interoperability, and
- Multimedia and traditional services.

The reality today is that the European space investment in defence-related space systems is both modest and very fragmented. There is a need to rationalise the activities of different national entities to complement each other's capabilities. The recent initiatives related to military telecommunications systems in Spain (SpainSat, XTAR), in the UK (Skynet), in France (Syracuse) and in Italy (Sicral) demonstrate how fragmented the European approach is[19].

An analysis of the overall European space-based defence capabilities reflected also in Reference 19, foresees the need for a 9 BEuro investment, 3150 million of which corresponds to the Telecommunications component. This forecast assumes that the telecommunications programme would last for 15 years and involve an expenditure of 210 MEuro/year.

In this context, it is clear that preparation of the technological capabilities of European industry for this is both a strategically and an economically important component and must constitute a key element of the TLTP.

(Dual-use) Technology Requirements from Security-orientated Systems

Communications security: Encryption, anti-jamming systems, selective reception (multispot-beam systems, digital beam forming), onboard processing. It is applicable to fixed and mobile services on existing commercial bands, and could be extended to the X, UHF, EHF and SHF bands.

System survivability: Protection, radiation hardening, network reconfigurability.

The support of the US DoD for the development of telecommunications systems and technologies will surely increase the advantages that US manufacturers enjoy today over their European counterparts.

It is necessary to ensure continued and reinforced public support for the Satellite Telecommunications programme, without which European Industry will soon be unable to compete.

ESA and its Member States should contemplate the explicit inclusion of dual-use technologies in the Telecommunications Programme. These technologies satisfy a social need, meet a market necessity and sustain the strategic capabilities of European institutions.

ESA should favour the technological innovation that is necessary to endow European Industry with the capabilities required to address the needs of the European defence institutions.

Evolution of the Needs for Satellite Telecommunications Platforms

Evolution of demand in terms of platform power requirements

Power requirements of recent satellites

The success of European industry on the global communication satellite market prior to the market downturn has been largely associated with two commercial platform product lines, the EADS Astrium Eurostar family and the Spacebus series by Alcatel Space.

Full market recovery is anticipated by 2006 based on the need for renewal of the global satcom fleet, representing more than 100 satellites at end-of-life between 2006 and 2011. Although the bulk of satellite orders are anticipated to be in the small to medium satcom range, the trend over the last two decades towards greater mass and power is ever present.

The contraction of the market sector has also resulted in a consolidation of satellite operators. It is anticipated that large and mature global operators will tend to extend their capacity in key orbital positions with fewer satellites, grouping services from several previously co-located spacecraft. The markets will furthermore require flexibility and adaptability on the part of the major European platform manufacturers in order to maintain market share against US competition – in other words, being able to offer the full range of satcom products from low, medium to high power to match the global competition.

The evolution in the mainstream market sector for medium- to high-power commercial platforms is shown in the accompanying graph.

Boeing has developed three platform lines: the Boeing 376, 601 and 702. The Boeing 702 is the sole product available on the global market to meet the demand for satellites accommodating payloads requiring powers above 12 kW. At the time of its introduction in 1995, the Boeing 702 incorporated advanced technologies covering Xenon ion propulsion, Ni-H_2 batteries, solar arrays based on dual- and triple-junction GaAs cells, deployable radiator panels and solar-array concentrators. Controversially, the latter technology caused excessive in-orbit degradation of the solar-array output and was the main cause of a setback to Boeing 702 product confidence following its initial successful introduction onto the market, with nine satellites contracted between 1998 and 2003.

The Boeing 702 product has matured since then, accumulating in-flight experience and applying lessons learned to new orders. Boeing now has a total of 16 firm satellite orders on its books, as well as 6 options, and is the uncontested leader for high-power bids.

The Lockheed Martin A2100 product line was first launched in 1996 and also has a proven track record, with 29 platforms sold and 22 satellites in orbit. Today the accommodated payload power is <11 kW, but the A2100 design is very modular and the industrial capability exists to improve the product for the 14 -16 kW range within an estimated period of two years.

