A Real Time Satellite Network for E-Culture Applications

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Abstract — **This paper presents a DVB-S satellite network infrastructure whose main role is the broadcast of cultural events in real time, mainly in the Hellenic area. In addition, the realization and usage of such a satellite network infrastructure is described, as well as how its interconnection with remote parts within the country is feasible. Hence, this paper extends the usage of a digital satellite network platform not only as a television program provider, but also as a Pan-Hellenic coverage network infrastructure (IP over DVB-S infrastructure). The satellite network comprises one transmission base station, one mobile transmission station and minimum ten pilot receiver stations, as well as the satellite itself. Finally, the real time broadcast of cultural events is realized using four synchronous alternative means of video broadcasting, which are divided into real time and non real time and will be discussed in detail throughout this paper.**

Keywords — **DVB-S, e-culture, Internet, IP, Satellite, Video on Demand**

I. INTRODUCTION

Satellite networks technologies and applications have dominated a large proportion of engineer's research and development time during the past few years. This has resulted in their gradual development worldwide, rendering them omnipresent and indispensable telecommunications tools [3]-[6]. This development has a significant effect on global and national economies and infrastructures, simultaneously changing the lives of millions of people. Especially for a small country like Greece, the usage of a satellite network for the broadcast of real-time cultural events, constitutes a major and unprecedented step forward. It must be mentioned that the term broadcast in satellite communications, refers to the transmission of data from a satellite to all receivers within the satellite spot beam.

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Undeniably, the Internet and the World Wide Web constitute a major part of every day life for a vast majority of people nowadays, who use it for a variety of different reasons. The easy access to any kind of information is taken for granted and rightly so. The development of e-services such as e-learning and e-culture [4], are slowly but steadily becoming a global reality. This gives to educational and cultural organizations and institutions the unparalleled opportunity to provide education and cultural information on demand, to the Internet users. It is a common belief that multimedia tools generate a high level of stimulation and attention for the recipient of cultural content. Since they draw the user's interest and hence increase the cognitive ability, it is only natural that the World Wide Web will be used as a common platform, to support electronic services such as e-culture.

This paper presents a telecommunications network that combines satellite network technologies with terrestrial networks such as the Internet, for e-culture purposes. This means, the broadcast of high quality cultural video content via a DVB-S satellite network and the Internet, to all citizens, especially those in remote places of the country as well as foreign citizens and target groups, with respect to the satellite spot beam.

The aim of the presented national satellite broadcasting infrastructure is the diffusion of cultural content from administration to administration and from administration to the citizen so that the mobility, penetration and visibility of the produced cultural product is achieved.

II. TECHNOLOGIES

This section presents and describes the technologies that were used in order to build and fully operate the satellite infrastructure for the real time broadcast of cultural events within the satellite spot beam.

A. The DVB-S Technology

The two most prominent satellite network technologies for broadband services are the DVB-S (Digital Video Broadcasting via Satellite) [5]-[8]-[9]-[12] and the DVB-RCS [10] (Digital Video Broadcasting Return Channel via Satellite). More specifically, the advantages and disadvantages of each are as follows. While the DVB-S technology requires a high cost base station, at the same time, it costs less per bandwidth unit and has a high speed bandwidth (10 Mbps). On the other hand, while the DVB-RCS technology requires a low cost base station, at the same time, it costs more per bandwidth unit and has a lower speed bandwidth (2 Mbps). Moreover, as far as their usage is concerned, DVB-S provides DVB (Digital Television) and IP (Internet) [11]-[13], while DVB-RCS provides only IP with the contemporary MPEG-4 video pattern. When it comes to comparing the two, one could state that DVB-RCS suits the users needs better, while DVB-S is considered the most tried and reliable solution.

