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WHITE PAPER

[Headline]

Scalable Video Coding

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The application of the scalable video coding

The user may use different terminals to view the video via different networks in actual surveillance scenario. For instance, when the bandwidth is wide enough, the user tends to watch the video with high resolution, and the user also needs to use a mobile phone to get the video over 3G network. Therefore, it is beneficial that video is simultaneously transmitted or stored with a scalable spatial and temporal resolutions or qualities. There are three dimensions of the scalability, the spatial, temporal and quality scalability.

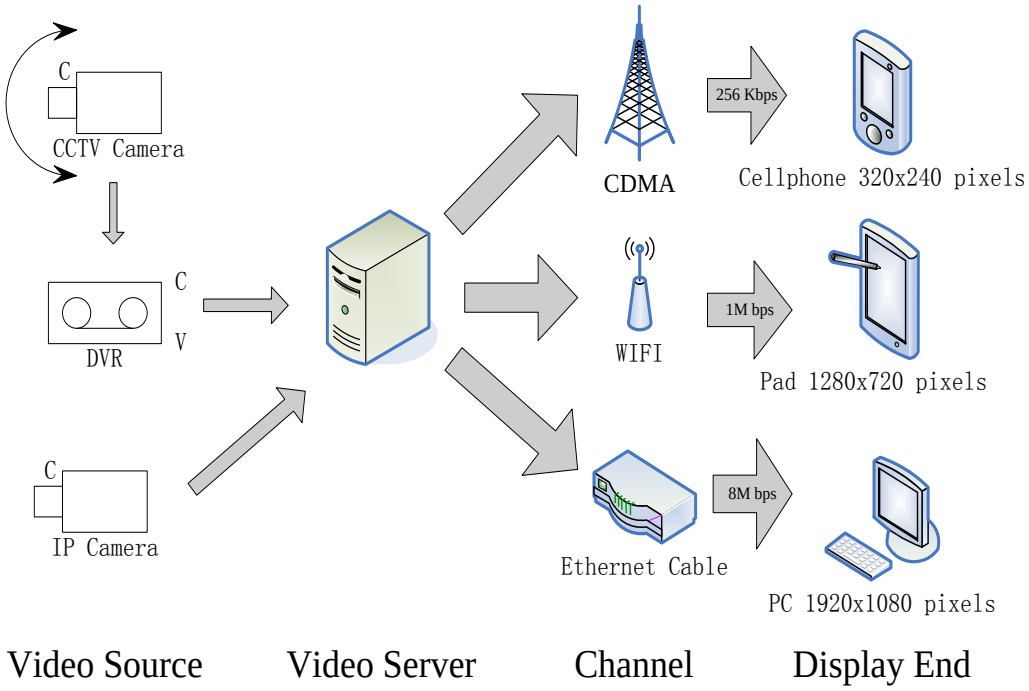

Figure 1 Differences of the requirement for bit stream of different signal channels

The core concept of SVC

The current main stream video compression algorithms, such as the MPEG-4, H.264/AVC, and the recent unveiled HEVC and others, are all based on a framework of hybrid video codecs, and the predictive reference is the core technology. The spatial reference is typical; it searches for the most similar area in the reference images for each part of the current image and only the residual is compressed to decrease the redundancy. So it is not hard to understand that the correctness of decoding for one image is interlocked with the correctness of the reference images.

The key of the scalability lies in the referential relation of the hierarchy of the layers of the stream. When the SVC technology is adopted, the base layer can be decoded independently and there are many enhancement layers lying above the base layer. Each enhancement layer and its lower layers can be encoded together. That is to say, the stream of the higher layer includes the stream of the lower layer, but no matter how many layers are there, the lower level layer is coded without referring to the higher level layer.

