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Active Content Compression (ACC)

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ACTIVE CONTENT COMPRESSION (ACC)

Introduction

This white paper illustrates the importance of video compression and the basis of ACC as well as the properties that make it the most advantageous choice for compressing surveillance video. We also present an overview of MPEG-4 technology and the results from performance tests showing side by side comparisons between MPEG-4 and ACC. For your convenience, we have included a glossary of technical terms at the end of this document; these terms appear underlined in the text and provide a hyperlink to the glossary.

The Best Compression for Your Security

ACC makes American Dynamics Intellex® family of digital video management systems the most efficient in the security industry. While competing video compression technologies originated to serve other purposes, we developed ACC specifically for security and productivity management. It addresses the needs unique to these applications in four important ways.

1. In test after test, ACC scored dramatically higher than the competition for **performance in low light** environments, one of the most common scenarios monitored by security cameras.

2. More efficient compression means you have less data to search through. Less data to search through means **faster, easier searches**—and in the security business, a few seconds can make the difference between stopping a crime or letting the trail grow cold.

3. Surveillance cameras often record 24 hours/day, which generates a tremendous amount of video data. ACC compresses this volume to the smallest size that is possible with minimal loss in quality of potentially important evidence. This smaller file size consumes **less storage** space on your hard drive, enabling you to save more days' worth of video surveillance.

4. The proprietary encoding technology used by Intellex makes manipulation and/or alteration of the original recorded video data stream virtually impossible and ensures the authenticity of the recorded video. The American Dynamics Intellex family of digital video recorders is the only commercially available product line capable of recording in this format. American Dynamics does not provide any method to edit the original recorded video stream. In this way, ACC protects the **court admissibility** of your video evidence.

ACC enables you to store and send more high quality images at faster update rates over networks than any other compression technology on the market today. You can record at more than double the video image resolution with ACC as you can with competing compression technologies and still use less disk space. The advantages add up to better, more foolproof security, whatever your situation.

Why Compress Video?

Without compression, delivering quality digital video is both economically and technologically infeasible. The amount of data generated by one camera alone over a 24 hour period is staggering. Just do the math.

A single video image comprising 640 (height) x 480 (width) pixels at 4CIF represents 0.88 megabytes. Now add motion in the equivalent of a series of images recorded at the rate of 30 images per second:

640(h) pixels x 480(w) pixels x 3 bytes/pixel	=	0.88 MB/image
0.88 MB/image x 30 images/second	=	26.37 MB/second
26.37 MB/sec x 3,600 secs/hr	=	94,921.88 MB/hr
94,921.88 MB/hr x 24 hr/day	=	2,278,125 MB/day

To store this much video data without any compression, you would need more than eight 300 GB hard drives. Downloading it would take about six days using a T-3 line (45 Mbits/sec). It makes a pretty compelling case for video compression, doesn't it?

Better security, of course, pays for itself in prevented losses. But ACC saves you money up front, too, further enhancing the return on investment in your security system.

Save on Storage

Reducing the size of your video data through more efficient compression reduces your requirements for storage capacity, and that reduces the amount of gigabytes you need to purchase. The dollars saved accrue quickly, especially when you're dealing with a large or intensely monitored surveillance area. For instance, 100 outdoor cameras set to record 15 images per second at 2CIF resolution for 30 days produce less than 14 terabytes of data in night-time conditions if you use ACC. Compare that with nearly 33 terabytes if you use MPEG-4 compression instead. At $3,500 per terabyte, that's up to $69,000 or 60% of storage costs that ACC saves you.

Save on Bandwidth

Smaller data files consume less bandwidth, which can reduce costs both in the local area network and, more significantly, in the wide area network where bandwidth is typically leased.

How Can ACC Do All This?

ACC is based on the following three principles.

1. Video imagery consists of two types of data: static data and dynamic data. Static data are those parts of a scene that remain unchanged from one image to the next, such as a building. Dynamic data are the parts of the scene that do change—like a car that passes in front of the building—and indicate motion (remember, video is a series of images that vary from one to the next at differing degrees).