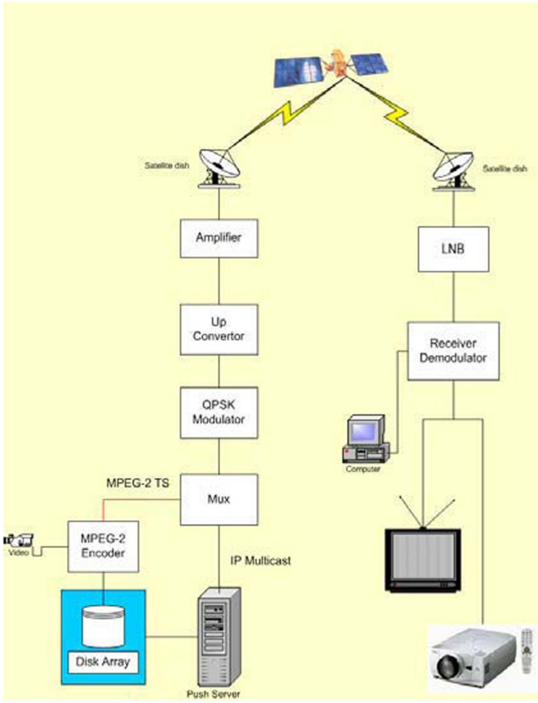


Figure 1: The DVB-S Technology Chain

The real time broadcast is realized with the DVB-S standard. A typical DVB-S chain is depicted in the above Fig 1. The video signal from a video camera is digitized according to MPEG-2, and a digital signal comes out with a bit rate that usually ranges from 3-10 Mbps. This digital signal is led to a multiplexer [1], which has the ability to encapsulate IP packets and provides a transport stream that contains all its input services multiplexed, whether television (MPEG-2) or IP. The transport stream is then led to a QPSK Modulator that creates an intermediate frequency signal at 70 MHz. Following this, the signal is converted to a higher frequency (~14 GHz), it is boosted and is then transmitted to the satellite. There, the signal is converted back to the 12 GHz frequency band, it is boosted again and is then retransmitted back to the earth.

The receiver system comprises the satellite network and the low noise amplifier, commonly known as Low Noise Block (LNB), which converts the signal to the 1-2 GHz band. In the real time transmission, the signal is led to a demodulator-demultiplexer, known as STB (Set Top Box) and from there to a reproduction stage, which can be either a television or a projector depending on the size of the audience.

B. *Video Broadcasting*

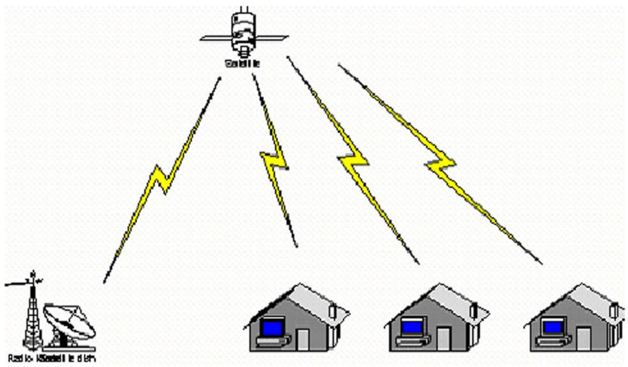
There are four synchronous alternative means of video broadcasting, which are:

1. Video on Demand [14] via the Internet (terrestrial) and reception via satellite for the clients, which are in specific and easily accessed public places.
2. Real time Video Broadcasting via satellite, where anyone with a satellite dish, within the satellite spot beam (either in the Hellenic or other neighboring areas), can tune in and watch the cultural event at the same time that it's being broadcast.
3. Video broadcasting using the "push" technology, where the video content is saved in a hard drive and is then broadcast to the receiver stations, using multicast and IP [2]-[7]-[15] over satellite Link technologies, in specific time.
4. Video broadcasting via the web for all the Internet users, using Real Video and Quick Time technologies for fast real time broadcasting via the web.

Hence, apart from the satellite networks clients who will receive the cultural events with the aforementioned services (1 and 3), with the second service (in real time), all those who are home users of the services, owning a satellite antenna and receiver, will be able to benefit from the network infrastructure and the broadcast of cultural events.

