Optimal Bandwidth Allocation for DVB based Networks

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1. Introduction.

Nowadays, the actual trend in the market is the convergence of networking infrastructures and the integration of fixed, mobile and broadcasting technologies, in order to create a new environment, that will enable citizens to access IST services wherever they are, whenever they want. The current trend and the challenge is to provide to end-users a variety of services (TV programs, Internet, multimedia applications, etc.) through wireless infrastructures.
This new convergence situation will lead to the design and development of tools, systems and platforms handling in optimised way different types of services. In need, the merging of TV, Internet and multimedia data flows imposes to assign resources with consideration of the requested quality of service. It is clear that the main advantage of using digital transmission for audio-video services has been and will be the ability to use less bandwidth and infrastructure for reduced operations expenses per program.
The presentation will analyse the problems related to the bandwidth utilisation in DVB based networks and will propose the solutions and an architecture for customised dynamic spectrum allocation. The goal is to optimise the bandwidth allocation for every DVB and/or IP service.
Furthermore, the presentation will elaborate on the convergence and synergy of DVB and IP based networks, not only in technical level, but also in the provision of services. In this respect, it is focused on the co-operation of various types of networks like DVB, UMTS, GPRS, WLAN, DAB and the investigation on the possible network configurations that are able to provide special types of services according to end-users' requirements. The presentation includes the description of the concept and the network architecture of three IST projects, namely MAMBO, SOQUET and REPOSIT, respectively.

2. MAMBO (Multi-Services Management Wireless Network with Bandwidth Optimisation) project.

The MAMBO project elaborates on three areas: First in the development of a re-multiplexing kernel which is able to multiplex all kind of services : DVB, IP etc and generate DVB and IP bouquets of services, according to the available bandwidth. Second, in the development of a distributed feedback loop bandwidth optimisation mechanism, which is able to adapt in real time, the bit rate of each service according to the available bandwidth and the complexity of the service, without degrading the service quality. Third in the development of an interactive broadcasting environment (network convergence) targeted to three configurations:

- DVB-T broadcasting downlink and WLAN return channel for residential end-users
- DVB-T broadcasting downlink and GSM/GPRS return channel for mobile end-users
- DAB downlink and GSM return channel, for the provision of only IP based services.

The proposed architecture is the solution for service providers and mobile operators, who demand a flexible and cost-effective method for managing compressed digital services, while maximising bandwidth capacity but maintaining the service quality.