Space Systems Loral's workhorse is the FS-1300 product line, with an accommodated payload power of up to 12 kW. Similar to the LM A2100, the size and capabilities of the 1300 can be expanded to handle payloads requiring 14 - 16 kW. Space Systems Loral has announced a new platform known as the 20.20™, with total satellite powers in the 17 - 30 kW range.

If Europe hopes to remain in the same league as the US competition, there is a need to fill the gap in the European product range and at least match both existing and latent US industrial capabilities in the high-power satcom range. The market niche for large high-power satcoms left a market share estimated to be greater than 4 BEuro to US manufacturers in the period 1998 to 2003.

History shows that large global FSS/DBS operators traditionally push satcom manufacturers to the upper limits of their product capabilities. The consolidation of satellite operators will lead to global operators who manage large fleets. The need to optimise fleet size and reduce operational costs will continue to create opportunities for large high-power satcoms in the FSS/DBS sector.

Power requirements and antenna-accommodation constraints push the geo-mobile and broadband sector towards large high-power satellites. Before the market downturn, 80% of mobile and broadband projects were based on the largest existing satellites.

Operators, investors and insurers have, however, become more apprehensive regarding the risks involved in the procurement of large advanced-technology satellites. Ground-based qualification is regarded as insufficient, and today's bids will require evidence of in-flight heritage and in-orbit demonstration of new technologies. Market recovery in these sectors will give US satcom manufacturers the competitive edge based on their capabilities and proven flight-demonstrations in the top-end market sector.

The previous Long-Term Plan (2002-2006) was conceptual and paved the way for the development and in-flight demonstration of a large European platform. Following a two-year preparatory phase, the main industrial development of the platform proper, called AlphaBus, has become a core element of the new Long-Term Plan (2005 - 2010). In the meantime, solid commercial and industrial production agreements exist between EADS Astrium (F) and Alcatel Space (F) to market AlphaBus as one common and unique product for Europe to compete in the top-end sector.

These agreements fit with the Agency's strategy, in cooperation with CNES, of avoiding the dispersion of the limited institutional R&D funding, and to direct support to the established European platform manufacturers in those areas where they are most vulnerable in the global competition with US industry.

In the medium-power range, there are several competitive European products. This competitiveness will be maintained through upgrade programmes supported by ESA. EADS Astrium and Alcatel Space will continue to offer the successful Eurostar 2000+/ 3000 and Spacebus 3000/4000 product lines. Both companies have embarked on programmes to extend their capabilities up to 12 kW, beyond their present 10 kW payload-handling qualification. Thereafter, the physical limitations of the basic design create an insuperable barrier.

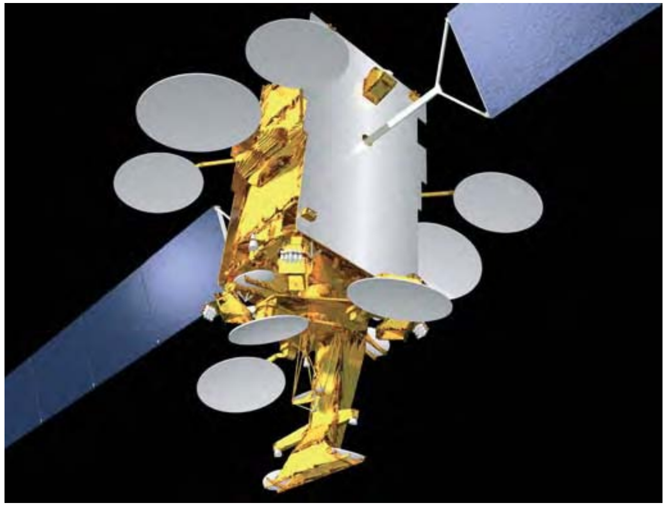
The merger between Finmeccanica – the parent company of Alenia Spazio – and Alcatel Space is expected to initiate a consolidation of the European satcom line, particularly for the 3 to 6 kW payload power range.