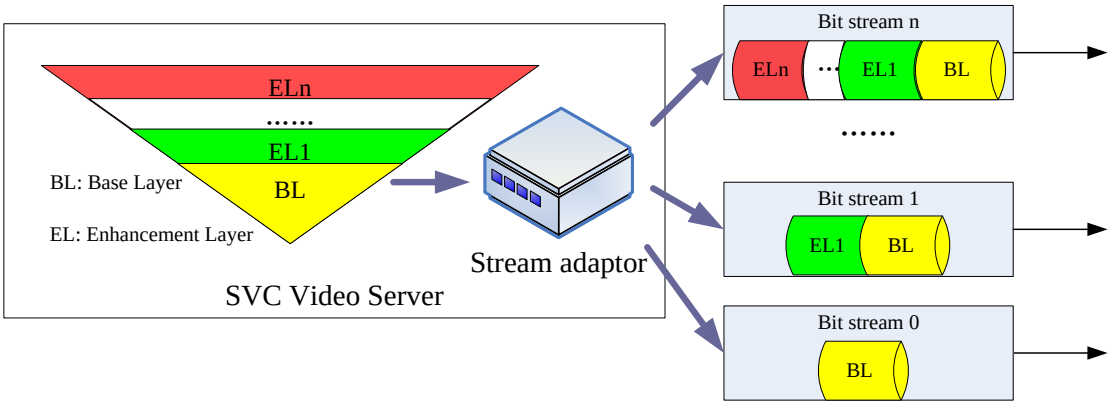

Figure 2 SVC Layers

Temporal SVC

The main function of the temporal SVC is to decoding the bit-stream with multiple layers with different frame rates. When a bit-stream needs to support the full frame rate, the ½ frame rate, the ¼ frame rate and the ⅛ frame rate, you can adopt the temporal SVC with 4 layers. In the below figure, we take the rectangle as a frame, and the black arrow indicates the referential relations. The black rectangle is I-frame and there is no temporal reference for the I-frame.

