The MediaGlobe Concept
– Watch What You Want, Whenever You Want!

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On 3 July 1998, the participants in the Second International SpaceTech* Space Systems Engineering Programme presented to an audience of European space professionals their proposal for an innovative multimedia broadcasting service based on a new information distribution concept. This 'MediaGlobe' concept is a user-oriented 'end-to-end system' that includes new approaches for doing business using the latest multimedia technology. It would facilitate the development of attractive new services and allow Europe to capitalise on its considerable expertise in satellite-related communication technologies. ESA is already involved in the development of high-performance multimedia communications through its ARTES (Advanced Research in Telecommunications Systems) programme, and pursuit of the MediaGlobe initiative would provide European industry with an excellent opportunity for active participation in this booming and highly competitive field.

Introduction

Television is today's single most important mass communication medium and has become an integral part of our society. There are more than a billion households with televisions world wide, but viewers are generally not satisfied with the programming on offer. Despite the ever-increasing number of channels available, there are inherent limitations in the way they are delivered. Television today means 'passive' consumption of real-time programming. The viewer is confronted with a multitude of simultaneously transmitted programmes, from which he or she may choose the one they fancy most at any given moment. The viewer has no further options, other than to use a video recorder. The MediaGlobe concept would revolutionise how we watch television in that it would allow viewers to see the programmes they want whenever they want, putting them in complete control.

All of the elements in the MediaGlobe end-to-end system have been analysed, including the mission architecture, the system verification and implementation plan, the business plan, and the marketing strategy. This analysis has shown that MediaGlobe represents a lucrative business opportunity for both broadcasters and investors.

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* SpaceTech is an international post-graduate programme run by Delft University of Technology, in The Netherlands. It leads to a Masters Degree in Space Systems Engineering, with a strong focus on market-oriented and cost-conscious end-to-end systems engineering. ESA is one of the organisations sponsoring and participating in the SpaceTech programme.

What is MediaGlobe?
MediaGlobe would be the first direct-to-home satellite broadcasting system to offer new digital TV and information broadcasting services where the home user has full control over the content. It would radically change the way in which the home user, equipped with a simple and compact dish-antenna terminal with high-volume data storage, would watch television in the future.

Which services?
MediaGlobe would offer its subscribers a personalised home videotheque and information store that is dynamically updated according to their specific profiles and wishes. At any point in time, viewers would be able to choose from hundreds of movies, live events, and thematic programmes stored on their own MediaGlobe terminal, somewhat akin to a huge video recorder.

The various TV services offered would differ in terms of content, delivery times and pricing. The latest movie, for example, might have a guaranteed delivery time of some 15 minutes, after being ordered from the MediaGlobe service centre via a telephone modem link and received via the next satellite download together with the authorisation code needed to view it.

MediaGlobe would also provide Intranet broadcasting services for direct-to-office and small-office/home-office users, typical applications being business information services, software distribution and catalogue updates to specialised user groups.

To whom is it devoted?
MediaGlobe would allow broadcasters and information service providers to expand their service offerings and thereby reach new customers. On behalf of its partners, MediaGlobe would offer 'television and information on-demand' services to millions of users in Western Europe, Eastern Asia and the Pacific, and Eastern North America.

How does it work?
MediaGlobe relies on three geostationary satellites, each of which would cover one of the three service areas (Fig. 1). Broadcasters and information providers send their contents to the respective MediaGlobe multiplex- and up-link stations, where the programme suite is assembled and up-linked to the satellite. Each MediaGlobe satellite then broadcasts thousands of video and information contents to millions of users in its particular service area. The video data is continuously received by the MediaGlobe terminal and, if there is a match with that user's personalised reception profile, stored for future viewing. The user, who then has full control over the stored contents of their terminal, would be charged per view and billed accordingly via toll-free terrestrial lines to the local MediaGlobe service centre.

An essential element in the MediaGlobe concept's success is the availability of high-volume digital storage capacity at an affordable price (Fig. 2). Fortunately, this capacity is continuously increasing, thereby enhancing the service's attractiveness and facilitating its future expansion to include memory-consuming applications like high-definition television (HDTV).

