Tech Note - 05

Surveillance Systems that Work!™

GUARD DOG Surveillance Systems

Calculating Recorded Volume Disk Space

Calculating required storage drive (disk space) capacity is sometimes be a rather tricky business. This Tech Note is written to inform customers and technical sales people alike understand the "art." Perhaps with some good estimates we'll all be a bit wiser when selecting our storage drive requirements.

In order to develop a working knowledge of the subject, it is necessary to have a basic understanding of how video surveillance systems process data. Generally speaking, cameras produce analog video information that is viewed "live" on the surveillance system's monitor. The analog information is converted to digital data in the microprocessor. This digital data is then "compressed" to maximize storage capacity. For a more comprehensive discussion of various compression technologies, please see Appendix A of this article.

Regardless of the compression technology in use by the DVR, the following variables each affect the required hard drive storage space of a video surveillance system:

Recording frame rate – Kb/Frame or FPS

- Recording resolution of each frame
- Number of system cameras
- Amount of motion viewed by each camera
- Hours of business operation - # of hours per week

Recording frame rate – Kb/Frame or FPS

30 frames per second (FPS) is real time. Unless your facility operates under a regulatory requirement, there is little reason to record in real time. A high FPS results in larger quantities of data storage (or less recorded time on the same storage device).

Recording resolution of each frame

Quality Digital Video Recorders (DVRs) have the capability of defining the recording resolution of each camera on the system. Common resolution settings include 352x240, 704x240 and 704x480. The larger the product of the two numbers the larger the file size (and the less recorded time on the same storage device).

Number of system cameras

This is the simplest factor to understand. All things equal, one camera will require half the storage capacity of two and an eight camera system will require roughly half the storage space of an identical sixteen camera system.

Amount of motion viewed by each camera

This is relatively simple to understand but most difficult to estimate. To minimize the storage requirement as well as to "create" a database of "motion events," most surveillance systems employ a "record only on motion" option – rather than record 100% of the time, a convenient (and huge space saving) option is to record only if something in the picture is changing. Rather than record the front door all day long – regardless if someone is entering or exiting - it's far more economical (from a storage space perspective) to record only when the door opens or closes.

There is no way to effectively calculate this function, as it will vary with each installation's traffic pattern and with each camera installed. While it's necessary – from a complete surveillance protection perspective – to have a camera on the back door, it's quite reasonable that out of a 24-hour day one may only record 10-15 minutes of activity from that camera. Conversely, a camera trained on a busy loading dock may record activity 20 out of the same 24 hours.

Hours of business operation - # of hours per week

Generally speaking a 24-hour per day operation will record more activity than another open for only one shift. Again, this is a simple concept to understand but difficult to accurately estimate the effect on required storage space. Since "Hours of Business Operation" will effectively define "Amount of motion viewed by each camera," this may not be a big factor. However, it can and should be used to determine a reasonable percentage of motion recorded.

Since we've provided (and analyzed after the fact) a number of surveillance systems into a wide variety of common applications, GuardDog Surveillance Systems has a general gut feel regarding required storage capacity for most applications. However, to move from the gut and provide a practical point of reference, we've evaluated the storage requirement of the systems we provide in a quantitative manner. From this information, you can "estimate" those function of your system that are different and thus come relatively close (within a few days accuracy) regarding the "sizing" of the required storage capacity of your new system.

Evaluation Basis

DVR Board:	16-CH, 480/120	120 fps across 16 cameras or 7.5 fps per camera
Recording Res.:	704x480	338Kb per recorded frame
Camera Count:	7	
Recording Rate:	Continuous	All cameras recording continuously, 24/7. Effectively, this removes the amount of motion viewed by each camera as well as the hours of business operation questions.

Conclusions: Our system requires 4.34 GB (gigabytes) of HD space per day per camera.

- Increased Board FPS (say to 240 FPS) will double capacity requirement
- Reducing Recording Resolution (to 352x240) will cut capacity requirement in half
- Camera count will not effect the charts – they're developed on a per camera basis
- The single largest factor is Recording Rate

Use the charts on the following page – for a more accurate (and dynamic calculator) please go to our website www.guarddogvideo.com and use our interactive analysis calculator.