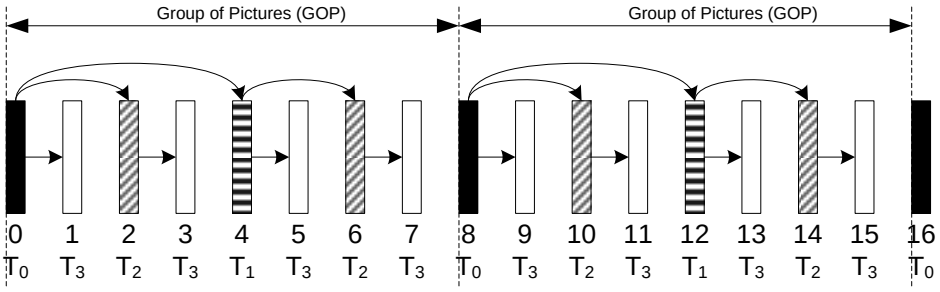

Figure 3 4-layer Temporal SVC stream

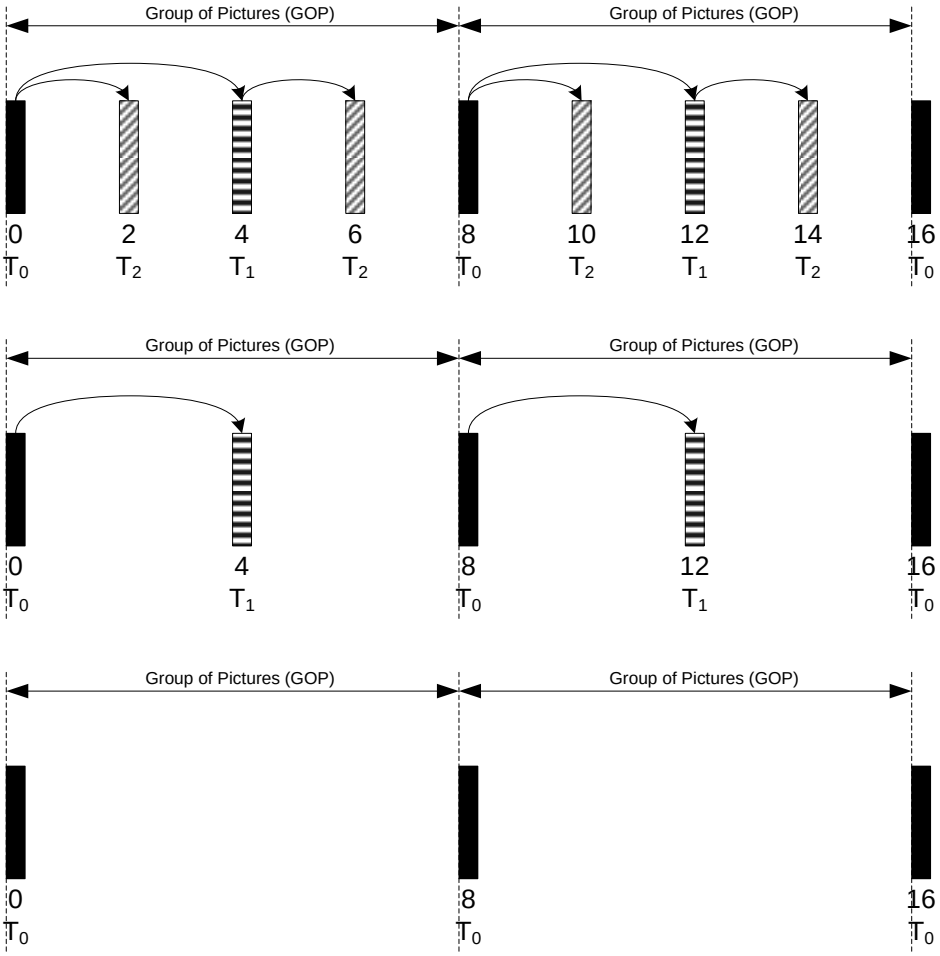

Figure 4 Extraction of the Temporal: ½ frame rate, the ¼ frame rate and the 1/8 frame rate

Although the temporal SVC is very flexible and efficient, it sacrifices the compression performance. Because only the residual is compressed, the performance decreases with the increase of the remaining residual. In the above picture, there are 2 frames between the T2 and its reference picture, so the data size of T2 is bigger than that of T3 with the same image quality. And the data size of the T1 is the biggest, since there is no reference picture for T1 as an I-frame. No doubt that, when the temporal SVC is used in compression, more storage space is occupied than that of the compression of a single bit stream.

Spatial and quality SVC

The main function of the spatial SVC is to decode the bit-stream with multiple layers of different resolution and quality. The quality SVC can be considered as a special case of the spatial SVC with identical resolution for layers but the quality is different. The below figure shows a two layer spatial SVC bit-stream and each rectangle is taken as a frame.

The inter-layer prediction between the base layer and the enhancement layer is the key feature of the spatial quality SVC.

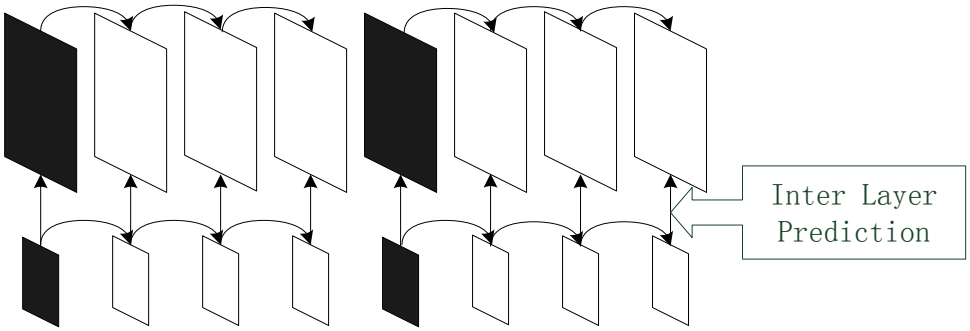

Figure 5 Temporal SVC

The storage space consumption for the spatial and quality SVC is bigger than that of the single layer encoded bit stream of different resolution but smaller than the total sum of bit-stream of all the layers.

The Multi-stream and SVC

The dual-stream or even multi-stream is widely used nowadays and for the end user it's hard to tell the difference of the function of the multi-stream and the SVC. The problem for the multi-stream is that not all the streams are stored, since different streams are designed either for network transmission and live view or for recording. And even all the streams are recorded; the management for the record files with different streams but same time is difficult.