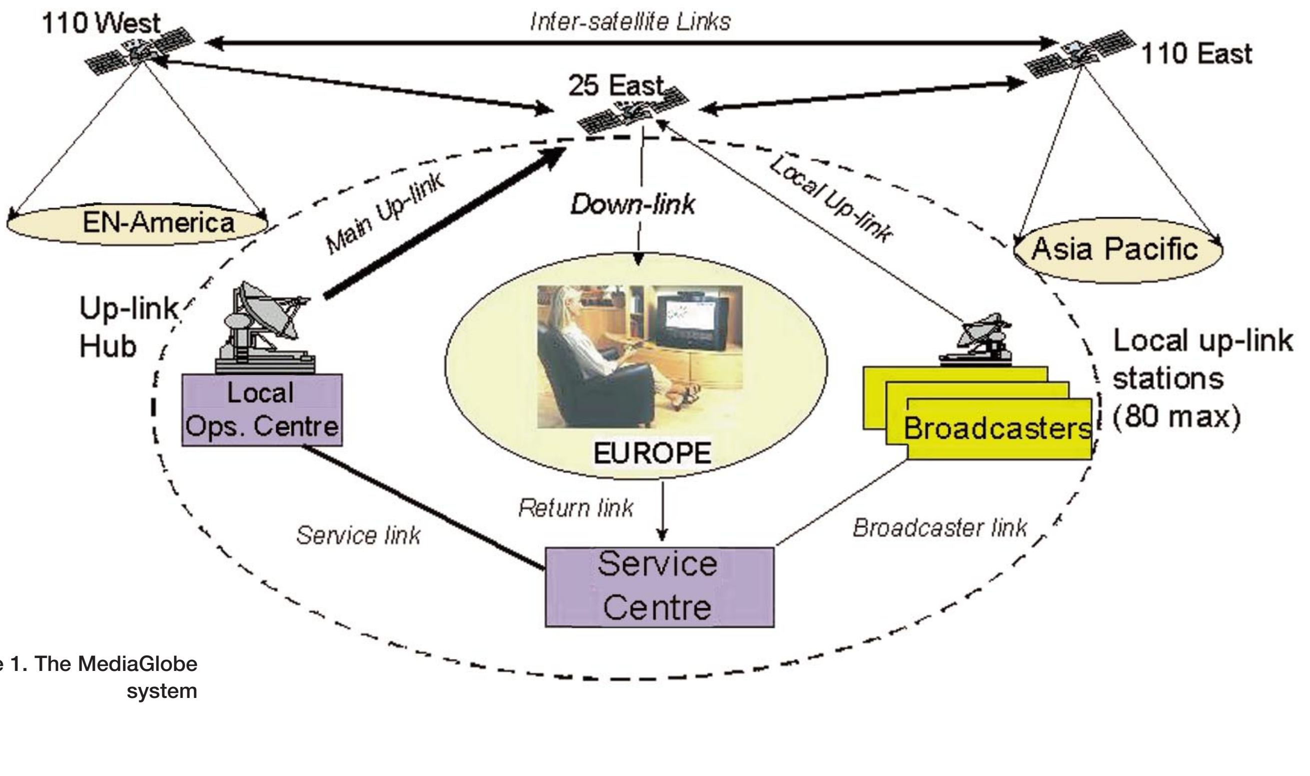

Figure 1. The MediaGlobe system

MediaGlobe would be the first space system to allow broadcasters direct access to the satellite and to provide service distribution to three different parts of the World simultaneously.

Local access
To achieve this, each satellite also has a number of onboard mutiplexers, which would allow small broadcasters to access the MediaGlobe satellites directly using small earth stations. Hence no dedicated communication links to an up-linking station are required, which allows significant cost savings and makes the MediaGlobe approach very attractive to its participating partners.

Global connectivity
The MediaGlobe satellites are interconnected via inter-satellite links in order to allow direct transmission of contents to users on all three continents without the need to organise dedicated point-to-point links on the ground, thereby allowing further cost savings.

Availability
MediaGlobe services could be introduced as early as 2002, when the necessary high-capacity data storage terminals will be readily available. MediaGlobe could be first to market with this new approach to television services, enabling it to capture an increased share of the emerging pay-TV market.

The market
MediaGlobe would target the lucrative digital direct-to-home pay-TV markets in Western Europe, Asia, the Pacific and North America. This market is expanding on a global basis with an annual subscriber growth rate of 37% (Fig. 3). By the year 2000, more than 30 million subscribers are predicted world-wide, with an ongoing transition from analogue to digital transmission, and annual revenues are expected to grow to $12 billion. In parallel, the cost of the equipment needed by the user will decrease, making these services globally available and affordable. This creates a high growth perspective for new multimedia applications like tele-banking, home-shopping and interactive television.

The most promising regions are Western Europe, Eastern North America and Asia Pacific, because of their predicted growth rates as well as their current gross domestic products and high-tech readiness. The Digital Video Broadcasting (DVB) market generates revenues via subscriptions, advertising and licence fees from public-service broadcasters. Of these, the subscription fee, at 64% of revenues, is the largest source of pay-TV income. Pay-TV applications are also the sector with the strongest growth expectations.

