White Paper

The Next Generation Video Codec – Scalable Video Coding (SVC)

Contents

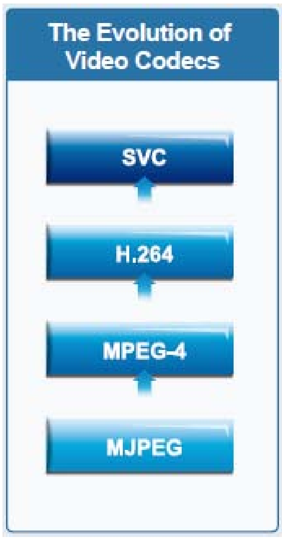
Background

In the past few years, megapixel resolution has become the mainstream specification for IP surveillance cameras. While these cameras deliver more details and better coverage than ever before, the dramatic increase in video data places greater demands on network bandwidth, recording storage, and CPU loading.

Moreover, video streaming performance may be degraded due to the varying capabilities of individual clients and the bandwidth available to them. The most common approach for resolving this dilemma is to provide multiple video streams with different configuration to meet the needs of varied clients. However, with present technology, the number of different streams afforded by a camera also limits the number of different types of clients that it can serve.

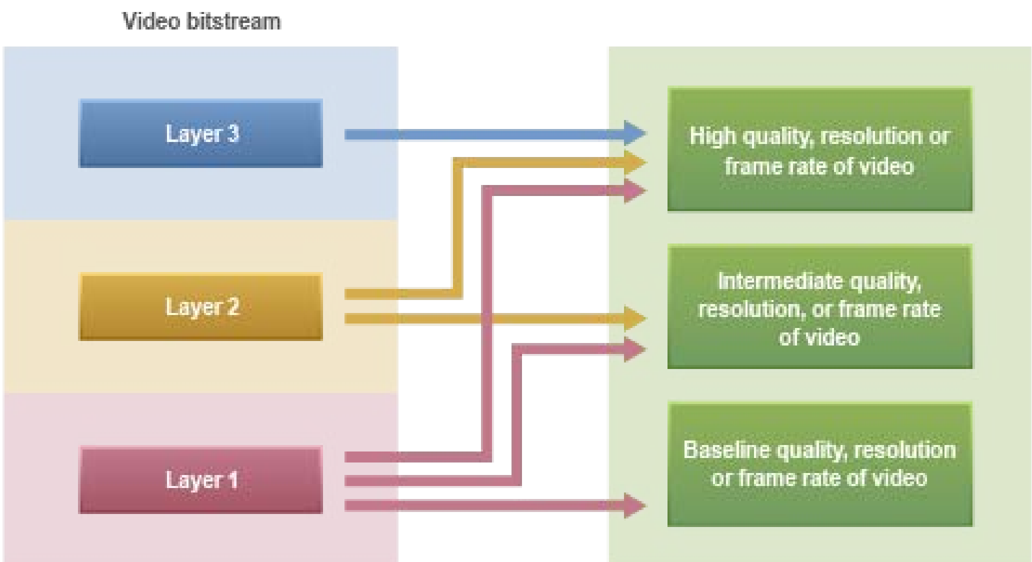
This paper discusses a new technology called Scalable Video Coding (SVC) that aims to provide a more flexible, robust IP surveillance system beyond these limitations.

What is SVC?



Scalable Video Coding (SVC) is an extension, which is also known as Annex G, to the H.264/MPEG-4 AVC video encoding standard. The objective of SVC is to enable the encoding of a video bitstream that contains one or more subset bitstreams. These subset bitstreams consist of one of more layers, each of which contain data that, when added to data from other layers, increases the decoded video frame rate, resolution, fidelity, or a combination of these three.