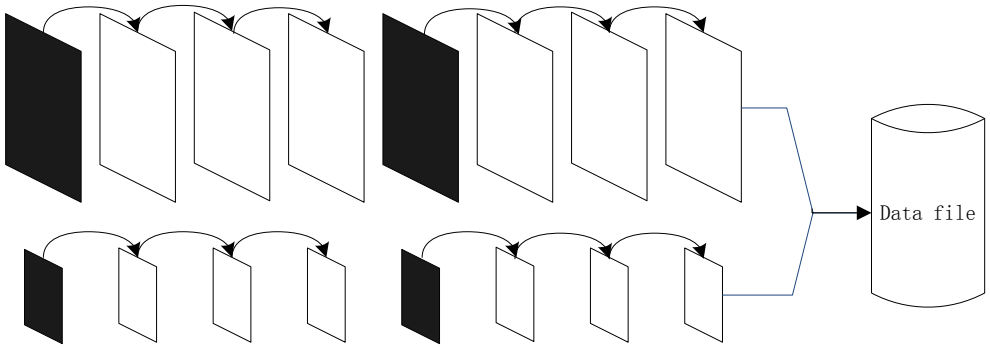

Figure 6 Multi-stream

The H.264/SVC standard

In 2007, the Joint Video Team of ITU-T VCEG and the ISO/IEC MPEG standardized the SVC as an extension of H.264/AVC which was published in 2003.

The H.264SVC is the same with H.264/AVC in basic codec mechanism, and extends the scalability. And its syntax of the base layer of the H.264/SVC is compatible with the syntax of the H.264/SVC. And H.264/SVC also defines the scalable baseline, scalable high and other profiles.

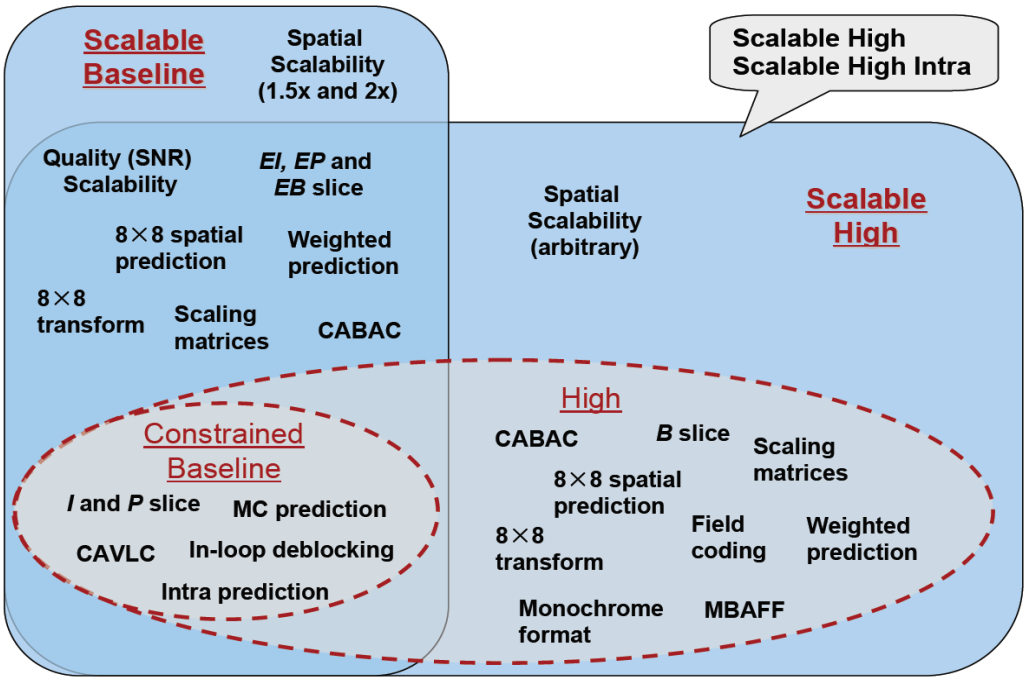

Figure 7 Profiles of H.264/SVC

Actually, the H.264/AVC also supports the temporal SVC. And the common SVC devices are mainly use the H.264/AVC technology to realize the temporal SVC function.

