MPEG Transcoders

The Digital Video Job of the Decade

High-density, Low-cost Transcoders for Delivering MPEG4 Content to the MPEG2 Edge, Broadcast Content to Mobile Devices, CATV to IP, and more!

A White Paper

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Introduction

With the immense volume of MPEG digital video content in the world today, making it available to consumers proves challenging in that the content is often times in the wrong format, on the wrong network, or in the wrong place. MPEG Transcoders are designed to help solve this problem by making the content available in the right format, on the right network, delivered to the right place.

What is MPEG?

Moving Picture Experts Group (MPEG) is a working group of scientific experts that establishes international standards for the compression and transmission of audio and video content. MPEG standards are embraced worldwide and provide an interoperability framework for the end-to-end ecosystems used in Digital Television (DTV) systems. This includes DTV ecosystems for Over-The-Air (OTA), Cable, and Satellite Television based delivery methods.

There are a myriad of MPEG standards to sift through. However, the most important/relevant MPEG standards for this discussion are MPEG-2 and MPEG-4 Advanced Video Codec (AVC) – also known as MPEG-4 Part 10, and also known by its International standard moniker H.264.

The MPEG-2 standard is a coder/decoder (CODEC) mechanism based in part on a complex mathematical calculus equation – the Discrete Cosine Transform (DCT). The MPEG-2 CODEC is used for the compression and decompression of audiovisual (AV) content. The "MPEG-2 Systems" part of the standard defines a "container format" called the Transport Stream (TS). There are Single Program Transport Streams (SPTS) that carry a single AV program and there are Multiple Program Transport Streams (MPTS) that carry many AV programs that are multiplexed (muxed) together in a hierarchical data table format.

$$f(m,n) = \frac{2}{N}\sum_{u=0}^{N-1}\sum_{v=0}^{N-1} c(u)c(v)F(u,v)\cos\left(\frac{2m+1}{2N}u\pi\right)\cos\left(\frac{2n+1}{2N}v\pi\right) \tag{11.29}$$

$$m = 0, 1, ..., N-1 \quad n = 0, 1, ..., N-1$$

MPEG-4 AVC (H.264) is also a CODEC and it is typically recognized as being 2-3 times more efficient than the MPEG-2 CODEC. This means that using H.264 takes fewer digital bits to represent the same AV information than when using MPEG-2. This efficiency gains are realized in the form of less storage and less network required to deliver the same program material, i.e. lower cost!

Sometimes, it can be confusing talking about MPEG because the MPEG-2 Transport Streams can not only carry MPEG-2 programs, but they can also carry MPEG-4 programs and even other ancillary data like program guide information, etc.

Formats, Resolutions, Scanning, and Bitrates…oh my!

Regardless of the CODEC used to compress a DTV program, there are some widely adopted standards and defacto-standards used to define the "formats" or different sizes /resolutions of the video image.

Resolution is a term that is used to describe the "size" of a digital video program, and is typically expressed in horizontal by vertical pixels. For example, a high definition (HD) digital TV channel delivered OTA in the US can be as large as 1920x1080, or it can be 1280x720. For standard definition (SD) digital TV channels, these are usually something like 640x480. Note that these resolutions lead to the two popular "aspect ratios" - the widescreen 16x9 which is typically used for HD, and nearly-square 4x3 used for SD (and is also the aspect ratio for NTSC analog transmissions).

"Scanning" refers to how a digital picture is created on a television or monitor screen, and is expressed as either Interlaced (every-other line, in two passes) or Progressive (every line in one pass). The letters "i" and "p" are used to denote the difference.

Often, shorthand is used to refer to various DTV formats. For example: 480i, 480p, 720p, 1080i, 1080p. It is generally understood that 720p means a video picture that is 1280 x 720 in size with a progressive scan.