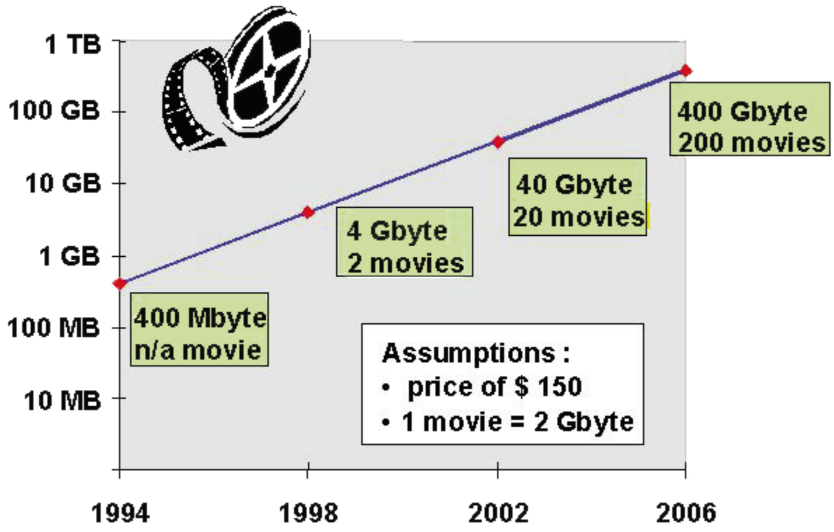

Figure 2. The key enabling technology: availability of digital storage capacity

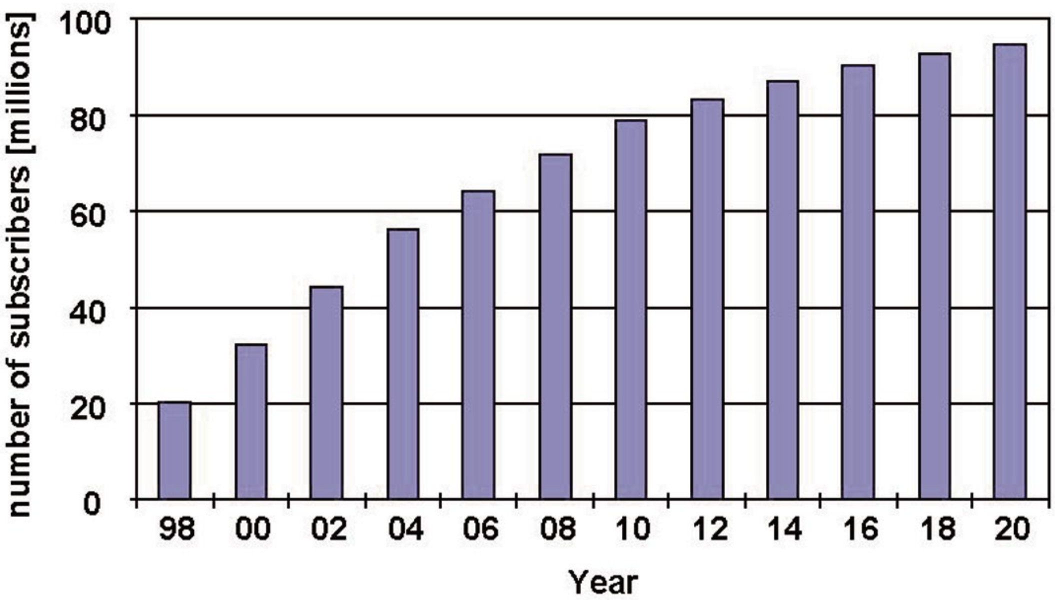

Figure 3. The world-wide digital pay-TV market

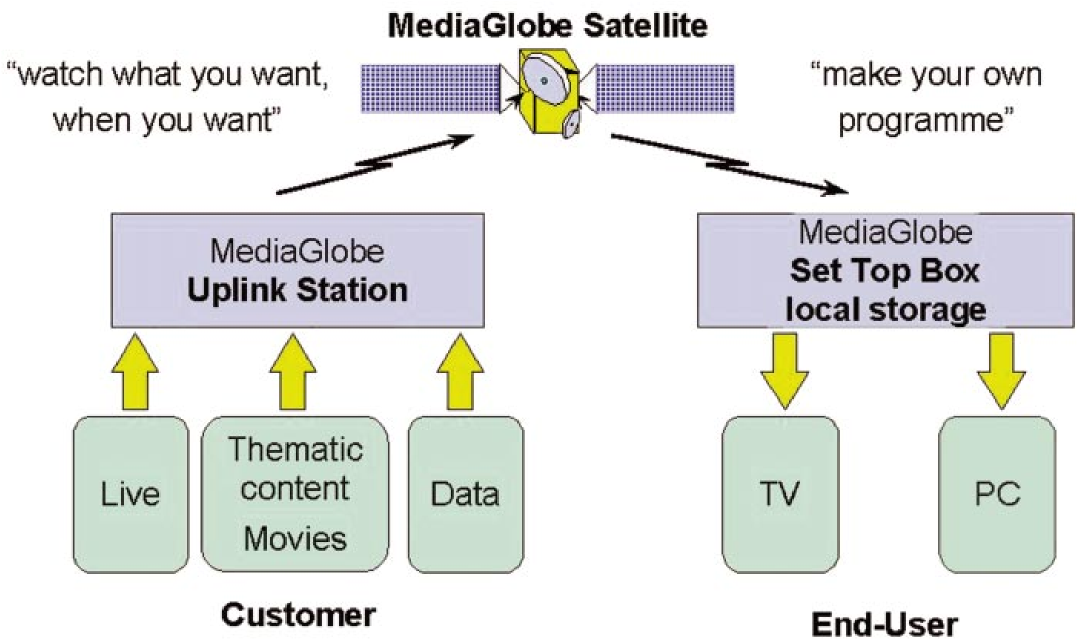

Figure 4. The MediaGlobe new service concept

Table 1. Movie transmissions per day depending on category, defined by user demand

	Europe	
Category	Number of movies	Repetition rate per day
Top seller	20	> 80
Best seller	160	18
Basic	1700	1

The services

TV-on-demand
This service would broadcast the most popular movies with better than VHS quality, and thematic television contents with subjects like nature, history, science, series, etc. in SDTV quality (Fig. 4). The movies would be divided into three categories, depending on user demand, with each category being transmitted several times per day (see Table 1).

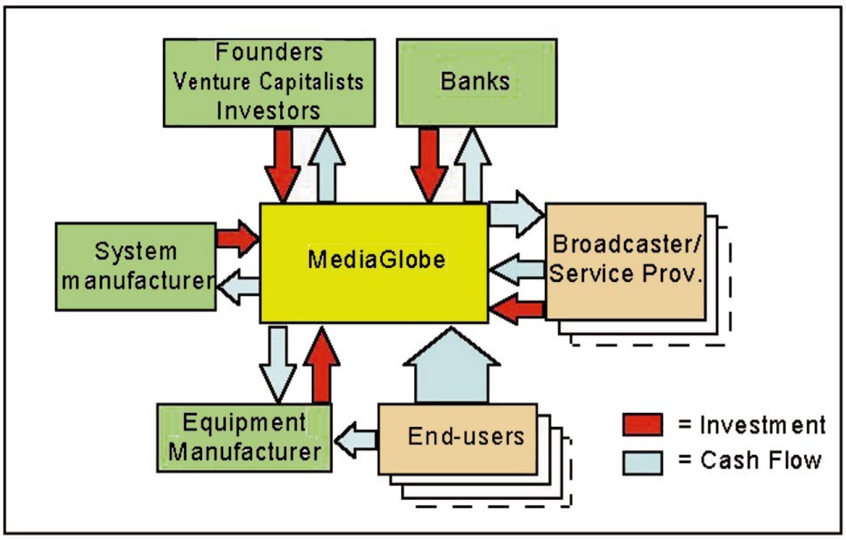

Figure 5. The strategic alliances and value chain

Live broadcasting
This service would include sets of programmes and events in Standard Digital TV (SDTV) that are interesting enough to be broadcast in real time. Examples are sports, popular shows, news and special events. The viewers could either watch these in real time as they do now, or programme their storage-and-ordering box to capture them for future viewing (even during transmission) much like today's video recorders.

Data
The broadcast data content would include software and software updates, databases, catalogues and their updates, games and Internet contents. Customers would include both business and private users. For example, software could be made available to a user for a specific (limited) period for a lower cost than purchasing the software outright. Private users might be expected to order computer games, catalogues and databases like phone books, whereas companies and smaller business users might be more interested in more specialised databases, business software and software updates.

A new approach to the value chain

Traditionally, satellite operators have provided bandwidth to broadcasters and service providers, who have then addressed the end user. MediaGlobe would provide TV and data services directly to end users, sharing this market sector with today's satellite operator's customers, namely the broadcasters (Fig. 5). This implies that the user would have only one interface for the MediaGlobe service, for central functions such as the updating of user profiles and billing. For the broadcasters, it means relinquishing their direct link to the end user, but in return they gain access to the new MediaGlobe approach to providing TV services, which means a high degree of flexibility and an overall increase in market volume.

