A L E N I A
A E R O S P A Z I O

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List of Abbreviations

ACK: Acknowledgement
ADBS: Advanced Data Broadcasting System
BER: Bit Error Rate
DBS: Direct Broadcast Satellite
DDSC: Data Distribution Service Center
DL: Downstream Link (i.e. DDSC ® user)
DTH: Direct-to-Home
DVB: Digital Video Broadcasting
EO: Earth Observation
EW: Earth Watching
FLS: Feeder-Link Station
FTP: File Transfer Protocol
HRPD: High Resolution Products Distribution
HTTP: Hyper Text Transfer Protocol
IP: Internet Protocol
ISDN: Integrated Services Digital Network
ISIS: Interactive Satellite Image Server
ISP: Internet Service Provider
LAN: Local Area Network
LBRFD: Low Bit Rate Fast Delivery
MPEG: Motion Picture Expert Group
MUIS: Multi-Mission User Information Services
NPUS: Network PC User Station
OSI: Open Systems Architecture
PC: Personal Computer
POP: Point-Of-Presence
PSTN: Public Switched Telephone Network
RFC: Request For Comment
RO: Receive-Only
SAUS: Stand-Alone User Station
TCP: Transmission Control Protocol
TV: TeleVision
UDP: User Datagram Protocol
UL: Upstream Link (i.e. user ® DDSC)
URL: Universal Resource Locator
US: Users Station

1. INTRODUCTION.

The ARTE project (**A**lternative distribution strategy for **R**eal **T**ime **E**uropean data) investigates the opportunities for broadband communication by satellite, more precisely the use of satellite digital broadcasting technology, in combination with terrestrial return links, for interactive communication.

The study analyses the use of the DVB platform to support the Internet TCP/IP protocol and services. It also includes a satellite-based demonstration.

The aim is to demonstrate, gain experience with, and validate the use of emerging technologies to enhance data collection and data distribution to end users, with special emphasis on Earth Observation (EO).

The identification of needs and opportunities in the mediterranean bassin is approached.

2. PROJECT SUMMARY

The objectives are:

- Use of broadcasting technology, in combination with terrestrial return links
- On-line access to Earth Observation catalogues
- Better service for the distribution of Earth Observation products
- Particular focus on the needs of Mediterranean basin area

The technical approach is based on the implementation of a satellite end-to-end Internet services using a DVB-MPEG2 platform with TCP/IP protocols. The rationale behind the extension of Satellite DVB/MPEG2 Digital Television standard to TCP/IP applications is to provide the final users with High-Speed Internet connections at competitive costs.
The study defines a business and marketing plan for the system and a business demonstration will show the viability of the concept. It allows also an identification of early application.
This demo via the Hotbird 1 satellite from Eutelsat organisation validates the use of emerging technologies enhancing data collection and distribution to users. The earth observation is taken as a demo case.

The activity comprises three different tasks, which are carried out in coordinated manner:

- Establishment of a "Data Distribution Service Center" (DDSC) for data distribution via satellite
- Interfacing of the DDSC with selected user information services at ESRIN
- Interconnection of ESRIN to a high speed communications backbone.

The industrial team for the project is the following:

- Alenia Aerospazio (IT): Prime Contractor
- Etnoteam (IT): Demonstrator Set-up and Lan
- GCS (Aut): DDSC and User Terminals
- RAI (IT): Satellite Broadcaster
- PARS (IT): Marketing and Business

3. SYSTEM ARCHITECTURE

3.1. Highlights.

Today most users access Internet via the PSTN/ISDN network, which does not provide adequate bandwidth to enable several attractive multimedia-based applications because of the limited capacity in the downstream connection

In fact a high-speed connection via satellite can be the right answer to access those services. Therefore, the exploitation of a unidirectional data link through a Digital Video Broadcast satellite would allow fast delivery of large data products to end users, through a dedicated Data Distribution Service Center (DDSC) which acts like a "kiosk" hosting multiservices.

Consequently, the project highlights are the following:

- a satellite based connection to the Internet makes the download times of large images acceptable
- feeder link is based on a DVB/MPEG stream at Ku band
- return link is a dial-up terrestrial Internet connection

The system architecture outlined in figure 3-1 supports one unidirectional high-speed forward channel and a certain number bi-directional low-speed return channels.

