IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLORADO

REALTIME ADAPTIVE STREAMING LLC, Plaintiff, v. ADVANCED MICRO DEVICES, INC., Defendant.	Case No. 18CV1173 JURY TRIAL DEMANDED

COMPLAINT FOR PATENT INFRINGEMENT

This is an action for patent infringement arising under the Patent Laws of the United States of America, 35 U.S.C. § 1 *et seq.* in which Plaintiff Realtime Adaptive Streaming LLC ("Plaintiff" or "Realtime") makes the following allegations against Defendant Advanced Micro Devices Inc. ("Defendant" or "AMD").

PARTIES

1. Realtime is a Texas limited liability company. Realtime has a place of business at 1828 E.S.E. Loop 323, Tyler, Texas 75701. Realtime has researched and developed specific solutions for data compression. As recognition of its innovations rooted in this technological field, Realtime holds multiple United States patents and pending patent applications.

2. On information and belief, Defendant AMD is a Delaware corporation with a place of business in Santa Clara, California. AMD has regular and established places of business in this District, including, e.g., at 2950 East Harmony Road, Suite 300, Fort Collins, Colorado 80528-9558. AMD offers its products and/or services, including those accused herein of infringement, to customers and potential customers located in Colorado and in this District. AMD may be served with process through its registered agent for service at The Corporation Company, 7700 E. Arapahoe Road, Suite 220, Centennial, Colorado 80112-1268.

JURISDICTION AND VENUE

3. This action arises under the patent laws of the United States, Title 35 of the United States Code. This Court has original subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a).

4. This Court has personal jurisdiction over Defendant AMD in this action because AMD has committed acts within the District of Colorado giving rise to this action and has established minimum contacts with this forum such that the exercise of jurisdiction over AMD would not offend traditional notions of fair play and substantial justice. Defendant AMD has committed and continues to commit acts of infringement in this District by, among other things, offering to sell and selling products and/or services that infringe the asserted patents.

5. Venue is proper in this district, e.g., under 28 U.S.C. § 1400(b). AMD is registered to do business in Colorado, and upon information and belief, AMD has transacted business in the District of Colorado and has committed acts of direct and indirect infringement in the District of Colorado. AMD has regular and established place(s) of business in this District, as set forth above.

THE PATENTS-IN-SUIT

6. This action arises under 35 U.S.C. § 271 for AMD's infringement of Realtime's United States Patent Nos. 7,386,046 (the "'046 patent"), 8,934,535 (the "'535 patent"), and 9,769,477 (the "'477 patent") (the "Patents-In-Suit").

7. The '046 patent, titled "Bandwidth Sensitive Data Compression and Decompression," was duly and properly issued by the United States Patent and Trademark Office ("USPTO") on June 10, 2008. A copy of the '046 patent is attached hereto as Exhibit A. Realtime is the owner and assignee of the '046 patent and holds the right to sue for and recover all damages for infringement thereof, including past

infringement.

8. The ’535 patent, titled “Systems and methods for video and audio data storage and distribution,” was duly and properly issued by the USPTO on January 13, 2015. A copy of the ’535 patent is attached hereto as Exhibit B. Realtime is the owner and assignee of the ’535 patent and holds the right to sue for and recover all damages for infringement thereof, including past infringement.

9. The ’477 patent, titled “Video data compression systems,” was duly and properly issued by the USPTO on September 19, 2017. A copy of the ’477 patent is attached hereto as Exhibit C. Realtime is the owner and assignee of the ’477 patent and holds the right to sue for and recover all damages for infringement thereof, including past infringement.

COUNT I

INFRINGEMENT OF U.S. PATENT NO. 7,386,046

10. Plaintiff re-alleges and incorporates by reference the foregoing paragraphs, as if fully set forth herein.

11. On information and belief, AMD has made, used, offered for sale, sold and/or imported into the United States AMD products that infringe the ‘046 patent, and continues to do so. By way of illustrative example, these infringing products include, without limitation, AMD’s products/solutions e.g., AMD’s Video Coding Engine, which is a “[F]ixed-function hardware accelerator that supports H.264 AVC, and SVC encoding.” *See e.g.,* http://developer.amd.com/wordpress/media/2013/11/MediaSDK_User_Guide_1_1_Beta.pdf. AMD integrates Video Coding Engine into all of their GPUs and APUs, such as, e.g., AMD Radeon R9 Series Graphics Cards, AMD Radeon

R7 Series Graphics Cards, AMD Radeon R5 Series Graphics Cards, AMD Radeon HD 6450 Graphics Cards, AMD Radeon HD 7700 Series Graphics Cards, and all versions and variations thereof since the issuance of the '046 patent ("Accused Instrumentalities").

12. On information and belief, AMD has directly infringed and continues to infringe the '046 patent, for example, through its sale, offer for sale, importation, use and testing of the Accused Instrumentalities, which practices the system claimed by Claim 40 of the '046 patent, namely, a system, comprising: a data compression system for compressing and decompressing data input; a plurality of compression routines selectively utilized by the data compression system, wherein a first one of the plurality of compression routines includes a first compression algorithm and a second one of the plurality of compression routines includes a second compression algorithm; and a controller for tracking throughput and generating a control signal to select a compression routine based on the throughput, wherein said tracking throughput comprises tracking a number of pending access requests to a storage device; and wherein when the controller determines that the throughput falls below a predetermined throughput threshold, the controller commands the data compression engine to use one of the plurality of compression routines to provide a faster rate of compression so as to increase the throughput. Upon information and belief, AMD uses the Accused Instrumentalities to practice infringing methods for its own internal non-testing business purposes, while testing the Accused Instrumentalities, and while providing technical support and repair services for the Accused Instrumentalities to AMD's customers.

13. For example, the Accused Instrumentalities utilize H.264 video compression standard, which utilizes Scalable Video Coding technology. See,

e.g., Recommendations ITU-T H.264 (03/2010) Annex G (Scalable video coding), p. 387-599.

Annex G

Scalable video coding

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies scalable video coding, referred to as SVC.

G.1 Scope

Bitstreams and decoders conforming to one or more of the profiles specified in this annex are completely specified in this annex with reference made to clauses 2-9 and Annexes A-E.

G.2 Normative references

The specifications in clause 2 apply with the following additions.

– ISO/IEC 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*.

– IETF RFC 3986 (2005), *Uniform Resource Identifiers (URI): Generic Syntax*.

G.3 Definitions

For the purpose of this annex, the following definitions apply in addition to the definitions in clause 3. These definitions are either not present in clause 3 or replace definitions in clause 3.

G.3.1 **arbitrary slice order (ASO)**: A *decoding order* of *slices* in which the *macroblock address* of the first *macroblock* of some *slice* of a *slice group* within a *layer representation* may be less than the *macroblock address* of the first *macroblock* of some other preceding *slice* of the same *slice group* within the same *layer representation* or in which the *slices* of a *slice group* within a *layer representation* may be interleaved with the *slices* of one or more other *slices groups* within the same *layer representation*.

G.3.2 **associated NAL unit**: A *NAL unit* that directly succeeds a *prefix NAL unit* in *decoding order*.

G.3.3 **B slice**: A *slice* that may be decoded using *intra-layer intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

G.3.4 **base layer**: A *bitstream subset* that contains all *NAL units* with the nal_unit_type *syntax element* equal to 1 and 5 of the *bitstream* and does not contain any *NAL unit* with the nal_unit_type *syntax element* equal to 14, 15, or 20 and conforms to one or more of the profiles specified in Annex A.

G.3.5 **base quality layer representation**: The *layer representation* of the *target dependency representation* of an *access unit* that is associated with the quality_id *syntax element* equal to 0.

G.3.6 **bitstream subset**: A *bitstream* that is derived as a *subset* from a *bitstream* by discarding zero or more *NAL units*. A *bitstream subset* is also referred to as *sub-bitstream*.

G.3.7 **bottom macroblock (of a macroblock pair)**: The *macroblock* within a *macroblock pair* that contains the samples in the bottom row of samples for the *macroblock pair*. For a *field macroblock pair*, the bottom macroblock represents the samples from the region of the *bottom field* or *layer bottom field* of the *frame* or *layer frame*, respectively, that lie within the spatial region of the *macroblock pair*. For a *frame macroblock pair*, the bottom macroblock represents the samples of the *frame* or *layer frame* that lie within the bottom half of the spatial region of the *macroblock pair*.

G.3.8 **coded slice in scalable extension NAL unit**: A *coded slice NAL unit* that contains an *EI slice*, *EP slice*, or an *EB slice*.

G.3.9 **complementary reference field pair**: A collective term for two *reference fields* that are in consecutive *access units* in *decoding order* as two *coded fields*, where the *target dependency representations* of the *fields* share the same value of the frame_num *syntax element* and where the second *field* in *decoding order* is not an *IDR picture* and the *target dependency representation* of the second *field* does not include a memory_management_control_operation *syntax element* equal to 5, or a *complementary reference base field pair*.

https://en.wikipedia.org/wiki/Scalable_Video_Coding

Scalable Video Coding (**SVC**) is the name for the Annex G extension of the H.264/MPEG-4 AVC video compression standard. SVC standardizes the encoding of a high-quality video bitstream that also contains one or more subset bitstreams. A subset video bitstream is derived by dropping packets from the larger video to reduce the bandwidth required for the subset bitstream. The subset bitstream can represent a lower spatial resolution (smaller screen), lower temporal resolution (lower frame rate), or lower quality video signal. H.264/MPEG-4 AVC was developed jointly by ITU-T and ISO/IEC JTC 1. These two groups created the Joint Video Team (JVT) to develop the H.264/MPEG-4 AVC standard.

Contents [hide]

Overview [edit]

The objective of the SVC standardization has been to enable the encoding of a high-quality video bitstream that contains one or more subset bitstreams that can themselves be decoded with a complexity and reconstruction quality similar to that achieved using the existing H.264/MPEG-4 AVC design with the same quantity of data as in the subset bitstream. The subset bitstream is derived by dropping packets from the larger bitstream.

A subset bitstream can represent a lower spatial resolution (smaller screen), or a lower temporal resolution (lower frame rate), or a lower quality video signal (each separately or in combination) compared to the bitstream it is derived from. The following modalities are possible:

- Temporal (frame rate) scalability: the motion compensation dependencies are structured so that complete pictures (i.e. their associated packets) can be dropped from the bitstream. (Temporal scalability is already enabled by H.264/MPEG-4 AVC. SVC has only provided supplemental enhancement information to improve its usage.)
- Spatial (picture size) scalability: video is coded at multiple spatial resolutions. The data and decoded samples of lower resolutions can be used to predict data or samples of higher resolutions in order to reduce the bit rate to code the higher resolutions.
- SNR/Quality/Fidelity scalability: video is coded at a single spatial resolution but at different qualities. The data and decoded samples of lower qualities can be used to predict data or samples of higher qualities in order to reduce the bit rate to code the higher qualities.
- Combined scalability: a combination of the 3 scalability modalities described above.

SVC enables forward compatibility for older hardware: the same bitstream can be consumed by basic hardware which can only decode a low-resolution subset (i.e. 720p or 1080i), while more advanced hardware will be able decode high quality video stream (1080p).

Background and applications [edit]

Bit-stream scalability for video is a desirable feature for many multimedia applications. The need for scalability arises from graceful degradation transmission requirements, or adaptation needs for spatial formats, bit rates or power. To fulfill these requirements, it is beneficial that video is simultaneously transmitted or stored with a variety of spatial or temporal resolutions or qualities which is the purpose of video bit-stream scalability.

Traditional digital video transmission and storage systems are based on H.222.0/MPEG-2 TS systems for broadcasting services over satellite, cable, and terrestrial transmission channels, and for DVD storage, or on H.320 for conversational video conferencing services. These channels are typically characterized by a fixed spatio-temporal format of the video signal (SDTV or HDTV or CIF for H.320 video telephone). The application behavior in such systems typically falls into one of the two categories: it works or it doesn't work.[1]

Modern video transmission and storage systems using the Internet and mobile networks are typically based on RTP/IP for real-time services (conversational and streaming) and on computer file formats like mp4 or 3gp. Most RTP/IP access networks are typically characterized by a wide range of connection qualities and receiving devices. The varying connection quality results from adaptive resource sharing mechanisms of these networks addressing the time varying data throughput requirements of a varying number of users. The variety of devices with different capabilities ranging from cell phones with small screens and restricted processing power to high-end PCs with high-definition displays results from the continuous evolution of these endpoints.

