IP over DVB-S

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Abstract: - This paper presents the DVB-S satellite network infrastructure that achieves the broadcast of cultural events in real time through a satellite network, in the Hellenic area. In addition, the realization and usage of such a satellite network infrastructure is described, as well as how the interconnection of remote parts within the country is feasible. Hence, this paper distinguishes not only the usage of a digital satellite network platform for the provision of television programs but also as a Pan-Hellenic coverage network 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 achieved 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 the paper.

Key-Words: - Satellite, Internet, DVB-S, DVB-RCS, IP Address, Video on Demand, e-culture

1. Introduction

Satellite networks technologies and applications have dominated a large proportion of the engineer's research and development time during the past few years resulting in their gradual development worldwide rendering them omnipresent and indispensable telecommunications tools [3,6]. This development has significant effect on global and national economies as well as 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.

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 [4] and e-culture are slowly but steadily becoming a global reality, giving education and cultural organizations and institutions the unparalleled opportunity to provide education and cultural information on demand to the Internet users. 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 usage of the World Wide Web will be used as a common platform to support electronic services such as e-culture.

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

The aim of the presented national satellite broadcasting infrastructure is the diffusion of the 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.

2. 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 in the Hellenic area.

2.1. The DVB-S and DVB-RCS Technologies

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 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.

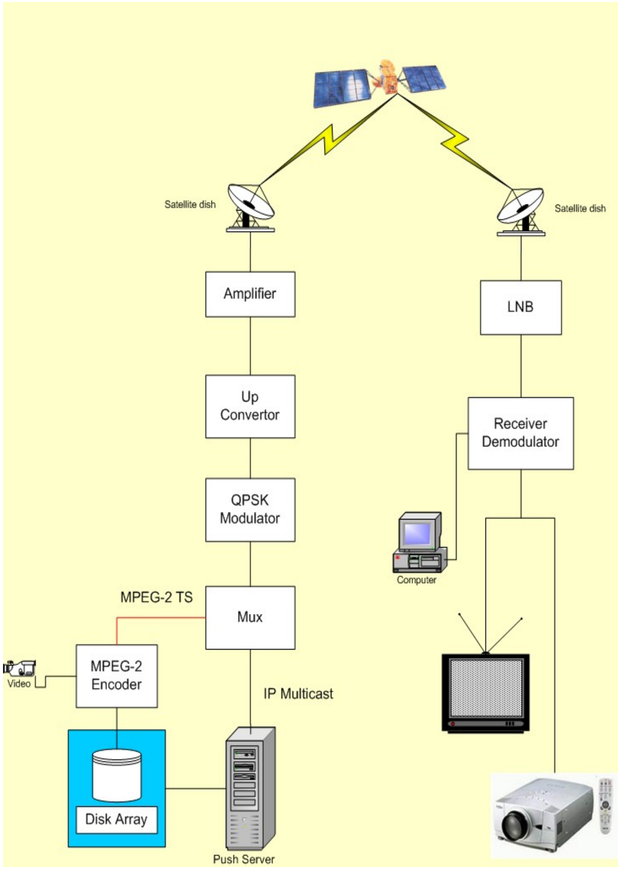


Figure 1: The DVB-S Technology Chain

The real time broadcast is realized with the DVB-S standard. A typical DVB-S chain is depicted in the above figure 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 also 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, this signal is converted to a higher frequency (~14 GHz), is boosted and is then transmitted to the satellite. There, the signal is converted back to the 12 GHz frequency band, 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.

Another technology that can be used instead of DVB-S is DVB-RCS. This technology uses less terrestrial base stations, which are cheaper. The whole communication takes place under the control of a main access point also known as HUB, which belongs to the provider of this service. In addition, this technology provides a limited bit rate (up to 2 Mbps) and has the ability to provide services only over IP. This means that at the receiver end, the signal will be able to be reproduced from a computer only and not by STB. Moreover, due to the limited bit rate, only MPEG-4 encoding is feasible. Finally, it must be mentioned that nowadays there is no DVB-RCS services provider in Greece and hence only the DVB-S technology was used. It is possible though, that in the near future there will be as well as existing providers in Europe extending their commercial activity in Greece.