Format Index	Type	Vertical Resolution	Horizontal Resolution	Aspect Ratio	Scan Type	Refresh Rate [Hz]	Raw Datarate [Mbit/S]	MPEG2 MP@ML Datarate Mbit/S
1	SDTV				interlaced	30	105	2
2						24	169	3
3						30	211	3
4			640	4:03	progressive	60	422	6
5					interlaced	30	116	2
6						24	186	3
7						30	232	3
8			704	4:03	progressive	60	464	7
9					interlaced	30	116	2
10						24	186	3
11						30	232	3
12	EDTV	480	704	16:09	progressive	60	464	10
13						24	506	8
14						30	633	9
15		720	1280	16:09	progressive	60	1,266	16
16					interlaced	30	712	11
17						24	1,139	17
18	HDTV	1080	1920	16:09	progressive	30	1,424	18

When using a CODEC like MPEG-2 or H.264 to compress a motion picture, the larger DTV formats take more digital bits of information to represent the same picture. Also, the quality of the resultant compressed video is dependent upon another factor: the bitrate – the number of bits per second that are used to represent the motion picture. A CODEC's bitrate can be tweaked downwards in an attempt to "save" storage or network costs, but this comes with at the expense of video quality. Therefore, in general the lower the bitrate, the lower the quality – the higher the bitrate, the higher the quality – both with obvious points of diminishing returns. Bitrates can also be either constant bitrate (CBR), or variable bitrate (VBR).

What is an MPEG Transcoder, and why is it useful?

Like many other technological advancements, DTV and MPEG standards evolve and improve – and often advance to the point of creating backward-compatibility issues and can result in equipment and system obsolescence. As shown below in three real world use case scenarios, transcoders can help bridge the compatibility gap, increase return on investment (ROI), and lengthen the useful life of older physical assets.

In the simplest of terms, Transcoders (as the name implies) are capable of converting one CODEC to another CODEC. The very best transcoders are those that support many different types of CODECS, audio/video formats, resolutions, bitrates, and provide flexible input and output (I/O) options, etc.

Essential Features and Benefits to Look For in an MPEG Transcoder

When looking for an MPEG transcoder there are several important features to look for in a solution. The ideal solution should provide from as few as 2 to as many as 16 streams in a standard 1U of rack space, and up to 48 to 64 streams in a 3U package.

The transcoder should obviously support as many audio and video formats as possible, but must support all the essential MPEG profiles for both MPEG-2 and H.264. Video formats should include: H.264 MP,HP@L4.2 (720p, 1080i, 1080p), H.264 MP,HP@L3.0 (480i, 576i), MPEG-2 MP@HL (720p, 1080i, 1080p), and MPEG-2 MP@ML (480i, 576i). Audio formats should include: MPEG-1 Layer II, MPEG-1 Layer III (MP3), AAC LC, Dolby Digital (AC-3), Dolby Digital Plus (EAC-3), PCM, WMA.

The transcoder should support transrating and transcaling. Transrating should support reducing stream bitrates from full HD at roughly 19.4Mbps on down to smaller mobile formats <1Mbps. Transcaling should support resizing of resolution for both upscaling and downscaling at HD resolutions.

The best transcoders provide the most flexible support of numerous profiles with user tweak-able parameters to ensure the highest level of source/destination compatibility of streams.

Many transcoders only support Gigabit Ethernet and Internet Protocol (IP) input and output (I/O). The best transcoders provide flexible I/O options including support for source inputs like DVB-ASI, and destination outputs like DVB-C (QAM modulation).

Finally, some of the very best transcoders provide options for decryption and encryption (or "transcryption") supporting various AES-128 industry standards.

Feature	Benefit
Scalable, High Density Packaging	From as few as 2 to as many as 16 streams per 1U of rack space. 48-64 streams in a 3U package.
Multi-format Video	H.264 MP,HP@L4.2 720p, 1080i, 1080p H.264 MP,HP@L3.0 480i, 576i MPEG-2 MP@HL 720p, 1080i, 1080p MPEG-2 MP@ML 480i, 576i
Multi-format Audio	MPEG-1 Layer II, MPEG-1 Layer III (MP3), AAC LC, Dolby Digital (AC-3), Dolby Digital Plus (EAC-3), PCM, WMA
Transrating	HD bitrates down
Transcaling	Upscaling / Downscaling, HD resolutions
Flexible profiles	Ensure source/destination compatibility
Flexible I/O	Gigabit Ethernet (IP) input & output, DVB-ASI inputs, DVB-QAM outputs
Optional Decrypt/Encrypt	Support for AES-128 industry standards

Table of Features and Benefits to look for in an MPEG Transcoder

Real World Use Case Scenarios for MPEG Transcoders

There are literally thousands of applications for MPEG transcoders! Real world use case scenarios from three different markets are presented below that demonstrate the flexibility of MPEG transcoder solutions: US Hospitality market, International CableTV market, and the burgeoning MobileTV market.