Scalable video coding (SVC) is one solution to the problems posed by the characteristics of modern video transmission systems. The following video applications can benefit from SVC:

- Streaming
- Conferencing
- Surveillance
- Broadcast
- Storage

Profiles and levels [edit]

As a result of the Scalable Video Coding extension, the standard contains five additional *scalable profiles*: Scalable Baseline, Scalable High, Scalable High Intra, Scalable Constrained Baseline and Scalable Constrained High Profile. These profiles are defined as a combination of the H.264/MPEG-4 AVC profile for the base layer (2nd word in scalable profile name) and tools that achieve the scalable extension:

- **Scalable Baseline Profile**: Mainly targeted for conversational, mobile, and surveillance applications.
  - A bitstream conforming to Scalable Baseline profile contains a base layer bitstream that conforms to a restricted version of Baseline profile of H.264/MPEG-4 AVC.
  - Supports B slices, weighted prediction, CABAC entropy coding, and 8×8 luma transform in enhancement layers (CABAC and the 8×8 transform are only supported for certain levels), although the base layer has to conform to the restricted Baseline profile, which does not support these tools. Coding tools for interlaced sources are not included.
  - Spatial scalable coding is restricted to resolution ratios of 1.5 and 2 between successive spatial layers in both horizontal and vertical direction and to macroblock-aligned cropping.
  - Quality and temporal scalable coding are supported without any restriction.
- **Scalable High Profile**: Primarily designed for broadcast, streaming, storage and videoconferencing applications.
  - A bitstream conforming to Scalable High profile contains a base layer bitstream that conforms to High profile of H.264/MPEG-4 AVC.
  - Supports all tools specified in the Scalable Video Coding extension.
  - Spatial scalable coding without any restriction, i.e., arbitrary resolution ratios and cropping parameters is supported.
  - Quality and temporal scalable coding are supported without any restriction.
- **Scalable High Intra Profile**: Mainly designed for professional applications.
  - Uses Instantaneous Decoder Refresh (IDR) pictures only. IDR pictures can be decoded without reference to previous frames.
  - A bitstream conforming to Scalable High Intra profile contains a base layer bitstream that conforms to High profile of H.264/MPEG-4 AVC with only IDR pictures allowed.
  - All scalability tools are allowed as in Scalable High profile but only IDR pictures are permitted in any layer.
- **Scalable Constrained Baseline Profile**
- **Scalable Constrained High Profile**

14. The Accused Instrumentalities include a data compression system for compressing and decompressing data input. For example, AMD's products/solutions utilize H.264 compression standard. As another example, AMD's products/solutions integrate Video Coding Engine, which is a "[F]ixed-function hardware accelerator that supports H.264 AVC, and SVC encoding." *See e.g.*, http://developer.amd.com/wordpress/media/2013/11/MediaSDK_ User_Guide_1_1_Beta.pdf.

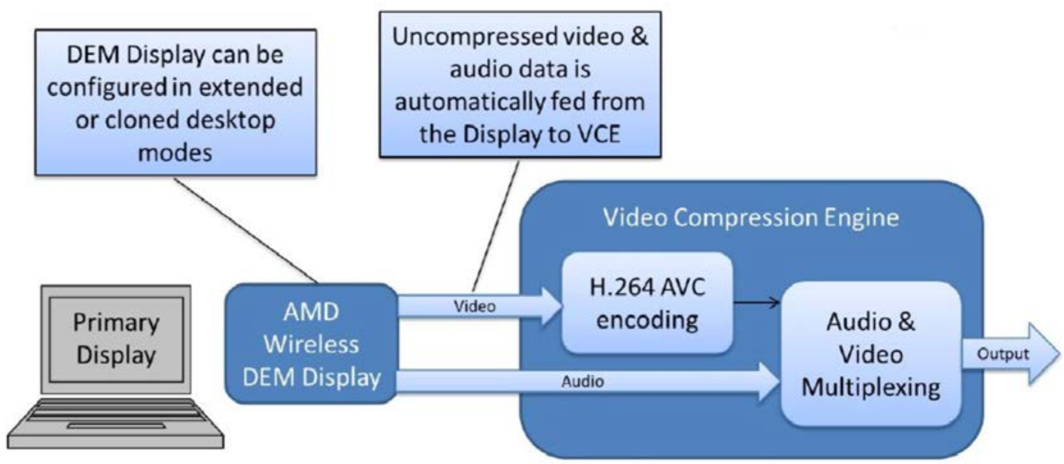

Figure 6.1 System Overview of the AMF Display Encode Mode

See e.g., http://developer.amd.com/wordpress/media/2013/11/MediaSDK_User_Guide_1_1_Beta.pdf.

15. The Accused Instrumentalities include a plurality of compression routines selectively utilized by the data compression system, wherein a first one of the plurality of compression routines includes a first compression algorithm and a second one of the plurality of compression routines includes a second compression algorithm. For example, the Accused Instrumentalities utilize H.264, which include, e.g., Context-Adaptive Variable Length Coding ("CAVLC") entropy encoder and Context-Adaptive Binary Arithmetic Coding ("CABAC") entropy encoder. H.264 provides for multiple different ranges of parameters (e.g., bitrate, resolution parameters, etc.), each included in the "profiles" and "levels" defined by the H.264 standard. *See* http://www.axis.com/files/whitepaper/wp_h264_31669_en_0803_lo.pdf at 5:

4. H.264 profiles and levels

The joint group involved in defining H.264 focused on creating a simple and clean solution, limiting options and features to a minimum. An important aspect of the standard, as with other video standards, is providing the capabilities in profiles (sets of algorithmic features) and levels (performance classes) that optimally support popular productions and common formats.

H.264 has seven profiles, each targeting a specific class of applications. Each profile defines what feature set the encoder may use and limits the decoder implementation complexity.

Network cameras and video encoders will most likely use a profile called the baseline profile, which is intended primarily for applications with limited computing resources. The baseline profile is the most suitable given the available performance in a real-time encoder that is embedded in a network video product. The profile also enables low latency, which is an important requirement of surveillance video and also particularly important in enabling real-time, pan/tilt/zoom (PTZ) control in PTZ network cameras.

H.264 has 11 levels or degree of capability to limit performance, bandwidth and memory requirements. Each level defines the bit rate and the encoding rate in macroblock per second for resolutions ranging from QCIF to HDTV and beyond. The higher the resolution, the higher the level required.

See https://en.wikipedia.org/wiki/H.264/MPEG-4_AVC:

Levels with maximum property values

Level	Max decoding speed		Max frame size		Max video bit rate for video coding layer (VCL) kbit/s			Examples for high resolution @ highest frame rate (max stored frames) Toggle additional details
	Luma samples/s	Macroblocks/s	Luma samples	Macroblocks	Baseline, Extended and Main Profiles	High Profile	High 10 Profile	
1	380,160	1,485	25,344	99	64	80	192	176×144@15.0 (4)
1b	380,160	1,485	25,344	99	128	160	384	176×144@15.0 (4)
1.1	768,000	3,000	101,376	396	192	240	576	352×288@7.5 (2)
1.2	1,536,000	6,000	101,376	396	384	480	1,152	352×288@15.2 (6)
1.3	3,041,280	11,880	101,376	396	768	960	2,304	352×288@30.0 (6)
2	3,041,280	11,880	101,376	396	2,000	2,500	6,000	352×288@30.0 (6)
2.1	5,068,800	19,800	202,752	792	4,000	5,000	12,000	352×576@25.0 (6)
2.2	5,184,000	20,250	414,720	1,620	4,000	5,000	12,000	720×576@12.5 (5)
3	10,368,000	40,500	414,720	1,620	10,000	12,500	30,000	720×576@25.0 (5)
3.1	27,648,000	108,000	921,600	3,600	14,000	17,500	42,000	1,280×720@30.0 (5)
3.2	55,296,000	216,000	1,310,720	5,120	20,000	25,000	60,000	1,280×1,024@42.2 (4)
4	62,914,560	245,760	2,097,152	8,192	20,000	25,000	60,000	2,048×1,024@30.0 (4)
4.1	62,914,560	245,760	2,097,152	8,192	50,000	62,500	150,000	2,048×1,024@30.0 (4)
4.2	133,693,440	522,240	2,228,224	8,704	50,000	62,500	150,000	2,048×1,080@60.0 (4)
5	150,994,944	589,824	5,652,480	22,080	135,000	168,750	405,000	3,672×1,536@26.7 (5)
5.1	251,658,240	983,040	9,437,184	36,864	240,000	300,000	720,000	4,096×2,304@26.7 (5)
5.2	530,841,600	2,073,600	9,437,184	36,864	240,000	300,000	720,000	4,096×2,304@56.3 (5)

16. A video data block is organized by the group of pictures (GOP) structure, which is a "collection of successive pictures within a coded video stream." *See* https://en.wikipedia.org/wiki/Group_of_pictures. A GOP structure can contain intra coded pictures (I picture or I frame), predictive coded pictures (P picture or P frame), bipredictive coded pictures (B picture or B frame) and direct coded pictures (D picture or D frames, or DC direct coded pictures which are used only in MPEG-1 video). *See* https://en.wikipedia.org/wiki/Video_compression_picture_types (for descriptions of I frames, P frames and B frames); https://en.wikipedia.org/wiki/MPEG-1#D-frames (for descriptions of D frames). Thus, at least a portion of a video data block would also make up a GOP structure and could also contain I frames, P frames, B frames and/or D frames. The GOP structure also reflects the size of a video data block, and the GOP structure can be controlled and used to fine-tune other parameters (e.g. bitrate, max video bitrate and resolution parameters) or even be considered as a parameter by itself.

17. Based on the bitrate and/or resolution parameter identified (e.g. bitrate, max video bitrate, resolution, GOP structure or frame type within a GOP structure), a

H.264-compliant system such as the Accused Instrumentalities would determine which profile (e.g., "baseline," "extended," "main", or "high") corresponds with that parameter, then select between at least two asymmetric compressors. If baseline or extended is the corresponding profile, then the system will select a Context-Adaptive Variable Length Coding ("CAVLC") entropy encoder. If main or high is the corresponding profile, then the system will select a Context-Adaptive Binary Arithmetic Coding ("CABAC") entropy encoder. *See* https://sonnati.wordpress.com/2007/10/29/how-h-264-works-part-ii/

	Baseline	**Extended**	**Main**	**High**	**High 10**
I and P Slices	Yes	Yes	Yes	Yes	Yes
B Slices	No	Yes	Yes	Yes	Yes
SI and SP Slices	No	Yes	No	No	No
Multiple Reference Frames	Yes	Yes	Yes	Yes	Yes
In-Loop Deblocking Filter	Yes	Yes	Yes	Yes	Yes
CAVLC Entropy Coding	Yes	Yes	Yes	Yes	Yes
CABAC Entropy Coding	No	No	Yes	Yes	Yes
Flexible Macroblock Ordering (FMO)	Yes	Yes	No	No	No
Arbitrary Slice Ordering (ASO)	Yes	Yes	No	No	No
Redundant Slices (RS)	Yes	Yes	No	No	No
Data Partitioning	No	Yes	No	No	No
Interlaced Coding (PicAFF, MBAFF)	No	Yes	Yes	Yes	Yes
4:2:0 Chroma Format	Yes	Yes	Yes	Yes	Yes
Monochrome Video Format (4:0:0)	No	No	No	Yes	Yes
4:2:2 Chroma Format	No	No	No	No	No
4:4:4 Chroma Format	No	No	No	No	No
8 Bit Sample Depth	Yes	Yes	Yes	Yes	Yes
9 and 10 Bit Sample Depth	No	No	No	No	Yes
11 to 14 Bit Sample Depth	No	No	No	No	No
8×8 vs. 4×4 Transform Adaptivity	No	No	No	Yes	Yes
Quantization Scaling Matrices	No	No	No	Yes	Yes
Separate Cb and Cr QP control	No	No	No	Yes	Yes
Separate Color Plane Coding	No	No	No	No	No
Predictive Lossless Coding	No	No	No	No	No

See http://web.cs.ucla.edu/classes/fall03/cs218/paper/H.264_MPEG4_Tutorial.pdf at 7:

The following table summarizes the two major types of entropy coding: Variable Length Coding (VLC) and Context Adaptive Binary Arithmetic Coding (CABAC). CABAC offers superior coding efficiency over VLC by adapting to the changing probability distribution of symbols, by exploiting correlation between symbols, and by adaptively exploiting bit correlations using arithmetic coding. H.264 also supports Context Adaptive Variable Length Coding (CAVLC) which offers superior entropy coding over VLC without the full cost of CABAC.