2.2. Video Broadcasting

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

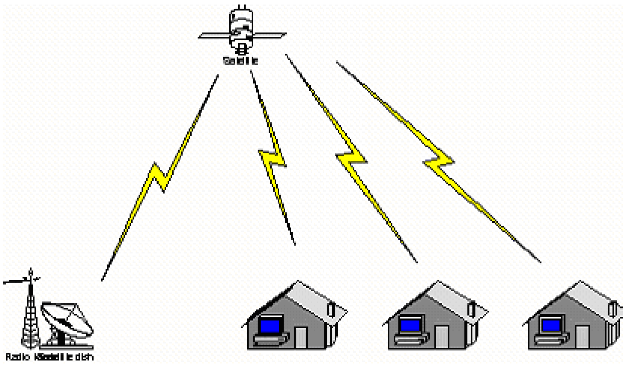
1. Video on Demand [14] via the internet (terrestrial) and reception via satellite for the clients, which are in specific public places with easy access.
2. Video broadcasting via the web for all the internet users, using Real Video and Quick Time technologies for fast – real time broadcast via the web.

3. Video broadcasting using the “push” technology, where the video 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. Real time Video Broadcasting via satellite, where anyone with a satellite dish, within the satellite radius (either in the Hellenic or other areas based on the satellite spot beam), can tune in and watch the cultural event at the same time that it’s being broadcast.

Hence, apart from the satellite networks clients who will receive the cultural events with the aforementioned services (1 and 3), with this fourth 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.

3. Abstract Level Description

This satellite infrastructure allows the video recording of images and sound from the venues, where the 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 figure 2 depicts a general image of the infrastructure.



Base Station Venue Venue Venue

Figure 2: Schematic Depiction of the Infrastructure

3.1. Transmission Base Station

The indicative architecture of the system will be described next. Initially, the transmission base station, which is depicted in figure 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 2 PCs. The Transmission Base Station must have maximum flexibility and maximum exploitation of bandwidth based on the relevant Link Budget.

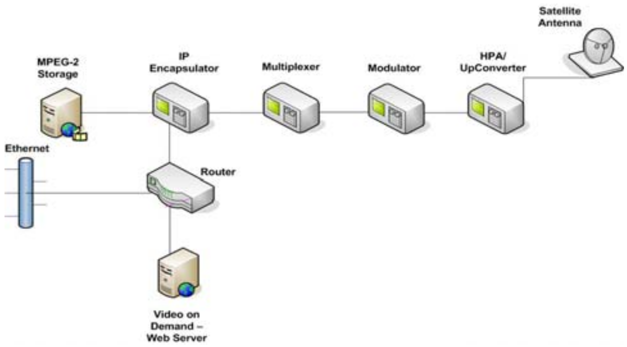


Figure 3: Transmission Base Station

3.2. Mobile Transmission Station

The mobile transmission station, which is depicted in figure 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 video and sound equipment units’ necessary for the real time shooting is included.

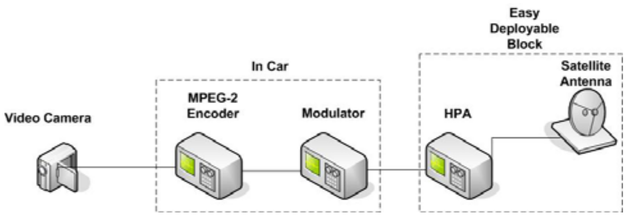


Figure 4: Mobile Transmission Station

3.3. Receiver Station

Each receiver station depicted in figure 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 video and audio information in DVB-S stream arrives at the receiver and with the help of software for the decoding of the MPEG-2 stream (S/W MPEG2 decoder), the video and sound appears on the PC. Additionally, using the necessary interface the video and sound can be led to a video projector.

