Triple Play Services Delivery over a DVB-S2 Satellite Network

Georgios Gardikis, Nikolaos Zotos and Anastasios Kourtis

***Abstract*— Digital satellite broadcasting, primarily targeted to unidirectional services, soon expanded to the interactive domain, utilising uplink technologies such as DVB-RCS. In this context, due to their wide and uniform coverage, satellites can provide an ideal medium for the provision of triple play services (voice, video and data) to remote areas not covered by terrestrial infrastructures. This paper discusses and demonstrates the delivery of triple play services over a fully functional platform utilising the second-generation satellite broadcasting technology (DVB-S2) for the downlink combined with DVB-RCS for the uplink.**

***Index Terms*— interactive satellite broadcasting, triple play, DVB-S2**

I. Introduction

THE widespread adoption of satellite links as carriers of integrated digital services, combined with the development and launching of novel infrastructures, equipped with broadband transponders and state-of-the-art signal processing capabilities, have accented the role of the satellite technology, mostly based on DVB-S, as an efficient end-to-end communication medium, targeted not only to network and TV operators, but also to end consumers [1]. The use of satellite infrastructures is necessary in cases where terrestrial solutions are proved inadequate, for instance in isolated, rural and less developed areas or in when a large coverage area is required.

Since the introduction of DVB-S, many technological advances have been achieved in the areas of satellite broadcasting technologies. The interaction protocol (DVB-RCS) [2] provides a standardized and efficient solution for the satellite return channel, thus allowing for the delivery of interactive services. Also, the recent second version of the DVB-S specification (DVB-S2) [3], which seems to be the most promising solution in satellite communications, features many improvements over its predecessor, including efficient support for data services, near-optimal coding schemes and Adaptive Coding and Modulation (ACM).

The combination of DVB-S2 and DVB-RCS constitutes a very efficient interactive access platform for IP-based satellite applications [4]. In this context, a very promising approach is this of the migration of triple play services (i.e. TV/video, data and voice telephony) to the satellite sector. Triple play is today offered mostly via terrestrial wired access infrastructures, like xDSL. There exists, however, a considerable percentage of customers living in rural/isolated areas which are not covered by terrestrial infrastructures. The same holds for customers on the move, such passengers as in trains, airplanes or ships. For all these cases, the satellite access solution is very promising for the delivery of ubiquitous broadband integrated services.

In this context, this paper presents the design and development of an interactive satellite access platform based on DVB-S2/RCS and equipped with the appropriate modules for the provision of video, voice and data streams to remote nodes. Service distribution from the satellite node to nearby customers is performed via a WiMAX infrastructure. A real on-air validation is carried out, via the HellasSat II satellite.

This paper carries on as follows: Section II presents the principles and benefits of DVB-S2 networks and discusses the nature of satellite IP-based triple play services. Section III describes the architecture of the implemented network and refers to the integration / validation process. Finally, Section IV concludes the paper.

II. DVB-S2 and Triple Play

Following the worldwide dominance of the DVB-S specification, ETSI proceeded in adopting its successor, which was designed after extensive research. DVB-S2, featuring optimal turbo coding along with per-stream adaptive coding and modulation, enables for significant improvements in satellite communications. DVB-S2 promises to improve transmission performance and add flexibility to existing broadcasting networks. DVB-S2 is intended to replace DVB-S in the forward link of next generation broadband satellite systems.

With the aim of promoting terminal cost reduction, DVB-S2 has been conceived as a single standard for addressing different application areas and market segments. The new standard owes its flexibility in the adoption of advanced coding and modulation schemes. DVB-S2 features a FEC system based on LDPC (Low-Density Parity Check) codes concatenated with BCH codes, which enables Quasi-Error-Free operation at about 0,7dB to 1 dB from the Shannon limit, depending on the transmission mode (AWGN channel,

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modulation constrained Shannon limit). Furthermore, DVB-S2 includes higher order modulation schemes (QPSK, 8PSK, 16APSK, 32APSK). The combination of the above coding and modulation schemes, may offer a 30% increase in spectral efficiency over DVB-S, for all the above-mentioned application areas.

Finally, support of individual quality-of-service targets has been recommended for interactive applications. For the latter case, no recommendation is included in the DVB-S and DVB-S2 standards, as far as the return path is concerned. Therefore, interactivity can be established either via terrestrial connection or via satellite. DVB offers a variety of return link specifications, such as for example via satellite (DVB-RCS), via PSTN/ISDN (DVB-RCP), via GSM (DVB-RCG), and via cable (DVB-RCC). This paper utilises a DVB-RCS return channel to implement a fully interactive satellite-based broadband access infrastructure.