2. Dynamic data have two principal components: noise and active content. Noise is data unrelated to motion or meaningful change from the previous image and tends to manifest as snow, graininess or picture static (poor or low light, which is common in surveillance areas, creates noise). Active content is data that indicates legitimate change from the previous image, such as the aforementioned car driving past the building.

3. Noise has measurable attributes that distinguish it from active content.

We've designed ACC to assess which changes in dynamic data constitute active content and retain only that—not the noise. Eliminating noise dramatically reduces the amount of data and is the key to ACC's superior efficiency.

As a hybrid compression technology, ACC combines intraframe, interframe and noise immunity techniques. It uses intraframe technique to compress the first image and create what's known as a reference frame, which represents the complete picture. It uses interframe and noise immunity techniques to compress the subsequent 31 images and create what's known as a prediction or update frame, which includes active content only. Every 32nd image is a reference frame and all images in between are prediction frames. The prediction frame contains vastly less data than the reference frame and accounts for nearly 97% of the total images comprising the video. Combining reference frames and prediction frames produces the effect of full motion video and at the same time minimizes the amount of data required to do so.

The Other Technologies

Like ACC, other video compression technologies use intraframe and interframe techniques (but lack video noise immunity). These technologies include:

JPEG (a still image compression standard),
JPEG 2000 (wavelet-based compression),
H.261/3 and H.320/3 (video conferencing standards),
MPEG-1 (developed for CD-ROM),
MPEG-2 (developed for DVD/digital motion pictures) and
MPEG-4 (developed for video conferencing).

Of these, MPEG-4 is the compression technology used most commonly in the video security industry.

Originally intended as a replacement for H.261/3 and H.320/3 video conferencing standards, MPEG-4 has since been expanded to address an "everything-and-the-kitchen sink" assortment of purposes.

It derives from MPEG, a standard for motion pictures developed along the lines of JPEG that uses motion prediction and, as a result, is very asymmetric (encoding is much more computation-intense than decoding). Like all MPEG standards to date, MPEG-4 is extremely memory intensive.

While audio and video lie at the core of the MPEG-4 specification, MPEG-4 can also support 3D objects, sprites, text and other types of media. It is designed to deliver DVD (MPEG-2) quality video at lower data rates with smaller file sizes and, in theory, can provide good video compression. But its effectiveness in video security can be limited by not having noise immunity. Other drawbacks include severe latency and the inability to scale well to multiple sources or multiplexed data streams. Additionally, MPEG-4 requires hardware acceleration to be effective and is significantly more computation—and resource—intense than ACC.

Superior Compression with ACC

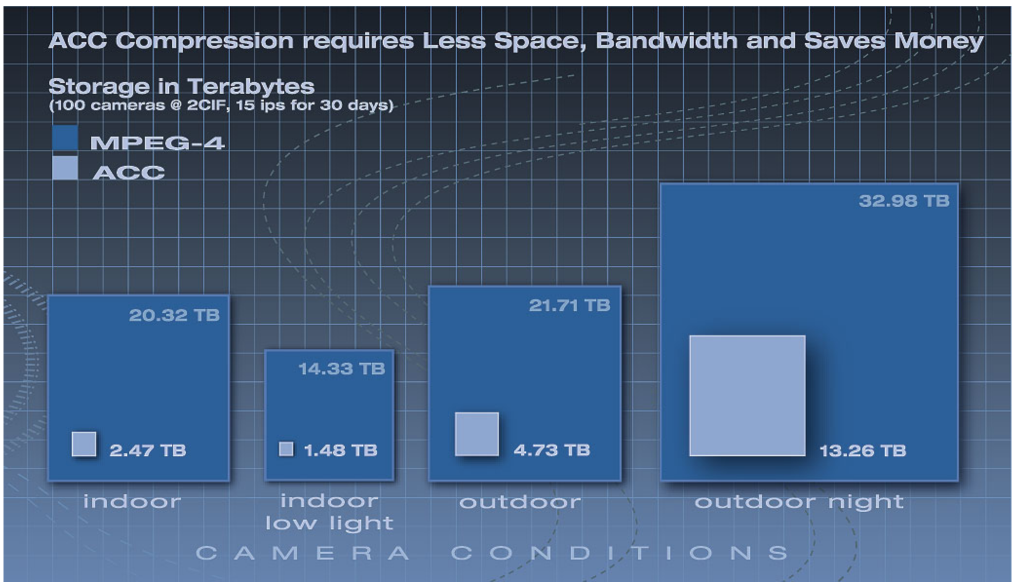
We conducted performance tests that compared ACC to the compression technologies of competing brands' digital video recorders (DVRs). These were namely MPEG-4 and modified versions of MPEG-4 (the others listed in the previous section above are seldom, if ever, used for surveillance video). Using 5-10 minute video clips at 2CIF resolution, we tested five different security scenarios with high image quality:

Indoor:	A fixed indoor camera with low to medium video motion.
Indoor Low Light:	A fixed indoor camera with low lighting and low to medium video motion.
Outdoor:	A fixed outdoor camera with medium video motion.
Outdoor Night:	A fixed outdoor camera at night with low video motion.
Rotating Dome:	A dome camera constantly rotating.

To ensure a level playing field with each DVR receiving the same video data, we captured raw (uncompressed) video from surveillance cameras using a Blackmagic Design's DeckLink SP™, which then allowed us to send a uniform composite signal to Intellex and the competing brands' DVRs for compression. Once the video was compressed, we measured the file size of each video clip by exporting it or checking the data rate in the settings dialog box of the DVR.

ACC Outperformed the Other DVRs' Compression Technologies in Every Test

The difference proved especially dramatic with low motion fixed cameras in low light conditions.



ACC-compressed video data files were over nine times smaller than those compressed with MPEG-4. The competitive testing demonstrated ACC as the most efficient compression technology—by a formidable margin—with results that are verifiable and reproducible.

Proof Positive

Designed from the ground up with security and productivity management in mind, ACC combines interframe and intraframe techniques, symmetric computational requirements and noise immunity to compress video more efficiently than any competing method available today.

By minimizing the amount of video that you have to search through, store and transmit, ACC saves you time, money and bandwidth capacity while ensuring the authenticity of your video evidence. Considering that ACC performs this feat at nearly 10 times the rate of the competition makes the point indisputable: you simply cannot buy a better compression technology.

Glossary of Terms

asymmetric When compressing a data stream requires a different degree of computational power as decompressing it. Most compression techniques exhibit at least some asymmetry, taking more computational energy to compress than to decompress. Symmetry is important because in a real time recorder or transmission system, you must both compress and decompress data to keep up with the real time expectations of the operator. Very asymmetric compression techniques can require a great deal of processing power, which is costly.

CIF (short for Common Intermediate Format) Refers to the size of an image. A 4CIF image is full size and consists of two interlaced fields, representing the highest possible quality. It also represents the largest file size and slowest record rate. All other CIF measurements—CIF (or 1CIF), 2CIF and QCIF (or Quad CIF)—include only one field. A 2CIF image is full size and artificially generates pixels to fill in the missing second field. A CIF image is one fourth and a Quad CIF image is 1/16th the size of a full size image, respectively. Both are too small to accommodate two fields' worth of pixels and therefore do not compensate for the missing second field as in a 2CIF image.

intraframe technique A compression scheme that treats each individual video image independently from every other video image. Intraframe techniques have the advantage of simplicity, ease of indexing, and ease of forward and reverse playback. They also have low latency, which means there isn't an appreciable delay in the compression stream. This is important for live monitoring and device control applications, where immediate feedback is critical. Intraframe techniques make managing multiplexed data streams easier as well, since each image is independent. ACC intraframe compression is based on JPEG algorithms.

interframe technique A compression scheme that treats video images interdependently, compressing only the motion (the pixels that change) between the video images. By compressing information from multiple images and treating the image sequence as a stream, interframe techniques are much more efficient than intraframe techniques. They are also more computationally intense, with indexing, playback and multiplexing becoming more complex. Interframe techniques must also be carefully implemented to prevent latency. ACC uses patented motion detection algorithms that balance motion analysis with symmetric computational requirements

noise immunity technique Compression schemes that detect video noise within each video image and eliminate it from the data being compressed. ACC uses patented video noise detection algorithms optimized for the video security environment.

stream (also known as a data stream or video stream) A sequence of digitally encoded coherent signals or packets of data used to transmit or receive information.