III. ABSTRACT LEVEL DESCRIPTION

This satellite infrastructure allows the video recording of images and sound from venues, where cultural events take place and their broadcast in real time from the main Base Station. Following this, the signal is transmitted to the satellite where it is retransmitted, in order to be received by the remote screening venues. The following Fig 2 depicts a general image of the infrastructure.



Base Station Venue Venue Venue

Figure 2: General Depiction of the Infrastructure

A. *Transmission Base Station*

The indicative architecture of the system will be described next. Initially, the Transmission Base Station, which is depicted in Fig 3, comprises the following units:

The IP Encapsulator, the Multiplexer, the QPSK modulator (DVB-S compliant), which modulates and encodes the satellite data, the Up Converter, the High Power Amplifier (HPA), the transmission antenna, one router and finally two PCs. The Transmission Base Station must have maximum flexibility and maximum exploitation of bandwidth based on the relevant Link Budget.

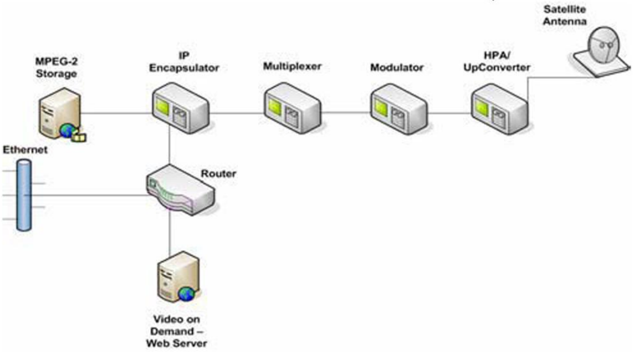


Figure 3: Transmission Base Station

B. *Mobile Transmission Station*

The Mobile Transmission Station, which is depicted in Fig 4, comprises an MPEG-2 encoder, a QPSK Modulator (DVB-S compliant), which modulates and encodes the satellite data, the Up Converter, the High Power Amplifier (HPA), and the satellite antenna. In addition, all the additional audiovisual equipment units necessary for the real time shooting, are included.

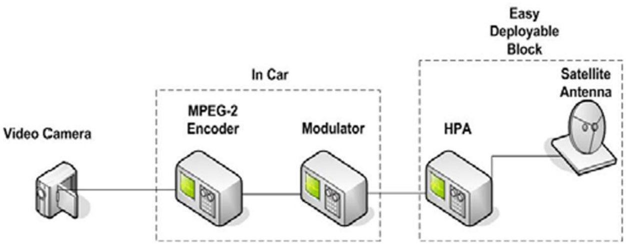


Figure 4: Mobile Transmission Station

C. *Receiver Station*

Each Receiver Station depicted in Fig 5, comprises a satellite dish with diameter 1,2m, the LNB (Low Noise Block), a DVB-S receiver card (PCI or PCMCIA), a PC (Desktop or Laptop) and a video projector (or alternatively a set-top-box). The audiovisual information in DVB-S stream arrives at the receiver and with the use of software for the decoding of the MPEG-2 stream (S/W MPEG2 decoder), the audiovisual content appears on the PC. Additionally, by using the necessary interface the audiovisual content can be led to a video projector.

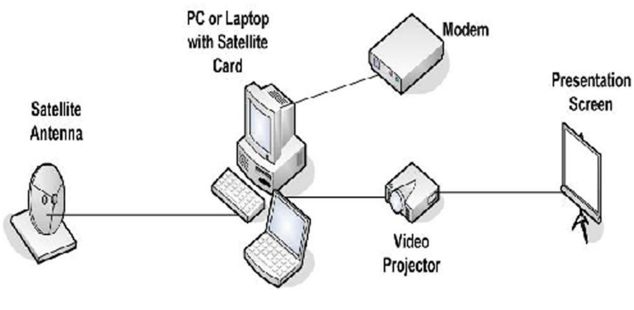


Figure 5: Receiver Station

IV. SYSTEM ANALYSIS

This section will present the actual satellite system and how the video broadcast of the cultural events can be realized, using schematic depictions. As it was mentioned earlier, there are four synchronous alternative means of video broadcasting, which are divided in real time and non real time and are used by this system as follows:

A. *Video on Demand*

As it can be seen in the following Fig 6, the client requests to watch a video via the Internet (terrestrial network). This request arrives at the base station, which transmits the request to the satellite using IP identification so that the specific client only, has access to the video. The client, who is in a specific, easily accessed public place, receives the video stream via the satellite multicast.