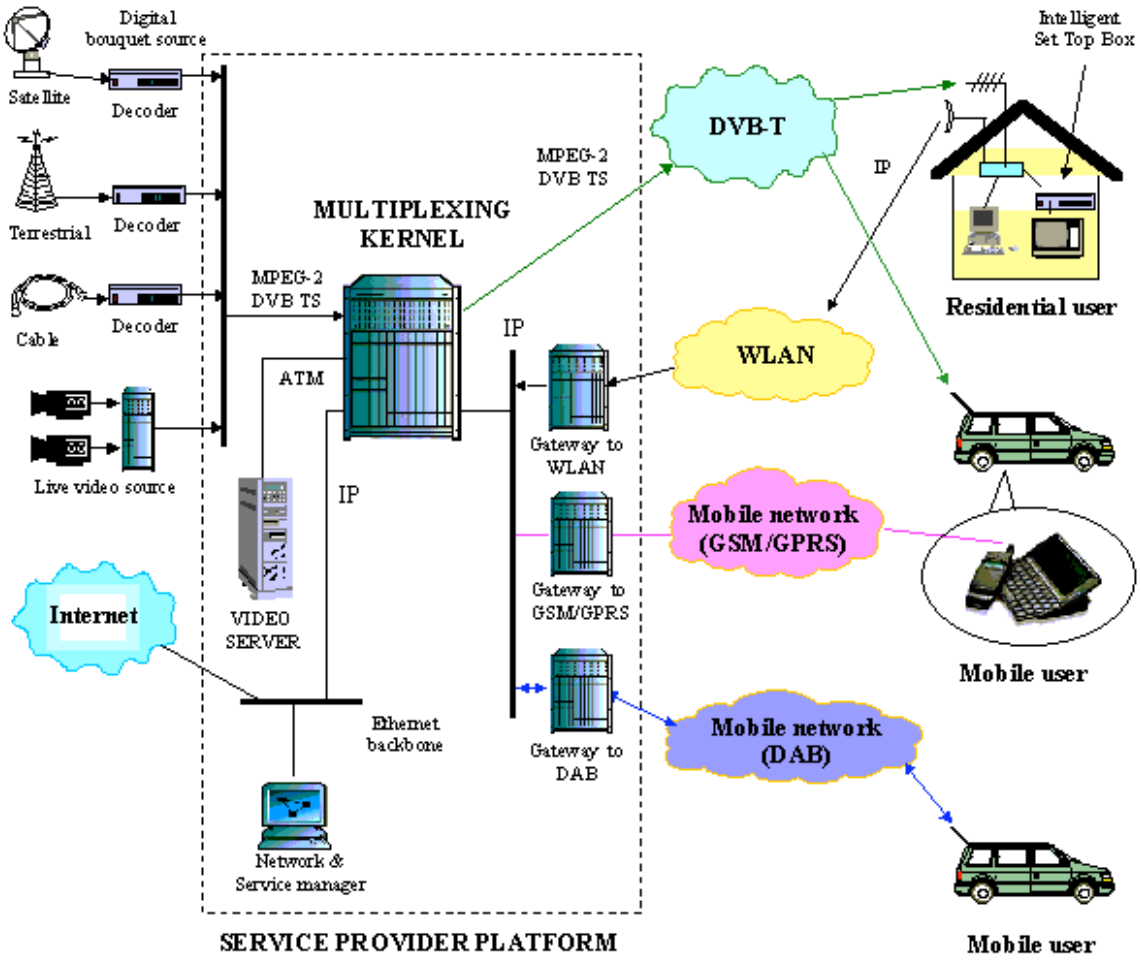


Figure 1. MAMBO general configuration.

At the service provider site, the operator is able to select specific services of interest, from a large number of TV and IP services, locally generated or arriving at its premises via satellite, terrestrial or cable networks. Then, the operator defines a priority service list for the selected TV programs, as an input to the transcoder and the statistical remultiplexer. The system automatically allocates the bandwidth to every service, changes the bit rate of the service, if necessary, and realises a statistical optimised multiplex, based on the feedback inputs from the available channel bandwidth, the IP traffic and the estimation of the quality of service. This solution, available in real time, enables operators to statistically remultiplex services from a variety of sources and create a new, customised statistical multiplex while optimising bandwidth for delivery of additional tiered services. User access is also allowed in IP-unicast or IP-multicast mode to: live broadcast, delayed broadcast, pay-per-view, near video-on-demand, video-on-demand, Internet services, etc.

3. SOQUET (System for Management of Quality of Services in 3G Networks) project.

The SOQUET project will develop QoS concepts based on multi-dimensional QoS inputs and perceived QoS outputs in order to augment the supervision of QoS in UMTS and DVB-T networks. SOQUET's intention is to meet the 3G vision, that services will be sold in a consumer mass market based on the provision of content at a requested quality.

It is well known that in digital transmission (MPEG-2/4) the minimum encoding bit rate is depended on the actual content, for a given quality, i.e. a talk show requires less bit rate than a football game, for the same quality of video. Based on this fact, SOQUET will create an enhanced data base, which will allow the end-users to access the desired content at the requested quality level, while consuming the minimum network resources. Consequently, only those resources sufficient to maintain user satisfaction are allocated. Since this is true for each user with perceived QoS enabled terminals, then the overall allocation of the radio resource results in an optimisation of the system spectral efficiency

Though the primary focus is to investigate the application of the PQMS to a UMTS scenario, *SOQUET* will also investigate important issues surrounding the combination of UMTS and DVB-T networks. There are many scenarios that can be considered for the co-operation between UMTS and DVB-T networks. These range from the simple sharing of content, to the sharing of spectrum or to the coordinated use of both networks for a service. SOQUET will be focused towards combining and taking advantage of the joined resources of these two networks, in order to give the appearance of a consolidated network.