Niche markets will continue to exist for small platforms requiring <3 kW, for instance to support small scale start-up initiatives, localised services or, following a recent trend, to fill allotted satcom slots.

The small satellites market attracts a healthy diversity of smaller companies mainly from outside Europe, but in general their business so far has been outside the mainstream commercial playing field dominated by large operators.

In fact, European industry has been virtually absent from the small GEO telecommunications market (i.e. under 3 kW), for the last few years: the last European product in this range was the launch of NILESAT 102 with the Eurostar 2000 Platform in 2000). Most open commercial sales have been achieved by US manufacturers (Boeing 376, and Orbital Sciences Corporation STAR). The rest of the competitors appear to be associated with national initiatives and have not sold their products outside their countries of origin (Russia's YACHTA and Express, Israel's AMOS and ISRO).

Of the 178 satellites currently deployed by the top 20 main satellite operators (ranked by revenue), only four have been manufactured by Orbital, while the rest are products of Alcatel, Astrium, Boeing, Loral and Lockheed[20]. Currently, there are 20 active satellites based on the Boeing 376 platform, but only four of these have been deployed since 1999. It is interesting to note that three of these four were acquired by European operators (Astra 2D, Astra 3A and Eutelsat e Bird 1).



AlphaBus

In summary, we can conclude that there is a relatively important market segment for small satcom satellites, probably in the range of one to three units per year. These could be strategically important in favouring the emergence of new services or new operators, or in addressing very specific needs in regional and national markets.

European industry may generate synergies with platforms intended for other space applications and thereby gain access to the commercial satcom market. It is therefore desirable to evaluate the possibility of stimulating the emergence of European products in the small-platform range.

The in-flight demonstration of the new AlphaBus platform is key to the success of this common industrial and institutional approach. It will provide operators, investors and insurers with the confidence that commercial bids based on the AlphaBus platform are founded on a sound policy of risk mitigation through in-orbit demonstration, and will create an equal playing field vis-a-vis US competition.

The new long-term plan caters for in-flight demonstration through various alternatives: utilisation of the AlphaBus platform within the original Alphasat mission concept of the 2002- 2006 Long-Term Plan, or utilisation in support of the Digital Divide initiative, likewise as part of the new technology-demonstrator mission of the new TLTP.

Europe is well-represented in the small- to medium-size commercial satcom product range. These products will continue to be improved through the technology components of the TLTP.

Despite the market downturn, the long-term trend towards greater mass and power remains. The established European platform manufacturers are vulnerable in the global competition due to lack of a European equivalent to US high-power satcom capabilities.

The industrial agreement to develop and commercialise one unique European platform for the high-power range allows a focused R&D effort in the new TLTP and the best use of public funding in this highly competitive field.

ESA's contribution is a key element for the industrial restructuring at European level, ensuring long-term partnerships between equipment providers and primes for a commercial product undertaking with the first introduction to market in 2006.

Furthermore, ESA must review the feasibility of supporting the development of small platforms to address the deployment of new services, and the requirements of emerging operators.

3

Space Segment Industry

The overall turnover of the European industry in 2002 was 4.7 BEuro, employing 33 254 people.[3]

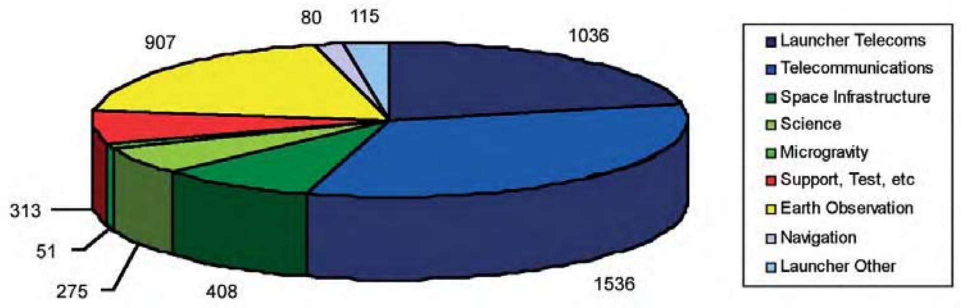
The relative value of the direct Telecommunications sector relative to the overall turnover of European Space Industry is 32.5%, or 1536 MEuro. If we take into account that Telecommunications supplies close to 90% of the launch business (1036 MEuro), the overall impact of this segment exceeds 54% of the total activity. These figures, which are the latest consolidated by Eurospace (January 2004), correspond to a year in which the Telecommunications activity was reduced due to the general crisis.

