

Open Statistical Multiplexing Architecture for Mobile TV

Abstract

This paper describes the principles of the Open Statistical Multiplexing Architecture (OSMA) for optimizing video content in a DVB-H network, its main benefits and deployment challenges. Following growing consumer demand for mobile TV services, the authors propose a simple, practical and open approach for implementation of statistical multiplexing within commercial Mobile TV networks. The solution is fully compliant with the current DVB-H standard. This paper discusses the impacts of the proposed architecture on the IP encapsulators, video encoders, and terminals as well as the specific requirements for local and regional content.



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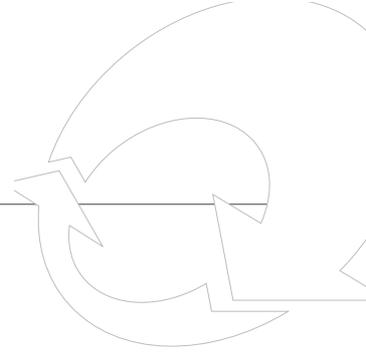
FULL IP OVER BROADCAST MEDIA



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1. INTRODUCTION



As Mobile TV deployments take off around the world with DVB-H (Digital Video Broadcasting - Handheld) and other technologies, users and operators are increasingly looking into new ways to optimize the complete transmission system. Optimization is desirable from a technical perspective, as well as from the business viewpoint, enabling more attractive services, higher margins or lower operational costs.

This paper focuses in particular on the aspects of a statistical multiplexing technique, and discusses the issues of implementing it within DVB-H networks.

2. DEFINITION OF STATISTICAL MULTIPLEXING

A generic definition of statistical multiplexing is the following:

Statistical multiplexing enables better use of network bandwidth by allocating the mean average link bandwidth to each connection instead of the peak bandwidth. Using the mean bandwidth allows a greater number of simultaneous connections on the same link, and increases bandwidth efficiency.

In the context of DVB-H, the audio/video content sent to the mobile phone is encoded using state-of-the-art highly efficient video encoding technology such as MPEG4, H.264 or similar.

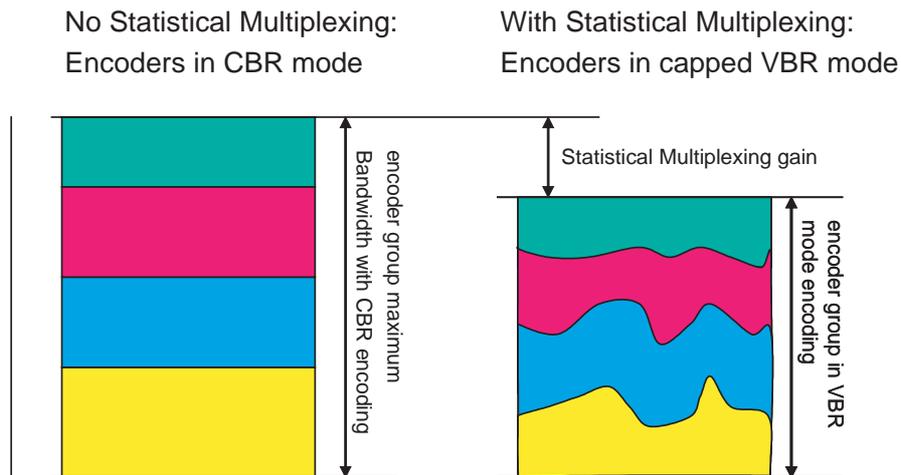
If the encoders operate in CBR (Constant Bit Rate) mode, then complex scenes and picture changes do not get enough bandwidth and the appearance of artefacts can be observed. In contrast, simple scenes that would not require as much bandwidth are wasting bandwidth.

While observing multiple parallel video streams, it has been found that complex scenes occurring simultaneously on more than one stream are very rare. The usage of VBR (Variable Bit Rate) encoding allows a lower encoding rate for simple scenes, and enables other video streams with more complex animation to take advantage of the additional bandwidth.

