INTERNET VIA SATELLITE FOR A VIRTUAL PANEL OF EXPERTS
INTERNET VIA SATELLITE PER UNA TAVOLA ROTONDA DI ESPERTI

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Abstract

Accessing the Internet using an Internet via satellite connection is still an emerging technology. The most critical problems range from high costs to slow terrestrial uplink and transmission delays. Many forecasts on the spreading of this access mode have failed: there are not yet sufficient customers to pay back the huge investments. Low earth orbit (LEO) satellites should provide better performances compared to the geostationary (GEO) ones, but they will not be soon in full operation. Moreover theoretical technical problems still have to be solved in practical tests. Meanwhile ground based technology, including wireless, such as UMTS, may fill all the needs and leave just a niche market to satellite IP.

We describe a two years experience with two different Internet via satellite providers aimed at developing applications for telemedicine and tele-education. The failures in achieving some of the initials goals have generated a new application for conducting panels of experts located in different places with a large geographically disperse audience.

L'accesso a Internet via satellite è ancora una tecnologia emergente. I punti critici vanno dai costi elevati alla lentezza del canale di ritorno terrestre, oltre ai ritardi di trasmissione. Molte previsioni sulla diffusione di questa modalità di accesso sono fallite: non c'è ancora un numero di clienti sufficiente per rimborsare gli ingenti investimenti. I satelliti a orbita bassa (LEO) dovrebbero fornire prestazioni migliori rispetto a quelli geostazionari (GEO), ma non saranno operativi in tempi brevi. Inoltre problemi teorici devono ancora essere risolti in test sul campo. Nel frattempo le tecnologie terrestri, incluso quelle senza fili, come UMTS, possono soddisfare tutte le necessità e lasciare solamente un mercato di nicchia all'IP via satellite.

Descriviamo un'esperienza biennale con due diversi fornitori di servizi Internet via satellite, con lo scopo di sviluppare applicazioni per la telemedicina e la teleformazione. L'insuccesso nel raggiungere alcuni degli obiettivi inizialmente proposti ha generato una nuova applicazione per gestire tavole rotonde di esperti collocati in posti diversi con un ampio pubblico geograficamente distribuito.

1. INTRODUCTION

A couple of years ago we started working with IP technology over DVB using two different providers, namely Telecom Italia (IperSpace platform through Eutelsat HotBird) and ESA-ESTEC (MOSES project through Eutelsat W3). Our initial goal was to test a set of IP-based applications to evaluate their performances and apply them to telemedicine and tele-education. The final purpose was to find the so-called *killer application*, which may boost the Internet via satellite market, by leveraging on the advantages given by a wireless and virtually borderless distribution.

Television broadcasters mainly drive today's satellite market, while mobile telephony is struggling to survive after some companies failed. Providers of IP over DVB are offering a choice of services but revenues are still small compared to the large business of terrestrial providers.

Two-way IP satellite may be an interesting option for true mobility, especially in places where telephone lines are not available or are limited to low speed. But SES Astra-Net (Société Européenne des Satellites: www.astra-net.com) failed to open its service in the first quarter of 2000 as promised in September 1999 and postponed commercial services for 2001. Gilat (www.gilat.com) already offers SkyBlaster, but the satellite return channel is limited to a maximum 153.6 Kbps. A small number of other companies are announcing similar or better services due in 2001, on the Ka-band. These operators are all using geostationary (GEO) satellites, which have a main limitation: distance from earth is too long, therefore the standard TCP transmission has around half a second delay [All 97]. The low earth orbit (LEO) constellation of satellites is growing day by day, but the first commercial service, only for telephony, failed for lack of customers. Iridium's bankruptcy in March and ICO partial failure in April pose many questions on the future success of Teledesic, by Motorola, Lockeed Martin, Bill Gates, Boeing and a few other investors. Initial plans were to be ready for 2002, but now they announce 2004 as the beginning of worldwide service. Globalstar, Hughes and Astrolink are other runners in the race. There are a number of theoretical problems in LEO satellite management, especially in the routing mechanism to pass the connection from one satellite to another. Solutions still have to be tested thoroughly on the field with high traffic. Failures in launching, due to rockets explosions, and former USSR space centres problems are also making the whole business less reliable.

