Rateshaping

Reduce costs, but offer more services
(VOD, CatchupTV, NPVR, Time shift TV etc…)

White paper



Digital video broadcasting and telecommunication

Rateshaping

The push for reducing costs but to offer more channels and services is an on going topic for broadcasters. Is it possible to reduce costs and offer more services to the end user?

In previous years broadcasters have tried a number of methods to reduce cost and be able to offer more services to the end user. During this time we have seen a major shift in the market from the traditional analogue services to now, where IPTV is the new hype. With this move in mind broadcasters have been able to offer VOD, Catchup TV, NPVR, Time shift TV and many more. Now there is increasing pressure to do this more effectively and with less cost. A new method is rateshaping, being very new to the market many broadcasters are sceptical on how much you can rateshape before it is noticeable to the end user.

About Divitel:
Divitel has established a reputation as a system integrator for professional systems in the European DVB and broadcast market.

The company has a broad experience in the fields of digital and analogue TV, broadcast, RF networks, terrestrial and satellite transmission and IPTV solutions.

Companies offering digital television turn to Divitel to effectively set-up the entire chain. Divitel was established in 1997 and is based in Apeldoorn, The Netherlands. www.divitel.com

Rateshaping is mainly based on mathematical manipulation of the DCT (discrete cosine transform) domain of the MPEG2 coding principle and uses a mathematical processor intensive algorithm to analyse and modify, real-time data. That data represents MPEG-2 coded material to the level of macro blocks. The mathematical technology of rateshaping allows bitrate reductions of any measurement. Rateshaping of MPEG2 coded video content is particularly useful where bandwidth is scarce and where the demand for an increasing number of services remains unsatisfied.

Rateshaping is typically applied in a DTA (digital turnaround) environment. Although algorithms are highly sophisticated, rateshaping involves a reduction of data in an already encoded stream. Therefore rateshaping will always be a inferior to a professional encoder, fed by a good quality, uncompressed source. However, cascading encoders in a distribution chain is not recommended either, since macro blocking effects at the beginning of the chain could result in either high encoding bitrate at the end of the chain or a significant deterioration of signal quality.

Rateshaping can also be used to obtain full control of bandwidth usage for distribution over RF and/or IP networks. VBR (variable bandwidth) is often a concern where packages of multiple services in the distribution chain are bound to limits of their cumulated bandwidth.

Picture quality

Picture quality is analysed based on the SSCQE (Single-Stimulus Continuous Quality Evaluation) scale. The analyser provides for a real-time assessment of picture quality based on subjective criteria. Artefacts resulting from digital compression are judged as they appear. SSCQE can be used to evaluate analogue systems alone, or for comparison with digital systems.

Especially when the source material is CBR (constant bit rate) of high quality, rateshaping will have a significant impact on bandwidth usage. After all, CBR is known to be inefficiency, specifically when movement and detail change in picture is limited. Often CBR streams are even filled up with stuffing data to establish the output bitrate as set in the configuration of the encoder. Source material originating from a statistical multiplexer from a broadcaster will be compressed more efficiently.

However, since re-broadcasters may compose their own channel line-up that is unlikely to match the original stat-muxed material, those VBR channels could be filling up with unwanted QAM packets.
The processing device is capable to process multiple services simultaneously. Often, grooming and multiplexing are functionalities that are included in the device, resulting in a highly densified, multichannel processor. Input and output are MPEG coded streams, packed in either DVB or IP packets.

Each service is read and decoded up to the level of DCT strings. The DCT information is analysed where run-level pairs are inspected to meet maximum efficiency. Due to encoding schemes and motion prediction algorithms that are based on expected values in video content, efficiency is not always optimised in the standard-configured encoder.
Revising the DCT quantisation and introducing a small doze of dynamic DCT noise can result in new, additional DCT coefficients that are valued zero or near-zero, depending on the amount of DCT noise. The identification of zero valued coefficients and modification of run-level pairs in series of pairs lead to revised DCT strings.
Applying variable length coding based on Huffman algorithms, the new output stream will have a decreased bitrate in comparison to the original stream. Typically, the output of the rateshape stage will be VBR.

Processing multiple rateshaped services allows for feeding the internal multiplexer. A feed-back loop could feed the rateshaping algorithm to establish a new statmux, tailor-made to the QAM that is built by the re-broadcaster. The output MPTS is aimed to be CBR again to optimise the channel bandwidth usage. If necessary, a small amount of stuffing is applied to establish real CBR as an output stream.

