H.264 High Profile: Codec for Broadcast & Professional Video Application

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Overview

High definition video content is becoming rampant as more countries are now transitioning into digital life. The ways of delivering High definition content in a bandwidth limited channel have become a challenge in itself. To cater to such high demanding broadcast & professional video markets, we require a compression / decompression standard that allows no compromise on the quality of the video that has to be broadcasted over a bandwidth constrained network. Broadcast / Professional Video markets are looking at H.264 as the right compression / decompression technology for such bandwidth limited applications and world leaders in such high end markets are already rolling out products that include H.264 as the de-facto standard.

Benefits of H.264 in Broadcast / Professional Video:

H.264 / MPEG-4 AVC (MPEG-4 Part 10) video coding is standardized by ITU-T in association with ISO / IEC MPEG, they are together called the Joint Video Team (JVT).,to cater to a wide variety of applications ranging from low data rate, low resolution consumer application to high quality content creation applications. The H.264 standard supports various profiles viz. Baseline, Main, Extended & High Profiles and extension to the existing profiles called Fidelity Range Extension (FRExt).

The broadcast / professional video markets require High quality video at higher frame-rates like 1080p60 performance. The fidelity range extension enables high quality video by supporting varied chroma sub-sampling formats – 4:2:0,4:2:2 & 4:4:4 with greater color bit-depth ranging from 8-bit up to 12-bits and resolution ranging from QCIF (176x144) to Full HD (1920x1080), both progressive and interlaced scanning. It also supports adaptive block transform switching between 4x4 macro-block (MB) & 8x8 MB and weighted prediction for rapid changes or motion in the picture.

Latest developments in the standards such as aspect ratio and color space conversion are specifically aided for professional video application.

Some of the other standard features that H.264 is known for are as follows:

- Multiple reference pictures
- Intra / Inter Picture prediction
- Motion compensation / estimation
- Temporal & Spatial coding techniques
- MBAFF / PicAFF
- De-blocking
- Entropy coding – CABAC / CAVLC
- Network Abstraction Layer (NAL) unit

The H.264 video provides better picture quality for a given data-rate compared to its predecessors, at the cost of higher compute power for compression and decompression leading to varied implementations using standard PCs/servers, embedded processors, ASSPs, DSPs and FPGAs.

DSP vs. FPGA

DSP or FPGA based custom hardware are popular implementations for broadcast & professional video applications, which demands high performance and high quality video, which can be achieved only by using High profile standard and beyond in H.264. Today with higher performance FPGAs being available it seems to be a better alternative for such demanding applications. These implementations are now possible using single FPGA, which otherwise would require a farm of DSPs for doing the same job. FPGAs provide the same degree of flexibility as DSPs making them more attractive

CoreEL's H.264 High Profile Decoder

CoreEL offers high performance, high quality and robust H.264 video decoding solutions on FPGAs for professional / broadcast video applications. CoreEL H.264 hand-coded RTL code is highly optimized for FPGA architecture delivering higher performance at lower clock speed and smaller memory footprint.

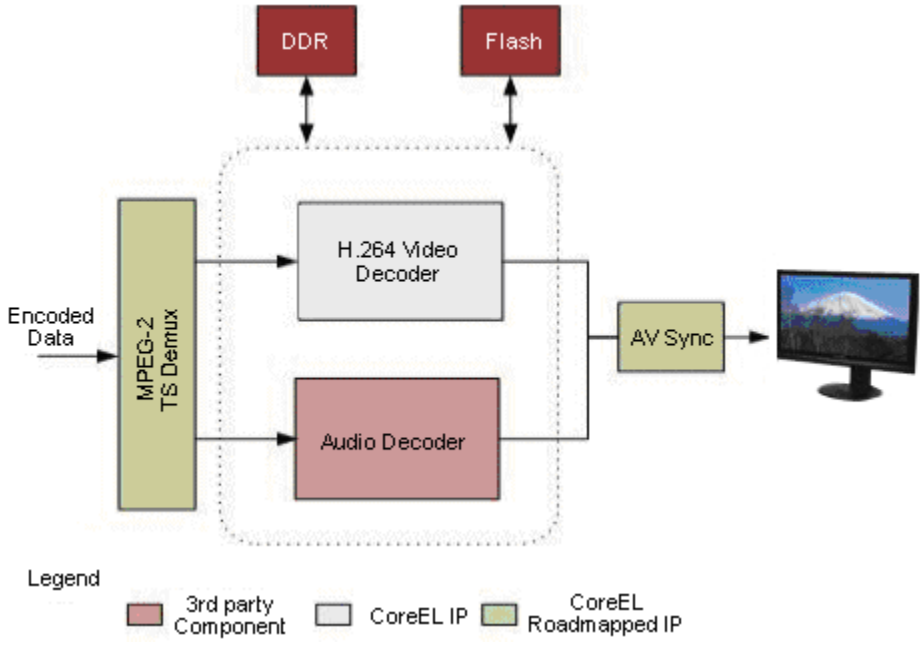

Figure 1 Video Decoding System

The decoder runs on a single FPGA and is capable of decoding H.264 HD and SD resolutions. It is also multi-channel capable with optimal number of channels decoding simultaneously.

In addition to Broadcast and Professional applications, CoreEL's decoder solution is suitable for high channel density surveillance applications with higher performance throughput.