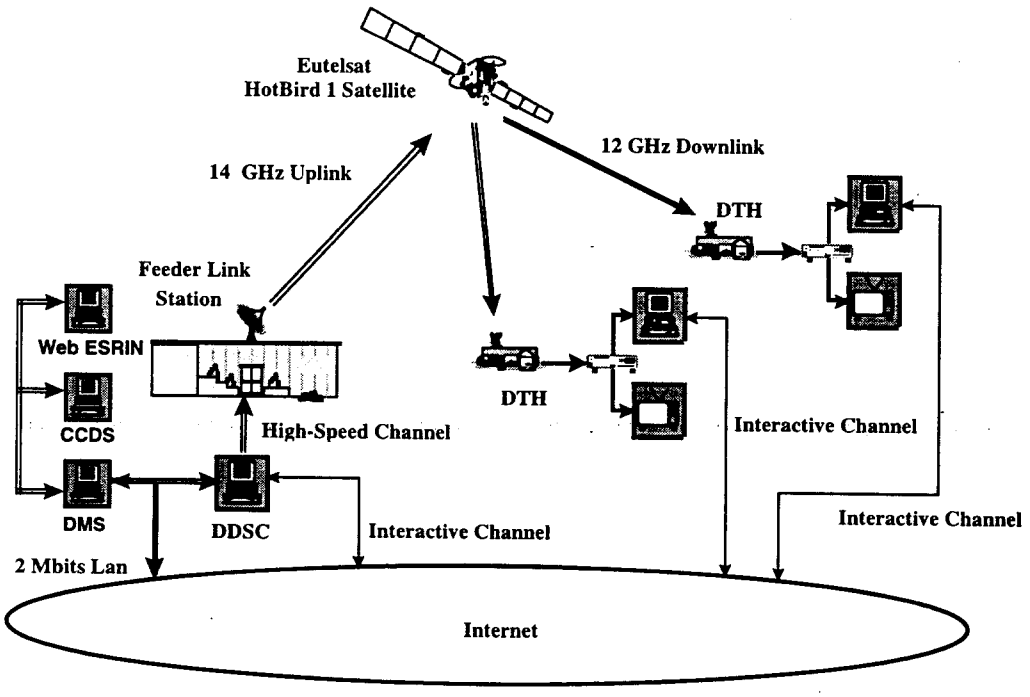


Figure 3-1: Overall System Architecture

3.2. Network Management Functions.

The scope of this section concerns the study and the optimisation of the Target System Network Functions specially those regarding security and commercial management systems, as pointed below:

- customer service;
- billing and accounting;
- authentication, authorization, cryptography, certification, data integrity and digital signature;
- communication protocols;
- network management protocols;
- contingency procedures.

The Data Distribution Service Center (DDSC) permits to distinguish users in "normal" and "sat", the first getting data return in standard way, the second directly by satellite.

The Data Multicasting Server (DMS) collects the data from the Esrin image databases (and, eventually, from other services data bases) that DDSC should transmit to perform the multicasting service.

A customer-centric data store (CCDS) should be established to contain all non-volatile (long term) information about the customer. This data base can serve as the single, authoritative source of customer information data for all processes within the corporation including billing, customer services, and operation support systems. Such information typically includes subscribing services, customer behavioral profiles, account balances, billing preferences, bill names and addresses, and other stable data elements.

Two transmission modality are possible:

- the first one is performed using the UDP/IP protocol to reach different users in a connection-less oriented session. Authorized users filtering is realized by an application developed for the purpose;
- the second one is used to send to a single user a particular and normally huge image (or other file) on request. To be sure of the right delivery of the data it is necessary to establish a TCP/IP session between the DDSC and the user client.

3.3. Internet Services on Satellite.

Satellites can play an important role for the provision of Internet services. Their main advantages are the following:

- satellites reach every part of the globe;
- easy deployment and expansion in terms of bandwidth;
- low complexity for re-routing data flows among peering points;
- more flexible standards, allowing uni-directional links to be more easily provided where required;
- very reliable service;
- a quality consistent with service requirements.

Within the characteristics above listed, the services more dedicated for a satellite network architecture are:

- Video:
  - * Videoconferencing: videoconferencing, real time exchange of video images between two or more locations, is the basis for many planned advanced communications applications in business, education and health.
  - * VOD (Video-on-demand): this service allows the user to enjoy of an electronic video rental system. Video material (films, TV programmes, etc.) is stored as compressed digitised material on a video server, which is able to manage users requests.
  - * NVOD (Near Video on demand): the same program above described (film, documentary, etc) is broadcasted on more channels with a time delay of ten minutes typically.
- Messaging services:
  - * E-mail: is one of the most used services in computer networks. Its evolution is represented by applications of Multimedia Mail, in which the simple text message is integrated by a video message with audio.
  - * Electronic Data Interchange (EDI): is the capability of transfer data among companies. Particularly, messages must be formatted with common standards and must be exchanged, with the lowest human presence, among applications resident on computers belonging to commercial partner and public administrations.