H.264 Entropy Coding – Comparison of Approaches

Characteristics	Variable Length Coding (VLC)	Context Adaptive Binary Arithmetic Coding(CABAC)
• Where it is used	MPEG-2, MPEG-4 ASP	H.264/MPEG-4 AVC (high efficiency option)
• Probability distribution	**Static** - Probabilities never change	**Adaptive** - Adjusts probabilities based on actual data
• Leverages correlation between symbols	**No** - Conditional probabilities ignored	**Yes** - Exploits symbol correlations by using "contexts"
• Non-integer code words	**No** - Low coding efficiency forhigh probability symbols	**Yes** - Exploits "arithmetic coding" which generates non-integer code words for higher efficiency

Moreover, the H.264 Standard requires a bit-flag descriptor, which is set to determine the correct decoder for the corresponding encoder. As shown below, if the flag = 0, then CAVLC must have been selected as the encoder; if the flag = 1, then CABAC must have been selected as the encoder. *See* https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-H.264-201304-S!!PDF-E&type=items (Rec. ITU-T H.264 (04/2013)) at 80:

entropy_coding_mode_flag selects the entropy decoding method to be applied for the syntax elements for which two descriptors appear in the syntax tables as follows:

– If entropy_coding_mode_flag is equal to 0, the method specified by the left descriptor in the syntax table is applied (Exp-Golomb coded, see clause 9.1 or CAVLC, see clause 9.2).

– Otherwise (entropy_coding_mode_flag is equal to 1), the method specified by the right descriptor in the syntax table is applied (CABAC, see clause 9.3).

18. After its selection, the asymmetric compressor (CAVLC or CABAC) will compress the video data to provide various compressed data blocks, which can be organized in a GOP structure (see above). *See* https://sonnati.wordpress.com/2007/10/29/how-h-264-works-part-ii/:

Entropy Coding

For entropy coding, H.264 may use an enhanced VLC, a more complex context-adaptive variable-length coding (CAVLC) or an ever more complex Context-adaptive binary-arithmetic coding (CABAC) which are complex techniques to losslessly compress syntax elements in the video stream knowing the probabilities of syntax elements in a given context. The use of CABAC can improve the compression of around 5-7%. CABAC may requires a 30-40% of total processing power to be accomplished.

See

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.602.1581&rep=rep1&type=pdf

at 13:

Typical compression ratios to maintain excellent quality are:

- 10:1 for general images using JPEG
- 30:1 for general video using H.263 and MPEG-2
- 60:1 for general video using H.264 and WMV9

See http://www.ijera.com/papers/Vol3_issue4/BM34399403.pdf at 2:

Most visual communication systems today use Baseline Profile. Baseline is the simplest H.264 profile and defines, for example, zigzag scanning of the picture and using 4:2:0 (YUV video formats) chrominance sampling. In Baseline Profile, the picture is split in blocks consisting of 4x4 pixels, and each block is processed separately. Another important element of the Baseline Profile is the use of Universal Variable Length Coding (UVLC) and Context Adaptive Variable Length Coding (CAVLC) entropy coding techniques.

The Extended and Main Profiles includes the functionality of the Baseline Profile and add improvements to the predictions algorithms. Since transmitting every single frame (think 30 frames per second for good quality video) is not feasible if you are trying to reduce the bit rate 1000-2000 times, temporal and motion prediction are heavily used in H.264, and allow transmitting only the difference between one frame and the previous frames. The result is spectacular efficiency gain, especially for scenes with little change and motion.

The High Profile is the most powerful profile in H.264, and it allows most efficient coding of video. For example, large coding gain achieved through the use of Context Adaptive Binary Arithmetic Coding (CABAC) encoding which is more efficient than the UVLC/CAVLC used in Baseline Profile.

The High Profile also uses adaptive transform that decides on the fly if 4x4 or 8x8-pixel blocks should be used. For example, 4x4 blocks are used for the parts of the picture that are dense with detail, while parts that have little detail are transformed using 8x8 blocks.

19. The Accused Instrumentalities includes a controller for tracking throughput and generating a control signal to select a compression routine based on the throughput, wherein said tracking throughput comprises tracking a number of pending access requests to a storage device, and a controller where, when the controller determines that the throughput falls below a predetermined throughput threshold, the controller commands the data compression engine to use one of the plurality of compression routines to provide a faster rate of compression so as to increase the

throughput. For example, the Accused Instrumentalities supports the H.264 standard that utilizes Scalable Video Coding, which enables the functionalities of adaptation for channel bandwidth. The controller in the Accused Instrumentalities decides which compression (e.g., CABAC, CAVLC, etc.) to use at a point in time based on parameters, for example, e.g., current or anticipated throughput. For example, when a low bandwidth is present, the Accused Instrumentalities select lower quality stream using a particular compression technique. As another example, when a high bandwidth is present, the Accused Instrumentalities select higher quality stream using another particular compression technique. As another example, the Accused Instrumentalities' use of different "Profiles" of H.264 is directed to selecting lower quality stream using a particular compression technique (e.g., CABAC or CAVLC, etc.) for lower anticipated bandwidth situations, and selecting higher quality stream using a higher compression technique (e.g., CABAC or CAVLC, etc.) for higher anticipated bandwidth situations.

20. On information and belief, AMD also directly infringes and continues to infringe other claims of the '046 patent.

21. On information and belief, all of the Accused Instrumentalities perform the claimed methods in substantially the same way, e.g., in the manner specified in the H.264 standard.

22. On information and belief, use of the Accused Instrumentalities in their ordinary and customary fashion results in infringement of the methods claimed by the '046 patent.

23. On information and belief, AMD has had knowledge of the '046 patent since at least the filing of this Complaint or shortly thereafter, and on information and belief, AMD knew of the '046 patent and knew of its infringement, including by way of this lawsuit. By the time of trial, AMD will have known and intended (since receiving such notice) that its continued actions would actively induce and contribute to the infringement of the claims of the '046 patent.

24. Upon information and belief, AMD's affirmative acts of making, using, and selling the Accused Instrumentalities, and providing implementation services and technical support to users of the Accused Instrumentalities, including, e.g., through training, demonstrations, brochures, installation and user guides, have induced and continue to induce users of the Accused Instrumentalities to use them in their normal and customary way to infringe the '046 patent. For example, AMD uses Quick Sync Video media processing technology in its processors. Quick Sync Video adopted H.264 as its video codec. For similar reasons, AMD also induces its customers to use the Accused Instrumentalities to infringe other claims of the '046 patent. AMD specifically intended and was aware that these normal and customary activities would infringe the '046 patent. AMD performed the acts that constitute induced infringement, and would induce actual infringement, with the knowledge of the '046 patent and with the knowledge, or willful blindness to the probability, that the induced acts would constitute infringement. For example, since filing of this action, AMD knows that the ordinary way of using Scalable Video Coding —which is directed to choosing different compression techniques based on current or anticipated throughput—in the Accused Instrumentalities infringes the patent but nevertheless continues to promote H.264 compression standard that utilizes Scalable Video Coding to its customers. The only reasonable inference is that AMD specifically intends the users to infringe the patent. On information and belief, AMD engaged in such inducement to promote the sales of the Accused Instrumentalities. Accordingly, AMD has induced and continue to induce users of the Accused Instrumentalities to use the Accused Instrumentalities in their ordinary and customary way to infringe the '046 patent, knowing that such use constitutes infringement of the '046 patent. Accordingly, AMD has been (as of filing of the original complaint), and currently is, inducing infringement of the '046 patent, in violation of 35 U.S.C. § 271(b).

25. AMD has also infringed, and continues to infringe, claims of the '046 patent by offering to commercially distribute, commercially distributing, making, and/or

importing the Accused Instrumentalities, which are used in practicing the process, or using the systems, of the ‘046 patent, and constitute a material part of the invention. AMD knows the components in the Accused Instrumentalities to be especially made or especially adapted for use in infringement of the ‘046 patent, not a staple article, and not a commodity of commerce suitable for substantial noninfringing use. For example, the ordinary way of using Scalable Video Coding—which is directed to choosing different compression techniques based on current or anticipated throughput—infringes the patent, and as such, is especially adapted for use in infringement. Moreover, there is no substantial noninfringing use, as Scalable Video Coding is directed to choosing different compression techniques based on current or anticipated throughput. Accordingly, AMD has been (as of filing of the original complaint), and currently is, contributorily infringing the ‘046 patent, in violation of 35 U.S.C. § 271(c).

26. By making, using, offering for sale, selling and/or importing into the United States the Accused Instrumentalities, and touting the benefits of using the Accused Instrumentalities’ compression features, AMD has injured Realtime and is liable to Realtime for infringement of the ‘046 patent pursuant to 35 U.S.C. § 271.

27. As a result of AMD’s infringement of the ‘046 patent, Plaintiff Realtime is entitled to monetary damages in an amount adequate to compensate for AMD’s infringement, but in no event less than a reasonable royalty for the use made of the invention by AMD, together with interest and costs as fixed by the Court.

COUNT II

INFRINGEMENT OF U.S. PATENT NO. 8,934,535

28. Plaintiff re-alleges and incorporates by reference the foregoing paragraphs, as if fully set forth herein.

29. On information and belief, AMD has made, used, offered for sale, sold and/or imported into the United States AMD products that infringe the ‘535 patent, and

continues to do so. By way of illustrative example, these infringing products include, without limitation, AMD's products/solutions e.g., AMD's Video Coding Engine, which is a "[F]ixed-function hardware accelerator that supports H.264 AVC, and SVC encoding." *See e.g.*, http://developer.amd.com/wordpress/media/2013/11/MediaSDK_User_Guide_1_1_Beta.pdf. AMD integrates Video Coding Engine into all of their GPUs and APUs, such as, e.g., AMD Radeon R9 Series Graphics Cards, AMD Radeon R7 Series Graphics Cards, AMD Radeon R5 Series Graphics Cards AMD Radeon HD 6450 Graphics Cards, AMD Radeon HD 7700 Series Graphics Cards, and all versions and variations thereof since the issuance of the '535 patent ("Accused Instrumentalities").

30. On information and belief, AMD has directly infringed and continues to infringe the '535 patent, for example, through its own use and testing of the Accused Instrumentalities, which when used, practices the method claimed by Claim 15 of the '535 patent, namely, a method, comprising: determining a parameter of at least a portion of a data block; selecting one or more asymmetric compressors from among a plurality of compressors based upon the determined parameter or attribute; compressing the at least the portion of the data block with the selected one or more asymmetric compressors to provide one or more compressed data blocks; and storing at least a portion of the one or more compressed data blocks. Upon information and belief, AMD uses the Accused Instrumentalities to practice infringing methods for its own internal non-testing business purposes, while testing the Accused Instrumentalities, and while providing technical support and repair services for the Accused Instrumentalities to AMD's customers.

31. For example, the Accused Instrumentalities utilize H.264 video

compression standard, which utilizes Scalable Video Coding technology. See, e.g., Recommendations ITU-T H.264 (03/2010) Annex G (Scalable video coding), p. 387-599.

Annex G

Scalable video coding

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies scalable video coding, referred to as SVC.

G.1 Scope

Bitstreams and decoders conforming to one or more of the profiles specified in this annex are completely specified in this annex with reference made to clauses 2-9 and Annexes A-E.