CoreEL has developed a very compelling H.264 HP decoder solution which is feature rich as well as optimal in performance. CoreEL's H.264 decoder comes in following flavors targeting different end applications needs requirements

H.264 Decoder	Color Bit-depth	Chroma Format	Prediction	Application
Main Profile	8-bit	4:2:0	Intra & Inter	Originally intended to consumer profile for broadcast & storage application
High Profile (HiP)	8-bit	Monochrome (4:0:0) & 4:2:0	Intra & Inter	Broadcast & storage applications, particularly for High definition television apps
Hi10P	Up to 10-bit	Monochrome (4:0:0) & 4:2:0	Intra & Inter	Same as HiP but with more bit resolution for more higher quality requirements
Hi422P	Up to 10-bit	Monochrome (4:0:0), 4:2:0 & 4:2:2	Intra & Inter	Professional video applications that use interlaced video
Hi444P	Up to 14-bit (CoreEL currently supports up to 12-bit)	Monochrome (4:0:0), 4:2:0, 4:2:2 & 4:4:4	Intra & Inter	Lossless video applications – Very high resolution requirements
Hi10Intra / AVC Intra 50	Up to 10-bit	4:2:0	Intra only	High end professional & broadcast video cameras, Post-processing applications, High bit-rate apps
Hi422Intra / AVC Intra 100	Up to 10-bit	4:2:2	Intra only	High end professional & broadcast video cameras, Post-processing applications, High bit-rate apps

AVC Intra decoder

Panasonic made a breakthrough in high end broadcast / professional video cameras & recorder-players by introducing H.264 technology with Intra frame only processing branded as the AVC Intra, which is used at very high bit-rates such as 50 Mbps and 100 Mbps. AVC Intra has now become de-facto technology in many of the upcoming broadcast / professional video cameras from various other manufacturers.

CoreEL has developed AVC Intra decoding solution and has tested for such compliance using professional level bit-streams.

CoreEL's AVC Intra 50 Decoder features:

- CABAC only entropy coding
- Bit-rate @ 50 Mbits/s
- Supports 1920x1080 resolution, High10 Intra profile @ Level 4
- Supports 1280x720 resolution, High10 Intra profile @ Level 3.2
- Support for 4:2:0 chroma sampling format, 10-bit color depth
- Frames are horizontally scaled by ¾ (1920x1080 is scaled to 1440x1080 & 1280x720 is scaled to 960x720)
- Frame rates supported for 1440x1080 – 60i, 50i, 30p, 25p, 24p
- Frame rates supported for 960x720 – 60p, 50p, 30p, 25p, 24p
- All Intra prediction modes – 4x4, 8x8, 16x16 supported

CoreEL's AVC Intra 100 Decoder features:

- CAVLC only entropy coding
- Bit-rate @ 100 Mbits/s
- Supports 1920x1080 i / p & 1280x720 p resolutions
- Support for High 4:2:2 Intra profile @ Level 4.1, 10 bit color depth
- Frame rates supported for 1920x1080 – 60i, 50i, 30p, 25p, 24p
- Frame rates supported for 1280x720 – 60p, 50p, 30p, 25p, 24p
- All Intra prediction modes – 4x4, 8x8, 16x16 supported

H.264 Intra frame only codecs are now increasingly used in post production industry. They are basically used for non-linear editing (NLE) and compositing of the video shot by cameras using such a technology.

Testing of H.264 Decoder Solution

CoreEL has tested its IP cores with ITU-T test vectors from the standardization body itself and industry accepted conformance bit-streams from Fraunhofer Institute. The core has also been tested with professional bit-streams from Panasonic / Mitsubishi for Intra-frame decoder testing.

Error Robustness

CoreEL has built the decoder solution with robust error handling. The entire stream is divided into independent NAL unit, if any errors are detected then the decoder stops decoding that particular NAL unit packet and continues to decode the next good NAL unit packet. CoreEL error handling mechanism is such that the decoder does not hang and gracefully exits when inputted with severely corrupted streams.

Design Flexibility & Modularity:

CoreEL's decoder solution is very flexible and modular to suit the requirements of a wide-array of broadcast / professional video & surveillance applications. CoreEL's decoder solution can be customized to achieve the desired bit rate, frame rate, resolution modes, chroma formats and bit-depth etc.

CoreEL's decoder solution can be customized to accomplish decoding of multiple streams simultaneously. Multiple streams decoding is required in applications such as multi-viewing. Use-cases can be to simultaneously decode more than one stream and display the video content simultaneously. For example, Quadrant view or picture-in-picture (PiP) in broadcast newsrooms. The customization can be further be extended to support various needs of broadcast & professional video applications.

For portability across various FPGA hardware platforms, the decoder is designed to be flexible & modular.

Advantages of CoreEL H.264 Decoder IP:

- Supports both Main and High Profile solution @ Level 4.2
- Highly pipelined & scalable architecture
- Optimized both for memory and speed
- Lower gate count and Block RAM requirements
- Programmable color bit depth up to 12-bits
- Programmable chroma format support: 4:2:0, 4:2:2 & 4:4:4
- Supports resolutions from QCIF to Full HD progressive & Interlaced
- Frame-rates up to 60 fps for HD decode
- High bit-rates support of up to 100 Mbps
- Simultaneous multi-channel decode
- Fully validated on custom built hardware using ITU-T and Fraunhofer test streams
- Supports Panasonic AVC Intra (I-frame) and H.264 Inter frame (I-P-B frames) decoding