* Intranet: is the descriptive term applied to the use of Internet standards and technologies within companies or organisations for their internal communications and sometimes by creating a closed user group on the public network. Internet and Intranet use the same tools and techniques, protocols and products, based on TCP/IP protocols. What is implemented on the Internet can be implemented on the Intranet as well.

These services are summarized in the table 3.3-1:

Application	Service	User
Video	Near Video on demand	Consumer
Transactional	Electronic Bank	Business & Consumer
	Financial Services	Business & Consumer
	Insurance Services	Business & Consumer
	Remote Shopping	Consumer
Messaging & Information access	www Services	Business, Consumer and Government
	Information access	
	FTP	
	E-mail	
Telemedicine	Remote Therapy	Government
	Remote Consultation	
	Patient History	
EO Services	Remote Sensing	Business & Government
Education and Work	Distance Learning	Business & Government
	Teleworking	

Table 3.3-1: Application and Services vs. Users Summary

In fact the concept of the DDSC allows such kind of multi services management and has a growth capability to answer to future demand.

4. MARKETING PLAN

4.1. Objectives:

The objectives are the following:

- define the main interactive multimedia services provided by Internet along with other applications (like telemedicine, Distance learning, etc.) that can be potentially supported in the considered satellite network architecture;
- offer a view of existing telecommunication infrastructures in the Mediterranean Basin countries;
- point out some basic telecommunication indicators to understand the potential market size of Internet via satellite in the Mediterranean Basin;
- provide a possible distribution chain, a pricing system for end user and services that best fit a country segment.

4.2. Marketing Plan Formulation.

This section describes the most significant segmentation criteria taking into account the geographical and technological peculiarities of the different countries considered that are characterised by unlike level of development.

Consequently, the most interesting potential target of users are the following:

- Business
- Government
- Consumer

The Mediterranean Basin Countries can be shared into category taking into account the development degree of existing terrestrial infrastructures and the feasibility to provide interactive multimedia services: see Table 4.2-1.

Group 1:	*Albania, Gaza, Egypt, Libya, Syria, Jordan, Algeria, Lebanon, Tunisia, Bosnia, Marocco, Serbia*
Group 2:	*Greece, Slovenia, Malta, Cyprus, Turkey*
Group 3:	*Italy, Spain, Portugal, Israel*

Table 4.2-1. Country Categories

Reviewing the groups, following comments can be made:

- Group 1: contains those countries characterised by a very low level of infrastructures diffusion and their aptitude of telecommunication investments. It can be assumed that providing multimedia interactive services are, in such countries, almost unexistent
- Group 2: contains those countries that are able to enjoy those services that could be available from the satellite network but, for the lack of ISDN networks, user-network interactivity level has to be low. That excludes those services that are not part "data queries" ones;
- Group 3: contains those countries that, for development of the existing infrastructures and for the investment capacity, can have interest in enjoying the complete bouquet of interactive multimedia services supplied by the satellite.

Moreover there is also an overview of existing telecommunication infrastructures in Mediterranean Basin and noticed that among North Africa countries, Marocco and Egypt are having great efforts to increase the number of main lines and the number of subscribers, while in Middle East only Israel seems to be a promising market for interactive multimedia services.

4.3. Outcomes.

A particular attention is done to tele-medicine, tele-education and Earth observation applications that seem particularly interesting for potential users of European and Mediterranean countries:

a) Tele-medicine. Some examples of services in this field are: remote therapy, through which the consumer can get all the information about the therapy he has to follow; services of first aid, through which, by help of a doctor and a multimedia interface, it is possible to provide an effective first aid in case of accident. An other important application is represented by services of remote consultation, through which it is possible to have a medical consultation from different sites, having all necessary elements (x-rays, medical files, reports). The main difference with a more traditional videoconference is that the necessary database can reside in a remote site to all the interlocutors.

b) Tele-education. This service such as distance learning is suitable to be provided on the network. In particular, a teacher holds lessons to individual or groups of students located in remote places. The students can interact with the teacher through e-mail or fax. This application has turned either to organisations like schools, jails, hospitals and companies or to private users that have difficulty to leave their own house or are unable to do it. Using distance learning in professional training is appealing for small and medium companies, for there could be the saving money and time, if professional training is carried out in the office. Thus courses demand could increase.

c) Earth observation. Nowadays, remote sensing is the second space application (after communication) with commercial and non-commercial demands and world wide web opportunities. Market evaluations have shown that resource managers need to make quicker and better decisions on a day-to-day basis in various field such as: Environmental and Resource Management, Human impact Management, Maritime Management, Informative/Science Applications and Earth mapping.