In summary, we can safely state that Satellite Telecommunications drives more than 50% of European Space Industry.

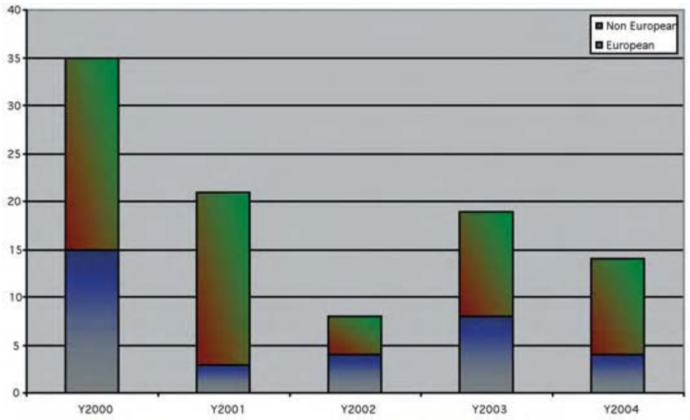
In 2000, a total of 35 commercial telecommunication satellites were ordered worldwide. Of those, the European primes were able to secure 15 orders, which actually represented 52% of the value contracted.

As a consequence of the excess of supply and the crisis in the demand, 2001 and 2002 were much worse, with 21 orders in 2001, of which three went to European primes, and just 7 orders in 2002, of which four went to European primes.

Industrial Situation



European Space Industry by sector



Number of satellites contracted per year to European and non-European primes[20]

The market appears to have rebounded to certain extent in 2003, with a total of 19 new satellite orders placed:

Alcatel:	Koreasat 5, HB 7R, RASCOM 1, STAR ONE
Astrium:	Anik F1R, HB 8, Arabsat 4A and 4B (platform and payload from Alcatel)
Lockheed:	JC Sat 9, Astra 1KR, Echostar 10, AMC 14
Loral:	DirecTV 8, DirecTV 9S, Galaxy 16
Boeing:	Measat 3, XM 4
Orbital:	Optus D1 and D2.

The combined value of European prime participation in 2003 was approximately 40% of the value of the total manufacturing market, which represents a good level of competitivity, although far from the record achieved in 2000. Seven of these orders do not constitute growth in demand, but the replacement of capacity previously lost either during launch or in orbit. On the other hand, in a market with very limited demand, the competition between manufacturers has been so fierce as to drastically reduce the profit margins on each of these contracts.

2004 was again a modest year for European Industry, with just four new orders. However, the results for US Industry may be distorted by the fact that they incorporated the order for five Rainbow Ka 1-5 satellites from LMCSS, which have been cancelled in the meantime[20].

The penetration by the European primes has been achieved in a market where the relation between the USA Dollar and the Euro is extremely unfavourable to European manufacturers. On the other hand, the ITAR policy maintained by the USA implies not only barriers and dependence on US approval procedures, but also a strong incentive to guarantee technological independence on key space equipment.

Even if these figures appear a bit brighter, the fact is that the prospects are not very positive in the long term. Assuming a global market of between 15 and 20 satellites per year, it is difficult to imagine Europe being able to capture more than 30-50% of the total.

An immediate consequence of the contraction in the demand for satellites has been the consolidation of the operations of Alcatel Space and Alenia Spazio into a single entity. This trend of consolidation not only applies in Europe, but has also occurred in America. However, the importance of and resources dedicated to other space activities in the USA allows the sustainability of multiple suppliers.

