H.264 Considerations
PART III

Recording • Live Viewing

In the first two articles of this series, we covered the basics between temporal and frame-based compression and identified 9 elements that should be considered when designing, specifying, or buying a high quality network video surveillance system. In articles I and II, we reviewed the first 7 of our 9 considerations. In this article, we will deal the last two. To review, the 9 considerations are:

1. RESOLUTION [Requirement] (Article 1)
2. FRAME RATE [Requirement] (Article 1)
3. WEATHER [Environment] (Article 2)
4. LIGHTING [Environment] (Article 2)
5. SCENE MOTION [Environment] (Article 2)
6. OBJECT SPEED [Environment] (Article 2)
7. CAMERA MOTION [Environment] (Article 2)
8. **RECORDING** [User Requirement]
9. **LIVE VIEWING** [User Requirement]

The considerations fall into two categories: "User Requirement" which will vary depending on the customer's preferences, and "Video Environment," which are the variables in an application that will likely have an impact on your video.

To frame the discussion of our final two considerations, it is our position that a video system should always be optimized to achieve a desired image quality, and then adjusted for frame rate to maximize bandwidth and storage efficiencies. When dealing with MJPEG, we encourage a compression setting no lower than medium (MJPEG= 50). With H.264, we recommend nothing lower than the MAIN profile and that you allow the bit rate to vary (VBR) to ensure delivery of the best quality image. Remember, the customer is paying for a video recording system that meets their expectations in all conditions, not just the optimal conditions—big difference. System designers and architects must work diligently to guarantee that the choices made during the design and configuration of the system do not degrade the video's quality during those times when events occur.

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RECORDING [User Requirement]

For many recording applications, users like to change frame rate and resolution when there is an event, such as motion. If you are using H.264, it is better to vary frame rate and image quality at the camera, using the camera's motion detection, than to stream all the compressed video back to your server to detect motion. Running motion detection at the server takes a lot of processing power and can even bring a high performance machine to its knees. Motion detection has to run on uncompressed video which is readily available in smart cameras. It is easy to do in a camera since the camera is detecting only the motion in its field of view. For a server to detect motion on every camera, it has to decode every stream, and decoding multiple streams like H.264 requires substantial processing. Even if the server has special H.264 decoding hardware (as many video cards do) it will probably struggle with multiple H.264 video streams. So, check with your NVR supplier and see how they do it. If they are using "server-based" motion detection for "RECORD ON MOTION" or "CHANGE FRAME RATE/IMAGE QUALITY ON MOTION", make sure you understand the processing requirements and select a server that can handle the load.

For determining frame rate, a general rule of thumb for compression schemes such as H.264 is the higher the frame rate, the better the video quality, albeit at the expense of higher bandwidth and storage. Keep in mind that many high resolution, megapixel sensors are limited in the frame rate they can deliver (some can deliver no more than 10 frames/second maximum), so make sure the specified compression scheme and the maximum frame rates of the cameras match accordingly.

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LIVE VIEWING [User Requirement]

When H.264 compression is implemented properly to deliver good quality video for security/surveillance, it WILL take more processing to display live video than it would using a frame-based compression like MJPEG. For this reason, you must carefully consider the maximum number of simultaneous cameras you wish to view and make sure the server is up to the task or budget for the additional hardware that may be required. The industry consensus is that displaying an H.264 stream (Main Profile or higher) requires about 2x the processing of equivalent quality MPEG-4 or MJPEG video.

Latency is also an important consideration. In terms of video, latency is the delay between when things happen in real time and when you see it on your monitor. The most common way to test this is to wave your hand in front of the camera and see how long it takes to see it wave on the monitor. Things that affect latency with H.264 include the profile utilized, how a manufacturer has designed the decoder, and the amount of buffer memory allocated for the video. For the same reason YouTube video is "buffered", many decoders try to "smooth" video, which can add 3 to 4 seconds of latency. Latency really doesn't matter too much for viewing recorded video, but too much latency can be unacceptable for live viewing and can make focusing a camera or using a mechanical pan/tilt/zoom camera nearly impossible. Most security professionals are accustomed to minimal latency and most video systems have latency far less than one second.

Last, pay attention to how the video is displayed on your monitor. A 1600 x 1200 image displayed on a 800 x 600 monitor will always appear crisper and clearer than if you showed it on a 1600 x 1200 monitor. That is because the computer will "downsample" the image to fit it on the screen and down-sampling masks many undesirable compression artifacts, making the live viewing experience better than displaying the image at 1:1. When you need to display the image at 1:1 (like during forensic analysis of video), inadequate compression techniques or sub-standard H.264 compression profiles will not meet your expectations for megapixel video quality.

H.264 PROFILES REVIEW

Repeat after us: **All H.264 Profiles are not created equal.**

H.264 Profiles define the *maximum* possible feature set of an H.264 category, but it is up to each manufacturer to decide which features they use in their implementation. Those decisions can greatly impact the video quality and bandwidth performance of any given H.264 encoder. IQinVision chose to utilize Main Profile (the next highest performance to Blu-Ray DVD encoding) for our HD1080p H.264 cameras because of its superior image quality. By comparison, the Baseline profile (created primarily for low-cost applications) is utilized in products like Axis' Q1755 720p camera as well as the TCM-5311 camera from ACTi, while the Constrained Baseline profile (created specifically for low-cost, low-performance mobile and videoconferencing applications) is utilized by Arecont Vision for their line of H.264 cameras.