Inmarsat seems the only successful company on the market, maybe because it started operating long ago with plain telephony at affordable costs. And now it is launching an interactive service for mobile multimedia systems called Horizon, with medium data rates, between 144 and 400 Kbps.

Multicasting is surely the most promising technology for the IP satellite market. High speed browsing, which uses TCP, can effectively reach only around 500 Kbps on the Internet via GEO satellite, and therefore it has been overwhelmed by xDSL technologies. On the other side, IP multicasting is not yet widely available on ground connections and is not supposed to be effective in a few years because it needs a complete renewal of routing infrastructure [Law 98].

Tele-education and telemedicine are just two of the fields in which an interactive satellite connection may prove to be effective. But not all applications are equally valid on the GEO platforms: real time interaction is affected by delay on TCP connection, while streaming media on UDP can use better the large bandwidth provided.

2. MATERIALS AND METHODS

2.1 Hermes platform

The first platform we used is based on the Telecom Italia IperSpace infrastructure with some modifications to comply with the European Space Agency funded Hermes project. The system works with a satellite downlink using a 60 cm dish, and an ISDN 128 Kbps uplink, calling directly the service provider centre in Rome. Users are located all over Europe in groups dealing with telemedicine or tele-education. "Campus Bio-Medico" University of Rome is in charge of integrating into the platform existing database services of 2D and 3D medical images.

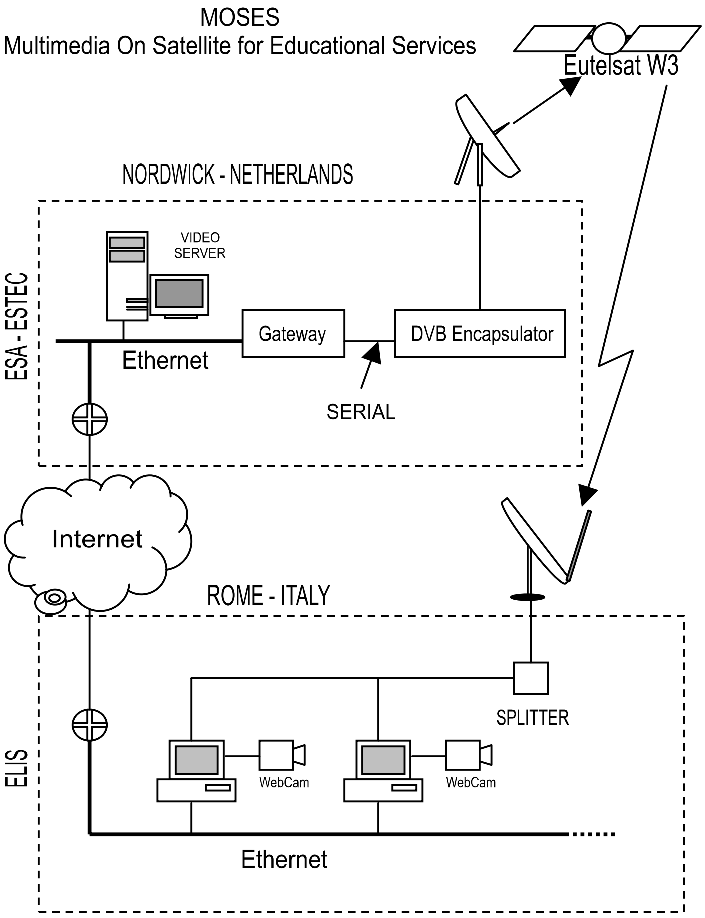
For technical reasons, the achieved transmission speeds are around 80 Kbps for the uplink and 500 Kbps for a TCP connection. Using UDP we reached nearly 2 Mbps [Cru 99].