European industry has US industry as its major competitor. However, it is not possible to overlook the fact that the support provided by institutional programmes to space industry is much smaller, both in absolute and relative terms, in Europe than in the USA. (A full account of the prospects for and competitiveness of European vs. USA industry can be found in Reference 21).

The total size of the European space sector, with sales of around 4 BEuro in 2003, is 5 times smaller than its US counterpart, with 21.5 B$ in sales.

Total space, MEuro	***USA***	***Europe***
Government Civil	*8640*	*2025*
Government Military	*10 900*	*547*
Commercial	*1975*	*1202*
Total	*21 515*	*4034*

Table 3. Total of space manufacturing in USA vs. Europe in 2003[21]

The European industry's commercial revenue (mainly telecommunications satellites) represents a much higher proportion of the total sales than is the case for US industry. The crisis in the Telecommunications market is therefore hitting European industry much harder than in the USA.

Thanks to the institutional support provided by ESA and national programmes, the commercial markets have almost single-handedly supported the European space capabilities. The production of satellites and launchers for the commercial market today supports today about half of European space activities.

US manufacturers lead the market. This leadership is reflected in their share (even if Europe has reached 30-40%), but it is much more significant in their technology edge. US manufacturers have and will continue to exploit the competitive advantages obtained through their much larger institutional and military programmes. This is even more important when considering the long-term impact of the strategic development programmes currently envisaged by the DoD.

To introduce new technology is a must. However, changes in insurance policies and the consolidation of Private Equity Investors as major shareholders in most satellite operators have underlined the need to have new technology demonstrated prior to its commercial deployment. This need implies the inclusion in the ESA programme of the provision for mission opportunities for embarking demonstrations and qualifications of new technology. Risk-reducing activities must be understood in their widest sense, involving components, equipment, subsystems or even a full end-to-end value chain. ESA should address this risk-mitigating function in a timely fashion, so that it is compatible with commercial developments.

ESA must continue its support to the competitiveness of European Industry, with more dedication than ever. ESA's efforts should focus on technological innovation and the generation and promotion of new commercially driven services that can support the industry and initiate a new cycle of growth. The market must drive their focus. In the context of defending the competitiveness of European industry, it is of no use to develop products that would not sell. While commercial rationale should be behind each of the ESA-supported initiatives, it is necessary to provide a framework in which long-term developments and a capacity qualification infrastructure are incorporated into the programme.

Space segment industry is particularly interested in the development of new systems, equipment and technologies as a mechanism for innovation and growth. A new round of technological drive must be supported to maintain the long-term competitiveness of European Industry: ideally this should be brought to commercial demonstration.

Satellite operators, on the other hand, are very reluctant to introduce unproven equipment into their satellites. ESA must act as catalyser of initiatives that allow innovation to be brought to operational status with acceptable risk.

A fundamental part of ESA's role in relation to satellite industry must be the provision of a technological-demonstration infrastructure that will allow the implementation, deployment, qualification, testing and eventual operation of innovative equipment, subsystems, systems and applications.

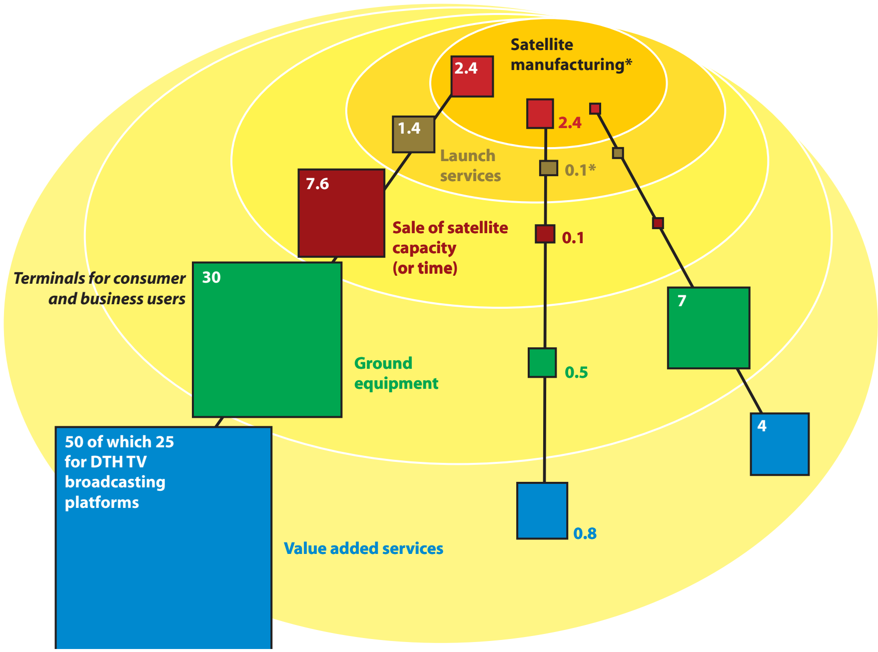
Europe must maintain strategic independence in Satellite Telecommunications: this is not only motivated by the commercial and economic importance of the sector, but also the impact that it has on other critical components of the European Space Strategy.