Since the infrastructure presented in this paper is IP-enabled, it can offer a "bouquet" of multiplexed IP heterogeneous streams, to constitute a triple-play environment:

-- *Digital Television over H.264/MPEG-4.* MPEG-2 has been for more than a decade the standard for digital satellite television. However, recent advances in coding techniques have come up with technologies which are remarkably more effective.

The MPEG-4 standard (ISO/IEC 14496) defines an audiovisual coding standard to address the emerging needs of the interactive and broadcasting service models as well as the needs of the mixed service models resulting from their convergence. Taking MPEG-4 a step beyond, MPEG and ITU created the even more efficient H.264 or MPEG-4 Part 10 Advanced Video Coding (AVC) codec.

Exploiting these advances, digital satellite TV can be provided over the H.264/RTP/UDP/IP multicast protocol stack, resulting in a 50% bandwidth saving over legacy MPEG-2.

-- *VoIP Telephony.* Despite all advances in broadband multimedia communication, the plain, PSTN-like voice conversation is still essential to everyone. A triple play satellite platform offers the capability to extend the coverage of the earth telephone network to remote areas, even where the mobile PLMN service is unavailable. Instead of using proprietary audioconferencing technologies of questionable effectiveness, open and widely adopted protocols (H.323/SIP) are preferable.

-- *Data (Internet) access.* Internet access has always been the main service offered by DVB-based interactive satellite networks and is an essential part of a triple play "package". A dedicated firewall/proxy can be utilized for interconnecting the satellite provider platform to the Internet and to other wired or wireless IP local networks. User-to-user data exchange is also possible, although with high delay, due to the double-hop connection. In all cases, standard TCP acceleration techniques can be employed with positive impact to the performance of the connection.

Last but not least, since in a satellite downlink all streams from heterogeneous services are multiplexed in the same bouquet, a resource management mechanism is essential to provide the per-stream required QoS. Multicast DTV streams must be delivered with as low losses as possible, whereas in the voice traffic, delay and jitter must be kept to the minimum. On the contrary, Internet (TCP) traffic can be assigned to the lowest QoS requirements.

III. An Infrastructure for Efficient Satellite Integrated Services

Based on the aforementioned issues, a satellite integrated services access solution has designed and realized in the frame of IST IMOSAN project [6], which constitutes a complement and an extension to triple play terrestrial platforms in the cases where the latter are proved inadequate. The developed system, whose overall architecture is depicted in Fig.1, provides a flexible and viable broadband communications path for individual users and small wired or wireless local networks which are geographically isolated or, in general, are in a condition which prevents them from connecting to terrestrial network infrastructures.

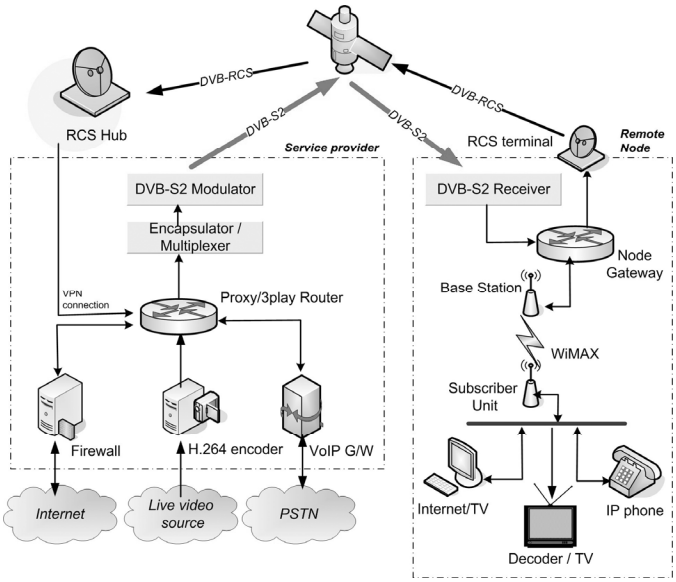

Fig. 1. The developed satellite infrastructure for triple play services

The platform is based on a DVB-S2 communication chain (IP-to-DVB Encapsulator, Multiplexer, Modulator) and a remote (commercial) DVB-S/RCS Hub which collects the uplink data. A VPN (Virtual Private Network) tunnel from the remote Hub feeds the data into the provider platform. There, a Proxy/3play Router feeds the triple play streams (destined to the end users) to the Encapsulator for processing and transmission, and routes appropriately the IP datagrams which arrive via DVB-RCS from the users' sites. The Encapsulator/Multiplexer operates in compliance to [5] and

treats each traffic stream individually and can apply different queuing priorities to each service.