We tested streaming video, using both RealSystem's RealVideo (www.realnetworks.com) and Microsoft's WindowsMedia (http://www.microsoft.com/windows/windowsmedia). RealVideo was able to transmit unicast packets at its maximum speed of 1024 Kbps, using RTSP. WindowsMedia version 4.1 still has the same limitation we reported last year [Cru 99], that is limiting to around 40 Kbps in unicast mode using MMS. Using multicast mode, WindowsMedia achieved 2 Mbps. We believe it is a sensitive mechanism of MMS protocol, which interprets the acknowledgment delays as low bandwidth connection to the WindowMedia server. It seems to be related to the ISDN uplink through which the acknowledgment packets pass.

Satellite bandwidth is always shared among all users of the IperSpace platform. Therefore actual performance depends on traffic. Reserved bandwidth is very costly because it is only available 24 hours a day: it cannot be bought for a few predefined hours.

2.2 MOSES project

For the Multimedia On Satellite for Educational Services (MOSES) project we used an asymmetrical scheme with ground Internet as a return channel. Therefore speed is variable, depending on the traffic through the routers connecting ELIS in Rome to ESA-ESTEC in the Netherlands. The allocation of satellite bandwidth is organized by an hourly-based reservation mechanism among all users of this research platform (http://uplinkdvb.estec.esa.nl). The scheme is shown below.



The platform uses a DVB encapsulation of IP packets that are transmitted over a transponder on the Eutelsat W3. The DVB link is located just outside of the ESA-ESTEC multimedia laboratory in Nordwick, Netherlands.

Testing RealVideo gave even better results than in Hermes, reaching 1.6 Mbps by aggregating more video streams using SMIL on RTSP. This is due to the higher satellite bandwidth available during the tests. With WindowsMedia the MMS protocol on unicast transmission did not show the mentioned limitation: we tested it at over 300 Kbps.

The ground link is not multicast enabled, but we could use the Java application mTunnel [Par 97] to transport multicast packets, originated by WindowsMedia server, over the public standard Internet. One instance of mTunnel runs on a PC in the ELIS LAN and another instance runs on the video server in the ESTEC LAN. The two computers act as gateway for the multicast flow between the two LAN's. Multicasting WindowsMedia was tested at 400 Kbps.

Using two soundboards we were able to retransmit in multicast mode over the satellite an IP H.323 multi audio conference based on Lipstream (www.lipstream.com) technology. The streaming video server was also used to multicast over the satellite a video source coming from an H.320 hardware based multivideoconferencing system.

2.3 Multivideoconferencing

Our tests on the Hermes platform using CUseeMe multivideoconferencing system, called MeetingPoint 3, have failed in providing an acceptable quality in both audio and video. The reflector software allows continuous presence, that is all users are able to see all the others at the same time and anyone can take the floor when desired. Routing problems seem not to allow an optimal use of the satellite bandwidth: most of the transmission is through the ISDN line, which is limited. Proper tuning of the CUseeMe client version 3 is always required, adjusting for the same codecs in order to lower the computational burden. Version 4 of the client, called CUseeMe Pro, is too CPU hungry and was not able to perform normally on the Pentium II 400 we were using.

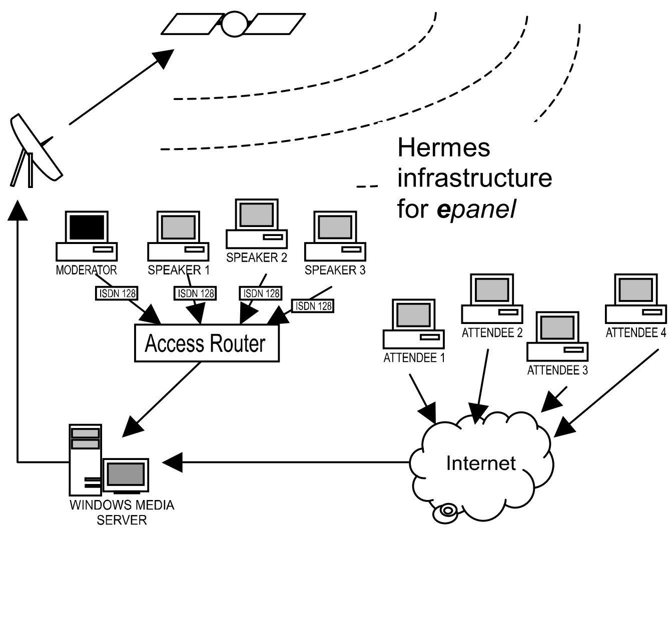
Poor video and interrupted audio when more than two users were connected did not provide a usable environment for the project pilot operations.