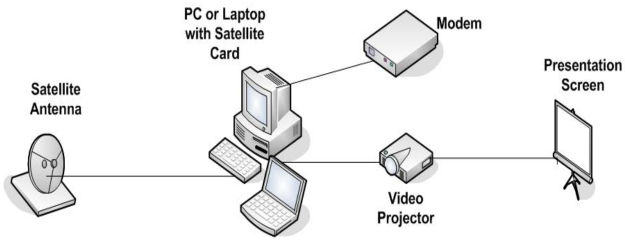


Figure 5: Receiver Station

4. 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:

4.1. Real Time Video Broadcasting

Video on Demand: As it can be seen in the following figure 6, the client requests to watch a video via the Internet (terrestrial network). This request arrives at the base station, which broadcasts the request to the satellite with an IP identification so that the specific client only, has access to the video. The client, which is in a specific public place with easy access for the public, receives the video stream via the satellite broadcast.

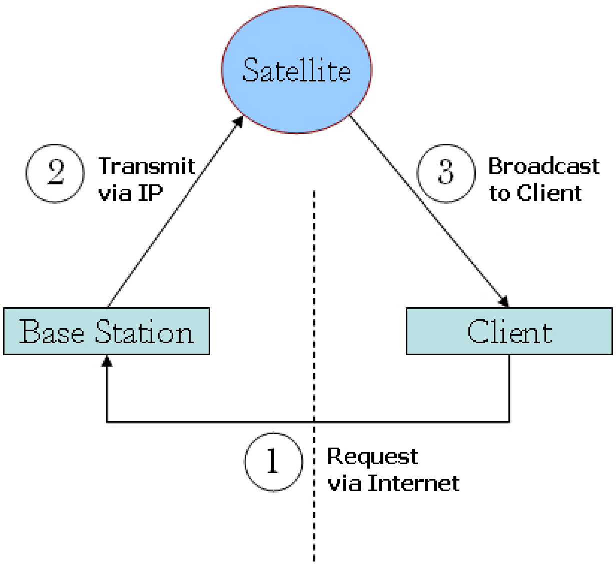


Figure 6: Video on Demand

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

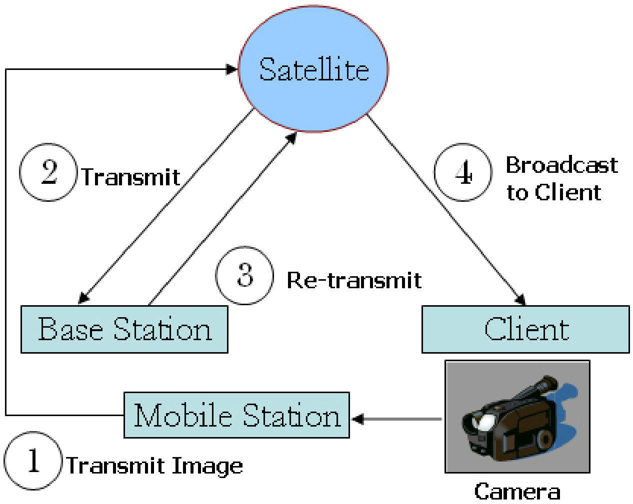


Figure 7: Real Time Video Broadcasting via Satellite

The two aforementioned means of video broadcasting are real time while the following two, which will be analyzed next, are non real time.

4.2. Non Real Time Video Broadcasting

The non real-time broadcast is realized over IP using the multicast technology. With multicast technology [11] data can be transmitted across a network from a single source to multiple destinations simultaneously. The network then makes multiple copies of the data and sends it to the multiple destinations. The main advantage of multicast is the reduced network bandwidth usage, which is very beneficial on satellite systems where resources are limited and expensive.

Video broadcasting using the "push" and multicast technology: In this case, as it is depicted in the following figure 8, the video is saved in a server's hard drive. The user makes a request to the base station, which in turn transmits the video image to the satellite with an IP identification. This signal is then broadcast to the receiver stations using multicast and IP [2,7,15] over satellite Link technologies in specific time.