G.2 Normative references

The specifications in clause 2 apply with the following additions.

– ISO/IEC 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*.
– IETF RFC 3986 (2005), *Uniform Resource Identifiers (URI): Generic Syntax*.

G.3 Definitions

For the purpose of this annex, the following definitions apply in addition to the definitions in clause 3. These definitions are either not present in clause 3 or replace definitions in clause 3.

G.3.1 **arbitrary slice order (ASO)**: A *decoding order* of *slices* in which the *macroblock address* of the first *macroblock* of some *slice* of a *slice group* within a *layer representation* may be less than the *macroblock address* of the first *macroblock* of some other preceding *slice* of the same *slice group* within the same *layer representation* or in which the *slices* of a *slice group* within a *layer representation* may be interleaved with the *slices* of one or more other *slices groups* within the same *layer representation*.

G.3.2 **associated NAL unit**: A *NAL unit* that directly succeeds a *prefix NAL unit* in *decoding order*.

G.3.3 **B slice**: A *slice* that may be decoded using *intra-layer intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

G.3.4 **base layer**: A *bitstream subset* that contains all *NAL units* with the nal_unit_type *syntax element* equal to 1 and 5 of the *bitstream* and does not contain any *NAL unit* with the nal_unit_type *syntax element* equal to 14, 15, or 20 and conforms to one or more of the profiles specified in Annex A.

G.3.5 **base quality layer representation**: The *layer representation* of the *target dependency representation* of an *access unit* that is associated with the quality_id *syntax element* equal to 0.

G.3.6 **bitstream subset**: A *bitstream* that is derived as a *subset* from a *bitstream* by discarding zero or more *NAL units*. A *bitstream subset* is also referred to as *sub-bitstream*.

G.3.7 **bottom macroblock (of a macroblock pair)**: The *macroblock* within a *macroblock pair* that contains the samples in the bottom row of samples for the *macroblock pair*. For a *field macroblock pair*, the bottom macroblock represents the samples from the region of the *bottom field* or *layer bottom field* of the *frame* or *layer frame*, respectively, that lie within the spatial region of the *macroblock pair*. For a *frame macroblock pair*, the bottom macroblock represents the samples of the *frame* or *layer frame* that lie within the bottom half of the spatial region of the *macroblock pair*.

G.3.8 **coded slice in scalable extension NAL unit**: A *coded slice NAL unit* that contains an *EI slice*, *EP slice*, or an *EB slice*.

G.3.9 **complementary reference field pair**: A collective term for two *reference fields* that are in consecutive *access units* in *decoding order* as two *coded fields*, where the *target dependency representations* of the *fields* share the same value of the frame_num *syntax element* and where the second *field* in *decoding order* is not an *IDR picture* and the *target dependency representation* of the second *field* does not include a memory_management_control_operation *syntax element* equal to 5, or a *complementary reference base field pair*.

https://en.wikipedia.org/wiki/Scalable_Video_Coding

Scalable Video Coding (**SVC**) is the name for the Annex G extension of the H.264/MPEG-4 AVC video compression standard. SVC standardizes the encoding of a high-quality video bitstream that also contains one or more subset bitstreams. A subset video bitstream is derived by dropping packets from the larger video to reduce the bandwidth required for the subset bitstream. The subset bitstream can represent a lower spatial resolution (smaller screen), lower temporal resolution (lower frame rate), or lower quality video signal. H.264/MPEG-4 AVC was developed jointly by ITU-T and ISO/IEC JTC 1. These two groups created the Joint Video Team (JVT) to develop the H.264/MPEG-4 AVC standard.

Contents [hide]

Overview [edit]

The objective of the SVC standardization has been to enable the encoding of a high-quality video bitstream that contains one or more subset bitstreams that can themselves be decoded with a complexity and reconstruction quality similar to that achieved using the existing H.264/MPEG-4 AVC design with the same quantity of data as in the subset bitstream. The subset bitstream is derived by dropping packets from the larger bitstream.

A subset bitstream can represent a lower spatial resolution (smaller screen), or a lower temporal resolution (lower frame rate), or a lower quality video signal (each separately or in combination) compared to the bitstream it is derived from. The following modalities are possible:

- Temporal (frame rate) scalability: the motion compensation dependencies are structured so that complete pictures (i.e. their associated packets) can be dropped from the bitstream. (Temporal scalability is already enabled by H.264/MPEG-4 AVC. SVC has only provided supplemental enhancement information to improve its usage.)
- Spatial (picture size) scalability: video is coded at multiple spatial resolutions. The data and decoded samples of lower resolutions can be used to predict data or samples of higher resolutions in order to reduce the bit rate to code the higher resolutions.
- SNR/Quality/Fidelity scalability: video is coded at a single spatial resolution but at different qualities. The data and decoded samples of lower qualities can be used to predict data or samples of higher qualities in order to reduce the bit rate to code the higher qualities.
- Combined scalability: a combination of the 3 scalability modalities described above.

SVC enables forward compatibility for older hardware: the same bitstream can be consumed by basic hardware which can only decode a low-resolution subset (i.e. 720p or 1080i), while more advanced hardware will be able decode high quality video stream (1080p).

Background and applications [edit]

Bit-stream scalability for video is a desirable feature for many multimedia applications. The need for scalability arises from graceful degradation transmission requirements, or adaptation needs for spatial formats, bit rates or power. To fulfill these requirements, it is beneficial that video is simultaneously transmitted or stored with a variety of spatial or temporal resolutions or qualities which is the purpose of video bit-stream scalability.

Traditional digital video transmission and storage systems are based on H.222.0/MPEG-2 TS systems for broadcasting services over satellite, cable, and terrestrial transmission channels, and for DVD storage, or on H.320 for conversational video conferencing services. These channels are typically characterized by a fixed spatio-temporal format of the video signal (SDTV or HDTV or CIF for H.320 video telephone). The application behavior in such systems typically falls into one of the two categories: it works or it doesn't work.[1]

Modern video transmission and storage systems using the Internet and mobile networks are typically based on RTP/IP for real-time services (conversational and streaming) and on computer file formats like mp4 or 3gp. Most RTP/IP access networks are typically characterized by a wide range of connection qualities and receiving devices. The varying connection quality results from adaptive resource sharing mechanisms of these networks addressing the time varying data throughput requirements of a varying number of users. The variety of devices with different capabilities ranging from cell phones with small screens and restricted processing power to high-end PCs with high-definition displays results from the continuous evolution of these endpoints.

Scalable video coding (SVC) is one solution to the problems posed by the characteristics of modern video transmission systems. The following video applications can benefit from SVC:

- Streaming
- Conferencing
- Surveillance
- Broadcast
- Storage

Profiles and levels [edit]

As a result of the Scalable Video Coding extension, the standard contains five additional *scalable profiles*: Scalable Baseline, Scalable High, Scalable High Intra, Scalable Constrained Baseline and Scalable Constrained High Profile. These profiles are defined as a combination of the H.264/MPEG-4 AVC profile for the base layer (2nd word in scalable profile name) and tools that achieve the scalable extension:

- **Scalable Baseline Profile**: Mainly targeted for conversational, mobile, and surveillance applications.
  - A bitstream conforming to Scalable Baseline profile contains a base layer bitstream that conforms to a restricted version of Baseline profile of H.264/MPEG-4 AVC.
  - Supports B slices, weighted prediction, CABAC entropy coding, and 8×8 luma transform in enhancement layers (CABAC and the 8×8 transform are only supported for certain levels), although the base layer has to conform to the restricted Baseline profile, which does not support these tools. Coding tools for interlaced sources are not included.
  - Spatial scalable coding is restricted to resolution ratios of 1.5 and 2 between successive spatial layers in both horizontal and vertical direction and to macroblock-aligned cropping.
  - Quality and temporal scalable coding are supported without any restriction.
- **Scalable High Profile**: Primarily designed for broadcast, streaming, storage and videoconferencing applications.
  - A bitstream conforming to Scalable High profile contains a base layer bitstream that conforms to High profile of H.264/MPEG-4 AVC.
  - Supports all tools specified in the Scalable Video Coding extension.
  - Spatial scalable coding without any restriction, i.e., arbitrary resolution ratios and cropping parameters is supported.
  - Quality and temporal scalable coding are supported without any restriction.
- **Scalable High Intra Profile**: Mainly designed for professional applications.
  - Uses Instantaneous Decoder Refresh (IDR) pictures only. IDR pictures can be decoded without reference to previous frames.
  - A bitstream conforming to Scalable High Intra profile contains a base layer bitstream that conforms to High profile of H.264/MPEG-4 AVC with only IDR pictures allowed.
  - All scalability tools are allowed as in Scalable High profile but only IDR pictures are permitted in any layer.
- **Scalable Constrained Baseline Profile**
- **Scalable Constrained High Profile**

32. The Accused Instrumentalities determine a parameter of at least a portion of a video data block. As shown below, examples of such parameters include bitrate (or max video bitrate) and resolution parameters. Different parameters correspond with different end applications. H.264 provides for multiple different ranges of such parameters, each included in the "profiles" and "levels" defined by the H.264 standard. *See* http://www.axis.com/files/whitepaper/wp_h264_31669_en_0803_lo.pdf at 5:

4. H.264 profiles and levels

The joint group involved in defining H.264 focused on creating a simple and clean solution, limiting options and features to a minimum. An important aspect of the standard, as with other video standards, is providing the capabilities in profiles (sets of algorithmic features) and levels (performance classes) that optimally support popular productions and common formats.

H.264 has seven profiles, each targeting a specific class of applications. Each profile defines what feature set the encoder may use and limits the decoder implementation complexity.

Network cameras and video encoders will most likely use a profile called the baseline profile, which is intended primarily for applications with limited computing resources. The baseline profile is the most suitable given the available performance in a real-time encoder that is embedded in a network video product. The profile also enables low latency, which is an important requirement of surveillance video and also particularly important in enabling real-time, pan/tilt/zoom (PTZ) control in PTZ network cameras.

H.264 has 11 levels or degree of capability to limit performance, bandwidth and memory requirements. Each level defines the bit rate and the encoding rate in macroblock per second for resolutions ranging from QCIF to HDTV and beyond. The higher the resolution, the higher the level required.

See https://en.wikipedia.org/wiki/H.264/MPEG-4_AVC:

Levels with maximum property values

Level	Max decoding speed		Max frame size		Max video bit rate for video coding layer (VCL) kbit/s			Examples for high resolution @ highest frame rate (max stored frames) Toggle additional details
	Luma samples/s	Macroblocks/s	Luma samples	Macroblocks	Baseline, Extended and Main Profiles	High Profile	High 10 Profile	
1	380,160	1,485	25,344	99	64	80	192	176×144@15.0 (4)
1b	380,160	1,485	25,344	99	128	160	384	176×144@15.0 (4)
1.1	768,000	3,000	101,376	396	192	240	576	352×288@7.5 (2)
1.2	1,536,000	6,000	101,376	396	384	480	1,152	352×288@15.2 (6)
1.3	3,041,280	11,880	101,376	396	768	960	2,304	352×288@30.0 (6)
2	3,041,280	11,880	101,376	396	2,000	2,500	6,000	352×288@30.0 (6)
2.1	5,068,800	19,800	202,752	792	4,000	5,000	12,000	352×576@25.0 (6)
2.2	5,184,000	20,250	414,720	1,620	4,000	5,000	12,000	720×576@12.5 (5)
3	10,368,000	40,500	414,720	1,620	10,000	12,500	30,000	720×576@25.0 (5)
3.1	27,648,000	108,000	921,600	3,600	14,000	17,500	42,000	1,280×720@30.0 (5)
3.2	55,296,000	216,000	1,310,720	5,120	20,000	25,000	60,000	1,280×1,024@42.2 (4)
4	62,914,560	245,760	2,097,152	8,192	20,000	25,000	60,000	2,048×1,024@30.0 (4)
4.1	62,914,560	245,760	2,097,152	8,192	50,000	62,500	150,000	2,048×1,024@30.0 (4)
4.2	133,693,440	522,240	2,228,224	8,704	50,000	62,500	150,000	2,048×1,080@60.0 (4)
5	150,994,944	589,824	5,652,480	22,080	135,000	168,750	405,000	3,672×1,536@26.7 (5)
5.1	251,658,240	983,040	9,437,184	36,864	240,000	300,000	720,000	4,096×2,304@26.7 (5)
5.2	530,841,600	2,073,600	9,437,184	36,864	240,000	300,000	720,000	4,096×2,304@56.3 (5)

33. A video data block is organized by the group of pictures (GOP) structure, which is a "collection of successive pictures within a coded video stream." *See* https://en.wikipedia.org/wiki/Group_of_pictures. A GOP structure can contain intra coded pictures (I picture or I frame), predictive coded pictures (P picture or P frame), bipredictive coded pictures (B picture or B frame) and direct coded pictures (D picture or D frames, or DC direct coded pictures which are used only in MPEG-1 video). *See* https://en.wikipedia.org/wiki/Video_compression_picture_types (for descriptions of I frames, P frames and B frames); https://en.wikipedia.org/wiki/MPEG-1#D-frames (for descriptions of D frames). Thus, at least a portion of a video data block would also make up a GOP structure and could also contain I frames, P frames, B frames and/or D frames. The GOP structure also reflects the size of a video data block, and the GOP structure can be controlled and used to fine-tune other parameters (e.g. bitrate, max video bitrate and resolution parameters) or even be considered as a parameter by itself.