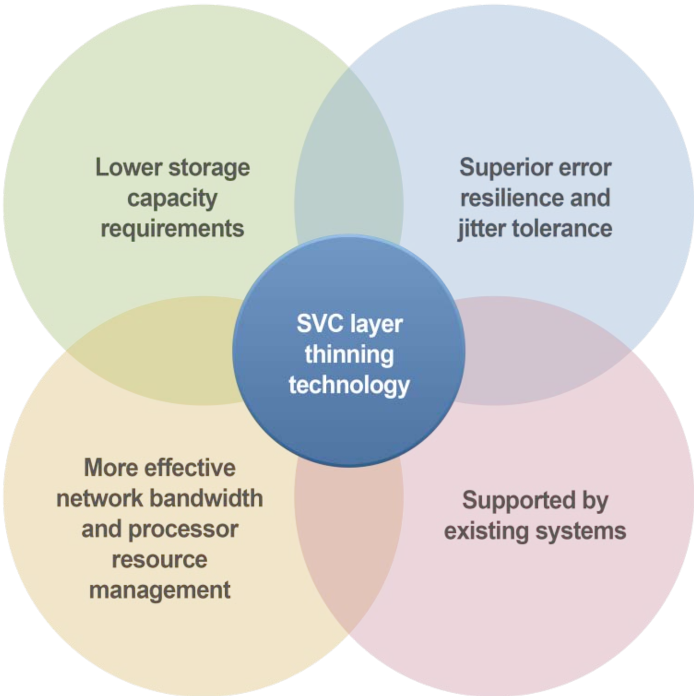
SVC layers that enable decoded video of different frame rates are said to provide frame rate or temporal scalability. This modality, currently the most widely adopted, is termed SVC-T. The other types of scalability are resolution, picture size, or spatial scalability; SNR (single-to-noise ratio), quality, or fidelity (quality) scalability; and combined scalability.



Take SVC-T for example. If a client uses all the layers of an SVC bitstream that contains three layers providing different frame rates, the resulting video will have the highest frame rate. If layer 3 is dropped, then an intermediate frame rate will result. If layers 2 and 3 are dropped, leaving just layer 1 to be used, only the lowest frame rate will be available on that client. In this way, a wide variety of client devices with differing capabilities or a range of different usage scenarios can be flexibly supported.

Benefits of SVC

The figure below illustrates the benefits of SVC technology. Not only does this codec address CPU loading, network bandwidth, and storage challenges that arise with the use of megapixel cameras, but it also offers a superior streaming experience over volatile network environments.



- **More Effective Network Bandwidth and Processor Resource Management**

Since SVC bitstream contains one or more subset bitstream layers, the process of "thinning out" layers can be used to reduce network bandwidth. For example, if a video source like a surveillance camera supports SVC encoding, it can thin out the layers in the bitstream transmitted to clients that cannot display the full-quality video or when it is not required by a particular application. For clients that can display the full quality video, or when an application requires it, more or all layers can be transmitted. Besides, for these layers comprising SVC bitstream are generated in the same one encoding process, the processor resources can be much saved and thus it can serve more channels for different types of clients than using the standard H.264 which needs to apply the dedicated encoding process for each different type of video configuration.

- **Lower Storage Capacity Requirement**

Naturally, the advantages of thinning out layers to lessen network loading carries over to storage requirements for recorded video. When unneeded layers are discarded, significantly smaller file sizes result when the video is recorded for archival or review purposes.

- **Superior Error Resilience and Jitter Tolerance**

Another powerful advantage provided by SVC compared to other video encoding methods is the superior error resilience of SVC streams. This is possible because even if particular layers of an SVC stream are lost due to unstable network conditions, the remaining layers can still be decoded by clients. Though lower in quality—for example, a reduced frame rate—the video remains usable. In contrast, conventional H.264 streams under similar network conditions will typically exhibit serious defects such as garbled images and false colors.

- **Supported by Existing Systems**

These substantial benefits are transparently supported by most existing systems through SVC-T streams as most current open-source video software can decode and display this H.264 variant. At a minimum, such software will be able to decode and display an SVC stream when all layers are present.

Implementations of SVC Technology: VIVOTEK as an Example

IP surveillance solution vendor VIVOTEK has been an industry pioneer in adopting SVC, implementing frame rate scalability through SVC for a number of applications and usage scenarios. Detailed applications and usage scenarios are described in the following sections.

