PATROLL Winning Submission

U.S. Patent 8,284,839

U.S. Patent 8,284,839 ("*Communication Advances*" or the "patent-at-issue") was filed on June 23, 2008 and claims priority on the same date. Claim 14 of the patent-at-issue is generally directed to a method of processing a video stream. Initially, it stores the input video, comprising multiple frames, in a storage module. Then, it extracts this video from storage and generates motion vectors based on its content. This is followed by encoding the video stream and creating a compressed bit-stream based on the motion vectors. It then employs motion judder cancellation (MJC) by utilizing a motion compensation unit, which generates an output video stream considering both the input video and its motion vectors. Finally, it reconstructs frames using another motion compensation unit and stores these reconstructed frames back into the storage module.

The primary reference, U.S. Patent 8,218,638 ("*Avago*"), was filed on October 31, 2007, and claims priority on the same date. The patent is directed to a method and system for optical flow-based motion vector estimation in picture rate up-conversion (PRUC) which involves generating motion vectors by minimizing a cost function derived from extracted PRUC data. These motion vectors are generated considering constraints such as block matching, smoothness, and bias. The PRUC data, obtained from a decompressed video data stream during decompression via a video decompression engine, includes various elements like local block motion vectors, block coding modes, quantization levels, quantized residual data, and decoded pictures. Using this PRUC data, multiple interpolated pictures are produced.

The secondary reference, "Source-Adaptive Encoding Options for HDTV and NTSC" ("Parulski"), was published in October 1992. The article discusses the origin of television images from various sources like video cameras, film, and digital graphics. It focuses on designing future all-digital high-definition television (HDTV) transmission systems and NTSC receivers to easily adapt to frame rate, aspect ratio, color mode, and resolution of the signal source. This adaptation aims to enhance picture quality and reduce transmission bandwidth for specific sources. HDTV transmission coders operate at the source frame rate, while receiver frame stores handle frame-rate conversion for display. Advanced receivers can reuse motion vectors from the HDTV coder. NTSC receivers with field stores and progressive scan displays use source-adaptive processing for better interlace-to-progressive scan conversion and improved decoding of images, especially from film. To optimize these methods, "origination-source ID" data is added to the video signal during post-production.

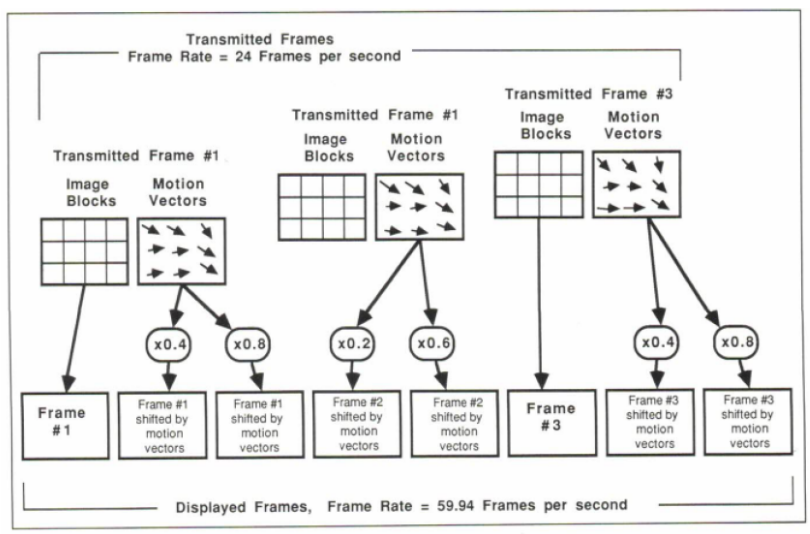
A sample claim chart comparing claim 14 of *Communication Advances* to *Avago* and *Parulski* is provided below.