34. Based on the bitrate and/or resolution parameter identified (e.g. bitrate,

max video bitrate, resolution, GOP structure or frame type within a GOP structure), any H.264-compliant system such as the Accused Instrumentalities would determine which profile (e.g., “baseline,” “extended,” “main”, or “high”) corresponds with that parameter, then select between at least two asymmetric compressors. If baseline or extended is the corresponding profile, then the system will select a Context-Adaptive Variable Length Coding (“CAVLC”) entropy encoder. If main or high is the corresponding profile, then the system will select a Context-Adaptive Binary Arithmetic Coding (“CABAC”) entropy encoder. Both encoders are asymmetric compressors because it takes a longer period of time for them to compress data than to decompress data. *See* https://sonnati.wordpress.com/2007/10/29/how-h-264-works-part-ii/

	Baseline	Extended	Main	High	High 10
I and P Slices	Yes	Yes	Yes	Yes	Yes
B Slices	No	Yes	Yes	Yes	Yes
SI and SP Slices	No	Yes	No	No	No
Multiple Reference Frames	Yes	Yes	Yes	Yes	Yes
In-Loop Deblocking Filter	Yes	Yes	Yes	Yes	Yes
CAVLC Entropy Coding	Yes	Yes	Yes	Yes	Yes
CABAC Entropy Coding	No	No	Yes	Yes	Yes
Flexible Macroblock Ordering (FMO)	Yes	Yes	No	No	No
Arbitrary Slice Ordering (ASO)	Yes	Yes	No	No	No
Redundant Slices (RS)	Yes	Yes	No	No	No
Data Partitioning	No	Yes	No	No	No
Interlaced Coding (PicAFF, MBAFF)	No	Yes	Yes	Yes	Yes
4:2:0 Chroma Format	Yes	Yes	Yes	Yes	Yes
Monochrome Video Format (4:0:0)	No	No	No	Yes	Yes
4:2:2 Chroma Format	No	No	No	No	No
4:4:4 Chroma Format	No	No	No	No	No
8 Bit Sample Depth	Yes	Yes	Yes	Yes	Yes
9 and 10 Bit Sample Depth	No	No	No	No	Yes
11 to 14 Bit Sample Depth	No	No	No	No	No
8×8 vs. 4×4 Transform Adaptivity	No	No	No	Yes	Yes
Quantization Scaling Matrices	No	No	No	Yes	Yes
Separate Cb and Cr QP control	No	No	No	Yes	Yes
Separate Color Plane Coding	No	No	No	No	No
Predictive Lossless Coding	No	No	No	No	No

See http://web.cs.ucla.edu/classes/fall03/cs218/paper/H.264_MPEG4_Tutorial.pdf at 7:

The following table summarizes the two major types of entropy coding: Variable Length Coding (VLC) and Context Adaptive Binary Arithmetic Coding (CABAC). CABAC offers superior coding efficiency over VLC by adapting to the changing probability distribution of symbols, by exploiting correlation between symbols, and by adaptively exploiting bit correlations using arithmetic coding. H.264 also supports Context Adaptive Variable Length Coding (CAVLC) which offers superior entropy coding over VLC without the full cost of CABAC.

H.264 Entropy Coding – Comparison of Approaches

Characteristics	Variable Length Coding (VLC)	Context Adaptive Binary Arithmetic Coding(CABAC)
• Where it is used	MPEG-2, MPEG-4 ASP	H.264/MPEG-4 AVC (high efficiency option)
• Probability distribution	**Static** - Probabilities never change	**Adaptive** - Adjusts probabilities based on actual data
• Leverages correlation between symbols	**No** - Conditional probabilities ignored	**Yes** - Exploits symbol correlations by using "contexts"
• Non-integer code words	**No** - Low coding efficiency forhigh probability symbols	**Yes** - Exploits "arithmetic coding" which generates non-integer code words for higher efficiency

Moreover, the H.264 Standard requires a bit-flag descriptor, which is set to determine the correct decoder for the corresponding encoder. As shown below, if the flag = 0, then CAVLC must have been selected as the encoder; if the flag = 1, then CABAC must have been selected as the encoder. *See* https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-H.264-201304-S!!PDF-E&type=items (Rec. ITU-T H.264 (04/2013)) at 80:

> **entropy_coding_mode_flag** selects the entropy decoding method to be applied for the syntax elements for which two descriptors appear in the syntax tables as follows:
>
> – If entropy_coding_mode_flag is equal to 0, the method specified by the left descriptor in the syntax table is applied (Exp-Golomb coded, see clause 9.1 or CAVLC, see clause 9.2).
>
> – Otherwise (entropy_coding_mode_flag is equal to 1), the method specified by the right descriptor in the syntax table is applied (CABAC, see clause 9.3).

35. The controller in the Accused Instrumentalities decides which compression (e.g., CABAC, CAVLC, etc.) to use at a point in time based on parameters, for example, e.g., current or anticipated throughput. For example, when a low bandwidth is present, the Accused Instrumentalities select lower quality stream using a particular compression technique. As another example, when a high bandwidth is present, the Accused Instrumentalities select higher quality stream using another particular

compression technique. As another example, the Accused Instrumentalities' use of different "Profiles" of H.264 is directed to selecting lower quality stream using a particular compression technique (e.g., CABAC or CAVLC, etc.) for lower anticipated bandwidth situations, and selecting higher quality stream using a higher compression technique (e.g., CABAC or CAVLC, etc.) for higher anticipated bandwidth situations.

36. The Accused Instrumentalities compress the at least the portion of the data block with the selected one or more asymmetric compressors to provide one or more compressed data blocks, which can be organized in a GOP structure (see above). After its selection, the asymmetric compressor (CAVLC or CABAC) will compress the video data to provide various compressed data blocks, which can also be organized in a GOP structure. *See* https://sonnati.wordpress.com/2007/10/29/how-h-264-works-part-ii/:

Entropy Coding

For entropy coding, H.264 may use an enhanced VLC, a more complex context-adaptive variable-length coding (CAVLC) or an ever more complex Context-adaptive binary-arithmetic coding (CABAC) which are complex techniques to losslessly compress syntax elements in the video stream knowing the probabilities of syntax elements in a given context. The use of CABAC can improve the compression of around 5-7%. CABAC may requires a 30-40% of total processing power to be accomplished.

See

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.602.1581&rep=rep1&type=pdf

at 13:

Typical compression ratios to maintain excellent quality are:

- 10:1 for general images using JPEG
- 30:1 for general video using H.263 and MPEG-2
- 60:1 for general video using H.264 and WMV9

See http://www.ijera.com/papers/Vol3_issue4/BM34399403.pdf at 2:

Most visual communication systems today use Baseline Profile. Baseline is the simplest H.264 profile and defines, for example, zigzag scanning of the picture and using 4:2:0 (YUV video formats) chrominance sampling. In Baseline Profile, the picture is split in blocks consisting of 4x4 pixels, and each block is processed separately. Another important element of the Baseline Profile is the use of Universal Variable Length Coding (UVLC) and Context Adaptive Variable Length Coding (CAVLC) entropy coding techniques.

The Extended and Main Profiles includes the functionality of the Baseline Profile and add improvements to the predictions algorithms. Since transmitting every single frame (think 30 frames per second for good quality video) is not feasible if you are trying to reduce the bit rate 1000-2000 times, temporal and motion prediction are heavily used in H.264, and allow transmitting only the difference between one frame and the previous frames. The result is spectacular efficiency gain, especially for scenes with little change and motion.

The High Profile is the most powerful profile in H.264, and it allows most efficient coding of video. For example, large coding gain achieved through the use of Context Adaptive Binary Arithmetic Coding (CABAC) encoding which is more efficient than the UVLC/CAVLC used in Baseline Profile.

The High Profile also uses adaptive transform that decides on the fly if 4x4 or 8x8-pixel blocks should be used. For example, 4x4 blocks are used for the parts of the picture that are dense with detail, while parts that have little detail are transformed using 8x8 blocks.

37. On information and belief, the Accused Instrumentalities store at least a portion of the one or more compressed data blocks in buffers, hard disk, or other forms of memory/storage.

38. On information and belief, AMD also directly infringes and continues to infringe other claims of the ‘535 patent.

39. On information and belief, all of the Accused Instrumentalities perform the claimed methods in substantially the same way, e.g., in the manner specified in the

H.264 standard.

40. On information and belief, use of the Accused Instrumentalities in their ordinary and customary fashion results in infringement of the methods claimed by the ‘535 patent.

41. On information and belief, AMD has had knowledge of the ‘535 patent since at least the filing of this Complaint or shortly thereafter, and on information and belief, AMD knew of the ‘535 patent and knew of its infringement, including by way of this lawsuit. By the time of trial, AMD will have known and intended (since receiving such notice) that its continued actions would actively induce and contribute to the infringement of the claims of the ‘535 patent.

42. Upon information and belief, AMD’s affirmative acts of making, using, and selling the Accused Instrumentalities, and providing implementation services and technical support to users of the Accused Instrumentalities, including, e.g., through training, demonstrations, brochures, installation and user guides, have induced and continue to induce users of the Accused Instrumentalities to use them in their normal and customary way to infringe the ‘535 patent by practicing a method, comprising: determining a parameter of at least a portion of a data block; selecting one or more asymmetric compressors from among a plurality of compressors based upon the determined parameter or attribute; compressing the at least the portion of the data block with the selected one or more asymmetric compressors to provide one or more compressed data blocks; and storing at least a portion of the one or more compressed data blocks. For example, AMD’s products/solutions utilize H.264 compression standard. As another example, AMD’s products/solutions integrate Video Coding Engine, which is a “[F]ixed-function hardware accelerator that supports H.264 AVC, and SVC encoding.” *See e.g.*, http://developer.amd.com/wordpress/media/2013/11/MediaSDK_ User_Guide_1_1_Beta.pdf.