3. USAGE & BENEFITS OF STATISTICAL MULTIPLEXING

Statistical multiplexing is widely used in the digital broadcasting world as a mean to gain 30% to 40% efficiency on a given transmission channel (Terrestrial, Cable or Satellite), and as a technology is widely mastered and accepted by operators.

The principle relies on the fact that only changing or highly complex scenes require a higher bandwidth, and that the rest of the picture data can be sent at a lower bitrate. The bandwidth setting on an encoder with CBR output has to be such that these complex scenes can be transmitted with good quality, meaning the encoders would generate on average more bandwidth than what they would really require.



The achieved gain can be used to:

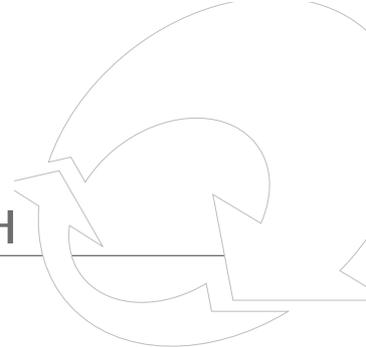
- transmit more video services of the same quality on the same available transmission bandwidth or,
- enhance the video quality of the available services while keeping their number constant

In the context of DVB-H, statistical multiplexing brings an additional level of complexity since the DVB-H IP encapsulators (IPE) have to adjust their burst parameters to the bandwidth of the incoming stream in order to optimize the utilisation of the transmission link and to take advantage of the DVB-H time slicing mechanism.

There are many ways to approach the problem; one is to have a connection between the encoders and the IPE, allowing the encoder and IPE to pass information between themselves.

There are some solutions like this currently on the market. They have, however, a drawback of relying on a proprietary communication protocol between the encoders and the IPE, locking the operators into a single vendor relationship. Another drawback is that the IPE and encoder need to be co-located which may not technically be feasible or practical depending upon the architecture of the network.

4. THE UDCAST OPEN STATISTICAL MULTIPLEXING ARCHITECTURE APPROACH



In a typical commercial DVB-H deployment, there are potentially several tens of IPEs located in the distribution network just before the transmitters, whereas the encoders are located in one or more places in the IP network. In this architecture it is essential that the statistical multiplexing on the IPE is independent of its physical location and of the encoder's manufacturer.

4.1. IMPLEMENTATION ON THE IP ENCAPSULATOR SIDE

In the UDCast implementation of statistical multiplexing, a group of video services originating from a group of encoders is allocated a specific amount of bandwidth (see diagram). Within this group, the individual services, potentially containing multiple IP sessions, are defined with a minimum guaranteed as well as with a maximum allowed bandwidth. The encoder grouping is defined at the IP encapsulation level and it does not require the encoders to be in close proximity to the IPE.

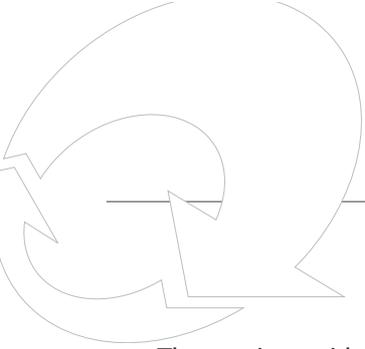
There can be multiple groups of encoders each of which are allocated a fixed amount of bandwidth. This approach is called hierarchical multiplexing, and could be useful in the following cases:

- **Various content providers on same IPE** - In this case the IPE guarantees that a providers available bandwidth is not take away by video services belonging to other providers
- **Logical groups of content** - In cases where there are common channels, such as national programs, as well as regional or local channels, this grouping ensures that the bandwidth sum of the national programs and the regional/local programs stays constant. This is particularly important when local content is filtered/removed/replaced from the multiplex, for example with the UDCast's DVB-H iSplicer local content filter and adapter.