We plan to test the recently released MeetingPoint 4, which enhances support for H.323 and allows different software clients beside the proprietary one.

2.4 The *ePanel* application

In order to find an alternative to multiconferencing for telemedicine and tele-education purposes, we developed a new application called ***ePanel*** with the experience gained in MOSES trials. Our goal was to give any user of the Hermes project the capability of transmitting and receiving video, audio and graphics among all users, making the best use of the satellite bandwidth. We started from the positive results of streaming media and multicasting tests. Multicasting keeps the bandwidth requirement independent from the number of concurrent users. We chose WindowsMedia Server because it is freely available, while RealSystem's multicasting option has a high licensing cost.

The general connection scheme for the ***ePanel*** on the Hermes platform is shown below. We developed three different service modalities in order to address different needs.



The *Seminar* mode is a one-to-many lesson. The speaker is the only one talking, while all attendees are watching and listening. There is no limitation on the number of listeners. The speaker can show slides or static web pages and everyone watches them in a window different from the running video. The listeners may ask questions by writing on a text box.

The *Panel* mode also targets to a wide audience. The typical scenario is that of a group of experts discussing about a topic, while a group of people is listening and watching the one speaking. Very little interaction is allowed for the attendees, who may only write simple questions. When a speaker ends his or her talk, he or she gives the floor to the next, who is automatically enabled according to a predefined schedule. A moderator can change this schedule if needed. The speaker can show slides or static web pages as in the *Seminar* mode.

The *Workgroup* mode is restricted to a small number of users, typically less than six, who want to share some computer applications in order to discuss with the others on the material shown by the application.

e*Panel* interface

After login into the network, the user can choose whether to send his or her audio and video using 20, 40 or 70 Kbps. We have the constraint of 128 Kbps for the uplink, but not more than 80 Kbps can be transmitted. Obviously, ***ePanel*** can be used with any bandwidth, reaching its best results when a medium level band, around 150 Kbps, is available for displaying a 15 fps video of 288x216 pixels on a 1024x768 monitor. The critical point is having a guaranteed uplink speed in order to keep a constant quality.

The interface is shown aside.

Below the video frame, which starts automatically when the allowed speaker begins his or her talk, there is a textual chat for a quick interchange of information and for questions. The allowed speaker may also activate the console from which he or she can push local images or any external URL. Typically the speaker chooses the files from his or her local network and uploads them to the remote server, which is the same hosting the WindowsMedia system: this can be done before the virtual meeting in order to save time. These uploaded files appear on a list and can be selected, one at a time, to be *pushed* to the server. Each listener's browser periodically and automatically scans the server to check whether a new resource has been *pushed* for showing, and retrieves it. If a URL is to be shown, the speaker writes it in the upper text box and *pushes* it to the server. Similarly to image files, the listener's browser executes it locally using its own satellite bandwidth. This results in a very fast retrieval even though it is in unicast mode. The URL can be a HTTP, FTP or even a RTSP which calls a RealVideo file that can be run, without audio, concurrently with the running talking window: it is the case of a 3D animation.

The listeners receive the audio and video stream after ten seconds. This is due to the buffering mechanism of the WindowsMedia server through which it preserves quality also when the bandwidth fluctuates. This is important because the bandwidth for video and audio is shared with the uploading data and eventually the shared application. The MediaPlayer client is set to buffer only one second in order not to add other delay.