US Hospitality Market: ***Saving the hotelier's investment for early adoption of MPEG2-only HDTV's.***

From late 1998 through much of the first decade of 2000, thousands of hotels and other hospitality establishments in the United States were early adopters of widescreen 16:9 HDTVs. Since MPEG-4 had yet to be introduced, these early HDTV's were only capable of decoding MPEG-2. Over time, the satellite-based linear content providers in the hospitality market switched to MPEG-4 H.264/AVC content exclusively. This transition to H.264 quickly rendered these early adopter HDTV's virtually useless for delivering HD content to the guestroom.

Rather than replacing every HDTV in every guestroom with a new HDTV capable of decoding MPEG-4, a transcoder can be deployed in the hotel headend to convert MPEG-4 to MPEG-2. The transcoder has saved the hotelier's investment in MPEG2-only HDTV's, and has lengthened the useful life of an expensive physical asset.

International CableTV Market: ***Extending the useful life of millions of MPEG2 endpoints***

Many countries all over the world are in some sort of state of DTV transition. As an example, India is going through a massive digitization effort to transition the country's analog television infrastructures to 100% digital services. Further, the explosive growth of television content in India has led to the path of using H.264 because of the tremendous savings in bandwidth MPEG-4 AVC offers.

There are two problem areas. Existing content assets as well as most content production facilities may still be in an MPEG-2 format. Also, cable companies in India have deployed millions of MPEG-2 only set-top-boxes (STB).

Obviously, MPEG transcoders can help solve these problems cost-effectively. Transcoders can be used off-line to convert existing MPEG-2 digital assets to H.264 format, prior to being uplinked to Satellite for distribution to the cable headends.

Once the newer H.264 content reaches the cable headend via satellite, once again a transcoder can be used to convert the H.264 content back into MPEG-2 format. This saves the cable company and consumers from having to deploy expensive new H.264 compatible STBs. It extends the useful life of millions of MPEG-2 only STBs.