The table below shows 27 of 51 identified key features supported by the different H.264 Profiles. Another source which helps to convey the complexity and widely varying implementations of the standard can be found here: http://en.wikipedia.org/wiki/H.264, where you can see that out of the 13 vendors listed supporting H.264 there are 13 DIFFERENT implementations of the feature set.

Major H.264 Profile Abilities/Functions	High	Main	Extended	Baseline	Constrained Baseline
I and P slice frames	●	●	●	●	●
In-loop enhanced deblocking	●	●	●	●	●
Multiple reference frames	●	●	●	●	
Heirerarchical P Frames	●	●	●	●	
Redundant slices	●	●		●	
Flexible macroblock ordering	●			●	
Arbitrary slice ordering	●			●	
B slice frames	●	●	●		
B-Slice inter-frame prediction	●	●	●		
B-Slice list 0 type prediction	●	●	●		
B-Slice list 1 type prediction	●	●	●		
B-Slice bi-prediction	●	●	●		
B-Slice direct prediction	●	●	●		
B-Skip macroblock mode	●	●	●		
Interlaced/field coding	●	●	●		
Weighted prediction	●	●	●		
Weighted bi-prediction	●	●	●		
Adaptive switching	●	●	●		
Heirerarchical B Frames	●	●			
SP/SI synchronizing/switching	●	●			
Slice data partitioning	●	●			
CABAC entropy coding	●	●			
1/4 pixel motion estimation	●	●			
8x8 transform adaption	●				
Quantization scaling matrices	●				
Separate Cb/Cr quality control	●				
Monochrome 4:0:0 coding	●				

The message here is simple: there is much more to the term "H.264" than meets the eye. As seen in the above chart there are thousands of different schemes and every one of them can be called H.264 even though the image quality and bandwidth and storage demands will vary greatly with the implemented features. You must know your video compression encoder and design the system accordingly.

Summary Chart for Article Series

The following chart is intended to help you design an optimal IP video surveillance system by highlighting the major differences between the H.264/Temporal and MJPEG/Frame-Based compression schemes for considerations 1 - 7 that we have in this article series. The highlighted regions show the most important areas to take into account when designing for the most robust video surveillance system.

	Effect of compression only on video quality, bandwidth and storage			
	H.264/Temporal Based		MJPEG/Frame Based	
Consideration:	Video Quality	Bandwith & Storage	Video Quality	Bandwith & Storage
[1] Higher Resolution (Requirement)	Same	Increases Proportionally	Same	Increases Proportionally
[2] Lower Frame Rate (Requirement)	Degrades	Decreases Proportionally	Same	Decreases Proportionally
[3] More Weather (Environment)	Degrades	Increases Significantly	Same	Increases Slightly
[4] Lower Lighting (Environment)	Degrades	Increases Significantly	Degrades	Increases Slightly
[5] More Scene Motion (Environment)	Degrades	Increases Significantly	Same	Same
[6] Faster Object Speed (Environment)	Degrades	Increases Slightly	Same	Same
[7] More Camera Motion (Environment)	Degrades	Increases Significantly	Same	Same

Summary Recommendations

In the interests of full disclosure it is important to note that IQinVision has a complete line of H.264 and MJPEG cameras so it is not our intention to promote one over the other. We are simply providing a navigational aid through the vast amounts of misinformation in the industry and, we hope, enough information to make the best choice for your application. Just as megapixel cameras are not all things to all people, neither is H.264/Temporal video compression. H.264 is a very complex subject and impossible to boil down to simple rules that fit 100% of all applications. Nevertheless, the following rules of thumb should help guide you in making better decisions when choosing your compression methodologies:

- *It is all about the Environment and the Requirement. The APPLICATION should determine the selection of a video compression scheme: "one size does not fit all".*
- *The main benefit of H.264 is lower bandwidth and storage under appropriate conditions, which in general are well lit, high frame rate (15fps+) installations with little scene motion (<20%).*
- *To maximize H.264 image quality, use at least MAIN profile compression and set it to Variable Bit Rate (VBR)*
- *If using H.264, be sure to design the network to handle high bandwidth spikes and select a server with the necessary processing power for handling increased decoding and display loads.*
- *Be sure to factor in weather and lighting conditions when calculating bandwidth and storage needs if specifying H.264 compression.*
- *Select a non-temporal compression scheme like MJPEG if the camera is on a mobile platform or in a PTZ unit.*

With H.264/temporal compression, system VARIABILITY increases and PREDICTABILITY decreases, complicating overall system design. These complications can be accounted for and designed around when you are armed with accurate information. Our company places high value on providing all the information you need to build a system that exceeds your customers' expectations. We trust these articles have exceeded YOUR expectations in providing such information.

References

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