This is summarized in the table 4.3-1:

Application	Service	User	Country segment
Video	Near Video on demand	Consumer	Group 2 - 3
Transactional	Electronic Bank Financial Services Insurance Services Remote Shopping	Business & Consumer Business & Consumer Business & Consumer Consumer	Group 2 Group 3
Messaging & Information access	www Services Information access FTP E-mail	Business, Consumer and Government	Group 2 Group 3 Group 1 (Government only)
Telemedicine	Remote Therapy Remote Consultation Patient History	Government	Group 1 Group 2 Group 3
EO Services	Remote Sensing	Business & Government	Group 1 Group 2 Group 3
Education and Work	Distance Learning Teleworking	Business & Government	Group 2 Group 3

Table 4.3-1: Application vs. Users Summary

We believe that in order to maximize the chances of success of the system, the reference market segment should be represented by Government and Business users.

On this basis, we conclude that, regarding telemedicine applications, remote consultation can be addressed to Government segment in group 2 and 3 countries.

Tele-education can be provided to Business (mainly big companies) and Government users in group 3 countries.

Regarding Messaging applications, EDI services can be provided to Business (small-medium companies) and Government users in group 3 countries, while medium companies are a promising market for Intranet too. EO services can be provided to Business (meteorological sites mainly) and Government users in any group.

This evaluation is useful to identify the most profitable market niches exhibited in the table 4.3-2:

Application	Service	User	Country segment
Telemedicine	Remote Consultation	Government	Group 2 - 3
EO Services	Remote sensing	Government & Business	Group 1- 2 - 3
Messaging Services	EDI - Intranet	Government & Business	Group 3
Education	Distance learning	Government & Business	Group 3

Table 4.3-2: Application and Services vs. Niches Summary

5. BUSINESS PLAN

5.1. Objectives:

The Business Plan approch has been projected to provide to a Service Provider an economical and financial overview with reference at management of satellite network architecture.

1.Main hypotesis

2.Investment and cost of the service provider

3.Debt and Credit of the "service provider"

4.Users trend

5.Financial need

6.Balance sheet

7.Economical and Financial evaluations

8.Scenarios

9.Outcomes

5.2. Business Plan Formulation.

We have assumed that "services" and "target of users" considered in the Marketing Plan outcomes (see previous Table 4-1) can be grouped in two main user profiles:

Class 1:

User Profiles description:

- Broadcasting: data, sound and *interactive video;*
- Services: Intranet (videoconferencing), Distance learning;
- Transmission rate: 2 Mbit/s.

Tariff:

- competitive "time tariff" equal to 1,20 $ a minute;
- "average connection time" which corresponds to 1,80 hours a day;
- "una-tantum" connection fee equal to 150 $.

Cost of Terminal:

- End-user cost: it is about 20000 $ for a Codec - MPEG1 purchase.
- Royalties: Service Provider gets 5% on terminal price.

Class 2:

User Profiles description:

- Broadcasting: data, sound and *non-interactive video*;
- Services: EDI - Intranet, Remote Consultation and Remote Sensing;
- Transmission rate: 64 Kbit/s.

Tariff:

- competitive "Full time tariff" equal to 900 $ a month;
- "una-tantum" connection fee equal to 150 $.

Cost of terminal:

- End-user cost: it is about 2700 $ which includes the cost of antenna + RF/IF, DVB+TCP/IP and a Pentium PC;
- Royalties: Service Provider gets 5% on terminal price.

5.3. Outcomes.

Pars produced 5 scenarios by stressing the most important variables of our simulation method. These are lested as follows:

- Shift of curve users
- Time connection - class 1 users
- Tariff a minute - class 1 users
- Full time tariff - class 2 users
- Investment

The main goal of this evaluation is to choose the main variables of input which most impact on GAPV analysis.

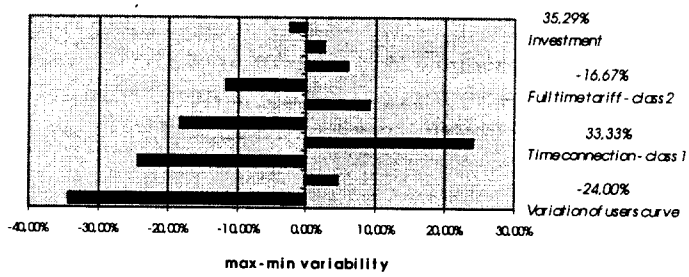
It is pointed out that:

- the service provider has major business opportunities whether the considered network architecture will be started up after 2 years of Business plan period. This consideration depends on the pessimistic forecasts which refer to the interactive multimedia users. This target will not give a great turnover in the time previously considered.