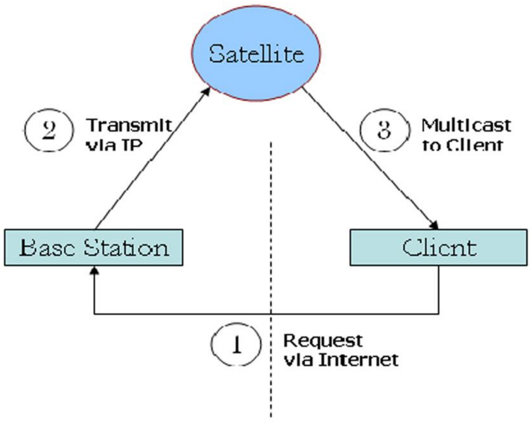


Figure 6: Video on Demand

B. *Real Time Video Broadcasting via Satellite*

In this case, as it can be seen in the following Fig 7, the video image is sent to the satellite directly from the mobile station, which is situated where the cultural event takes place. From there, it is transmitted to the base station. The base station retransmits it to the satellite, which in turn broadcasts it to the client. This way of video broadcasting, enables anyone (whether a satellite network client or not) with a satellite dish, within the satellite radius (either in the Hellenic area or abroad), to tune in and watch the cultural event at the same time that it's being broadcast.

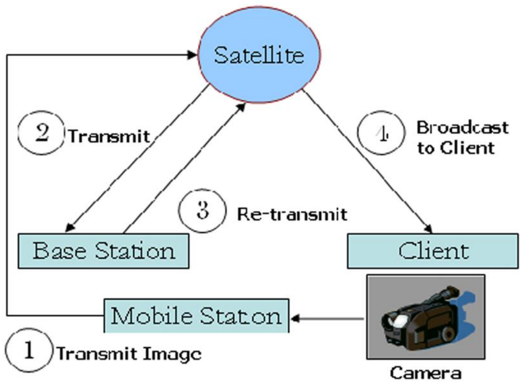


Figure 7: Real Time Video Broadcasting via Satellite

The two aforementioned means of video broadcasting are real time. It goes without saying that since the system supports real time video broadcasting, it also supports the two non real time video broadcasting means, namely, video broadcasting using the "push" technology and video broadcasting via the web using video over IP technologies, which were mentioned earlier in this paper.

V. CONCLUSION

The benefits that Greece gains from a DVB-S satellite network infrastructure of Pan-Hellenic coverage, for the real time broadcasting of cultural events, are various and attractive.

Firstly, the access to cultural events that take place far from where the inhabitants of remote parts of Greece as well as Greek immigrants actually live, is very difficult if not impossible. This DVB-S satellite network infrastructure that was presented and described throughout this paper, enables these people to access, acquire information and participate in these cultural events that take place either in the capital or in other big cities throughout the country. This has an immediate effect on the preservation of the Hellenic identity in the digital era, elevating it to new levels of cultural globalization. The primary beneficiaries are undoubtedly the Hellenic citizens, who have the unique opportunity to improve and strengthen their cultural education and make themselves participants of the Hellenic cultural reality.

Moreover, the Hellenic culture is projected and advertised directly and uniquely, not only to Hellenic citizens but also to Greeks living abroad as well as to European citizens (wherever that is possible depending on the satellite coverage), provided that the user possesses a satellite antenna for his/her television set. This action covers the basic need for extending the geographical boundaries, aiming at the diffusion of Hellenic cultural information abroad and especially to the European Union.

Finally, this introduction of Hellenic culture to the real time broadcasting through modern satellite networks has an immediate effect on the Hellenic economy. Given that even e-culture belongs to the new economy and knowledge society domain, numerous new job positions will be made available, resulting in the gradual decrease of unemployment in the country.

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