SVC Applications and Scenarios in IP Surveillance

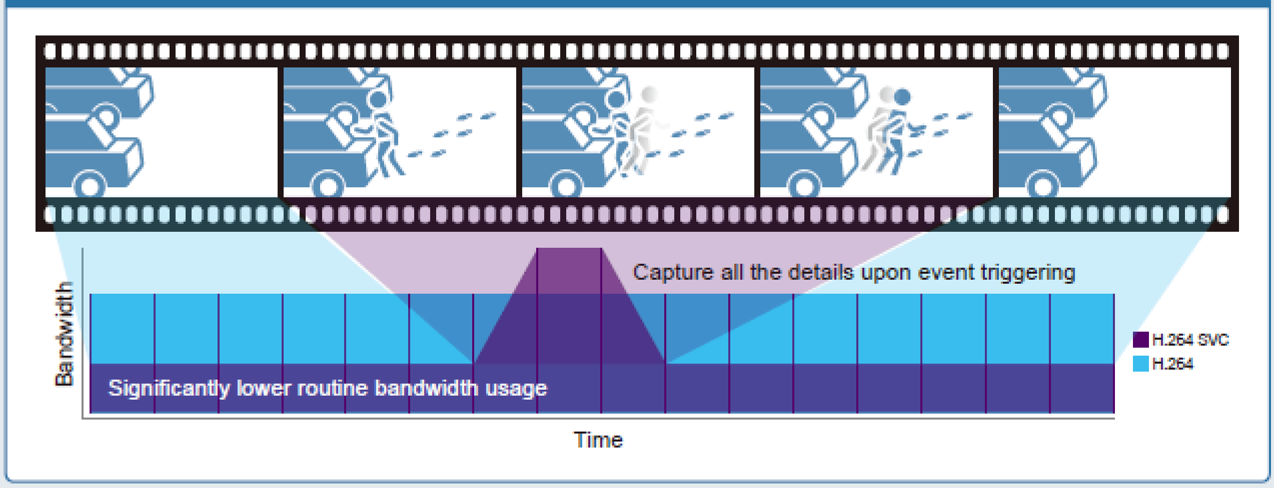
- Activity Adaptive Streaming (AAS)

VIVOTEK Activity Adaptive Streaming (AAS) is designed to achieve savings in network bandwidth and storage requirements by dynamically adjusting video quality in response to event triggers. For example, lower quality video can be used for routine monitoring and high quality video for event-triggered recording. AAS can thus optimize the network bandwidth usage when monitoring while ensuring superior picture quality when recording events.

With SVC, VIVOTEK makes its AAS more versatile. The addition of SVC encoding to provide frame rate scalability in AAS significantly improves performance with flexibility because it allows more options of frame rates for routine monitoring and event-recording. For example, through SVC-T with 3 scalability layers for 8 fps, 15 fps and 30 fps, the network camera is able to transmit video at 8 fps for routine monitoring and increases the frame rate to 15 fps or 30 fps for different levels of event recording. Compared to the conventional approach in which video is continuously transmitted and recorded at full frame rate, 30 fps, AAS with SVC-T saves up to as much as 70% of bandwidth and storage in average.