- The negative cash flows calculated in the first years should be funded by shareholders unless the service provider is trustworthy from banks or Financial Institution to incur in a greater loan.

The main goal of this evaluation is to choose the main variables of input which most impact on GAPV analysis (see figure 4).

GAPV % Variation
figure 4



After the previous simulation, we have defined the following scenarios:

1.Worst case

2.Best case

3.Baseline

In these different scenarios we calculated , at the same time, the variation extremes of those variables which seem more affecting our economical indicators. This evaluation is exibited in the Table "Sensitivity analysis overview".

Sensitivity analysis overview		
	variation extremes	% GAPV variation
Variation of users curve	-24,00%	-34,21%
Variation of users curve	15,00%	4,42%
Time connection - class 1	-33,33%	-24,11%
Time connection - class 1	33,33%	24,11%
Tariff a minute - class 1	-25,00%	-18,08%
Tariff a minute - class 1	12,50%	9,04%
Full time tariff - class 2	-16,67%	-11,60%
Full time tariff - class 2	8,33%	5,80%
Investment	-35,29%	2,56%
Investment	35,29%	-2,56%

WORST CASE				
	variation extremes	GAPV	MEF	IRR
Variation of users curve	-24%			
Time connection - class 1	1,20			
Tariff a minute - class 1	0,90	38.869.034 -	25.245.653	19,58%
Full time tariff - class 2	750			

BEST CASE				
	variation extremes	GAPV	MEF	IRR
Variation of users curve	15%			
Time connection - class 1	2,40			
Tariff a minute - class 1	1,35	194.612.720 -	19.320.279	44,56%
Full time tariff - class 2	975			

BASE CASE				
	hypotesis base	GAPV	MEF	IRR
Variation of users curve	0%			
Time connection - class 1	1,80			
Tariff a minute - class 1	1,20	**131.826.713 -**	**21.074.624**	**36,28%**
Full time tariff - class 2	900			

We notice that in the "worst case" the GAPV variation is not so low to risk the shareholders capital and that get difficult the business management.

5.4. Suggestions.

We point out that:

- The service provider has major business opportunities whether the considered network architecture will be started up after 2 years of Business plan period. This consideration depends on the pessimistic forecasts which refer to the interactive multimedia users. This target will not give a great turnover in the time previously considered.
- The negative cash flows calculated in the first years should be funded by shareholders unless the service provider is trustworthy from banks or Financial Institution to incur in a greater loan.
- The DDSC cannot survive only on one specific service because this is not financially viable. In fact the business plan shows no enough incomes and profit to keep-on working. The center must act as a "kiosk" and opens to multi-services.

6. SETUP AND PERFORMANCES

6.1. System Setup

ESRIN centre is the core of the exploitation of Earth Observation (EO) data in ESA. In fact ESRIN is one of the hubs of a worldwide network which has, as final goal, the distribution of EO data to end users.
The earth observation data distribution were chosen as support for the business demonstration.

The original setup for the ARTE project is described in Figure 6.1-1.