The main lines of action in the ESA programme should be:

- *Sustain technological programme and maintain competences and technical excellence.*
- *Favour market-driven initiatives.*
- *Develop technology in-orbit-demonstration opportunities.*
- *Support the deployment of new systems and services, including such specific systems as Multispot Ka-band and L-band with OBP.*
- *Support infrastructure elements, i.e. small and medium-sized platforms.*
- *Reinforce strategic vision on the Large Platform initiative.*
- *Reinforce strategic independence with an ITAR-free policy.*
- *Provide strategic support to conventional payloads, i.e. generic, Ku-band, and C-band.*
- *Support a programme for the industrialisation of satellite production.*
- *Support competitive provision of equipment.*
- *Develop a programme for dual-use technology.*

User Segment and Applications Industry

Here User Segment and Applications refer to the set of equipment functions and value associated with the utilisation of satellite systems by the end user. Both the User Segment and the Applications constitute key components of the satellite-services value chain, which exceeds several times in value the cost of procuring and leasing the space segment, as shown in the accompanying figure for the three major areas of commercial utilisation of space. This is also reflected in Reference 5.



Value chain (billions Euro) for the three major commercial satellite applications in 2002
(Source Euroconsult, ESA Industry Days, November 2003)

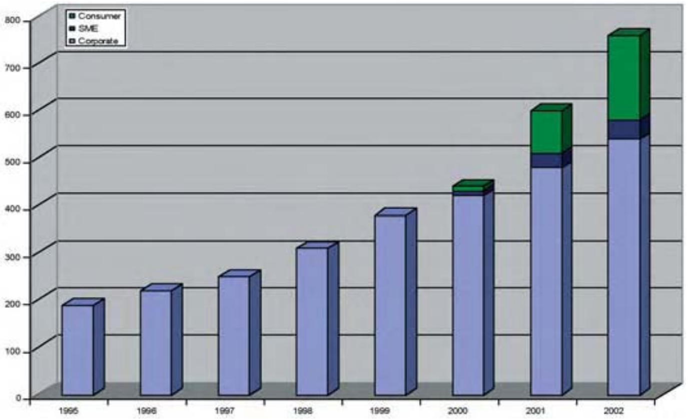
This figure shows that while the volume of business produced by the lease/sale of satellite capacity is around 7 billion Euro per year, the business around terminals exceeds 30 billion Euro and the revenue accrued from the sale of services reaches 50 billion Euro.

It is even more significant that while the value of the space component of the Telecommunications value chain is expected to grow only moderately in the next five years, the value of final user services and applications is expected to increase by 3-4 times by 2010. It is therefore paramount to ensure that European Industry is able to reap the economic benefits of this most important segment of the satellite telecommunications value chain.

The User Segment embraces the market associated with satellite terminals. For the FSS and DBS segments, it can be divided into three componen

- Professional Satellite/Service Operator Stations: The global professional User Segment market (including all applications, such as Science, Earth Observation, etc.) is estimated to be worth 1.7 billion Euro per Year. The Telecommunications component of this market is approximately 83% or 1455 million Euro. The European share of this market is approximately one quarter of the total[4].