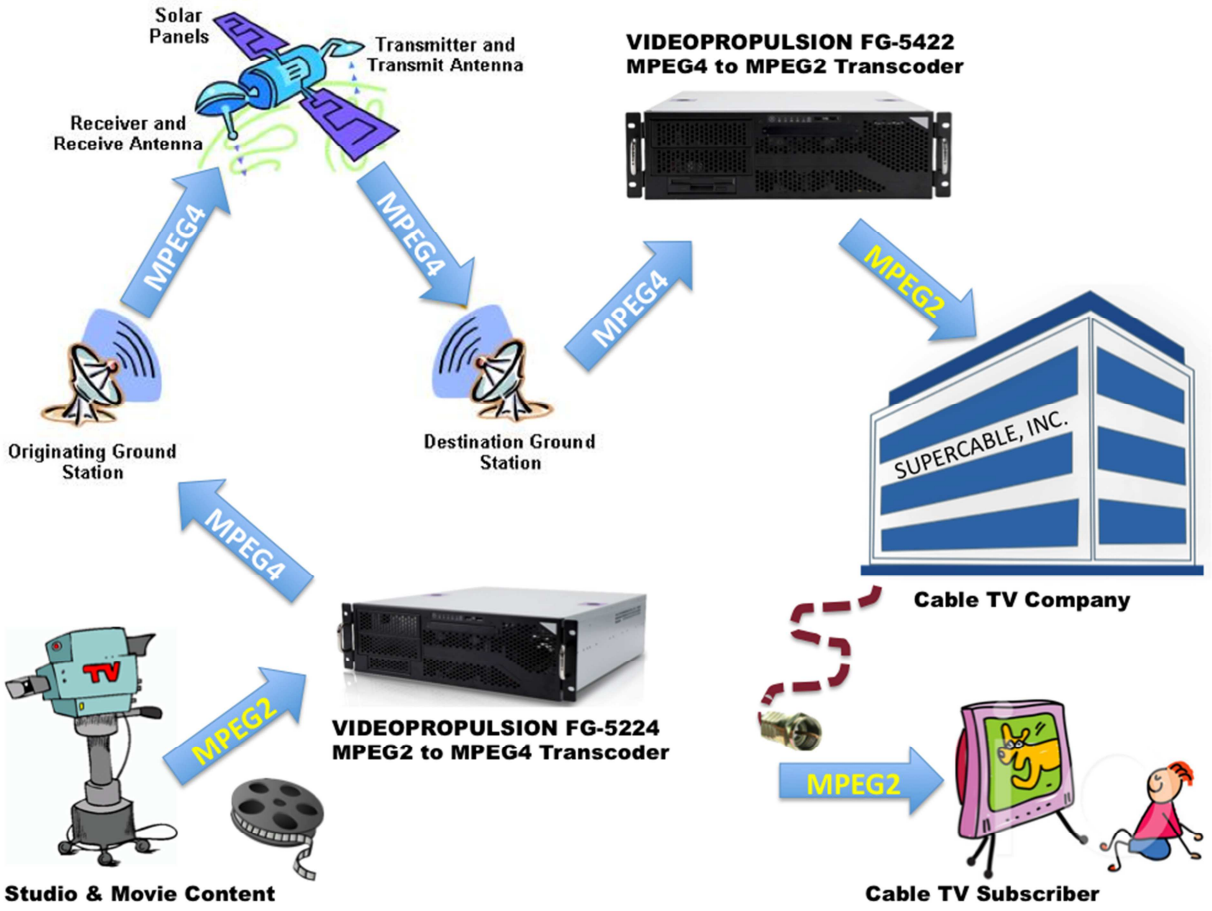

Diagram: Extending the useful life of millions of MPEG2 endpoints

Mobile TV Market: ***Deriving new sources of revenue using existing content in the MobileTV markets***

There is no denying the current explosion in delivering video to mobile and handheld devices. However, the problem of delivering existing content assets is two-fold: mobile network bandwidth is a premium, and mobile devices are not capable of ingesting legacy full HD MPEG-2 content. Even much of the H.264 broadcast content is still too "fat" to be carried on most mobile networks.

Enter the transcoder. Using MPEG transcoders, operators can utilize existing MPEG2 and H.264 content and repurpose the content for MobileTV use. Transrating and transcaling content down to fit on mobile networks and mobile devices, the transcoder helps the operator derive new sources of revenue using existing content.

Final Thoughts

The future is bright for transcoders, with little to no end in sight! The use of newer 4K and 8K formats for digital cinematography production reveals new work for the multi-format transcoder. Squeezing an 8K movie down to a mobile phone on a 4G LTE network will be just one of the tasks. So what else is new?

About the Author

Lee McKenna is Vice President of Marketing for VideoPropulsion Interactive Television, Inc. Lee was previously Vice President of Product Management & Technology at Guest-Tek, and held a senior technical staff position at LodgeNet Interactive. He pursued studies in Electrical Engineering and Computer Science at South Dakota School of Mines & Technology, and holds an AS in Computer Applications Programming from Black Hills State University, and a BS in Business Administration Management from Colorado Technical University.

About VideoPropulsion

For nearly 40 years, VideoPropulsion has been a world leader in hardware and software for high performance, low cost per stream, digital content manipulation, and has established a reputation for providing unique HDTV, VoD, and IPTV products. The Company offers revolutionary FloodGate satellite and CATV transcryption appliances as well as OEM computer modules for a variety of applications, including streaming, multiplexing, demultiplexing, modulation, demodulation, transcoding, encryption, and splicing MPEG formatted data.

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