MediaGlobe would be responsible for system procurement and mission operations. It would also be responsible for the service operations, which include contents processing, data encoding and up-linking, order processing, billing, networking and provision of the help-desk functions. This clearly distinguishes MediaGlobe from other satellite operators whose role has been limited, as noted above, to the provision of bandwidth to broadcasters.

All of the players in the MediaGlobe value chain are strategic partners who provide the equity and invest in the system. These partners would share in MediaGlobe's success and receive a proportion of the revenue. Success of the venture depends on the participation of broadcasters, contents providers and end-user equipment manufacturers. The latter need to be involved from the outset, as the timely development and availability of the MediaGlobe set-top storage-and-ordering box, including all of the specialised user interfaces and control functions, is critical.

Pricing and marketing

MediaGlobe foresees an approach leading to comparatively low charges for the three services offered, with pricing on a pay-per-view/pay-per-volume basis. There would be a monthly charge of, say, $9 per month for two years for the end-user equipment (dish antenna, storage-and-ordering box, integrated receiver and decoder). The charges for the movies would depend on the category; e.g. $2.5 for a top movie would compare favourably with pay-TV providers' rates and be comparable to normal video-store rental charges. Based on the average pay-TV viewing times in Europe, the price for the MediaGlobe live-broadcast service might be $8-10 per month, which would be highly competitive compared with any other pay-TV service concept. Data-push services would be offered to the end user for a charge of $0.1 per megabit, independent of the number of users.

As part of its new business approach, MediaGlobe would subsidise the transponder costs and charge broadcasters only a fraction of the market price for satellite capacity. In return, it would keep 20% of the end-user revenues, corresponding to its added value, namely the service provision to television viewers. This concept is very favourable and would allow new broadcasters and content providers to get to the market quickly.

For the TV-on-demand broadcast service, MediaGlobe proposes to charge only $1 million per transponder per year, which is considerably cheaper than the strongest competitors currently charge.

MediaGlobe charges to broadcasters for live services would be at least 25% lower than those of any competing satellite operator, and would be in the range of $200-450 per hour, depending on the region and time of transmission.

MediaGlobe targets a market share of 15% of the pay-TV market within three years of starting operation, and 20 to 30% in the longer term. In order to achieve that degree of market penetration, MediaGlobe's marketing campaign would include a demonstration service prior to full service launch, both to provide proof of concept and attract potential users. Heavily subsidising end-user equipment would help to penetrate the market quickly.

MediaGlobe does not aim at a new market, but at the existing and established direct-to-home market. This means that MediaGlobe users would be equipped with a dual-reception antenna, allowing them to receive the TV programmes of the already established satellite operators and the new MediaGlobe service offerings with a MediaGlobe TV receiver (equipped with the special storage-and-ordering box).

The technical solutions

The technical solutions address all of the space- and ground-based resources needed to implement the end-to-end MediaGlobe service concept, plus the infrastructure required to operate and maintain it (Fig. 6 and Table 2).

The different services provided by the broadcaster are up-linked to the satellite either via local up-link hub stations, or directly via a dedicated up-link station at the broadcaster's premises. The data contents are selected by the end users via their storage-and-ordering boxes, which are connected to the different MediaGlobe local service centres via low-data-rate terrestrial communications links (using the Public Switched Telephone Network) for ordering and billing purposes. The data stream is multiplexed either on the ground in the case of up-linking via the hub station, or onboard for the data that come from broadcasters using their own up-links. The MediaGlobe satellite constellation then provides access to the three coverage areas from a single point, since the data are relayed to the satellite covering the target area via the inter-satellite links.

Table 2. Primary characteristics of the MediaGlobe space and ground segments

Functional Requirements

Performance

- Number of transponders:	50 (+12 redundant)
- Transponder data rate:	38 Mbps
- Transponder bandwidth:	36 MHz
- Bit error rate (BER):	10^{-10}
- EIRP:	> 56 dBW peak
- Receiver G/T:	12 dB/K (standard 60 cm diam. dish)
- Storage device memory:	40 GB
- Equipment cost:	< $500

Coverage

Service regions (Fig. 7):
- Asia-Pacific region comprising Japan, northern coastal regions of China (from Beijing to Shanghai) and South Korea
- Western Europe in particular with Italy and Spain as well as the German-speaking countries, the Benelux and France
- The Eastern part of North America from Florida up to Newfoundland, and west to the Mississippi River

leading to the following orbital-slot requirements (Fig. 8):

- Asia-Pacific satellite:	110° East
- European satellite:	25° East
- American satellite:	110° West
- Beam coverage on surface:	4000 km x 2000 km
- Connectivity:	satellites interconnected via inter-satellite links
- ISL data rate:	200 Mbps
- System response time:	< 24 hours, depending on service

Operational Requirements

- Start of service:	2002
- Duration:	15 years
- Orbit:	GEO
- Availability:	99.5% during sunlight and eclipse
- Reliability:	0.68 at end-of-life for overall spacecraft bus, and 0.82 for payload
- Security:	To deny unauthorised access data encryption to data and command channels since services are commercial in a very attractive market
- Survivability:	Capability to survive natural / launcher induced environments No capability to survive external wartime threats
- Data content, form and format:	DVB standard ETS 300421, ETS 301192

Constraints

- Schedule:	Programme decision: end-1998 Order launches: mid-1999
- Set up industrial organisation and preliminary phase with partners by beginning of 1999	
- Development phase: early 1999 to early 2002 (= 3 years)	
- Regulatory issues:	1998
- Regulation:	Agreement with ITU & WARC for allocation of frequencies, bandwidth and orbital slots

Interfaces

- Data:	DVB
- Launcher:	Ariane-5: max. GTO mass 6800 kg, fairing 4.57 m x 10.35 m (single launch) Proton D1e: max. GTO mass 5500 kg, fairing 3.97 m x 7.3 m (single launch)