- Interactive User Terminals (VSATs, DVB-RCS SITs, etc.): The total value of the interactive terminals market is around 400 million Euro. The total number of sites in service is currently around 800 000, while it is important to emphasise the up-surge in consumer and SME installations (COMSYS 2003) in the last years. The majority of these systems and terminals are sold by non-European manufacturers, such as Hughes Network Systems (53%) and Gilat (36%). European DVB RCS systems account for 2-3% of the total sales[22].



Growth in the deployment of interactive terminals: Number of sites in service x 1000 (VSATs and broadband)

Notwithstanding the dominance of US and Israeli companies in this market, the European approach, based on Open Standards, seems to be triggering a much wider interest that current market penetration indicates. The Open Standard approach, based on DVB-S, has been fundamental to the development of Digital TV. Several satellite-operator ventures addressing large number of users consider Open Standards to be the key to guarantee competitive provision of terminals and services. Therefore ESA's support to this strategic line must be maintained and reinforced, especially when considering the emergence of the spectrum- and power-efficient DVB S2 version of the standard.

- The third component of the market i.e. Digital TV user terminals, has a volume worth 1.5 billion Euro (5M units/year at 300 Euro/unit). European manufacturers, which include Thomson Multimedia, Pace and Nokia, are very well positioned.

The Agency's support will also be needed in the MSS market. The on-going introduction of BGAN services on the Inmarsat satellites is expected to produce a large market. Other services, especially the eventual emergence of broadcasting to mobiles, will require specific developments.

Applications are understood as the set of end-to-end functions that allow the use the satellite system for a given purpose. In fact, the provision of applications to the end user constitutes the ultimate goal of all telecom infrastructures. Most of the regular applications of satellite telecommunications are triggered by commercial user requirements and do not require any specific promotion by ESA, e.g. Production of TV content, telephony, or generic Internet content.

There are, however, several important groups of applications where ESA promotion/intervention can be crucial to their adoption by the user community. By doing so, ESA stimulates the adoption of new satellite systems, increasing the demand for satellite capacity and providing solutions to meet the citizens' needs. In some cases, ESA's intervention is necessary to trigger the emergence of sustainable business-driven uses of the satellite system. In other cases, the proposed application may not have a purely economic rationale, but may be considered a worthwhile public service.

It is therefore in this context that ESA should continue exercising its capacity to aggregate user needs, with the technical expertise of system/terminals suppliers, to bring about further innovative uses of satellites.

ESA must continue its support to ground-segment manufacturers. This support is intended to cover all elements and services, but it should emphasise the development of user equipment for the residential broadband market.

Additional effort must be dedicated to the consolidation of European products for interactive broadband (i.e. DVB RCS) and narrowband services, and associated developments.

The ESA programme should facilitate the development of present- and future-generation mobile terminal user equipment.

Satellite applications may be primarily commercially/business orientated, but there are also some that are public-service orientated. The development, integration and demonstration of satellite telecom applications constitutes a key component of the ESA programme, in which the following themes are currently identified:

- Telemedicine
- Internet in Public Transport
- Broadband Internet Access Applications
- Interactive TV
- Networking for Satcom and Terrestrial Integration
- Location-based/Automotive Applications
- Civil Protection

Particular emphasis should be placed on support for the implementation of demonstrations of applications to further promote market development.

4

The Telecommunications Programme and Relations with the European Union

The cooperation between ESA and the European Union on telecommunications is a major component of the overall partnership between the two organisations. Both share the common objective of strengthening Europe, its institutions and its industrial capabilities. At the same time, both entities are endeavouring to bring the benefits of space to Europe's citizens.

This common perspective has been reflected in the high-level discussions that have resulted in the consolidation of a common European Strategy on Space, reflected in References 23 and 24.