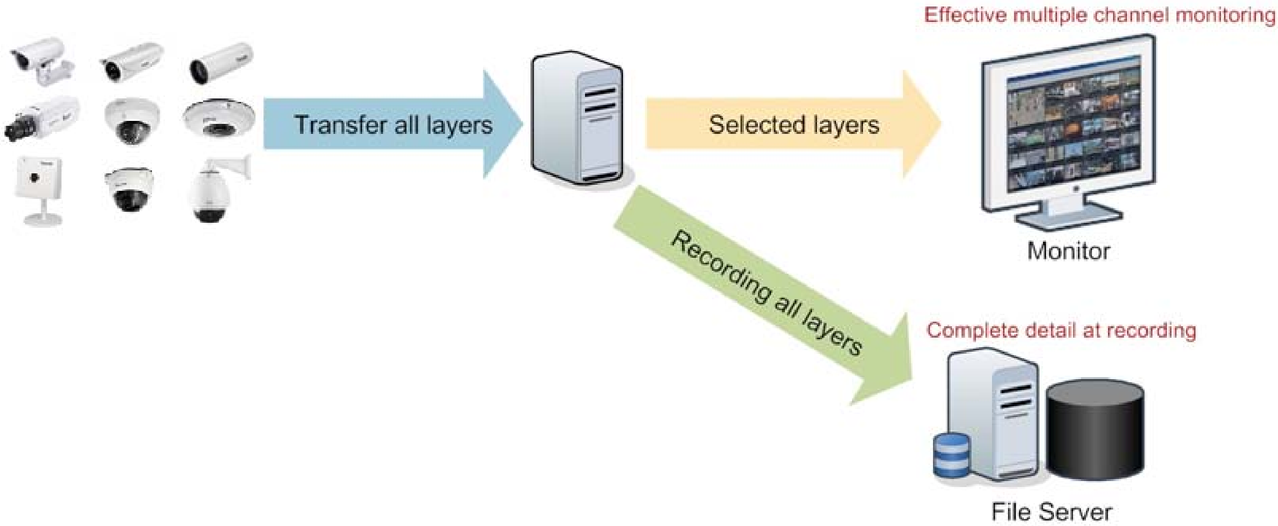
AAS provides a method to adjust video quality in response to events and SVC make this adjustment more flexible with the scalability of different layers. Therefore, AAS with SVC technology will make dramatic savings on bandwidth and storage while still meeting the security demand of monitoring and recording.

The figure below illustrates activity-adaptive streaming



- Effective Monitoring and Recording

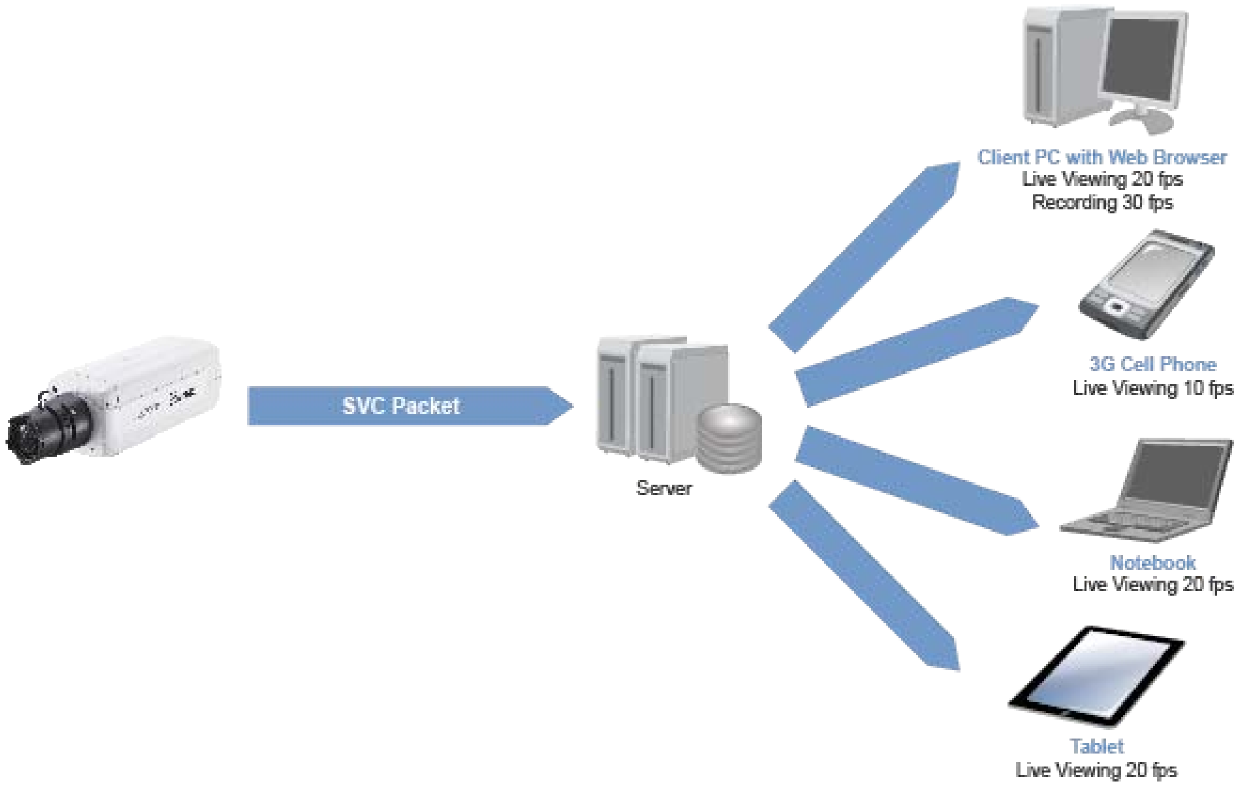
Powered by SVC technology, an optimal solution is provided for effectively monitoring and recording multiple channels of video with CMS or VMS. The layered architecture of SVC bitstream allows the CMS or VMS to decode only those layers that are needed, depending on the requirement of video quality or the capability of the devices. The fewer layers are decoded, the greater the amount of processor resources are conserved. For example, the monitoring stations can only decode the layer for smaller resolution to achieve multiple channel monitoring without overtaxing processor resources while all layers of video bitstream are still recorded without dropping off any frame or sacrificing the video quality and resolution. This effect will be particularly pronounced in large-scale multi-channel monitoring systems, enabling more reliable performance and greater system responsiveness.