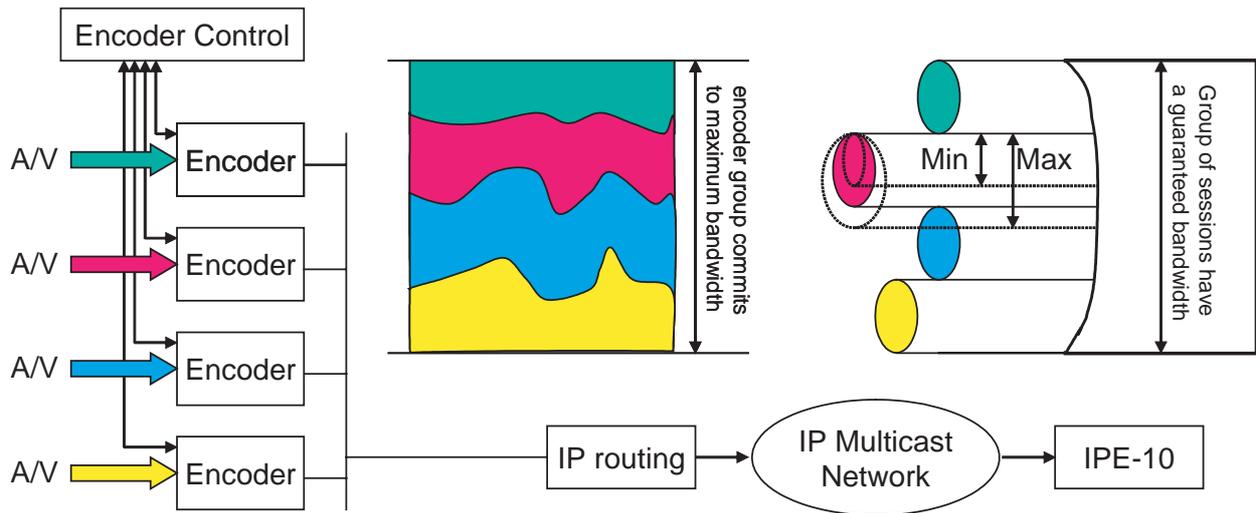
The minimum bandwidth defined for any service cannot be taken away by any other services. The maximum bandwidth that is defined for a service will be used as the bandwidth limit of the service, as well as the basis to calculate the boundaries of the burst geometry. These parameters are the MPE-FEC table size in number of rows which must stay constant during the duration of the complete content session, as well as the signalling in the PSI/SI tables.

Each content session can be given a priority, so that in case of congestion (i.e. the sum of the encoder bandwidth is greater than the total allocated bandwidth) it can be decided what sessions to send first. Other sessions will then be buffered at the IP encapsulator input and transmitted at a later point when capacity is available again.

This can be useful in a scenario where the encoders do not strictly enforce the upper bandwidth limit for the group of services, or where the encoders are not capable of doing statistical multiplexing.



The services with lower priority (i.e. background file transfers, datacasting, carousel files) can then be transmitted when the aggregated bandwidth of high priority video services is at a low level, optimising the transport system with opportunistic data insertion.



The main IPE statistical multiplexing parameters for each service are minimum and maximum bandwidth, service group affiliation, and service group priority level.

The configuration of the session parameters, including the min/max bandwidth and priority is done either via the UDcast IPE-Network Manager Graphical User Interface (GUI) or through its SNMP control.

In the case of usage of the standalone IPE-10 without IPE-Network Manager, the min/max bandwidth and priority values are configured through the GUI of IPE.

4.2. IMPACT OF SCENARIOS WITH REGIONAL CONTENT, AND LOCAL CONTENT FILTERING AT THE TRANSMITTER

When using a DVB-H local content adapter like the UDcast iSplicer, filtering out channels of a statistically multiplexed encoder group might lead to some non-deterministic behaviour if not carefully planned. Therefore it is important to use the hierarchical grouping feature, making the national (i.e. common) content a single statistically multiplexed group.

Regional or Local content groups will then either be encoded in Constant Bit Rate, or the different groups of regional content will be in separate statistical multiplexing groups. Therefore it will be possible to keep a fully deterministic behaviour in case of DVB-H content filtering.