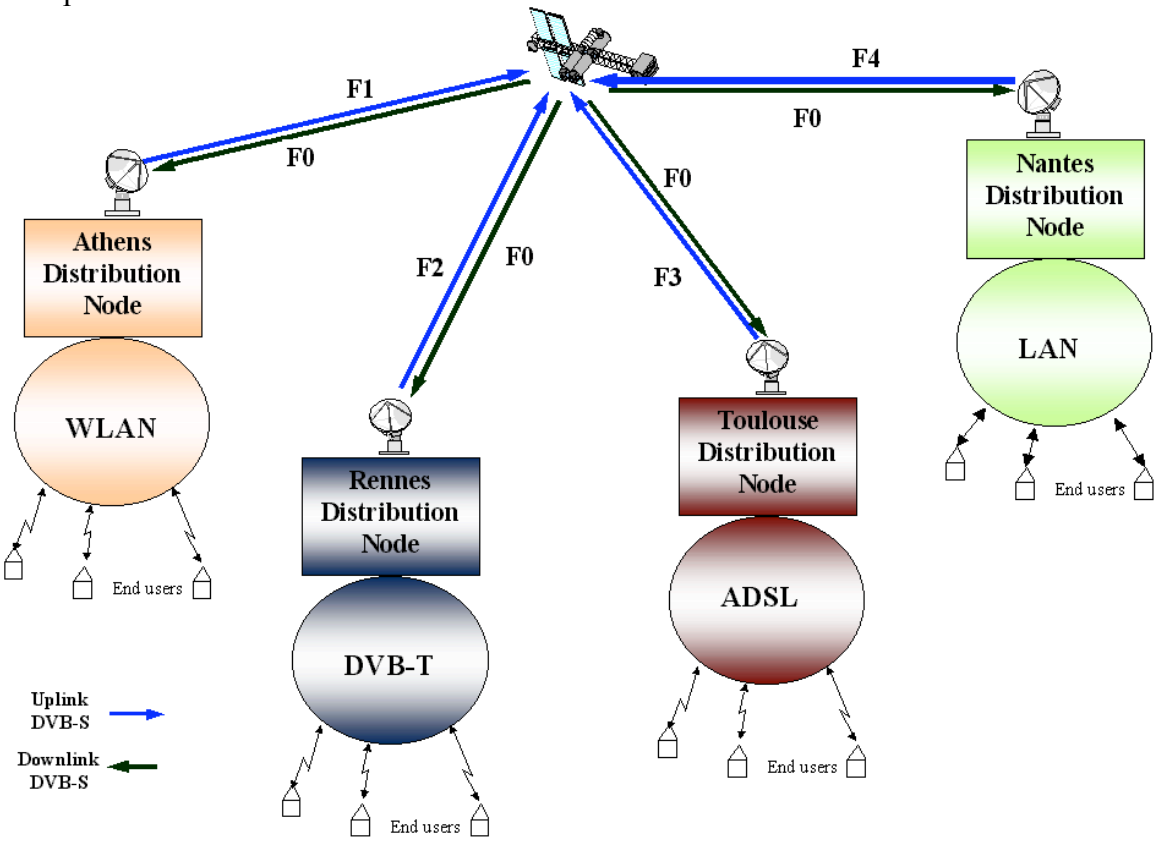
Figure 2. SOQUET architecture.

Thus, SOQUET objective is triple : first to contribute to the synergy of DVB-T and UMTS network, second to optimise the scarce resource of bandwidth and third to allow the provision of high bit rate services to a large number of mobile end-users, which is not possible if only one network (UMTS or DVB-T) is employed. In this respect, a large number of UMTS users will be able to receive high bit rate multimedia services (>1 Mb/s) by exploiting the high bit rate downlink channel capabilities of a DVB-T channel. To achieve this, a seamless IP traffic diversion technique between DVB-T and UMTS will be implemented.