US8284839 ("*Communication Advances* ")	**A. US8218638** (*"Avago"*) **B. "Source-Adaptive Encoding Options for HDTV and NTSC"** (*"Parulski"*)
14.pre. A video processing method of **performing a video coding and a frame rate conversion on an input video stream**, the method comprising:	**A. US8218638** "1. A method for **processing video data**, the method comprising: **generating one or more motion vectors based on extracted picture rate up-conversion (PRUC) data** by minimizing a cost function, wherein said cost function is constrained by one or more of: . . . ." *Avago* at claim 1 "The **encoder** 118 **may be enabled to generate the encoded compressed video stream** based on encoding the filtered video output stream." *Avago* at col. 4:7-9 **B. "Source-Adaptive Encoding Options for HDTV and NTSC"** "This article describes how future all-digital high-definition television (HDTV) transmission systems and NTSC receivers can be **designed to adapt to the frame rate**, aspect ratio, color mode, and resolution of the signal source in a simple and cost-effective manner. This can **provide improved picture quality or reduced transmission bandwidth requirements for image segments** from certain sources." *Parulski* at p. 674 "Figure 15 shows **a digital HDTV system with source-adaptive encoding**. The 24 frame/sec film is again transferred on a telecine using 3:2 pulldown, to provide a 59.94-Hz frame rate." *Parulski* at p. 679
14.a. (a) **storing the input video stream comprising a plurality of frames in a storage module**;	**A. US8218638** "The video processing block 102 may be enabled to **receive a video input stream and, in some instances, to buffer at least a portion of the received video input stream in the input buffer** 112. In this regard, **the input buffer** 112 may comprise suitable logic, circuitry, and/or code that **may be enabled to store at least a portion of the received video input stream**." *Avago* at col. 3:21-26

(cont.) 14.a. (a) **storing the input video stream comprising a plurality of frames in a storage module**;	**B. "Source-Adaptive Encoding Options for HDTV and NTSC"** "In the receiver, each film frame is displayed multiple times, to prevent flicker. This requires **a digital frame memory in the receiver**." *Parulski* at p. 680 "The source-adaptive frame rate conversion circuitry can **utilize the same full frame memory included in the receivers of the four all-digital systems**, although the memory control circuit may be slightly more complex, since the memory must now operate at various input frame rates. The number of allowable frame rates and aspect ratios has little impact on the receiver cost." *Parulski* at p. 681
14.b. (b) **extracting the input video stream from the storage module**, and **generating a plurality of motion vectors according to the input video stream**;	**A. US8218638** "1. A method for processing video data, the method comprising: **generating one or more motion vectors based on extracted picture rate up-conversion (PRUC) data** by minimizing a cost function, wherein said cost function is constrained by one or more of: . . . ." *Avago* at claim 1 **B. "Source-Adaptive Encoding Options for HDTV and NTSC"** "The shift directions and magnitudes of each block, known as motion vectors, are shown as arrows in Fig 12. The **motion vectors describe the average motion that occurred within each block of the image during the time between the current frame and the previous frame**. The strange-looking image within the white grid in Fig. 12 shows the difference between the blocks of the current image frame and the shifted blocks of the previous (delayed) frame. This difference image is called the "residual." The residual is compressed, using the discrete cosine transform (DCT) or multiscale subband filters, and transmitted to the receiver along with the motion vectors." *Parulski* at p. 678
14.c. (c) encoding the input video stream to **generate a compressed bit-stream according to the motion vectors**;	**A. US8218638** "The encoder 118 may be enabled to receive and process a plurality of statistical inputs from the processor 104 and the video processing block 102. The **encoder** 118 **may be enabled to generate the encoded compressed video stream based on encoding the filtered video output stream**." *Avago* at col. 4:5-9

(cont.) 14.c. (c) encoding the input video stream to **generate a compressed bit-stream according to the motion vectors**;	**B. "Source-Adaptive Encoding Options for HDTV and NTSC"** "Of the six proposed ATV systems shown in Fig. 9, four use all-digital transmission. These four systems use very similar **image-compression techniques**, which can be more easily understood using simple photographic illustrations. Figure 10 shows a cropped section from one frame of a simulated motion sequence, where the camera is zooming in while panning to the right. The **four compression systems compute the differences between blocks of the current frame, shown inside the white grid overlay** in Fig. 11, **and spatially shifted blocks from the previous frame**." *Parulski* at p. 678
14.d. (d) **performing motion judder cancellation (MJC) on the input video stream** by **using a first motion compensation unit** of a motion compensation circuit to **generate an output video stream according to the input video stream and the motion vectors**; and	**A. US8218638** "The **motion compensated interpolation block 224 may be enabled to reduce motion judder**. The **motion compensated interpolation block** 224 **may be enabled to modify the processing of a picture rate converter so that it may follow moving objects similar to the human eye**. The picture may appear clean and sharp as it moves without the motion judder. The **PRUC engine** 204 **may be enabled to analyze a stream of input pictures to identify each object in the scene to determine how the object may be moving**. The **PRUC engine** 204 **may be enabled to interpolate the location of the plurality of objects at different time instants to generate each output picture**." *Avago* at col. 7:56-67 **B. "Source-Adaptive Encoding Options for HDTV and NTSC"** "High-end source-adaptive HDTV receivers may include additional processing to provide improved picture quality. For example, the use of 3:2 pulldown to perform 24 Hz-to-60 Hz conversion in the telecine, as shown in Fig. 14, or in a source-adaptive receiver, as shown in Figs. 15 and 16, can cause motion judder. **Motion compensated frame-rate conversion can eliminate motion judder**. Such processing is normally prohibitively expensive in a receiver because of the computations needed to calculate motion vectors. **In the all-digital HDTV systems, the expensive transmitter has already calculated the motion vectors and sent them to the receiver**." *Parulski* at p. 681 "In top-of-the-line receivers, these same vectors can be reused for frame-rate conversion. The simple algorithm shown in Fig. 20 **performs 24 Hz-to-60 Hz motion-compensated frame-**

