H.264 The Next Generation IP Video Surveillance Compression Technology

Abstract
H.264, the latest video compression standard, is expected to become the video standard of choice in the coming years across all market segments from digital video surveillance to broadcast television. H.264 is an open, licensed standard that supports the most efficient video compression techniques available today. Without compromising image quality, an H.264 encoder can reduce the size of a digital video file by more than 80% compared with the Motion JPEG format and 50% more than MPEG-4 Part 2 standard. This means that much less network bandwidth and storage space are required for a video file of equal or greater picture quality. It also means much higher video quality can be achieved for a given bit rate than Motion JPEG or MPEG-4. Jointly defined by standardization organizations in the telecommunications and IT industries, H.264 is expected to be more widely adopted than previous standards. H.264 has already been introduced in new electronic gadgets such as mobile phones and digital video players, and has gained fast acceptance by end users. Service providers such as online video storage and telecommunications companies are also beginning to adopt H.264.

In the video surveillance industry, H.264 will most likely find the quickest traction in applications where demands for high frame rates and resolution, such as in traffic surveillance, public transits, manufacturing, airports, and casinos. This is where the economies of reduced bandwidth and storage needs will deliver the biggest savings. Megapixel cameras are also benefiting from the adoption of the H.264 compression technology. There are tradeoffs, however. While H.264 provides savings in network bandwidth and storage costs, it will require higher performance network cameras and monitoring stations due to the increase in CPU processing demands. Also thanks to the Moore's law where technology double in performance every 8 months made H.264 possible across all market segments.

H.264 Development
H.264 is the result of a joint project between the ITU-T's Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group (MPEG). ITU-T is the sector that coordinates telecommunications standards on behalf of the International Telecommunication Union. ISO stands for International Organization for Standardization and IEC stands for International Electrotechnical Commission, which oversees standards for all electrical, electronic and related technologies. H.264 is the name used by ITU-T, while ISO/IEC has named it MPEG-4 Part 10/AVC since it is presented as a new part in its MPEG-4 suite. The MPEG-4 suite includes, for example, MPEG-4 Part 2, which is a standard that has been used by IP-based video encoders and network cameras.

Designed to address several weaknesses in previous video compression standards, H.264 delivers on its goals of supporting:

- Implementations that deliver an average bit rate reduction of 50%, given a fixed video quality compared with any other video standard
- Error robustness so that transmission errors over various networks are tolerated
- Low latency capabilities and better quality for higher latency
- Straightforward syntax specification that simplifies implementations
- Exact match decoding, which defines exactly how numerical calculations are to be made by an encoder and a decoder to avoid errors from accumulating

H.264 also has the flexibility to support a wide variety of applications with very different bit rate Requirements. For example, in entertainment video applications—which include broadcast, satellite, cable and DVD—H.264 will be able to deliver a performance of between 1 to 10 Mbit/s with high latency, while for telecom services, H.264 can deliver bit rates of below 1 Mbit/s with low latency.

How video compression works
Video compression work to reduce and remove redundant video data making it transmission of video across wired or wireless network more effectively. Currently, there are two main compression methods, inter-frame compression or intra-frame compression. Inter-frame compression uses one or more earlier or later frames in a sequence to compress the current frame, while intra-frame compression uses only the

current frame, which is effectively image compression. In other words, for Inter-frame a reference image is transmitted and updated little by little until a major change requires a new reference image. Intra-frame compression transmit a complete image every time. The time it takes to compress, send, decompress and display a file is called latency. The more advanced the compression algorithm, the higher the latency, given the same processing power.

When considering an upgrade to a networked surveillance system with recording capabilities, there are a number of factors to consider in determining the most appropriate compression method:

- How high a frame rate is needed?
- Are different frame rates needed during certain events or at specific times?
- What image quality is needed?
- What image resolution is needed?
- What is the available bandwidth for network transmission?

Roles of Video Encoder and Decoders

A pair of video compression and decompression algorithms that works together is called a video codec or encoder and decoder. Video codecs that implement different standards are normally not compatible with each other; that is, video content that is compressed using one standard cannot be decompressed with a different standard. For instance, an MPEG-4 Part 2 decoder will not work with an H.264 encoder or a Microsoft decoder will not work with an Apple encoder. This is simply because one algorithm cannot correctly decode the output from another algorithm but it is possible to implement many different algorithms in the same software or hardware, which would then enable multiple formats to be compressed.

Different video compression standards utilize different methods of reducing data, and hence, results differ in bit rate, quality and latency. Results from encoders that use the same compression standard may also vary because the designer of an encoder can choose to implement different sets of tools defined by a standard. As long as the output of an encoder conforms to a standard's format and decoder, it is possible to make different implementations.

This is advantageous because different implementations have different goals and budget. Professional non-real-time software encoders for mastering optical media should have the option of being able to deliver better encoded video than a real-time hardware encoder for video conferencing that is integrated in a hand-held device. A given standard, therefore, cannot guarantee a given bit rate or quality. Furthermore, the performance of a standard cannot be properly compared with other standards, or even other implementations of the same standard, without first defining how it is implemented. A decoder, unlike an encoder, must implement all the required parts of a standard in order to decode a compliant bit stream. This is because a standard specifies exactly how a decompression algorithm should restore every bit of a compressed video.

What does this all mean? It means producer of one IP video surveillance cameras in most cases are not compatible with another producer of IP video surveillance camera

H.264 streaming profiles and levels

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 macro-block per second for resolutions ranging from QCIF to HDTV and beyond. The higher the resolution, the higher the level required.

H.264 Efficiency
H.264 takes video compression technology to a new level. With H.264, a new and advanced intra prediction scheme is introduced for encoding the starting image frames. This scheme can greatly reduce the bit size and maintain a high quality video by prediction of future video frames. The intelligence to predict future video frames is a key part of the H.264 technology that has proven to be very efficient.

Conclusion
H.264 presents a huge step forward in video compression technology. It offers techniques that enable better compression efficiencies due to more accurate prediction capabilities, as well as improved resilience to errors. It provides new possibilities for creating better video encoders that enable higher quality video streams, higher frame rates and higher resolutions at same bit rates (compared with previous standards), or, conversely, the same quality video at lower bit rates.

H.264 represents the first time that the international organization ITU, ISO and IEC have come together on a common standard for video compression. Due to its flexibility, H.264 has been applied in diverse areas such as home entertainment, internet video storage and streaming, and IP TV. With support from many industries and applications for consumer and professional needs, H.264 is expected to replace other compression standards and methods in use today.

For more information on Inscape Data line of H.264 IP video surveillance cameras and NVR software, please contact an Inscape Data product and sales representative.