QoS management to be developed in SOQUET will allow service providers / network operators to offer end-users a broad range of services with a broad range of prices. It will enable the customers of a communications service to select the QoS and the price in a flexible choice scheme that includes QoS level, tolerance and price for all possible choices at the particular user end. Typically, users will have a ranking for the requirements of the QoS that they desire.

REPOSIT (Real Time Dynamic Bandwidth Optimisation in Satellite Networks) project.

REPOSIT project will implement a spectrum efficient interactive satellite (DVB-S) network, using real time dynamic management of the available bandwidth, for supporting a variety of heterogeneous bit rate services, like interactive TV, Internet and multimedia services. The network will be used for the interconnection of terrestrial distribution nodes and will be tested, demonstrated and validated over an actual regenerative satellite (STENTOR).
REPOSIT proposes an advanced network solution capable to offer Interactive Integrated Satellite Broadcast / Internet services of the future. The network uses spectrum in a more efficient way: it is dynamically and in real time adaptable according to the services, the end-users requirements and the available network resources. Using this system, the service operators can achieve the optimum use of the scarce resource of spectrum and are given the maximum flexibility to cater to the possible different customer/market requirements, in a dynamic way. Furthermore, it contributes towards the integration of satellite key features (such as broadcasting, multicasting, delivery of multimedia services) with the wireless terrestrial networks and achieve a seamless provision of services from one type of network to the other (DVB-S, WLAN, DVB-T, ADSL). Three characteristic cases of distribution nodes have been selected for implementation and demonstration: WLAN and DVB-T, as representative types of DVB and IP based broadband wireless terrestrial networks and ADSL as representative of broadband wired networks.



REPOSIT results are addressed to :

- Telecommunication and Satellite operators, who wish to validate and ultimately exploit new telecommunication services, transmission methods, innovative bandwidth management techniques, related to the satellite and terrestrial networks;

- Television broadcasters, who wish to exploit techniques merging MPEG-2 and IP in order to introduce the concept of interactive television to their customers. It is expected that they will become more competitive as long as they will be able to provide interactive television programmes, fast access to Internet and multimedia services via their platform. The convergence among satellite and terrestrial wireless networks will allow them to enter deeper in the market;
- Service providers/network operators, who wish to exploit the advantage of the MPEG-2 and IP skyplex multiplexing capabilities on the new generation of satellites, in order to provide high bit rate connection to the Internet, and interactive multimedia services to their customers and, in so doing, provide a whole new range of value added services;
- Content providers, who intend to offer innovative Broadcast and Multimedia services independently of the underlying networking infrastructure;
- special groups of end-users, who require high bandwidth in the return channel and large area coverage, to further exploit the provided services.

Conclusions.

Many projects have been financed by the IST Programme in the areas of network convergence and optimisation of the spectrum and three of them have been briefly described in this paper. Future work should concentrate on the investigation concerning the need of synergy (better than convergence) between broadcasters and telecom operators in order to provide new affordable services to the users, fulfilling two observed tendencies: the personalisation of services, and the consumption of bandwidth hungry multimedia services that cannot be offered by existing communication networks specially on the move. The solutions should be able to offer different degrees of seamless integration, interworking and interoperability of communication and broadcasting networks as well as rich-media delivery combining broadcast and Internet service paradigms.

In this respect, it would be interesting to investigate the concept of managing different types of networks and different types of services through a unique Integrated Management System. This integrated system can be an open kernel, based on tools and technologies evolved from MPEG-21 / MPEG-7 standards, supporting : resources management, networks configuration, bandwidth allocation, QoS supervision, real time broadcasting and supervision, content searching, etc., thus being able to manage the functionality of various entities in the digital information distribution chain, from Service Providers, to Access Networks and Users. For this purpose, it is necessary to define a multimedia framework to enable transparent and augmented use of multimedia resources across a wide range of networks and devices used by different users.