(cont.) 14.d. (d) **performing motion judder cancellation (MJC) on the input video stream** by **using a first motion compensation unit** of a motion compensation circuit to **generate an output video stream according to the input video stream and the motion vectors**; and	**rate conversion**. The **receiver decodes and displays film frame 1, using the motion vectors sent with each residual block to perform the normal decoding process**. **But rather than discarding the motion vectors and repeating film frame 1 for the next two video frames, it displays slightly shifted versions of film frame 1**. **Each block within film frame 1 is shifted by an amount equal to the scaled motion vector for that block**. The **scale factors are multiples of 0.4, in order to provide the proper temporal alignment of the film frames, which have a frame rate equal to 40% of the video display rate**. Instead of a 60-Hz display rate, some high-end sets could use a higher rate, such as 72 Hz, to more completely eliminate flicker. In these receivers, **the transmitted motion vectors would be used to upconvert video camera sources, as well as film sources**." *Parulski* at p. 681
14.e. (e) **generating a reconstructed frame** by **using a second motion compensation unit of the motion compensation circuit** according to the input video stream and the motion vectors, and **storing the reconstructed frame into the storage module**.	**A. US8218638** "The **motion compensated prediction block** 214 may comprise suitable logic, circuitry and/or code that **may be enabled to receive one or more motion vectors from the entropy decoder** 206 **to generate a motion compensated block of pixels**. The **summer** 212 **may be enabled to add the motion compensated block of pixels to the reconstructed residual pixels to generate one or more decoded pictures**. One or more decoded pictures may be fed back to the motion compensated prediction block 214. The **motion compensated prediction block** 214 **may be enabled to generate the motion compensated block of pixels from a reference image or a previous output picture based on receiving one or more motion vectors from the entropy decoder** 206." *Avago* at col. 5:63-67 through col. 6:1-8 "The video processing block 102 may generate the filtered video output stream after performing the noise reduction filtering operation. In some instances, **the filtered video output stream may be stored in the output buffer** 114 before being transferred out of the video processing block 102." *Avago* at col. 4:24-28 **B. "Source-Adaptive Encoding Options for HDTV and NTSC"** "In top-of-the-line receivers, these same vectors can be reused for frame-rate conversion. The simple algorithm shown in Fig. 20 performs 24 Hz-to-60 Hz motion-compensated frame-rate

(cont.) 14.e. (e) **generating a reconstructed frame** by **using a second motion compensation unit of the motion compensation circuit** according to the input video stream and the motion vectors, and **storing the reconstructed frame into the storage module**.	conversion. The **receiver decodes and displays film frame 1, using the motion vectors sent with each residual block to perform the normal decoding process**. **But rather than discarding the motion vectors and repeating film frame 1 for the next two video frames, it displays slightly shifted versions of film frame 1. Each block within film frame 1 is shifted by an amount equal to the scaled motion vector for that block**. The **scale factors are multiples of 0.4, in order to provide the proper temporal alignment of the film frames, which have a frame rate equal to 40% of the video display rate**. Instead of a 60-Hz display rate, some high-end sets could use a higher rate, such as 72 Hz, to more completely eliminate flicker. In these receivers, the transmitted motion vectors would be used to upconvert video camera sources, as well as film sources." *Parulski* at p. 681  *Figure 20 . Motion-compensated frame-rate conversion in HDTV receiver.* Figure 20, *Parulski* at p. 681