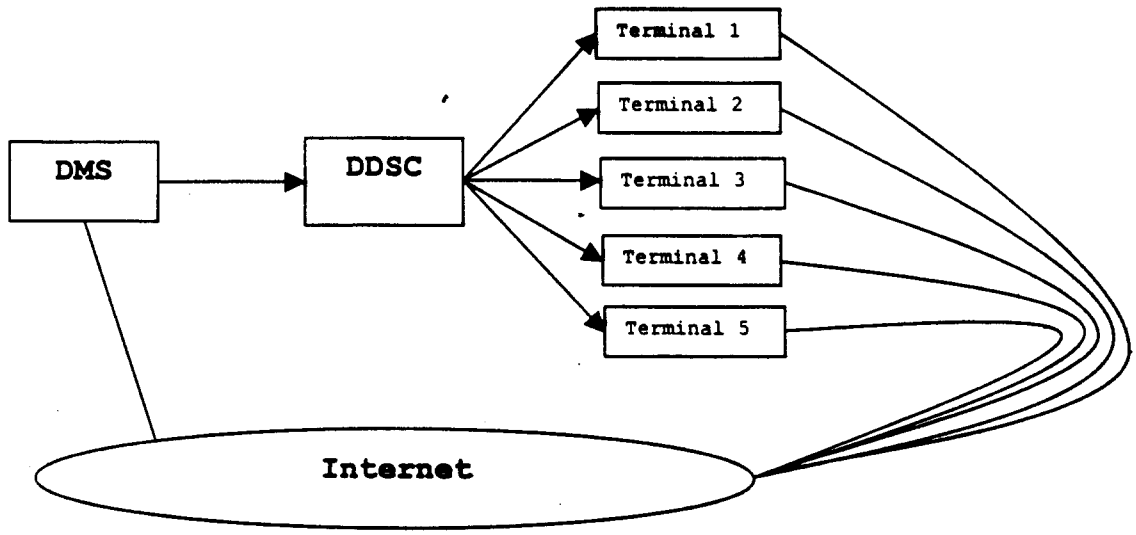


Figure 6.1-1: Baseline Overall System Setup

The DMS is connected to the DDSC through a dedicated 2 Megabit CIR link. The DMS location is Frascati and the DDSC location is Turin. Terminal #1 to #5 are connected through standard dial-up lines (modem) to their favorite ISP. To allow an easy static routing tables management and access control at the DMS and DDSC, it was agreed to use special dial-up account with fixed IP addresses for the terminals.

Once set up, the terminals send their request to the DMS indicating what type of information they want, i.e. out of the earth observation images database from the Frascati database. The DMS then collect such requests and bundles them into a package consisting of an image file (100 MB) plus an description file (1-2KB). The description file contains the filename of the image plus the two-byte initials of the persons (not terminals!) and the image is sent via the satellite link. Upon completion of the bundling, the DMS then

sends the package to the DDSC in utilizing the ftp upload directory at the DDSC.

As soon as the DDSC has received the package, it examines the description file and maps group of persons to a multicasting address plus port combination. It then waits until completion of the upload (please note that it may take a while [in best case xxMB / 245KB seconds] to transfer xxMB from the DMS to the DDSC) and then immediately "pushes" the image file to the terminals.

At the terminal side, a receiver program is permanently running that stores the files to the local harddisk. Once a file is received, a report (containing statistics, such as download time, packet loss, ...) is sent back from the terminals to the DDSC which, in return, collects such reports and makes a summary report available for the DMS.
Only during the initial request and the final report transmissions, the terminals need to be on-line, i.e. connected to their ISP. During the download of the image files the terminals can disconnect from the ISP and remain in receive-only mode.

This whole system design is intended to allow transactions only to be initiated from the DMS and the DDSC reacting only as a passive FTP server plus push server.

During the setup campaign, the architecture was modified according to the Figure 6.1-2.

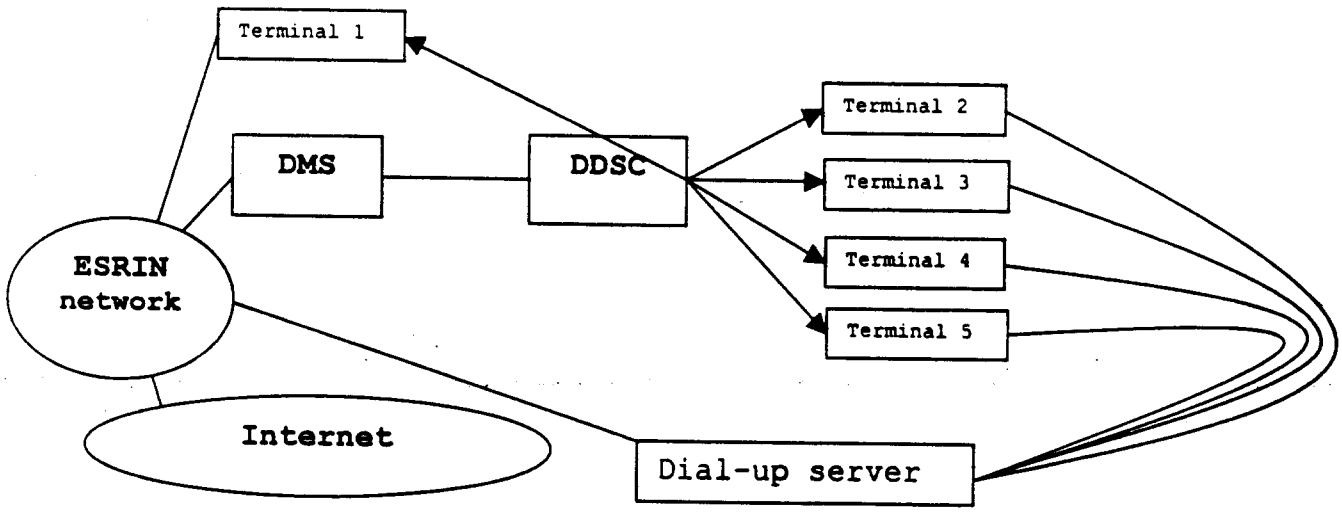


Figure 6.1-2: Demo Overall System Setup

During the setup period at Frascati, it was agreed with ESRIN that the Terminal #1 shall be connected directly to the ESRIN internal network and shall run Linux in order to allow access