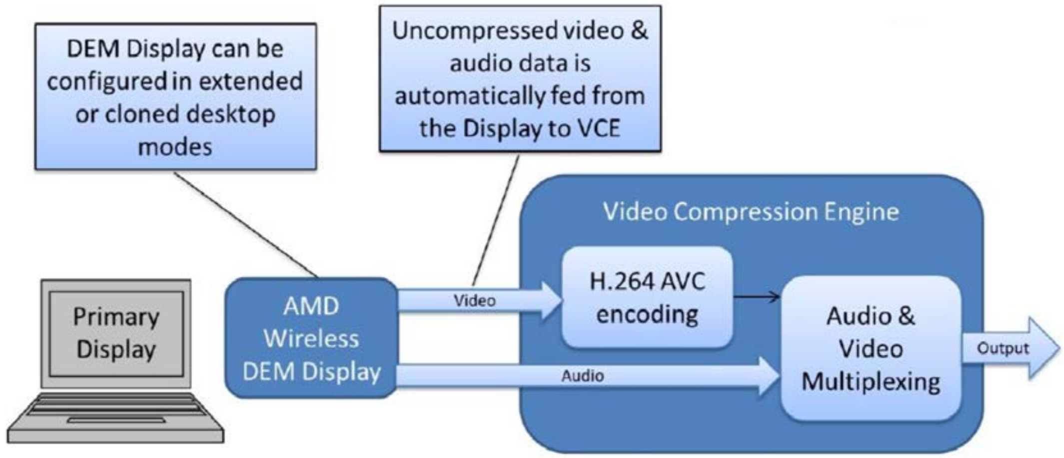

Figure 6.1 System Overview of the AMF Display Encode Mode

See e.g., http://developer.amd.com/wordpress/media/2013/11/MediaSDK_User_Guide_1_1_Beta.pdf. For similar reasons, AMD also induces its customers to use the Accused Instrumentalities to infringe other claims of the '535 patent. AMD specifically intended and was aware that these normal and customary activities would infringe the '535 patent. AMD performed the acts that constitute induced infringement, and would induce actual infringement, with the knowledge of the '535 patent and with the knowledge, or willful blindness to the probability, that the induced acts would constitute infringement. For example, since filing of this action, AMD knows that the ordinary way of using Scalable Video Coding —which is directed to choosing different compression techniques based on current or anticipated throughput—in the Accused Instrumentalities infringes the patent but nevertheless continues to promote H.264 compression standard that utilizes Scalable Video Coding to its customers. The only reasonable inference is that AMD specifically intends the users to infringe the patent. On information and belief, AMD engaged in such inducement to promote the sales of the Accused Instrumentalities. Accordingly, AMD has induced and continue to induce users of the Accused Instrumentalities to use the Accused Instrumentalities in their ordinary and customary way to infringe the ‘535 patent, knowing that such use constitutes infringement of the ‘535 patent. Accordingly, AMD has been (as of filing of the original complaint), and currently is, inducing infringement of the ‘535 patent, in violation of 35 U.S.C. § 271(b).

43. AMD has also infringed, and continues to infringe, claims of the ‘535 patent by offering to commercially distribute, commercially distributing, making, and/or importing the Accused Instrumentalities, which are used in practicing the process, or using the systems, of the ‘535 patent, and constitute a material part of the invention. AMD knows the components in the Accused Instrumentalities to be especially made or especially adapted for use in infringement of the ‘535 patent, not a staple article, and not a commodity of commerce suitable for substantial noninfringing use. For example, the ordinary way of using Scalable Video Coding—which is directed to choosing different compression techniques based on current or anticipated throughput—infringes the patent, and as such, is especially adapted for use in infringement. Moreover, there is no substantial noninfringing use, as Scalable Video Coding is directed to choosing different compression techniques based on current or anticipated throughput. Accordingly, AMD has been (as of filing of the original complaint), and currently is, contributorily infringing the ‘535 patent, in violation of 35 U.S.C. § 271(c).

44. By making, using, offering for sale, selling and/or importing into the United States the Accused Instrumentalities, and touting the benefits of using the Accused Instrumentalities’ compression features, AMD has injured Realtime and is liable to Realtime for infringement of the ‘535 patent pursuant to 35 U.S.C. § 271.

45. As a result of AMD’s infringement of the ‘535 patent, Plaintiff Realtime is entitled to monetary damages in an amount adequate to compensate for AMD’s infringement, but in no event less than a reasonable royalty for the use made of the invention by AMD, together with interest and costs as fixed by the Court.

COUNT III

INFRINGEMENT OF U.S. PATENT NO. 9,769,477

46. Plaintiff re-alleges and incorporates by reference the foregoing paragraphs, as if fully set forth herein.

47. On information and belief, AMD has made, used, offered for sale, sold and/or imported into the United States AMD products that infringe the '477 patent, and continues to do so. By way of illustrative example, these infringing products include, without limitation, AMD's products/solutions e.g., AMD's Video Coding Engine, which is a "[F]ixed-function hardware accelerator that supports H.264 AVC, and SVC encoding." *See e.g.,* http://developer.amd.com/wordpress/media/2013/11/MediaSDK_User_Guide_1_1_Beta.pdf. AMD integrated Video Coding Engine into all of their GPUs and APUs, such as, e.g., AMD Radeon R9 Series Graphics Cards, AMD Radeon R7 Series Graphics Cards, AMD Radeon R5 Series Graphics Cards AMD Radeon HD 6450 Graphics Cards, AMD Radeon HD 7700 Series Graphics Cards, and all versions and variations thereof since the issuance of the '477 patent ("Accused Instrumentalities").

48. On information and belief, AMD has directly infringed and continues to infringe the '477 patent, for example, through its sale, offer for sale, importation, use and testing of the Accused Instrumentalities that practice Claim 1 of the '477 patent, namely, a system, comprising: a plurality of different asymmetric data compression encoders, wherein each asymmetric data compression encoder of the plurality of different asymmetric data compression encoders is configured to utilize one or more data compression algorithms, and wherein a first asymmetric data compression encoder of the plurality of different asymmetric data compression encoders is configured to compress

data blocks containing video or image data at a higher data compression rate than a second asymmetric data compression encoder of the plurality of different asymmetric data compression encoders; and one or more processors configured to: determine one or more data parameters, at least one of the determined one or more data parameters relating to a throughput of a communications channel measured in bits per second; and select one or more asymmetric data compression encoders from among the plurality of different asymmetric data compression encoders based upon, at least in part, the determined one or more data parameters.

49. For example, the Accused Instrumentalities utilize H.264 video compression standard, which utilizes Scalable Video Coding technology. See, e.g., Recommendations ITU-T H.264 (03/2010) Annex G (Scalable video coding), p. 387-599.

Annex G

Scalable video coding

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies scalable video coding, referred to as SVC.

G.1 Scope

Bitstreams and decoders conforming to one or more of the profiles specified in this annex are completely specified in this annex with reference made to clauses 2-9 and Annexes A-E.

G.2 Normative references

The specifications in clause 2 apply with the following additions.

– ISO/IEC 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*.

– IETF RFC 3986 (2005), *Uniform Resource Identifiers (URI): Generic Syntax*.

G.3 Definitions

For the purpose of this annex, the following definitions apply in addition to the definitions in clause 3. These definitions are either not present in clause 3 or replace definitions in clause 3.

G.3.1 **arbitrary slice order (ASO)**: A *decoding order* of *slices* in which the *macroblock address* of the first *macroblock* of some *slice* of a *slice group* within a *layer representation* may be less than the *macroblock address* of the first *macroblock* of some other preceding *slice* of the same *slice group* within the same *layer representation* or in which the *slices* of a *slice group* within a *layer representation* may be interleaved with the *slices* of one or more other *slices groups* within the same *layer representation*.

G.3.2 **associated NAL unit**: A *NAL unit* that directly succeeds a *prefix NAL unit* in *decoding order*.

G.3.3 **B slice**: A *slice* that may be decoded using *intra-layer intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

G.3.4 **base layer**: A *bitstream subset* that contains all *NAL units* with the nal_unit_type *syntax element* equal to 1 and 5 of the *bitstream* and does not contain any *NAL unit* with the nal_unit_type *syntax element* equal to 14, 15, or 20 and conforms to one or more of the profiles specified in Annex A.

G.3.5 **base quality layer representation**: The *layer representation* of the *target dependency representation* of an *access unit* that is associated with the quality_id *syntax element* equal to 0.

G.3.6 **bitstream subset**: A *bitstream* that is derived as a *subset* from a *bitstream* by discarding zero or more *NAL units*. A *bitstream subset* is also referred to as *sub-bitstream*.

G.3.7 **bottom macroblock (of a macroblock pair)**: The *macroblock* within a *macroblock pair* that contains the samples in the bottom row of samples for the *macroblock pair*. For a *field macroblock pair*, the bottom macroblock represents the samples from the region of the *bottom field* or *layer bottom field* of the *frame* or *layer frame*, respectively, that lie within the spatial region of the *macroblock pair*. For a *frame macroblock pair*, the bottom macroblock represents the samples of the *frame* or *layer frame* that lie within the bottom half of the spatial region of the *macroblock pair*.

G.3.8 **coded slice in scalable extension NAL unit**: A *coded slice NAL unit* that contains an *EI slice*, *EP slice*, or an *EB slice*.

G.3.9 **complementary reference field pair**: A collective term for two *reference fields* that are in consecutive *access units* in *decoding order* as two *coded fields*, where the *target dependency representations* of the *fields* share the same value of the frame_num *syntax element* and where the second *field* in *decoding order* is not an *IDR picture* and the *target dependency representation* of the second *field* does not include a memory_management_control_operation *syntax element* equal to 5, or a *complementary reference base field pair*.

https://en.wikipedia.org/wiki/Scalable_Video_Coding

Scalable Video Coding (**SVC**) is the name for the Annex G extension of the H.264/MPEG-4 AVC video compression standard. SVC standardizes the encoding of a high-quality video bitstream that also contains one or more subset bitstreams. A subset video bitstream is derived by dropping packets from the larger video to reduce the bandwidth required for the subset bitstream. The subset bitstream can represent a lower spatial resolution (smaller screen), lower temporal resolution (lower frame rate), or lower quality video signal. H.264/MPEG-4 AVC was developed jointly by ITU-T and ISO/IEC JTC 1. These two groups created the Joint Video Team (JVT) to develop the H.264/MPEG-4 AVC standard.

Contents [hide]

Overview [edit]

The objective of the SVC standardization has been to enable the encoding of a high-quality video bitstream that contains one or more subset bitstreams that can themselves be decoded with a complexity and reconstruction quality similar to that achieved using the existing H.264/MPEG-4 AVC design with the same quantity of data as in the subset bitstream. The subset bitstream is derived by dropping packets from the larger bitstream.

A subset bitstream can represent a lower spatial resolution (smaller screen), or a lower temporal resolution (lower frame rate), or a lower quality video signal (each separately or in combination) compared to the bitstream it is derived from. The following modalities are possible:

- Temporal (frame rate) scalability: the motion compensation dependencies are structured so that complete pictures (i.e. their associated packets) can be dropped from the bitstream. (Temporal scalability is already enabled by H.264/MPEG-4 AVC. SVC has only provided supplemental enhancement information to improve its usage.)
- Spatial (picture size) scalability: video is coded at multiple spatial resolutions. The data and decoded samples of lower resolutions can be used to predict data or samples of higher resolutions in order to reduce the bit rate to code the higher resolutions.
- SNR/Quality/Fidelity scalability: video is coded at a single spatial resolution but at different qualities. The data and decoded samples of lower qualities can be used to predict data or samples of higher qualities in order to reduce the bit rate to code the higher qualities.
- Combined scalability: a combination of the 3 scalability modalities described above.

SVC enables forward compatibility for older hardware: the same bitstream can be consumed by basic hardware which can only decode a low-resolution subset (i.e. 720p or 1080i), while more advanced hardware will be able decode high quality video stream (1080p).

Background and applications [edit]

Bit-stream scalability for video is a desirable feature for many multimedia applications. The need for scalability arises from graceful degradation transmission requirements, or adaptation needs for spatial formats, bit rates or power. To fulfill these requirements, it is beneficial that video is simultaneously transmitted or stored with a variety of spatial or temporal resolutions or qualities which is the purpose of video bit-stream scalability.

Traditional digital video transmission and storage systems are based on H.222.0/MPEG-2 TS systems for broadcasting services over satellite, cable, and terrestrial transmission channels, and for DVD storage, or on H.320 for conversational video conferencing services. These channels are typically characterized by a fixed spatio-temporal format of the video signal (SDTV or HDTV or CIF for H.320 video telephone). The application behavior in such systems typically falls into one of the two categories: it works or it doesn't work.[1]

Modern video transmission and storage systems using the Internet and mobile networks are typically based on RTP/IP for real-time services (conversational and streaming) and on computer file formats like mp4 or 3gp. Most RTP/IP access networks are typically characterized by a wide range of connection qualities and receiving devices. The varying connection quality results from adaptive resource sharing mechanisms of these networks addressing the time varying data throughput requirements of a varying number of users. The variety of devices with different capabilities ranging from cell phones with small screens and restricted processing power to high-end PCs with high-definition displays results from the continuous evolution of these endpoints.