Development

- Development time:	< 3 years, with time-to-market as key driver

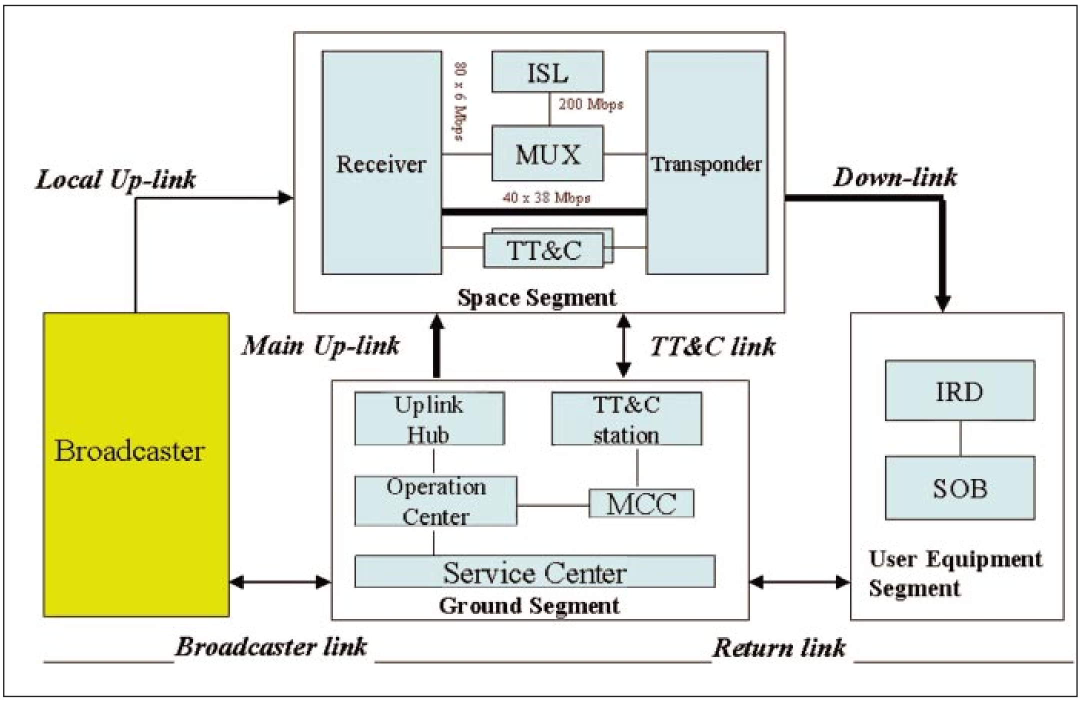

Figure 6. The space- and ground-segment architectures

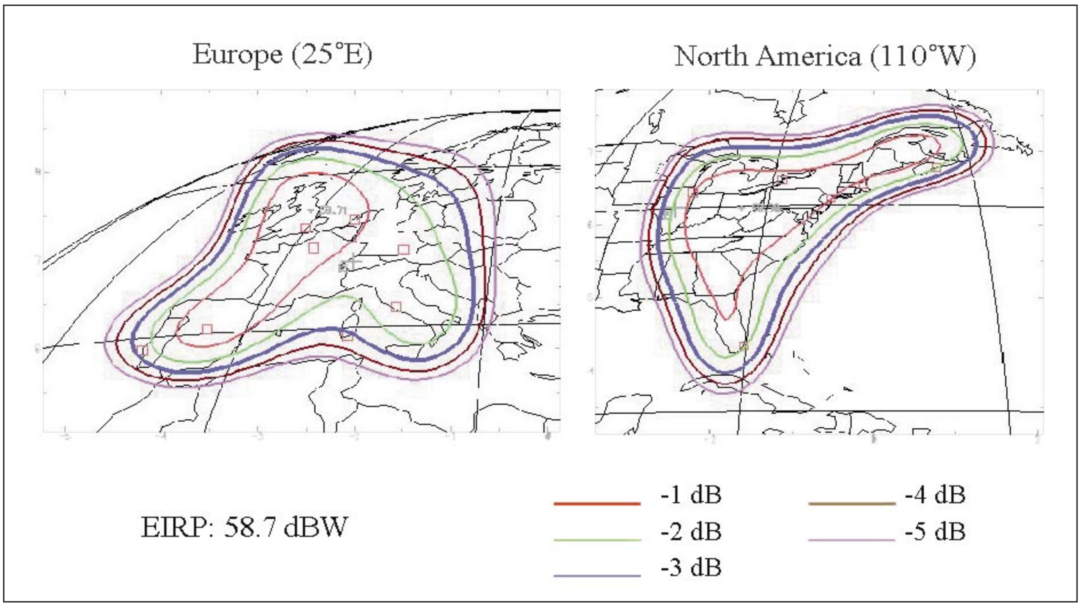

Figure 7. The Northern Hemisphere coverage areas

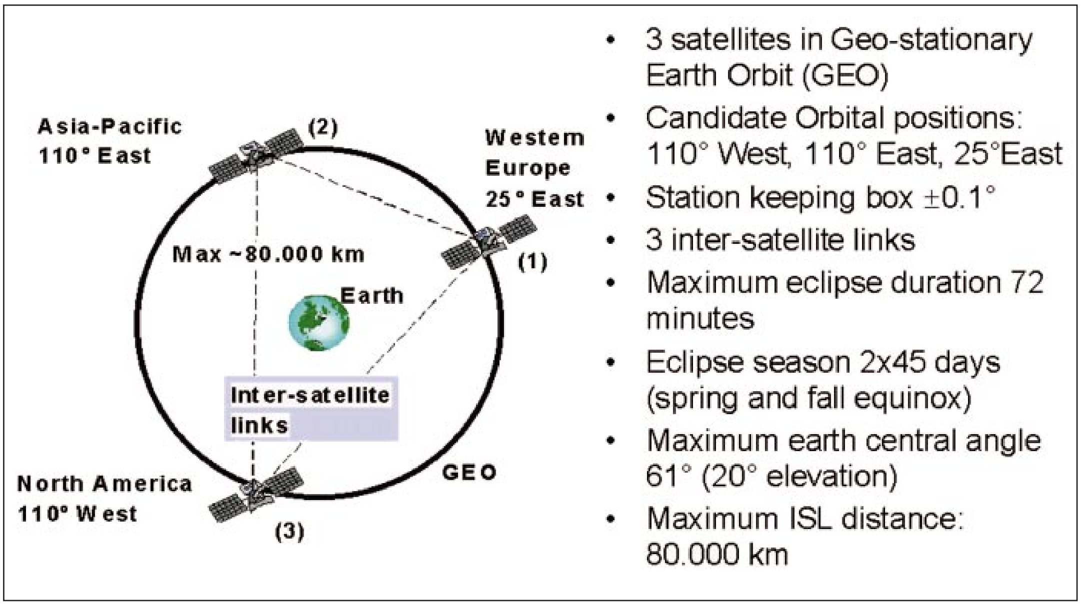

Figure 8. The MediaGlobe constellation

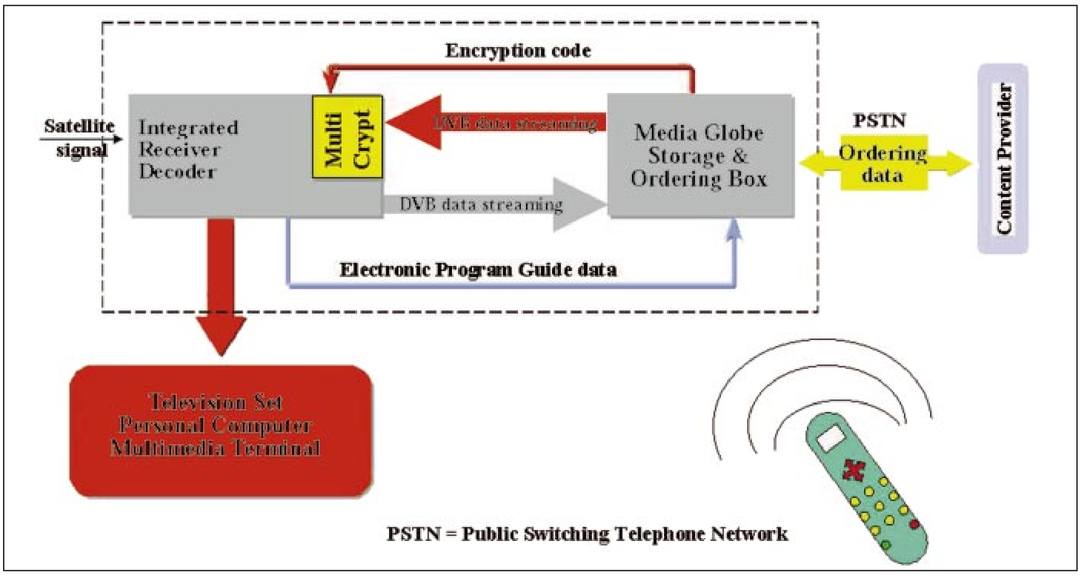

Figure 9. End-user equipment data flow

The data are received by the end users via standard satellite dishes (60 cm), possibly with a dual feed for reception from two satellites, and DVB-compatible Integrated Receiver Decoders. The end-user equipment requirements have been established on the basis of the market-analysis and the business-case study. The storage capacity of the end-user equipment is therefore sized according to the expected average use of the system based on the market study.

The MediaGlobe end-user equipment needs to be specially designed (Fig. 9). The broadcast signals are received and decoded by a standard DVB-compatible Integrated Receiver Decoder (IRD). The IRD has a DVB data streaming output for the video data to be stored in the Storage-and-Ordering Box (SOB) and an input for the data to be played back. The interface between the IRD and the SOB is a PCI-compatible Smart-Card. The main SOB sub-components are a microprocessor, a hard disk with controller and a modem for transmitting the ordering data, selected via the Electronic Programming Guide (EPG), to the billing centres and receiving the decryption code.

The three MediaGlobe geostationary spacecraft have to carry and support the communications payloads and provide all the necessary housekeeping functions. From the initial payload mass and power budgets, it is evident that high-end next-generation communications satellites will be needed:
- Accommodation of 450 kg payload and provision of 9.5 kW of payload power
- Payload Earth-pointing better than 0.1 deg in roll/pitch, 0.25 deg in yaw
- Support of mission operations, including data up-linking, broadcasting, ISLs
- Service provision 24 hours per day (daylight, eclipse) without interruption
- Operational in geostationary orbit (launcher type and environment)
- 15 year nominal design lifetime
- Spacecraft functions and subsystems fully controlled (autonomously/from ground).

Implementation

The MediaGlobe schedule (Fig. 10) is based on a three-year implementation period, from system definition to operational qualification of the first MediaGlobe spacecraft (flight model 1), foreseen to be launched in 2002. The second and third flight models would be launched in consecutive years. The short time span requires that certain activities be conducted in parallel, particularly those relating to the early design and manufacture of the spacecraft and the co-ordination between the space- and ground segments needed to validate the complete system.

Due to the short schedule for the development, assembly and delivery of the MediaGlobe satellites, and in order to reduce the overall costs, the following approach is foreseen:
- maximum use of commercially available hardware (modified as necessary)
- use of the protoflight model philosophy at all levels, with engineering models only being used for newly developed equipment and equipment that has been drastically modified
- subcontracting of all development, test and verification activities

The characteristics of the proposed MediaGlobe space- and ground segments are shown in Figure 11.

Figure 12 shows the spacecraft bus, with its Ku-band antennas (1.5 m for transmission, 1.3 m for reception) and its optical inter-satellite terminals. The power subsystem is based