to ESRIN people. At that time interest arose also for interactive services, allowing the ARTE terminals to also access general Internet resources through the DDSC and the high-speed satellite link.
Fortunately, the DDSC was also able to support such services, although it was not initially foreseen. One difficulty came up with Terminal #1 (acting as an internal proxy for ESRIN users). It was necessary to add an hierarchical proxy application both on the DDSC and on Terminal #1. At that time also the configuration for Terminal #2 to #5 was changed in order to have them dial-up Frascati directly and allowing them to access only the DMS and granting them interactive access to the Internet only through the DDSC.

To support interactive services through the DDSC as well, a number of configuration changes were needed to:

- set up a satellite virtual network with private IP addresses
- properly set up the routing tables,
- adjust/fine tune TCP parameters for the terminals,
- optimize the network router configuration at ESRIN,
- optimize overall system throughput.

The physical location of the DDSC is not at ESRIN, where the EO User Information systems and the images master database archiving are located. But it is at RAI/Turin where the satellite feeder link is available.

In fact the DDSC is connected with ESRIN via a high speed lan, which is used to:

- transfer the data requested by the users to the Service Center, which will then route them further via satellite
- enable the ESRIN services and the Service Center to exchange all the data required for their joint operation
- establish and update a cache at the DDSC for frequently dissiminated or broadcast data.

This technology is identified as asymmetric because the user of the service, in order to effect their requests, must open an Internet connection using whatever available type of link (i.e. dial-up, ..) and they receive back the data by mean of a medium-bandwidth satellite link, using a device connected between the receive antenna and the PC able to carry out the required conversion from DVB/MPEG to IP.
The DDSC is a dedicated server with operating system Linux. It is based on a standard 200MHz Intel Pentium processor with

64 MB of RAM, a 4 GB harddisk, a 10/100 Mb Ethernet card and a 2/4 Mb High-speed Serial Adapter card.

On the Ethernet side it is connected at 10Mb to the router that drives the dedicated 2Mb connection to ESRIN Frascati. On the HSSA side it is directly attached to a Sat/Sagem DVB Data Encoder (SAT gateway) at 2 Mb. The routine engine of the Linux operating system takes care about the proper routing of the packets from the Ethernet to the HSSA card.

The software installed on the DDSC consists of four main packages:

- an HTTP secure Web server
- an hierarchical proxy server
- a FTP server
- the DataCast^{RRMP} multicast push server

The secure HTTP server provides the interface for the users to log on/off and for the operator to control the DDSC.

The hierarchical proxy server (which was installed during the trials due to ESRIN request) is responsible for connecting the similar proxy server at ESRIN with the Internet. The reason for choosing an hierarchical proxy was to allow users within ESRIN to transparently access the Internet through the local ESRIN proxy (i.e. Terminal 1). The local proxy then forwards its requests whenever needed to the DDSC proxy that sends back the reply via satellite link.

The main purpose of the FTP server is to provide an easy mechanism to update the information on the DDSC through the DMS. It stores the incoming files from the DSM into a special upload directory where they are prepared for being multicasted through satellite.

The most important software is the DataCast^{RRMP} multicast push server. This software regularely looks into the upload directory whether new files are available and processes them according to the description file. DataCast^{RRMP} provides forward error correction in interleaving the data packets and adding additional redundancy packets. The rate control of DataCast^{RRMP} allows for different distribution speeds in order to ensure efficient downloads to many terminals with different processing capabilities.

RAI (Research Center located in Turin) courtesy offers his satellite uplink station facilities.
The transmission was daily five days a week from 10:00 AM to 13:00 AM for 2 months.

The satellite was Hotbird 1 from the Eutelsat Organization. 16 transponders of 36 Mhz are available. The EIRP is 49 dBW for the european coverage (super widebeam). It means that user can receive with a dish of 80/90 cm. It operates in the frequency range [11.20 GHz - 11.55 GHz] and the transponder n° 8 supports the demo.

6.2. Performances.

Daily connections were performed at ESRIN during the Hotbird 1 availability period. The two modes (interactive and broadcast) shows pretty good performances in term of bit error rate and downstream data bit rates. Two terminals were used: Terminal #1 (with Linux) and Terminal #2.

Only one demo was conducted. It was done during the ECSC-4 conference (Fourth **E**uropean **C**ommunication **S**atellite **C**onference) at Rome.

It took place in November 18-20, '97. It was a successfull event and people showed a great interest for this concept.