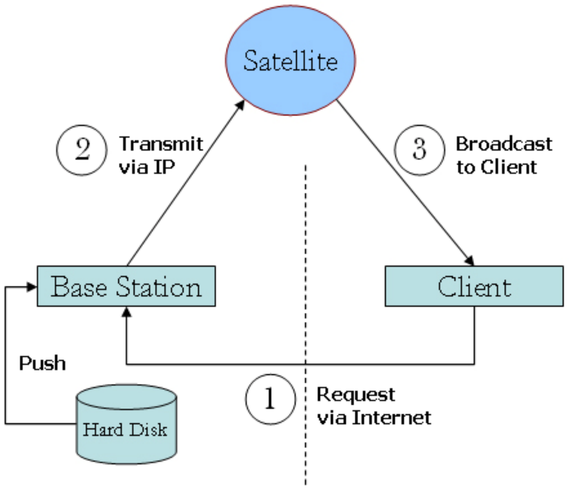


Figure 8: Video broadcasting using the Push and Multicast Technologies

More specifically, the audiovisual content (from the cultural event) is recorded in digital format in the MPEG-2 pattern. The MPEG-2 bit stream is then converted to MPEG-4 format, using the relevant software. This compression format assures a very satisfying quality of video and voice with less bit rates (ranges between 500-1000 kbps). The files that are about to be transmitted in non real time are saved in a relevant folder, in the server's hard drive in MPEG-4 format.

In order to "push" a chosen content to the users, special "push" software is used over IP. This comprises two sections: the server and the client. The former, takes the folders' content and transmits it to a specific number of IP addresses, which correspond to the systems' clients, using the "push" technology. The encapsulation of the multicast packets in the transport stream and in the uplink satellite signal later, allows the reception and storage of the audiovisual content in the users' computer. It goes without saying that the user must have both his/her computer and software on during broadcast time. This way, once the broadcast is terminated, all the users that have chosen this service will have the aforementioned content at their disposal as well as other relevant information stored in their computer for future use.
Video over IP: In this case, as it is depicted in the following figure 9, the Internet user makes a request via the Internet and the base station broadcasts the video signal via the web, using Real Video and Quick Time technologies for fast – real time broadcast via the web.

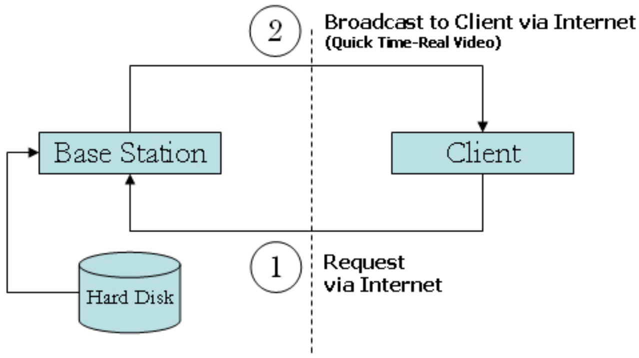


Figure 9: Video over IP

5. Pilot Project

The presented infrastructure was developed under the framework of the Hellenic research program, namely "Real Time Broadcast of Cultural Events through a Satellite Network" that was funded by the General Secretariat of Research and Technology (G.S.R.T.). The projects main objective was the real time broadcast of cultural events using a satellite network to remote parts of Greece and wherever the satellite spot beam permitted aiming at the distribution of cultural information to Hellenic as well as foreign citizens.

6. Conclusions

The benefits that Greece gains from a DVB-S satellite network infrastructure of Pan-Hellenic coverage, for the real time broadcasting of cultural events in easy access public places such as theatres and cinemas, are various and attractive.

Firstly, the access to cultural events that take place far from where they actually live is very difficult if not impossible for the inhabitants of remote parts of Greece as well as for the Greek immigrants. This DVB-S satellite network infrastructure that was presented and described throughout this paper, enables these people to have access, get informed and participate in these cultural events that take place either in the capital or in other big cities throughout the country. This has immediate effect in the preservation of the Hellenic identity and culture 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 content.

Moreover, the Hellenic culture is projected and advertised directly and uniquely, not only to

Hellenic citizens but also to Greeks living abroad and Europeans (wherever that is possible depending on the satellite coverage), provided that the user possesses a satellite antenna for his television set. This action covers the basic need for extending the geographical boundaries aiming at the dilatation of the Hellenic cultural information abroad and especially to the European Union.

Finally, this introduction of the Hellenic culture to the real time broadcasting through modern satellite networks has immediate effect in the Hellenic economy as numerous new job positions will open resulting in the gradual decrease of unemployment in the country.

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