Besides, cameras supporting SVC can provide streams with different groups of layers to accommodate a variety of clients and usage scenarios, providing just the layers needed to support a given level of video quality, thereby conserving the network bandwidth. Mobile devices or other resource-constrained devices can therefore request a base layer of frames while desktop or laptop can request more layers to achieve larger resolution and better video quality. Moreover, the network storage devices may request all layers so as to record all details of the surveillance video data.

In addition, the layered architecture of SVC streams can also be leveraged on the client side. Client devices can determine how many layers of an SVC stream to decode depending on local requirements or capabilities. The fewer layers decoded, the greater the amount of CPU and other system resources are conserved. This effect will be particularly pronounced in large-scale multi-channel monitoring systems, enabling more reliable performance and greater system responsiveness.

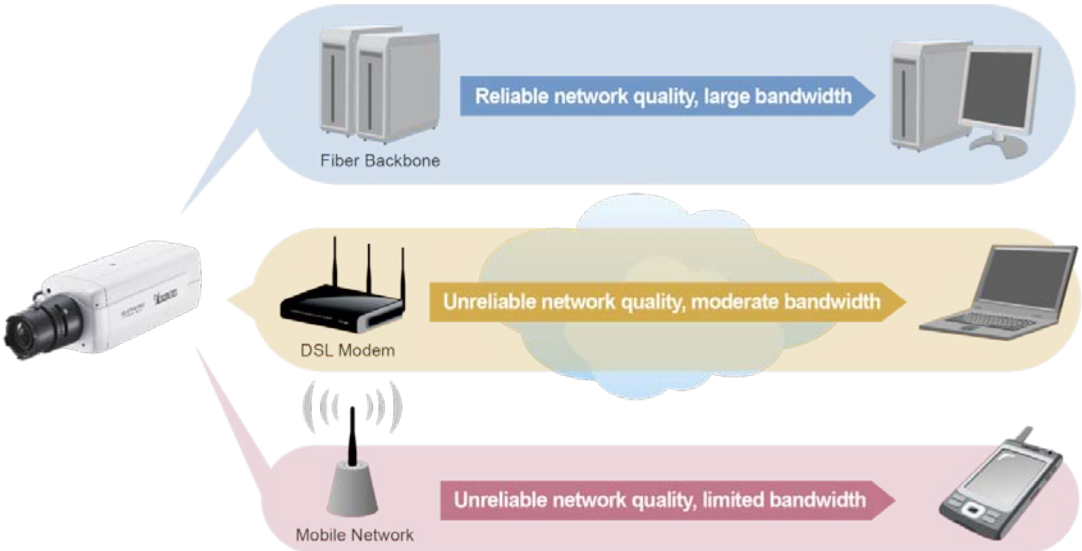
The figure below illustrates several usage scenarios for effective monitoring and recording, with adaptive bandwidth control for different clients.