For sharing applications we produced a stripped down version of Microsoft's NetMeeting, allowing only sharing, whiteboard and file transfer. Therefore the application does not conflict with the audio and video run by WindowsMedia. In order to minimize costs and management, we did not use any central reflector server hardware or software, like the CU-see-Me MeetingPoint. The same NetMeeting client installed on the ***ePanel*** server can host a meeting, being a conference manager. All the users wanting to share applications call the same location, namely the IP of the ***ePanel*** server. The speaker can allow other participants to take control over the application.

3. RESULTS AND DISCUSSION

The ***ePanel*** application is under test among the users of the Hermes project. Its application is not limited to telemedicine, but can be expanded to any topic in which a panel of expert is required to discuss in (virtual) front of a wide attendance.

The requirements for the experts' locations are minimal: a standard multimedia PC equipped with a webcam and a DVB card for receiving, plus an Internet connection with a guaranteed bandwidth for the uplink. Normally this is accomplished through a direct ISDN dialling or through a leased line. For this purposes, we are also experimenting with Telecom Italia the new Quality of Service Internet connection based on CISCO 2600 routers, named Videonet.

The attendee's platform does not require the webcam. The Internet connection can be through any provider. If no interaction at all is needed, the connection can be closed after starting the multicast transmission. In this case only audio and video will be received via satellite and no still image or chat.

The *Seminar* mode is the simplest one and has the best acceptance for its fast set up. The only perceived difficulty is the ten seconds delay between the speaking person and the listening ones. The pushing of images or sites is often faster; therefore a slight lack of synchronization can be annoying. The solution is training the speaker not to change images too fast, leaving them shown for a few seconds after completing their explanation.

The *Panel* mode is the most interesting one because it allows a teleconsultation among various physicians in different places, watching the same case: images, texts, animations, and videos. There are a number of improvements to make for example faster the cutting and pasting of the URL to be shown.

In the *Workgroup* modality the ten seconds delay produces a lack of synchronization with the application-sharing tool, which is almost in real time. The speaker is therefore requested not to move too fast around the application. This is a critical point, which could be solved by avoiding the use of NetMeeting, if WindowsMedia 7 will deliver live screen capture using very low bandwidth, as planned by Microsoft. In this case the application could be only shown, but the other participants would not be able to take control.

The CPU is a critical point when listening, transmitting and sharing applications at the same time. The standard Hermes platform is based on Pentium II 400 with 256 MB RAM, which was the high level standard PC when the project started. Any Pentium III now performs better, but requires at least the same amount of RAM.

4. CONCLUSION

The IP transport over satellite seems to be a cost effective solution only when many users are addressed, in order to spread the cost. Minimizing the human work done by the service provider can be another means of saving money. The ***ePanel*** use of multicasting shares the satellite bandwidth among all clients independently of the number of users and moves the administration of a session from the service centre to any client station. If we compare it to the typical ISDN multiconferencing it means that any little trained user could be to manage the MCU, which is normally quite complicated. But in the ***ePanel*** application the situation is even better: there is no need for specialized hardware like the MCU, because a computer server is sufficient with proper software.

Satellite Internet will gain its market share if it succeeds in providing solutions at affordable costs addressing situations where ground connections are weak. It is not just a matter of having more bandwidth. Competitors like optical fibres, xDSL or UMTS solve the broadband problem better in ground and wireless connections. A sentence by Bob Metcalfe late in 1997 is still valid: "If you do the arithmetic, the satellites won't "win" against optical fibers, because the capacities are orders of magnitude out of whack. That doesn't mean they have to win. We're going to see satellites being very useful for broadcast applications, for highly mobile applications, and for highly remote applications. But you're not going to eliminate optical fibers with satellites" [Met 97].

5. ACKNOWLEDGMENTS

We thank Francesco Feliciani of ESA-ESTEC for providing us the facilities for testing our applications on MOSES.

We thank Flavio Fulciniti for writing part of ***ePanel*** code and for the help in running the final tests.

Hermes project is run by Telecom Italia, Citec S.p.A. and Consorzio Nettuno with funding by ESA-ESTEC under the ARTES3 framework.

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