4.3. IMPLEMENTATION ON THE ENCODERS

To make sure that bandwidth is used in an optimal way, the encoders might need to communicate between them in order to commonly commit to a maximum usable bandwidth.

The encoders have to agree between them, which encoder is allowed what output bandwidth at a any given moment of time, so they can make an optimal use of the total maximum usable bandwidth. The inter-encoder communication and the allocation method is out the scope of this document and left to the implementation of the encoder vendors.

In most implementations, the communication between the individual encoders is managed either by one of the encoders, assigned as the "master encoder" within its group, or by adding a separate encoding control device.

4.4. IMPACT ON DVB-H TERMINALS

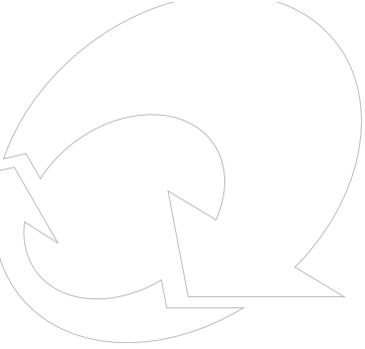
The usage of open architecture statistical multiplexing on the transmitting side is totally transparent for the receiving DVB-H terminals.

The video player application on the terminal will consume as much bandwidth as was generated by the encoder at the same picture sequence and therefore the data consumption rate on the receiver will be matched to the varying data volume arriving in the receiver's buffer due to different burst sizes.

It is recommended, however, to validate the end-to-end behaviour of a terminal being used with a statistically multiplexed stream.

5. CONCLUSIONS

The proposed open architecture enables broadcaster and mobile operators to increase the efficiency of their DVB-H service leading to an increase in their revenues and consumer satisfaction, thanks to an extended offer of TV content. The additional capacity can be used for new premium subscription services, thematic channels, local and regional content, or interactive advertising. The open approach described in this white paper is the only one to guarantee multi-vendor interoperability, allowing the operator to choose "best of breed" solutions for encoding and IP encapsulation to deliver enhanced mobile TV services.

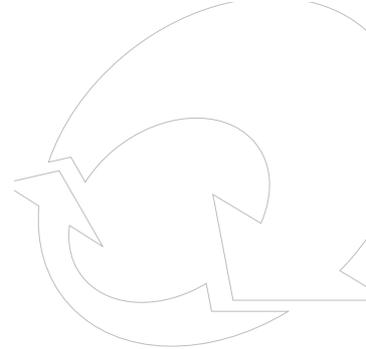


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ACRONYMS LIST

CBR	Constant Bit Rate
DVB-H	Digital Video Broadcasting - Handheld
H.264	Video encoding standard
IP	Internet Protocol
IPE	IP Encapsulator (IPE-10 is a brand of UDcast)
MPE-FEC	Multi-Protocol Encapsulation - Forward Error Correction
MPEG4	Video encoding standard
OSMA	Open Statistical Multiplexing Architecture
PSI/SI	Program Specific Information/Service Information
SNMP	Simple Network Management Protocol
VBR	Variable Bit Rate



ABOUT UDCAST

UDcast is the leader in the DVB-H IP Encapsulation providing its IP Encapsulators, transmission systems (DVB-H iSplicer), as well as network monitoring and analyzing solutions to 70% of global DVB-H deployments and trials. The solutions of UDcast are deployed in the countries like Finland, Vietnam, USA, France, UK, Spain, Italy, Germany, Netherlands, China, Hong Kong, Singapore, Taiwan, Philippines, Indonesia, Malaysia, India, Australia, and South Africa. The equipment and technologies of UDcast are distributed by Nokia, Motorola, Alcatel-Lucent, Harris and other global broadcasting and telecom OEMs and integrators. UDcast has been at the forefront of DVB-H development from the very beginning, and was involved in the standardisation process through ETSI, as well as in the development and standardisations of protocols enabling satellite IP communication.

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