Scalable video coding (SVC) is one solution to the problems posed by the characteristics of modern video transmission systems. The following video applications can benefit from SVC:

- Streaming
- Conferencing
- Surveillance
- Broadcast
- Storage

Profiles and levels [edit]

As a result of the Scalable Video Coding extension, the standard contains five additional *scalable profiles*: Scalable Baseline, Scalable High, Scalable High Intra, Scalable Constrained Baseline and Scalable Constrained High Profile. These profiles are defined as a combination of the H.264/MPEG-4 AVC profile for the base layer (2nd word in scalable profile name) and tools that achieve the scalable extension:

- **Scalable Baseline Profile**: Mainly targeted for conversational, mobile, and surveillance applications.
  - A bitstream conforming to Scalable Baseline profile contains a base layer bitstream that conforms to a restricted version of Baseline profile of H.264/MPEG-4 AVC.
  - Supports B slices, weighted prediction, CABAC entropy coding, and 8×8 luma transform in enhancement layers (CABAC and the 8×8 transform are only supported for certain levels), although the base layer has to conform to the restricted Baseline profile, which does not support these tools. Coding tools for interlaced sources are not included.
  - Spatial scalable coding is restricted to resolution ratios of 1.5 and 2 between successive spatial layers in both horizontal and vertical direction and to macroblock-aligned cropping.
  - Quality and temporal scalable coding are supported without any restriction.
- **Scalable High Profile**: Primarily designed for broadcast, streaming, storage and videoconferencing applications.
  - A bitstream conforming to Scalable High profile contains a base layer bitstream that conforms to High profile of H.264/MPEG-4 AVC.
  - Supports all tools specified in the Scalable Video Coding extension.
  - Spatial scalable coding without any restriction, i.e., arbitrary resolution ratios and cropping parameters is supported.
  - Quality and temporal scalable coding are supported without any restriction.
- **Scalable High Intra Profile**: Mainly designed for professional applications.
  - Uses Instantaneous Decoder Refresh (IDR) pictures only. IDR pictures can be decoded without reference to previous frames.
  - A bitstream conforming to Scalable High Intra profile contains a base layer bitstream that conforms to High profile of H.264/MPEG-4 AVC with only IDR pictures allowed.
  - All scalability tools are allowed as in Scalable High profile but only IDR pictures are permitted in any layer.
- **Scalable Constrained Baseline Profile**
- **Scalable Constrained High Profile**

50. The Accused Instrumentalities include a plurality of different asymmetric data compression encoders, wherein each asymmetric data compression encoder of the plurality of different asymmetric data compression encoders is configured to utilize one or more data compression algorithms, and wherein a first asymmetric data compression encoder of the plurality of different asymmetric data compression encoders is configured to compress data blocks containing video or image data at a higher data compression rate than a second asymmetric data compression encoder of the plurality of different asymmetric data compression encoders. H.264 provides for multiple different ranges of parameters (e.g., bitrate, max video bitrate, resolution parameters, etc.), each included in the "profiles" and "levels" defined by the H.264 standard. *See* http://www.axis.com/files/whitepaper/wp_h264_31669_en_0803_lo.pdf at 5:

4. H.264 profiles and levels

The joint group involved in defining H.264 focused on creating a simple and clean solution, limiting options and features to a minimum. An important aspect of the standard, as with other video standards, is providing the capabilities in profiles (sets of algorithmic features) and levels (performance classes) that optimally support popular productions and common formats.

H.264 has seven profiles, each targeting a specific class of applications. Each profile defines what feature set the encoder may use and limits the decoder implementation complexity.

Network cameras and video encoders will most likely use a profile called the baseline profile, which is intended primarily for applications with limited computing resources. The baseline profile is the most suitable given the available performance in a real-time encoder that is embedded in a network video product. The profile also enables low latency, which is an important requirement of surveillance video and also particularly important in enabling real-time, pan/tilt/zoom (PTZ) control in PTZ network cameras.

H.264 has 11 levels or degree of capability to limit performance, bandwidth and memory requirements. Each level defines the bit rate and the encoding rate in macroblock per second for resolutions ranging from QCIF to HDTV and beyond. The higher the resolution, the higher the level required.

See https://en.wikipedia.org/wiki/H.264/MPEG-4_AVC:

Levels with maximum property values

Level	Max decoding speed		Max frame size		Max video bit rate for video coding layer (VCL) kbit/s			Examples for high resolution @ highest frame rate (max stored frames) Toggle additional details
	Luma samples/s	Macroblocks/s	Luma samples	Macroblocks	Baseline, Extended and Main Profiles	High Profile	High 10 Profile	
1	380,160	1,485	25,344	99	64	80	192	176×144@15.0 (4)
1b	380,160	1,485	25,344	99	128	160	384	176×144@15.0 (4)
1.1	768,000	3,000	101,376	396	192	240	576	352×288@7.5 (2)
1.2	1,536,000	6,000	101,376	396	384	480	1,152	352×288@15.2 (6)
1.3	3,041,280	11,880	101,376	396	768	960	2,304	352×288@30.0 (6)
2	3,041,280	11,880	101,376	396	2,000	2,500	6,000	352×288@30.0 (6)
2.1	5,068,800	19,800	202,752	792	4,000	5,000	12,000	352×576@25.0 (6)
2.2	5,184,000	20,250	414,720	1,620	4,000	5,000	12,000	720×576@12.5 (5)
3	10,368,000	40,500	414,720	1,620	10,000	12,500	30,000	720×576@25.0 (5)
3.1	27,648,000	108,000	921,600	3,600	14,000	17,500	42,000	1,280×720@30.0 (5)
3.2	55,296,000	216,000	1,310,720	5,120	20,000	25,000	60,000	1,280×1,024@42.2 (4)
4	62,914,560	245,760	2,097,152	8,192	20,000	25,000	60,000	2,048×1,024@30.0 (4)
4.1	62,914,560	245,760	2,097,152	8,192	50,000	62,500	150,000	2,048×1,024@30.0 (4)
4.2	133,693,440	522,240	2,228,224	8,704	50,000	62,500	150,000	2,048×1,080@60.0 (4)
5	150,994,944	589,824	5,652,480	22,080	135,000	168,750	405,000	3,672×1,536@26.7 (5)
5.1	251,658,240	983,040	9,437,184	36,864	240,000	300,000	720,000	4,096×2,304@26.7 (5)
5.2	530,841,600	2,073,600	9,437,184	36,864	240,000	300,000	720,000	4,096×2,304@56.3 (5)

51. A video data block is organized by the group of pictures (GOP) structure, which is a "collection of successive pictures within a coded video stream." *See* https://en.wikipedia.org/wiki/Group_of_pictures. A GOP structure can contain intra coded pictures (I picture or I frame), predictive coded pictures (P picture or P frame), bipredictive coded pictures (B picture or B frame) and direct coded pictures (D picture or

D frames, or DC direct coded pictures which are used only in MPEG-1 video). *See* https://en.wikipedia.org/wiki/Video_compression_picture_types (for descriptions of I frames, P frames and B frames); https://en.wikipedia.org/wiki/MPEG-1#D-frames (for descriptions of D frames). Thus, at least a portion of a video data block would also make up a GOP structure and could also contain I frames, P frames, B frames and/or D frames. The GOP structure also reflects the size of a video data block, and the GOP structure can be controlled and used to fine-tune other parameters (e.g. bitrate, max video bitrate and resolution parameters) or even be considered as a parameter by itself.

52. The Accused Instrumentalities include one or more processors configured to: determine one or more data parameters, at least one of the determined one or more data parameters relating to a throughput of a communications channel measured in bits per second; and select one or more asymmetric data compression encoders from among the plurality of different asymmetric data compression encoders based upon, at least in part, the determined one or more data parameters. For example, based on the bitrate and/or resolution parameter identified (e.g. bitrate, max video bitrate, resolution, GOP structure or frame type within a GOP structure), any H.264-compliant system such as the Accused Instrumentalities would determine which profile (e.g., "baseline," "extended," "main", or "high") corresponds with that parameter, then select between at least two asymmetric compressors. If baseline or extended is the corresponding profile, then the system will select a Context-Adaptive Variable Length Coding ("CAVLC") entropy encoder. If main or high is the corresponding profile, then the system will select a Context-Adaptive Binary Arithmetic Coding ("CABAC") entropy encoder. Both encoders are asymmetric compressors because it takes a longer period of time for them to compress data than to decompress data. *See* https://sonnati.wordpress.com/2007/10/29/how-h-264-works-part-ii/

	Baseline	Extended	Main	High	High 10
I and P Slices	Yes	Yes	Yes	Yes	Yes
B Slices	No	Yes	Yes	Yes	Yes
SI and SP Slices	No	Yes	No	No	No
Multiple Reference Frames	Yes	Yes	Yes	Yes	Yes
In-Loop Deblocking Filter	Yes	Yes	Yes	Yes	Yes
CAVLC Entropy Coding	Yes	Yes	Yes	Yes	Yes
CABAC Entropy Coding	No	No	Yes	Yes	Yes
Flexible Macroblock Ordering (FMO)	Yes	Yes	No	No	No
Arbitrary Slice Ordering (ASO)	Yes	Yes	No	No	No
Redundant Slices (RS)	Yes	Yes	No	No	No
Data Partitioning	No	Yes	No	No	No
Interlaced Coding (PicAFF, MBAFF)	No	Yes	Yes	Yes	Yes
4:2:0 Chroma Format	Yes	Yes	Yes	Yes	Yes
Monochrome Video Format (4:0:0)	No	No	No	Yes	Yes
4:2:2 Chroma Format	No	No	No	No	No
4:4:4 Chroma Format	No	No	No	No	No
8 Bit Sample Depth	Yes	Yes	Yes	Yes	Yes
9 and 10 Bit Sample Depth	No	No	No	No	Yes
11 to 14 Bit Sample Depth	No	No	No	No	No
8×8 vs. 4×4 Transform Adaptivity	No	No	No	Yes	Yes
Quantization Scaling Matrices	No	No	No	Yes	Yes
Separate Cb and Cr QP control	No	No	No	Yes	Yes
Separate Color Plane Coding	No	No	No	No	No
Predictive Lossless Coding	No	No	No	No	No

See http://web.cs.ucla.edu/classes/fall03/cs218/paper/H.264_MPEG4_Tutorial.pdf at 7:

The following table summarizes the two major types of entropy coding: Variable Length Coding (VLC) and Context Adaptive Binary Arithmetic Coding (CABAC). CABAC offers superior coding efficiency over VLC by adapting to the changing probability distribution of symbols, by exploiting correlation between symbols, and by adaptively exploiting bit correlations using arithmetic coding. H.264 also supports Context Adaptive Variable Length Coding (CAVLC) which offers superior entropy coding over VLC without the full cost of CABAC.

H.264 Entropy Coding – Comparison of Approaches

Characteristics	Variable Length Coding (VLC)	Context Adaptive Binary Arithmetic Coding(CABAC)
• Where it is used	MPEG-2, MPEG-4 ASP	H.264/MPEG-4 AVC (high efficiency option)
• Probability distribution	**Static** - Probabilities never change	**Adaptive** - Adjusts probabilities based on actual data
• Leverages correlation between symbols	**No** - Conditional probabilities ignored	**Yes** - Exploits symbol correlations by using "contexts"
• Non-integer code words	**No** - Low coding efficiency forhigh probability symbols	**Yes** - Exploits "arithmetic coding" which generates non-integer code words for higher efficiency

53. Moreover, the H.264 Standard requires a bit-flag descriptor, which is set to determine the correct decoder for the corresponding encoder. As shown below, if the flag = 0, then CAVLC must have been selected as the encoder; if the flag = 1, then CABAC must have been selected as the encoder. *See* https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-H.264-201304-S!!PDF-E&type=items (Rec. ITU-T H.264 (04/2013)) at 80:

entropy_coding_mode_flag selects the entropy decoding method to be applied for the syntax elements for which two descriptors appear in the syntax tables as follows:

– If entropy_coding_mode_flag is equal to 0, the method specified by the left descriptor in the syntax table is applied (Exp-Golomb coded, see clause 9.1 or CAVLC, see clause 9.2).