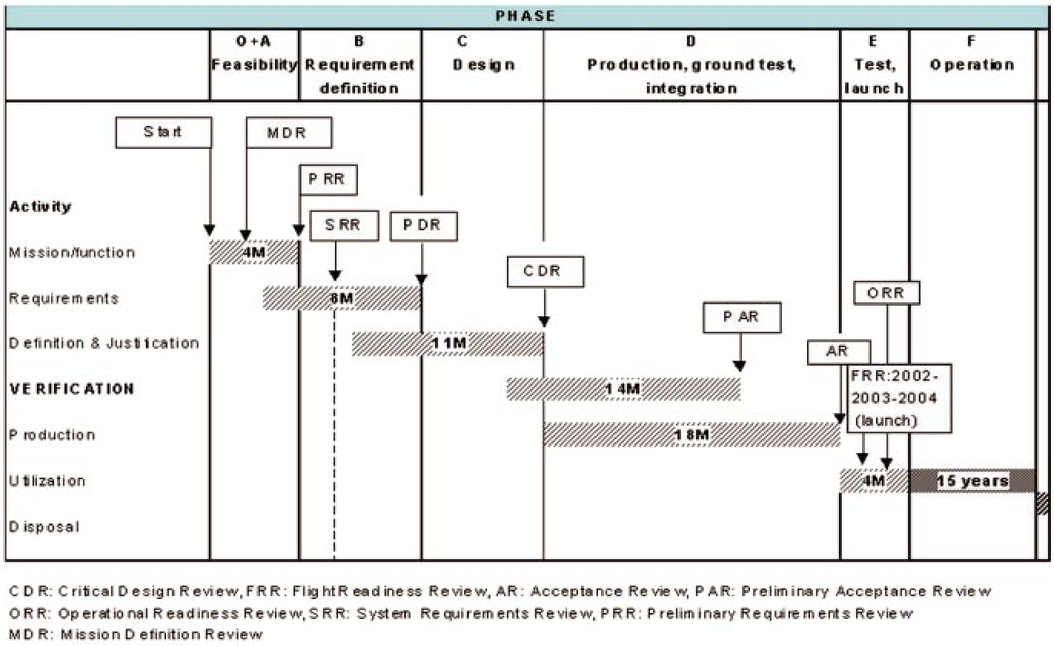

Figure 10. The implementation schedule

Space Segment

- GEO-satellite constellation: 3 spacecraft
- Lifetime: 15 years
- Data throughput: 1.9 Gbps
- Down-link EIRP: >56 dBW peak
- Transponders: 50+(12), with 10^{-10} BER (QPSK)
- Inter-satellite links: 1.046 microns, 200 Mbps (BPSK)
- Dry/wet mass: 2450/4600 kg
- Power (EOL): 16.0 kW

Ground Segment

Users
- Dual reception dish : 60 cm
- Integrated receiver decoder
- Storage and Order box: 40 Gbit
- TV and PC multimedia terminal

Control
- Mission Control Centre: 1
- Local Operation Centres: 3
- Local Service Centres: 3
- Broadcaster Uplink Stations: <80
- Telemetry, Tracking and Command (TTC) Stations: 3

Figure 11. MediaGlobe system summary

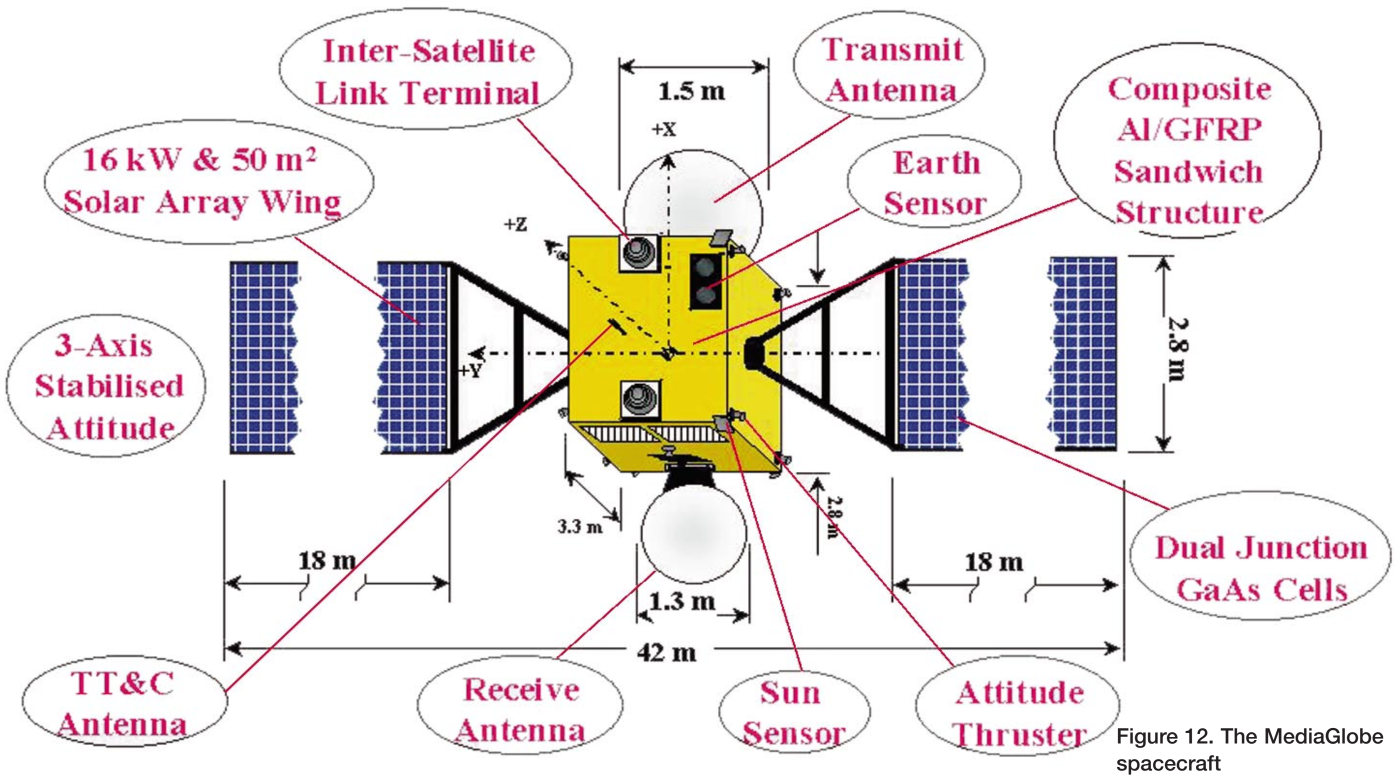

Figure 12. The MediaGlobe spacecraft

on rigid fold-out, dual-junction, gallium-arsenide/germanium solar-panel arrays with nickel-hydrogen batteries. The solar-array performance is 16 kW at end-of-life and the battery capacity is 13 kWh. The spacecraft platform is three-axis-stabilised, with momentum wheels for pitch control and roll-yaw stiffness, reaction wheels for momentum storage, and reaction-control thrusters for momentum dumping and attitude manoeuvres.

