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High Efficiency Video Coding (HEVC)

High Efficiency Video Coding (HEVC) is a proposed video compression standard, a successor to H.264/MPEG-4 AVC (Advanced Video Coding), currently under joint development by the **ISO/IEC Moving Picture Experts Group (MPEG)** and **ITU-T Video Coding Experts Group (VCEG)**. MPEG and VCEG have established a **Joint Collaborative Team on Video Coding (JCT-VC)** to develop the proposed HEVC standard.

HEVC aims to substantially improve coding efficiency compared to AVC High Profile, i.e. reduce bitrate requirements by half with comparable image quality, probably at the expense of increased computational complexity. Depending on the application requirements, HEVC should be able to trade off computational complexity, compression rate, robustness to errors and processing delay time.

HEVC is targeted at next-generation HDTV displays and content capture systems which feature progressive scanned frame rates and display resolutions from QVGA (320x240) up to 1080p and Super Hi-Vision, as well as improved picture quality in terms of noise level, color gamut and dynamic range.

Features

The JCT-VC is currently evaluating modifications to current coding tools, such as:

- adaptive loop filter (ALF),
- extended macroblock size (EMS),
- larger transform size (LTS),
- internal bit depth increasing (IBDI), and
- adaptive quantization matrix selection (AQMS),

as well as new coding tools, such as:

- modified intra prediction,
- modified de-block filter, and
- decoder-side motion vector deviation (DMVD).

Many new features are proposed to meet the requirements:

- 2-D non-separable adaptive interpolation filter (AIF)
- Separable AIF
- Directional AIF
- "Supermacroblock" structure up to 64x64 with additional transforms
- Adaptive prediction error coding (APEC) in spatial and frequency domain
- Competition-based scheme for motion vector selection and coding
- Mode-dependent KLT for intra coding

It is speculated that these techniques are most beneficial with multi-pass encoding.

History

The ITU-T Video Coding Experts Group (VCEG) began significant study of technology advances that could enable creation of a new video compression standard (or substantial compression-oriented enhancements of the H.264/MPEG-4 AVC standard) in about 2004.

Various techniques for potential enhancement of the H.264/MPEG-4 AVC standard were surveyed in October 2004. At the next meeting of VCEG, in January 2005, VCEG began designating certain topics as "Key Technical Areas" (KTA) for further investigation. A software codebase called the KTA codebase was established for evaluating such proposals in 2005. The KTA software was based on the Joint Model (JM) reference software that was developed by the MPEG & VCEG Joint Video Team for H.264/MPEG-4 AVC. Additional proposed technologies were integrated into the KTA software and tested in experiment evaluations over the next four years.

Two approaches for standardizing enhanced compression technology were considered: either creating a new standard or creating extensions of H.264/MPEG-4 AVC. The project had tentative names ***H.265*** and *H.NGVC* (Next-generation Video Coding), and was a major part of the work of VCEG until its evolution into the HEVC joint project with MPEG in 2010. The "H.265" nickname was especially associated with the potential creation of a new standard.

The preliminary requirements for NGVC were bit rate reduction of 50% at the same subjective image quality comparing to H.264/MPEG-4 AVC High profile, with computational complexity ranging from 1/2 to 3 times that of the High profile. NGVC would be able to provide 25% bit rate reduction along with 50% reduction in complexity at the same perceived video quality as the High profile, or to provide greater bit rate reduction with somewhat higher complexity.

"H.265" was used as a nickname for an entirely new standard, as was the "*High-performance Video Coding*" work by the ISO/IEC Moving Picture Experts Group (MPEG). Although some agreements about the goals of the project had been reached by early 2009, e.g. computational efficiency and high compression performance, the state of technology at the time seemed not yet mature for creation of an entirely new "H.265" standard, as all contributions were essentially modifications closely based on the H.264/MPEG-4 AVC design.

The ISO/IEC Moving Picture Experts Group (MPEG) started a similar project in 2007, tentatively named *High-performance Video Coding*. Early evaluations were performed with modifications of the KTA reference software encoder developed by VCEG. By July 2009, experimental results showed average bit reduction of around 20% compared with AVC High Profile; these results prompted MPEG to initiate its standardization effort in collaboration with VCEG.

A formal joint Call for Proposals (CfP) on video compression technology was issued in January 2010 by VCEG and MPEG, and proposals were evaluated at the first meeting of the MPEG & VCEG Joint Collaborative Team on Video Coding (JCT-VC), which took place in April 2010. A total of 27 full proposals were submitted. Evaluations showed that some proposals could reach the same visual quality as AVC at only half the bit rate in many of the test cases, at the cost of 2x-10x increase in computational complexity; and some proposals achieved good subjective quality and bit rate results with lower computational complexity than the reference AVC High profile encodings. At that meeting, the name *High Performance Video Coding* (HEVC) was adopted for the joint project. The JCT-VC is currently working to integrate features of some of the best proposals into a single software codebase and to perform further experiments to evaluate those features; the results will be discussed at July and October 2010 meetings.

The current timeline calls for completing the drafting of a final standard for HEVC by approximately **July 2012**.

Multimedia compression formats

Video compression	**ISO/IEC**	MJPEG · Motion JPEG 2000 · MPEG-1 · MPEG-2 (Part 2) · MPEG-4 (Part 2/ASP · Part 10/AVC) · **HEVC**
	ITU-T	H.120 · H.261 · H.262 · H.263 · H.264 · **HEVC**
	Others	AMV · AVS · Bink · CineForm · Cinepak · Dirac · DV · Indeo · Microsoft Video 1 · OMS Video · Pixlet · RealVideo · RTVideo · SheerVideo · Smacker · Sorenson Video & Sorenson Spark · Theora · VC-1 · VP3 · VP6 · VP7 · VP8 · WMV
Audio compression	**ISO/IEC**	MPEG-1 Layer III (MP3) · MPEG-1 Layer II · MPEG-1 Layer I · AAC · HE-AAC · MPEG-4 ALS · MPEG-4 SLS · MPEG-4 DST · MPEG-4 HVXC · MPEG-4 CELP
	ITU-T	G.711 · G.718 · G.719 · G.722 · G.722.1 · G.722.2 · G.723 · G.723.1 · G.726 · G.728 · G.729 · G.729.1
	Others	AC-3 · AMR · AMR-WB · AMR-WB+ · Apple Lossless · ATRAC · DRA · DTS · FLAC · GSM-HR · GSM-FR · GSM-EFR · iLBC · Monkey's Audio · TTA (True Audio) · MT9 · μ-law · Musepack · Nellymoser · OptimFROG · OSQ · RealAudio · RTAudio · SD2 · SHN · SILK · Siren · Speex · TwinVQ · Vorbis · WavPack · WMA
Image compression	**ISO/IEC/ITU-T**	JPEG · JPEG 2000 · JPEG XR · lossless JPEG · JBIG · JBIG2 · PNG · WBMP
	Others	APNG · BMP · DjVu · EXR · GIF · ICER · ILBM · MNG · PCX · PGF · TGA · QTVR · TIFF
Media containers	**ISO/IEC**	MPEG-PS · MPEG-TS · MPEG-4 Part 12/JPEG 2000 Part 12 · MPEG-4 Part 14
	ITU-T	H.222.0
	Others	3GP and 3G2 · ASF · AVI · Bink · DivX Media Format · DPX · EVO · Flash Video · GXF · M2TS · Matroska · MXF · Ogg · QuickTime File Format · RealMedia · REDCODE RAW · RIFF · Smacker · MOD and TOD · VOB · WebM
	Audio only	AIFF · AU · WAV