– Otherwise (entropy_coding_mode_flag is equal to 1), the method specified by the right descriptor in the syntax table is applied (CABAC, see clause 9.3).

54. The processor in the Accused Instrumentalities decides which compression (e.g., CABAC, CAVLC, etc.) to use at a point in time based on parameters, for example, e.g., current or anticipated throughput. For example, when a low bandwidth is present, the Accused Instrumentalities select lower quality stream using a particular

compression technique. As another example, when a high bandwidth is present, the Accused Instrumentalities select higher quality stream using another particular compression technique. As another example, the Accused Instrumentalities' use of different "Profiles" of H.264 is directed to selecting lower quality stream using a particular compression technique (e.g., CABAC or CAVLC, etc.) for lower anticipated bandwidth situations, and selecting higher quality stream using a higher compression technique (e.g., CABAC or CAVLC, etc.) for higher anticipated bandwidth situations.

55. After its selection, the asymmetric compressor (CAVLC or CABAC) will compress the video data to provide various compressed data blocks, which can be organized in a GOP structure (see above). *See* https://sonnati.wordpress.com/2007/10/29/how-h-264-works-part-ii/:

Entropy Coding

For entropy coding, H.264 may use an enhanced VLC, a more complex context-adaptive variable-length coding (CAVLC) or an ever more complex Context-adaptive binary-arithmetic coding (CABAC) which are complex techniques to losslessly compress syntax elements in the video stream knowing the probabilities of syntax elements in a given context. The use of CABAC can improve the compression of around 5-7%. CABAC may requires a 30-40% of total processing power to be accomplished.

See http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.602.1581&rep=rep1&type=pdf at 13:

Typical compression ratios to maintain excellent quality are:

- 10:1 for general images using JPEG
- 30:1 for general video using H.263 and MPEG-2
- 60:1 for general video using H.264 and WMV9

See http://www.ijera.com/papers/Vol3_issue4/BM34399403.pdf at 2:

Most visual communication systems today use Baseline Profile. Baseline is the simplest H.264 profile and defines, for example, zigzag scanning of the picture and using 4:2:0 (YUV video formats) chrominance sampling. In Baseline Profile, the picture is split in blocks consisting of 4x4 pixels, and each block is processed separately. Another important element of the Baseline Profile is the use of Universal Variable Length Coding (UVLC) and Context Adaptive Variable Length Coding (CAVLC) entropy coding techniques.

The Extended and Main Profiles includes the functionality of the Baseline Profile and add improvements to the predictions algorithms. Since transmitting every single frame (think 30 frames per second for good quality video) is not feasible if you are trying to reduce the bit rate 1000-2000 times, temporal and motion prediction are heavily used in H.264, and allow transmitting only the difference between one frame and the previous frames. The result is spectacular efficiency gain, especially for scenes with little change and motion.

The High Profile is the most powerful profile in H.264, and it allows most efficient coding of video. For example, large coding gain achieved through the use of Context Adaptive Binary Arithmetic Coding (CABAC) encoding which is more efficient than the UVLC/CAVLC used in Baseline Profile.

The High Profile also uses adaptive transform that decides on the fly if 4x4 or 8x8-pixel blocks should be used. For example, 4x4 blocks are used for the parts of the picture that are dense with detail, while parts that have little detail are transformed using 8x8 blocks.

56. On information and belief, AMD also directly infringes and continues to infringe other claims of the ’477 patent.

57. On information and belief, all of the Accused Instrumentalities perform the claimed methods in substantially the same way, e.g., in the manner specified in the H.264 standard.

58. On information and belief, use of the Accused Instrumentalities in their ordinary and customary fashion results in infringement of the methods claimed by the ‘477 patent.

59. On information and belief, AMD has had knowledge of the ‘477 patent since at least the filing of this Complaint or shortly thereafter, and on information and

belief, AMD knew of the ’477 patent and knew of its infringement, including by way of this lawsuit. By the time of trial, AMD will have known and intended (since receiving such notice) that its continued actions would actively induce and contribute to the infringement of the claims of the ’477 patent.

60. Upon information and belief, AMD’s affirmative acts of making, using, and selling the Accused Instrumentalities, and providing implementation services and technical support to users of the Accused Instrumentalities, including, e.g., through training, demonstrations, brochures, installation and user guides, have induced and continue to induce users of the Accused Instrumentalities to use them in their normal and customary way to infringe the ’477 patent by using a system comprising: a plurality of different asymmetric data compression encoders, wherein each asymmetric data compression encoder of the plurality of different asymmetric data compression encoders is configured to utilize one or more data compression algorithms, and wherein a first asymmetric data compression encoder of the plurality of different asymmetric data compression encoders is configured to compress data blocks containing video or image data at a higher data compression rate than a second asymmetric data compression encoder of the plurality of different asymmetric data compression encoders; and one or more processors configured to: determine one or more data parameters, at least one of the determined one or more data parameters relating to a throughput of a communications channel measured in bits per second; and select one or more asymmetric data compression encoders from among the plurality of different asymmetric data compression encoders based upon, at least in part, the determined one or more data parameters. For example, AMD’s products/solutions utilize H.264 compression standard. As another example, AMD’s products/solutions integrate Video Coding Engine, which is a “[F]ixed-function hardware accelerator that supports H.264 AVC, and SVC encoding.” *See e.g.*, http://developer.amd.com/wordpress/media/2013/11/MediaSDK_ User_Guide_1_1_Beta.pdf.

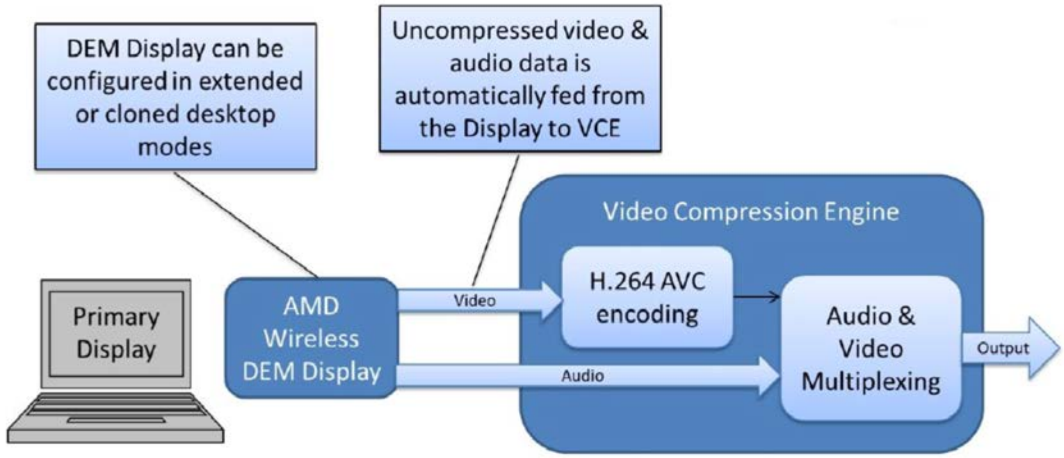

Figure 6.1 System Overview of the AMF Display Encode Mode

See e.g., http://developer.amd.com/wordpress/media/2013/11/MediaSDK_User_Guide_1_1_Beta.pdf. For similar reasons, AMD also induces its customers to use the Accused Instrumentalities to infringe other claims of the ’477 patent. AMD specifically intended and was aware that these normal and customary activities would infringe the ’477 patent. AMD performed the acts that constitute induced infringement, and would induce actual infringement, with the knowledge of the ’477 patent and with the knowledge, or willful blindness to the probability, that the induced acts would constitute infringement. For example, since filing of this action, AMD knows that the ordinary way of using Scalable Video Coding —which is directed to choosing different compression techniques based on current or anticipated throughput—in the Accused Instrumentalities infringes the patent but nevertheless continues to promote H.264 compression standard that utilizes Scalable Video Coding to its customers. The only reasonable inference is that AMD specifically intends the users to infringe the patent. On information and belief, AMD engaged in such inducement to promote the sales of the Accused Instrumentalities. Accordingly, AMD has induced and continue to induce users of the Accused Instrumentalities to use the Accused Instrumentalities in their ordinary and customary way to infringe the ’477 patent, knowing that such use constitutes infringement of the ’477 patent. Accordingly, AMD has been (as of filing of the original complaint), and currently is, inducing infringement of the ’477 patent, in violation of 35 U.S.C. § 271(b).

61. AMD has also infringed, and continues to infringe, claims of the ’477 patent by offering to commercially distribute, commercially distributing, making, and/or importing the Accused Instrumentalities, which are used in practicing the process, or using the systems, of the ’477 patent, and constitute a material part of the invention. AMD knows the components in the Accused Instrumentalities to be especially made or especially adapted for use in infringement of the ’477 patent, not a staple article, and not a commodity of commerce suitable for substantial noninfringing use. For example, the ordinary way of using Scalable Video Coding—which is directed to choosing different compression techniques based on current or anticipated throughput—infringes the patent, and as such, is especially adapted for use in infringement. Moreover, there is no substantial noninfringing use, as Scalable Video Coding is directed to choosing different compression techniques based on current or anticipated throughput. Accordingly, AMD has been (as of filing of the original complaint), and currently is, contributorily infringing the ’477 patent, in violation of 35 U.S.C. § 271(c).

62. By making, using, offering for sale, selling and/or importing into the United States the Accused Instrumentalities, and touting the benefits of using the Accused Instrumentalities’ compression features, AMD has injured Realtime and is liable to Realtime for infringement of the ’477 patent pursuant to 35 U.S.C. § 271.

63. As a result of AMD’s infringement of the ’477 patent, Plaintiff Realtime is entitled to monetary damages in an amount adequate to compensate for AMD’s infringement, but in no event less than a reasonable royalty for the use made of the invention by AMD, together with interest and costs as fixed by the Court.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff Realtime respectfully requests that this Court enter:

a. A judgment in favor of Plaintiff that AMD has infringed, literally and/or under the doctrine of equivalents the ’046, ’535, and ’477 patents (the “asserted patents”);

b. A judgment and order requiring AMD to pay Plaintiff its damages, costs, expenses, and prejudgment and post-judgment interest for its infringement of the asserted patents, as provided under 35 U.S.C. § 284;

c. A judgment and order requiring AMD to provide an accounting and to pay supplemental damages to Realtime, including without limitation, prejudgment and post-judgment interest;

d. A permanent injunction prohibiting AMD from further acts of infringement of the asserted patents;

e. A judgment and order finding that this is an exceptional case within the meaning of 35 U.S.C. § 285 and awarding to Plaintiff its reasonable attorneys’ fees against AMD; and

f. Any and all other relief as the Court may deem appropriate and just under the circumstances.

DEMAND FOR JURY TRIAL

Plaintiff, under Rule 38 of the Federal Rules of Civil Procedure, requests a trial by jury of any issues so triable by right.

Respectfully Submitted,

Dated: May 15, 2018 /s/ *Eric B. Fenster*

Eric B. Fenster

Eric B. Fenster, LLC
P.O. Box 44011
Denver, CO 80201
Telephone: 720-943-3739
FAX: 720-255-0377
Email: eric@fensterlaw.net
Attorney for Plaintiff

RUSS AUGUST & KABAT
12424 Wilshire Blvd., 12th Floor,
Los Angeles, CA 90025
Telephone: 310-979-8251

Marc A. Fenster (CA SBN 181067)
Email: mfenster@raklaw.com
Reza Mirzaie (CA SBN 246953)
Email: rmirzaie@raklaw.com
Brian D. Ledahl (CA SBN 186579)
Email: bledahl@raklaw.com
C. Jay Chung (CA SBN 252794)
Email: jchung@raklaw.com
Philip X. Wang (CA SBN 262239)
Email: pwang@raklaw.com

Attorneys for Plaintiff
REALTIME ADAPTIVE STREAMING LLC