The download bit rate were the following:

- Interactive Mode: 350-550 Kbps
- Broadcast Mode: 1.5-1.6 Mbps.

6.3. Lessons Learned.

The team has experienced a number of problems solved in the frame of the study. Anyhow these issues must be kept in mind for future similar projects or an eventual extension of ARTE.

DDSC-DMS Link:
A high speed lan is a heavy process in terms of setup and logistic. In fact the Telecom Italia service is very expensive and was half budget of one partner. In term of throughput, the lan was excellent and did not degrade the overall system performance. It is essential for future similar concept to have the service provider co-located at the satellite hub station. If the two machines are not at the same place, the alternative solution is to use the upload directory of the DDSC to download files prior any satellite transmission. Obviously in this configuration, the throughput performance in interactive mode is very poor. The bit rate is limited by the speed capability between the DMS and the DDSC.

Receive PC Card:
The PC card used in ARTE was the first version from SAT-SAGEM and has shown some troubles in term of bit error rate performance and local oscillator stability.
We saw in some cards RF degradations when the hardware was used for a hours. For example, at the start-up, the local oscillator (LO) frequency was set for a correct signal acquisition. In fact after a couple of hours of operation, the BER degraded and the phase lock loop (PLL) lost the lock and the system was unable to demodulate correctly the RF input downlink signal.
The recovery action in this case was to set a new frequency figure for the LO to compensate the frequency drift and get the PLL locked again.
Moreover the receive card driver running on the PC of the terminal was not very "user friendly". In fact, several features very usefull to check the good functionning of the user terminal were missing: such as real time monitoring of the BER, RF input level strenght for antenna pointing, lock status of the different PLLs ...
We know that end of '97, SAT-SAGEM improves its product and now a second generation is available on the market replacing the card used in the frame of ARTE. This card is called "Telsat turbo". The driver was completely re-designed and now includes features like lock status, BER monitoring, RF signal strength. The RF section is also improved.
In fact it would be very interesting to use and test this card in a terminal in a frame of ARTE extension or a similar project.

Broadcast Mode:
The multicast transmission showed some weakness and needs futher works for a commercial use. We experienced mainly the following issues.
The DDSC machine was not running 24 hours but was turned On every day. This was due to a logistic issue at RAI. It was located where the main power was shut-down at night for safety. It means that it increased a little bit the procedure for the daily transmission.
The multicast works in a kind of manual mode. GCS enables the images transmission at the DDCS via remote from Salzburg. The images are sent from the DMS in the upload directory of the DDSC machine.
The files reporting management for multicast mode was not so much accurate and needs more work. In fact sometimes, we had a good reporting and the transmission did not go through, or the files were incomplete.

Obviously the above issues acceptable for a pre-operational phase shall be upgraded for commercial use.

DDSC Definition:
Business and marketing analysis show that the DDSC supporting only the EO service is not economically viable. In fact it design shall be compatible with other services such as: digital packages delivery, multimedia service (video, audio, text, distance learning, sports and financial informations), TurboInternet. It shall be also flexible to have growth capability and to answer to the market demands.

7. CONCLUSIONS

The project has demonstrated the technical feasibility of the DDSC concept for distribution of multimedia information. The team has gained considerable experience with the use of this novel and promising technology.
The specific test case, the access and distribution of Earth Observation images, has proved very representative of the class of services which could be offered by a DDSC.
In an operational service the sub-carrier used in the project (provided the DVB capacity free of charge and giving excellent support to the rest of the team) should be substituted with a SCPC signal, allowing to use antenna dishes of smaller size, and solving the problems related to antenna pointing experienced in the course of the project.

The hardware and software used has shown to provide good performance results during the tests, it proved however to be still not completely mature. Specifically, the DVB decoding cards from SAT-Sagem behaved erratically, although there is now a new version of the card on the market which should have corrected the problems we encountered.
The software used proved to function correctly, however it could gain from the improvement of the multicasting functions.

The marketing and business analysis have highlighted that a number of potential services exist which could benefit from a star infrastructure based on the DDSC. It also has shown that for the DDSC to be profitable, it should not concentrate in the offering of a single service, but should adopt a "kiosk" model, acting as a broker for a palette of services towards the users.

DISTRIBUTION RECORD

Code	Name	Q.ty	Code	Name	Q.ty
	B. PERROT	1		ESTEC	
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	K. GUNTER	1		S. BATTIFERRI	1
	M. LEONI	1		PARS	
	R. GIUBILEI	1		C. DE ANNA	1
				GCS	
				B. NOCKER	1
				RAI	
				R. MORELLO	1