The baselined propulsion subsystem is a liquid bi-propellant Unified Propulsion System (UPS) consisting of a liquid apogee motor and reaction-control thrusters, providing the required delta-V for orbit transfer, attitude-control manoeuvres and east-west station-keeping. Ion propulsion has been selected for north-south station-keeping, leading to a 33% net propellant-mass saving compared with chemical propulsion, at the expense of an increase in the overall power budget to accommodate the 870 W required to operate each ion thruster (for 2 h/orbit).

The mission-operations concept is based on a single Mission Control Centre (MCC) providing the functionality for spacecraft and ground-station monitoring and control, and offline mission planning, mission analysis and network monitoring activities.

Table 3. Internal rates of return (IRRs) for less-than-optimum MediaGlobe scenarios

Business Case	IRR, %
Baseline	44.3
Number of users in all service regions	
30% lower than expected	35.0
All launches delayed by 1 year	32.4
Interest rate increases by 30%	43.4
Movie prices drop by 30% in all regions	38.0
Cost of end-user equipment increases by 30%	37.5
Free-of -charge end-user equipment	26.8
Launch failure necessitates leasing alternative capacity for 1 year	36.7

MediaGlobe – A superior business opportunity

As the accompanying panel detailing the 'MediaGlobe Business Case' shows, MediaGlobe represents a unique business opportunity offering high rates of financial return. MediaGlobe is ready to offer potential investors a 7-year equity investment, with entry in 1999 and exit in 2006. Taking into account the predicted annual profit before tax of $900 Million averaged for the years 2007-2012, the valuation of MediaGlobe in 2006 should be some $4500 Million. With the overall investment equity set at $820 Million, the shareholders would get 5.6 times their invested capital back, corresponding to an Internal Rate of Return (IRR) of 45% per annum. From a company point of view, the IRR is a function of the investment period. Approximately 6 years after startup, MediaGlobe would have an IRR of about 13% per year, while in the longer term (>12 years) this should increase to more than 40%. Even factoring in the impact of a number of potential threats to MediaGlobe revenues (Table 3), the worst-case IRR would still exceed 25%. Considering the very conservative business assumptions that have been made throughout, MediaGlobe therefore constitutes an exceptionally attractive commercial

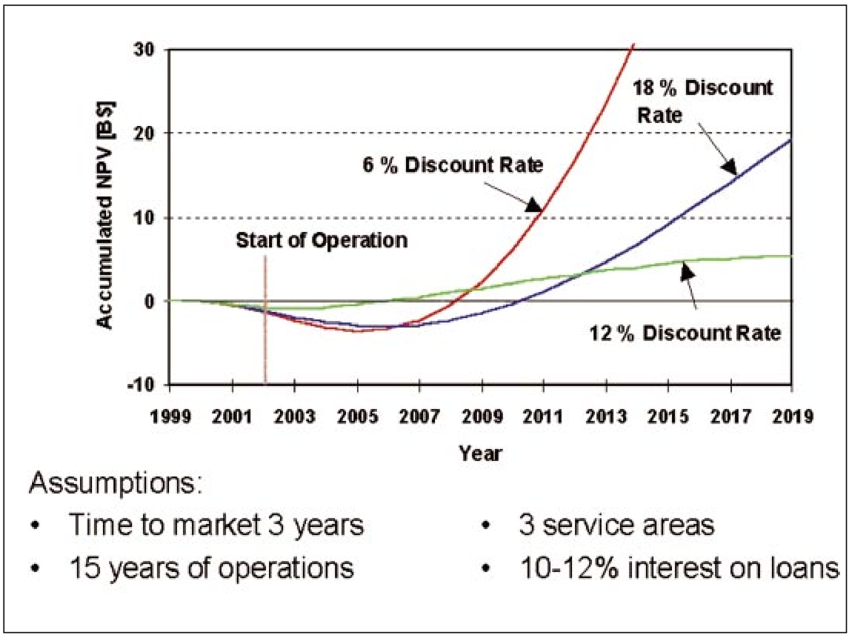

Figure 13. Financial-return projections

The MediaGlobe Business Case

MediaGlobe's business case for the three proposed service regions depends strongly on the procurement schedule for the three spacecraft and the ground segment, which are coupled to the launch dates in 2002, 2003 and 2004.

The major milestones can be directly translated into the capital investments and expected revenues shown in Figure 14. The overall investment needed for MediaGlobe amounts to about \$1.9 billion, peaking in 2002 with a total annual investment of \$570 million and decreasing thereafter to a steady annual level of about \$60 million from 2005 onwards (Fig. 15).

A substantial marketing effort will be necessary to secure rapid market entry and penetration. The MediaGlobe marketing plan therefore consists of three elements:
– general marketing costs in the pre-operational and operational phases, which form part of the MediGlobe operations costs
– subsidising of end-user equipment costs in the early operational phases, which form part of the MediaGlobe capital investment costs.

MediaGlobe's projected operations costs are \$200-250 million annually. The marketing cost (46%) is also the largest element of the investment cost (\$1.9 billion in total), corresponding to the end-user equipment subsidy, followed by the combined cost of the space and launch segments (44%).

The MediaGlobe project would have three distinct phases: the foundation and development phase, the investment phase, and the operational phase. The investment phase, comprising the procurement of the three satellites and the ground segment, would end with the full deployment of the space segment and feed into the operational phase. As business develops and revenue streams and overall profitability burgeon, there could be an Initial Public Offering (IPO) of MediaGlobe shares in say 2006/2007.

MediaGlobe would seek equity funding for about 67% of the total up-front investment to minimise capital borrowing costs (interest on bank loans). The initial start-up capital would be provided by Venture Capitalists and the Founding Partners. Broadcasters and service providers, as well as spacecraft and equipment manufacturers, would be invited to become shareholders and thereby participate in the success of the emerging business.

MediaGlobe's projected revenues from 2002 onwards show strong growth potential, with a six-fold increase projected over the total 15-year mission lifetime for all three service regions, leading to total revenues of \$31.3 billion. This equates to revenues of \$14 million per transponder per year, which is a factor of 3 to 7 higher than current returns.

Figure 14. Market-revenue breakdown

Figure 15. Capital investment breakdown