Video streams are served by a real-time H.264 encoder fed by a live source, and a VoIP Gateway utilising H.323/SIP acts as an interface to the public PSTN network. Internet connections are firewalled and served via a Web proxy.

At the remote node, since integrated DVB-S2/RCS terminals are not fully deployed, reception and transmission is undertaken by two separate modules – a DVB-S2 receiver and a separate, standard DVB-RCS terminal. A Node Gateway undertakes the routing and the policing of the traffic within the node. Each node can serve one or more users, and distribution of services can be done by any LAN or MAN technology. In our platform, a WiMAX infrastructure is used to connect the end users to the satellite node, as shown in Fig.1. At the user site (featuring a WiMAX Subscriber Unit), integrated services are presented using separate devices: a VoIP phone, an H.264 decoder/TV screen and a standard PC with a Web browser for the voice, video and service respectively.

The platform was tested in a real scenario during a 2-hour transmission via the HellasSat II satellite. A single customer, located near the remote satellite node, received triple play services via its WiMAX SU. For the DVB-S2 downlink, 18 MHz of satellite bandwidth were used, utilising 8PSK modulation and code rate of 3/5. For the uplink, the HellasSat commercial RCS infrastructure was exploited. Web access was satisfactory despite the increased response time, and voice connection was validated via a standard call to an external PSTN number. A live TV feed was served via the H.264 encoder, over multicast IP, and presented at the user's decoder.

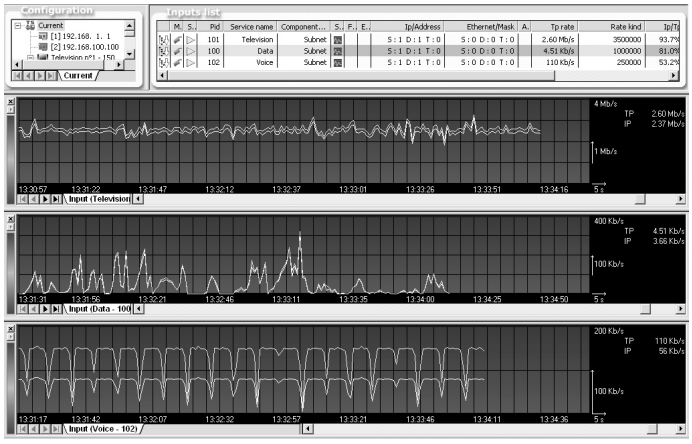

Fig.2. The satellite triple play multiplex, as monitored in the DVB-S2 Multiplexer; per-service traffic view (video, data, voice).

Fig. 2 depicts a screenshot from the GUI of the DVB-S2 Multiplexer, where the three different service streams are combined into a single Multiplex. The upper graph shows the video traffic (CBR H.264 multicast at 2.5 Mbps), the middle corresponds to Web access, and the lower shows the voice-related activity (a single voice call at 64kbps). In each graph, the lower line corresponds to the actual IP bit rate whereas the upper shows the bit rate measured after encapsulation (at MPEG-2 TS level). The difference between the two is most observable in the voice case, where the use of small-sized IP packets results in a relatively high overhead inserted by the encapsulation procedure.

IV. Conclusions

The provision of integrated services over satellite provides a promising and viable solution in cases where fixed terrestrial access is not applicable (e.g. in remote/rural areas or in mobile use). The exploitation of the newly standardised DVB-S2 technology -which has been designed taking interactive services into consideration- adds efficiency and flexibility. This paper proposed and implemented an infrastructure for the provision of triple play services (voice, video and data) over a DVB-S2/RCS network, in an all-IP environment, featuring Web access, interfacing with the public PSTN network for voice calls and encoding/re-transmission of live TV feeds using H.264. The operation of the platform was validated in a real on-air trial over the Hellas Sat II satellite. The infrastructure proposed provides a quite efficient solution and, when optimised and combined into a single commercial platform/solution, is bound to add a new dimension to satellite-based communications.

Acknowledgment

The design and implementation of the DVB-S2/RCS platform for triple play services provision is being carried out in the frame of the EU-funded IST IMOSAN research project (Integrated Multi-layer Optimization in broadband DVB-S.2 SAtellite Networks). IMOSAN will also study issues concerning per-service multi-layer optimisation, exploiting the ACM (Adaptive Coding and Modulation) features of DVB-S2.

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