



Advanced Encoding Mechanism and Statistical Multiplexing

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Squeezing up to 18 channels per satellite transponder

With rising costs in the broadcasting industry, operators in the Direct-to-Home (DTH) and to a lesser degree, the Content and Distribution (C&D) markets are seeking to use their existing infrastructure for broadcasting an increasing amount of content. While this is true in the cable and Telco industries, the most hard-hit area is the DTH satellite market, where operators are motivated by their drive to achieve best cost performance per transponder.

The satellite transmission environment still suffers from the high cost of annual operation fees due to heavy investment and the high risk of placing a communication satellite in space. Therefore, the more programs per MHz an operator can squeeze into its transponder's bandwidth resources without sacrificing picture quality, the higher the cost savings.

Maximizing bandwidth capacity is a key issue for cable TV and Telco operators, as is implementing Triple Play, that is, delivering video, data and voice using over the same infrastructure. This paper discusses examples from the satellite industry but similar savings can be projected in the cable and Telco markets.

Scopus Video Networks, an expert in broadcast headends, has developed and implemented advanced encoding mechanisms and statistical multiplexing solutions. TriplePass™ yields significantly higher levels of bandwidth optimization, leading to reduced costs and the ability to offer a wider range of content and services.

The patent-pending TriplePass mechanism, based on Scopus' 20+ years of experience in encoding algorithm development, provides best-in-class picture quality at a very low average bitrate, reaching as many as 18 channels per satellite transponder.

TriplePass Overview

TriplePass is a three-step parallel approach to encoding and multiplexing in a multi-encoder environment. The first two encoding passes are performed in a single encoder environment, while the third pass operates in multi-encoder environment. The processes are described below.

Pre-processing: First Pass

With the first pass, the encoder performs full content picture smoothing, dynamic noise reduction using adaptive and temporal filters, sync-cut detection for I-frame insertion and buffer control. Moreover, depending on the bitrate budget, picture re-sizing is considered to find the appropriate bit per pixel compression. This initial processing pass enables the encoder to optimize second pass encoding and thus improve the picture quality.

Complexity Estimation: Second Pass

Complexity Estimation determines the best encoding process for each picture. A pre-processing and look-ahead mechanism is used to predict the relative complexity of each picture in order to enable the third pass to allocate the bitrate such that almost equal quality will be maintained within the various pictures and the various programs.

To achieve the best Figure Of Merit (FOM) in terms of human visual system, Scopus developed a special algorithm which takes into account the Estimated Complexity in advance of processing. The algorithm provides a mechanism that labels each picture during encoding to provide the optimal encoding strategy. The patented FOM mechanism improves picture quality by optimizing the encoder decision criteria on an individual basis for each picture.

Statistical Multiplexing: Third Pass

The statistical multiplexing algorithm is executed in a multi-program environment. The process is based on patent-pending Joint Rate Allocation (JRA) technology, which manages and controls each encoder output buffer, optimizing its VBR operating mode based on each of the program's statistics.

Scopus' Statistical Multiplexing

The Statistical Multiplexing process provides a mechanism that maintains a constant bitrate (needed for the channel modulator) at the multiplexer output, while achieving almost constant picture quality of each encoder. Each encoder operates in Variable Bitrate mode (VBR). The bitrate of each encoder is dynamically allocated such that adequate resources are provided to program scenes which are difficult to compress (lot of details and high motion) and fewer resources to programs which are easier to compress (low dynamics or static scenes or scenes without high spatial frequencies).

The Statistical Multiplexing algorithm utilizes a per frame mechanism in order to control and optimize the bitrate allocation process.

The Statistical Multiplexing process enables efficient data bandwidth utilization, true bandwidth on demand and QoS (Quality of Service) implementation, supported by a user-friendly graphic interface for monitoring and control.

Operational Modes

Two modes of operation are available for the statistical multiplexing process, as well as a combination of the two modes. They are as follows:

Given Quality with Various Priorities

A desired quality for each channel can be specified to ensure the picture quality of high bitrate programs. The bitrate of each channel is dynamically modified to maintain the specified quality. Rate resources are distributed among the encoders according to their priorities. If the requested quality cannot be achieved at all channels at the given total output rate, the quality of each encoder is reduced in accordance with the associated priority of the encoder.

Given Priorities

Bitrate allocation is achieved based on pre-defined program priority. A screenshot of the overall encoding and statistical multiplexing process is presented below:



Better quality per bandwidth

Scopus TriplePass provides excellent encoding efficiency and best picture quality at a given bandwidth. The following numeric example illustrates Scopus' encoding multiplexing performance, based on standard satellite transponder characteristics:

- Assuming 36Mhz transponder with QPSK transmission, error correction coding and roll-off factor provided for the following ratio: 1bit/sec/Hz.
- Program mix includes 2-3 sport channels, while the rest are talking heads programs, classical movies and dramas.
- Conditional access and PSI/SI tables consume up to 2 Mbps
- Associated Audio Channel – 2-4 Mbps

TriplePass can provide up to 18 programs per transponder, increasing the DTH satellite operator's revenue generation by 10% compared to other technologies.

Future directions

The MPEG-2 compression standard has been the enabling driver of the success of digital television broadcasting. However, as it begins to reach the theoretical limits of its capabilities, other technologies are likely to succeed it. The two main candidates are MPEG-4 AVC (also known as JVT), and Windows Media 9.

Both MPEG-4 AVC and WM9 provide major bandwidth savings, and will enable broadcasters to carry broadcast quality-signal at less than 1 Mbps.

The migration path from MPEG-2 to the new standards will be one of the key elements of future encoding platforms. Scopus, as a leading compression vendor, has focused on developing a Universal Encoder platform with multiple-standard encoding capabilities that support MPEG-2 simultaneously with future standards. This approach secures smooth and cost effective migration to future encoding systems and guarantees Scopus customers a smooth transition without sacrificing advanced and emerging technologies.