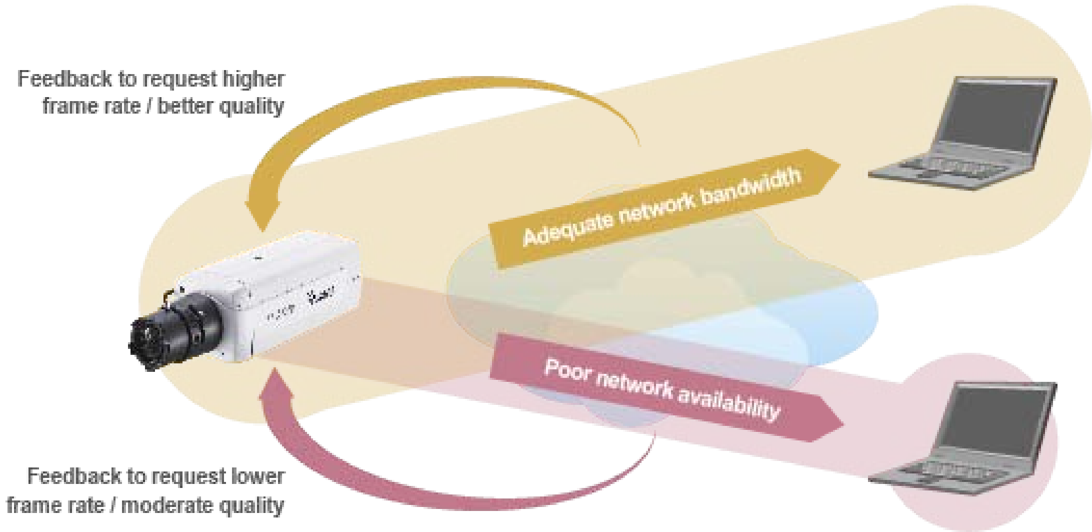
- Smart Bit Rate Control

One of the challenges of maintaining the quality of camera video is the inherent unreliability of most networks. The most common problems with transmitting video over unreliable networks include jitter, dropped frames, and noisy images—all of which can severely degrade both viewing and recording of surveillance footage.

Smart bit rate control was developed to adjust the video stream for specific clients to accommodate variations in different types of networks. For a comprehensive solution, the camera should also be able to make adjustments to streams for particular clients independently without affecting the streams for other clients.



By utilizing SVC, the bitstream provided to a particular client can be adjusted for the video configuration (frame rate/quality/resolution) needed in real time based on a request from that client. For example, in the figure below, when a client has detected instability in the network and is suffering from video jitter or lost frames, it can provide this information to the camera, which can adjust to the bitstream by thinning out layers so it presents a smaller footprint and is less affected by network issues. Once network conditions have returned to normal, another notification from the client allows the camera to restore the original video quality. Notice that with SVC, any adjustment made to one stream will not affect the streams provided to other clients.



Conclusion

Scalable Video Coding (SVC) is the advanced video compression technology derived from standard H.264, providing a compelling solution to the challenges that have arisen with the advent of megapixel or HDTV network camera. VIVOTEK is taking the lead to leverage this state-of-the-art technology with its innovative design to maximize SVC benefits for IP surveillance.

SVC provides more effective bandwidth and processor resource management, which enables a network camera to serve video streams of different configurations simultaneously to meet the requirements of different client devices and network conditions. SVC technology can also transmit even more video channels than using the existing standard H.264 by the same processor power. Besides, SVC provides more flexibility for Activity Adaptive Streaming (AAS) to optimize the balance between the bandwidth usage and the requirement of video quality in response to the security events, thus saving more storage capacity than continuously recording the full frame rate video stream as well.

With SVC, the CMS/VMS is able to monitor more channels in one station without multiplying the additional loading to the system while recording all layers of the bitstreams for the future retrieval of all detailed video data. Moreover, by taking advantage of layers information, the storage capacity of recorded files can be dramatically reduced.

Again, as a leading IP surveillance provider, VIVOTEK keeps up with the newest SVC technology with its innovative design to provide the total solution with superior video quality, resilient network transmission, and cost-saving storage capacity.

VIVOTEK
BUILT WITH RELIABILITY

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