The coordination of EU and ESA actions on Satellite Telecommunications has two components:

- R&D: Within their respective terms of reference, ESA and the EU coordinate their respective actions, providing each other mutual support and transparency. Specific projects are developed in partnership (i.e. with components funded by ESA and by the EU). The developemnt of a specific thematic initiative by the EU under the 7th Framework Programme foreseen for the period 2006-2013, will be coordinated with ESA's Telecommunications Long-Term Plan.

- Digital Divide: Resolution of the problem of the lack of broadband connectivity experimented by users in less-advanced rural areas of Europe (and other regions of the World) by means of advanced multispot-beam broadband satellites, constitutes a potential area of joint ESA/EU action. This objective has been included in the action plan reflected in the White Paper[24] and it has been the subject of analysis by a dedicated Digital Divide Forum, whose report[11] is currently undergoing public scrutiny. One of the most significant statements of this report is that:

  "The current EU policy framework does not dispose of a direct mechanism to aggregate demand at EU level. However, the Commission's services intend to investigate the feasibility of a pan-European initiative that may bring satellite services at a lower price to those communities where satellite is the only available option."

In fact, the EU supports a substantial amount of deployment of Telecommunications infrastructure. However, since this is exclusively done within the framework of the structural funds at the initiative of local institutions, pan-European satellite-based solutions are generally not contemplated. In fact, there are no 'mechanisms' for considering support by the EU programmes for such infrastructures.

ESA's position is that satellite solutions could be cost-effective and extremely beneficial in providing high-performance telecommunication services to the significant proportion of the population that will not be served by terrestrial (mainly ADSL) means. Specific satellites able to assign resources efficiently to customers should be able to provide sustainable solutions in the medium and long term.

In this respect, ESA will continue to endeavour to develop, within the framework of cooperation with the relevant EU programme, the implementation of a satellite-based Digital Divide solution.

5

Conclusions

Satellite telecommunications is the most important of the commercial space application. In terms of business volume, activity and employment generated it constitutes the most important segment of the Industry. In addition, the turnover generated from the space activity (in Europe, around 2 billion Euro/year in industrial contracts, and nearly 3 billion Euro in transponder leases), the ground-segment delivery and the provision of services and content exceeds that amount by one order of magnitude.

It can therefore be said, without fear of overstating the case, that Satellite Telecommunications is vital to the continuity and viability of European Space Industry. Its health depends not only the actual capabilities to design and built efficient and competitive telecommunications satellites, but also on the related industries such as launchers, where close to 90% of the business is generated by telecommunications-satellite launches, and ground-segment industries.

Satellite Telecommunications knowhow, technologies, and capabilities constitute an important strategic asset for Europe. There is an important synergy between security- and military-related telecommunications satellites and civil systems. Critical technologies substantially overlap. In the USA, the military research and development contracts that American manufacturers enjoy allow them to transfer their resulting technical edge into the civil market. This situation is likely to be much more acute following the recent DoD Initiative on Transformation, which involves the investment of 17 billion $ in the Transformation programme, 8.7 billion $ of which is for new satellite systems.

Europe needs to maintain its technological capability level in order to preserve and enhance the degree of competitiveness achieved so far. Technologies and new services must be developed, demonstrated and tested. Market drive must be a fundamental component of the action, but not the only component: institutional initiatives and strategic thinking must allow for the preparation of a new generation of satellite communication systems.

Satellite Telecommunications has been experiencing the deepest crisis in its history. Cyclic crises are not new to this sector, but the major problem with the present situation is that, in general, commercial satellite operators, which are now in the hands of financial institutions, are very reluctant to accept the risks associated with introducing new technology and services. This attitude will lead sooner or later to stagnation of the well-trodden trunking and broadcast market. It is therefore fundamental to trigger a new virtuous cycle of growth not unlike the one that resulted from the adoption of Digital Television ten years ago.

Therefore ESA, in fulfilment of its charter, should act now. It is necessary to introduce a reinforced version of the Telecommunications Long-Term Plan allowing for a new round of industrial activity. The support of Industry and satellite operators will be requested, but ESA should still be able to act even if the commercial situation does not favour partnerships. Cooperation with other institutions such as the national agencies and particularly the European Union will be called for.

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