An analysis has been conducted in a DTA environment with a large number of live video channels. To obtain a good overview of the effects rateshaping has with different content and to minimise the influence of differentiation in the sources and encoders earlier in the chain. As the end result is the experience of the picture presented to the home this is leading in the evaluation of any part in the total chain.
Analysis of quality was both done by scientific and reproducible measurement, and by a panel of broadcast professionals by reviewing the presented picture on the screen.

Results

Although some of the results were already expected in advance, some of the findings were truly unexpected. Modern rateshaping technology proves to be able to handle signals efficiently. Rateshaping does have for sure a bright future in DTA applications where bandwidth is increasingly costly.

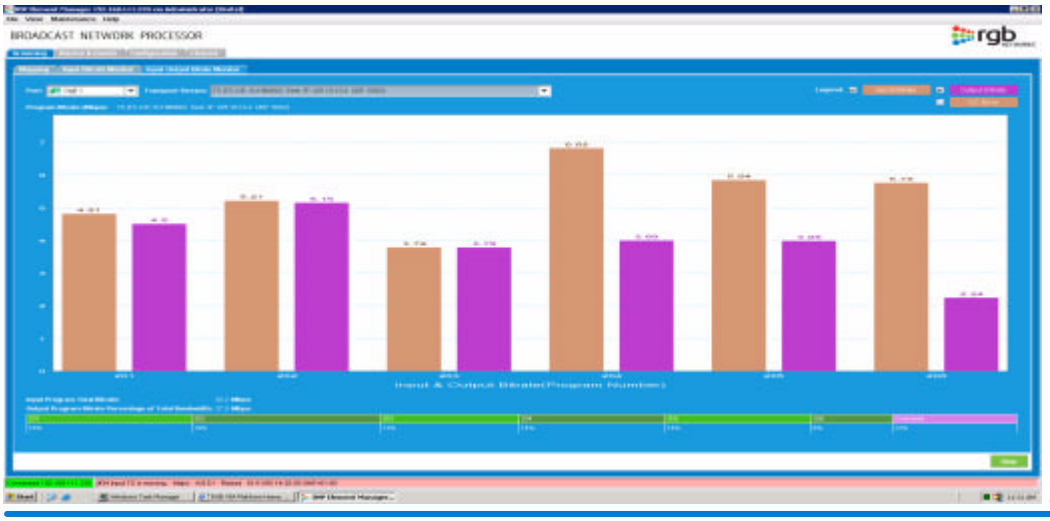
In case of high quality (8.2Mbit/s) CBR input signals an achievement of up to 39% of bit count reduction is realised, still giving the qualification ‘good’ for picture quality. Even in ‘broadcast quality’ CBR sources of appr. 4-6Mbit/s a bit count reduction of over 25% give results with barely visible / measurable decrease of picture quality.

VBR sources originating from statmux platforms in both high and lower quality were subjected to this testing. Even with these VBR sources an achievement of up to 15% would not significantly reduce picture quality. In some experiments the measured quality figure of the DVQ and in the panel's opinion on the picture quality was better after the rateshaping stage!
The modern rateshaping processor analyses the input signal carefully before choosing the depth of bit rate reduction on a per-DCT string sequence base. The user will set a preferred rateshaping level, dependent of required output quality and the nature of the content in the channel in question.
The processor is also applied where no reduction of bitrate is required in most situations or where picture quality should remain untouched. In those cases the processor is only used to cut off peak levels where user defined threshold levels are exceeded.

Decrease in SSCQE figures give always a relation as a comparison of input and output. A change in the DVQ value up to 10 is experienced as acceptable on comparison to bandwidth benefits. Comparison of quality levels between different sources is also useful to consider: high quality sources may decrease significantly in SSCQE figure without resulting in disturbing artefacts in the output, where an originally poor quality source will not allow any modification in the MPEG stream at all.
Including a processor / multiplexer in the stream brings another advantage that may positively effect the experienced service quality to the consumer: a PCR restamp will be done in most applications. Settop boxes theoretically should be able to lock faster to the input signal and may appear more stable showing less artefacts by blocking.

In future

Rateshaping is especially suitable to optimise bandwidth usage in distribution networks. An average bandwidth reduction over 20 QAM's of more than 20% is achieved without significant loss of picture quality. A clever analysis and re-arranging of the channel line-up in this typical 20 channel QAM64 network example could result in creating space for 40-45 extra DTA channels without re-engineering the RF grid at all. In future networks with a higher number of QAM's, probably QAM256 constellations and a higher scarcity of bandwidth due to increased number of services and broadband application requirements, rateshaping would be an essential technology in DTA environments that eliminates the necessity of a huge amount of re-encoding equipment.



(Input & Output Bitrate)

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