Compared to the multi-stream method, the spatial and quality SVC increases the compression performance with the inter-layer prediction. If the CIF and 4CIF streams are all needed, and the bitrate for each stream is 500Kbps and 1500Kbps, assuming that the bitrate for SVC stream is 10% less than the total bitrate of the two streams, the total bitrate for SVC stream is 18000Kbps. So, for the storage, the SVC can save 10% of the storage space. But, things are different for the network transmission; the stream of the base layer for SVC is the same with that of CIF stream of the multi-stream, if we use the multi-stream method to get a 4CIF image, we need 15000Kbps; and for SVC, since it transfers the streams of the two layers, 1800Kbps bitrate is needed. In this perspective, the transmission performance of the SVC is lower than that of multi-stream.

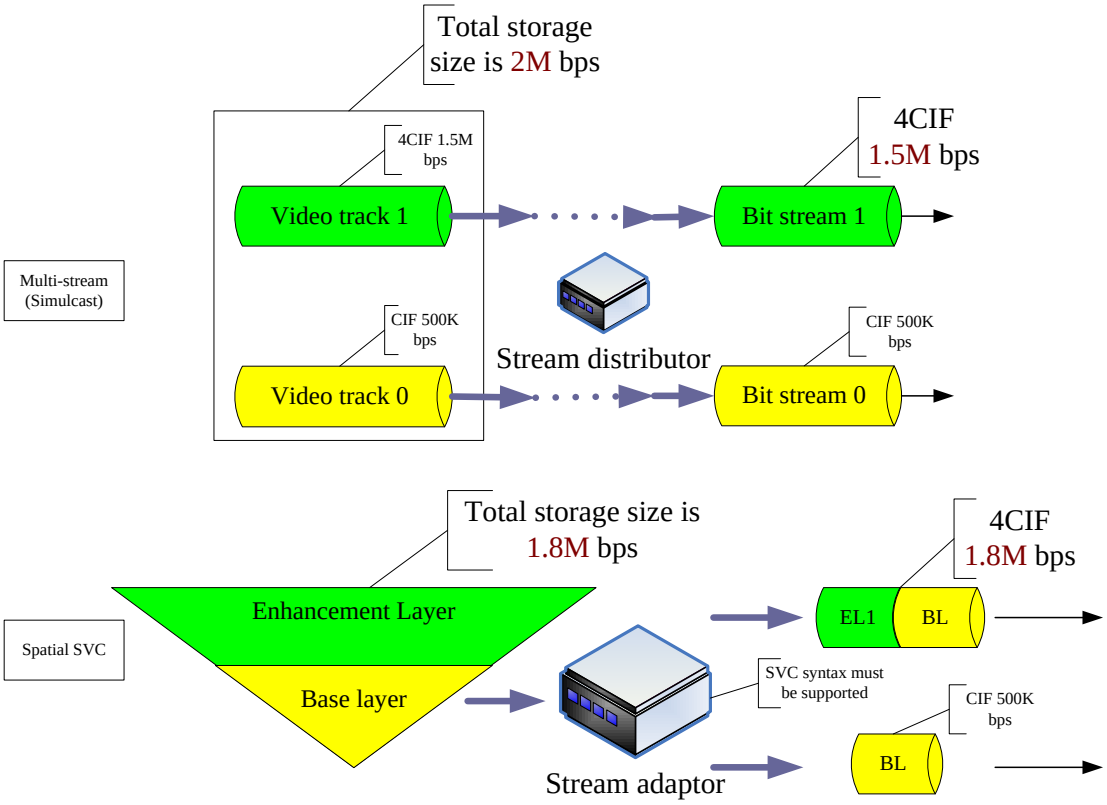

Figure 8 Comparison of the SVC and multi-stream

Furthermore, we should note that the industry system based on the H.264/AVC is already very mature and the H.264/SVC standard still has a long way to go for the cost-effectiveness and competitiveness of the products. Most of the now known products with the spatial/quality SVC function don't adopt the inter-layer prediction, but the multi-stream combination technology.

Conclusion

SVC enables the transmission and decoding of partial bit stream to provide flexible and scalable services for video compression, transmission and storage. Hikvision, as first generation of the manufacturers in the surveillance industry to use the H.264/AVC standard, provides the best performance of video compression. Hikvision will continue to develop the functionality to enhance the transmission and storage applications and provides the product to meet the need of the market.