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General HD Capacity Chart – Given various % Time Recording Rates

# CAMS	GB/DAY	100% Recording HD (GB) REQ'D		% Time Recording					
				20%		40%		60%	
		2-WKS	30 DAYS	2-WKS	30 DAYS	2-WKS	30 DAYS	2-WKS	30 DAYS
1	4.34	61	130	12	26	24	52	36	78
2	8.68	121	260	24	52	49	104	73	156
3	13.01	182	390	36	78	73	156	109	234
4	17.35	243	521	49	104	97	208	146	312
5	21.69	304	651	61	130	121	260	182	390
6	26.03	364	781	73	156	146	312	219	469
7	30.37	425	911	85	182	170	364	255	547
8	34.70	486	1041	97	208	194	416	292	625
9	39.04	547	1171	109	234	219	469	328	703
10	43.38	607	1301	121	260	243	521	364	781
11	47.72	668	1432	134	286	267	573	401	859
12	52.06	729	1562	146	312	292	625	437	937
13	56.39	790	1692	158	338	316	677	474	1015
14	60.73	850	1822	170	364	340	729	510	1093
15	65.07	911	1952	182	390	364	781	547	1171
16	69.41	972	2082	194	416	389	833	583	1249

Specific (by camera) Capacity Chart – Select % Time Recording by Camera

CAM #	GB/DAY (100%)	% Time Recording	HD Space Req'd Per…						
			Day	Week	2-Wks	3-Wks	4-Wks	5-Wks	6-Wks
1	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
2	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
3	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
4	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
5	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
6	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
7	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
8	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
9	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
10	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
11	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
12	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
13	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
14	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
15	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
16	4.34	50%	2.17	7.59	15.18	22.77	30.37	37.96	45.55
		Total HD Capacity Required	**34.70**	**121.47**	**242.93**	**364.40**	**485.86**	**607.33**	**728.79**

Appendix – A
Compression Technology Standards

At its simplest level, compression occurs when an input video stream is analyzed and information that is deemed indiscernible to the viewer is discarded. Each event, depending upon its frequency of occurrence is assigned a code. There are four methods for compression, discrete cosine transform (DCT), vector quantization (VQ), fractal compression, and discrete wavelet transform (DWT).

- **Discrete Cosine Transform** is a compression algorithm that samples an image at regular intervals. Frequency components present in the sample are analyzed - those frequencies that do not affect the image (as the eye perceives them) are discarded. DCT is the basis of standards such as JPEG, MPEG, H.261, and H.263.
- **Vector Quantization**, rather than considering a regular interval sample, looks at an array of data. It then generalizes what it sees, removing redundant data, while retaining the desired object and/or data stream's original content.
- **Fractal Compression** is a form of VQ and is also a lossy compression that is performed by locating similar sections of an image. Using a fractal algorithm, sectional views are generated.
- **Discrete Wavelet Transform**, like DCT, mathematically transforms an image into frequency components. Differing from other methods, DWT performs its compression on the entire image. The result is a hierarchical representation of an image, where each layer represents a frequency band.

Compression Standards

MPEG

Is an acronym for the Moving Picture Experts Group, an ISO/IEC working group, established in 1988 to develop standards for digital audio and video formats. There are five MPEG standards being used or in development. Each standard was developed with specific applications in mind. MPEG compression scales well with increased bit rates. The five (5) standards include:

- **MPEG-1**, supports up to 1.5 Mbit/sec, quickly became the standard for the compression of moving pictures and audio. This was based on CD-ROM video applications, and is a popular standard for video on the Internet, transmitted as .mpg files. In addition, level 3 of MPEG-1 is the most popular standard for digital compression of audio--known as MP3. MPEG-1 is the standard of compression for Video CD, the most popular video distribution format throughout much of Asia.
- **MPEG-2**, designed for between 1.5 and 15 Mbit/sec, is the standard on which Digital Television and DVD compression is based. While based on MPEG-1, but designed for the compression and transmission of digital broadcast television, the most significant enhancement is its ability to efficiently compress interlaced video. MPEG-2 scales well to HDTV resolution and bit rates, obviating the need for MPEG-3.
- **MPEG-4**, based on object compression, is the standard for multimedia and Web compression. Similar to the Virtual Reality Modeling Language, individual objects within a scene are tracked separately and compressed together to create an MPEG4 file. This results in very efficient, very scalable compression from very low to very high bit rates. It also allows developers to control objects independently in a scene, and therefore introduces interactivity.
- **MPEG-7**
- This standard, currently under development, is also called the Multimedia Content Description Interface. When released, the group hopes the standard will provide a framework for multimedia content that will include information on content manipulation, filtering and personalization, as

well as the integrity and security of the content. Contrary to the previous MPEG standards, which described actual content, MPEG-7 will represent information about the content.

- **MPEG-21**
- Work on this standard, also called the Multimedia Framework, has just begun. MPEG-21 will attempt to describe the elements needed to build an infrastructure for the delivery and consumption of multimedia content, and how they will relate to each other.

JPEG
Is an acronym for Joint Photographic Experts Group. Like MPEG, it is also an ISO/IEC working group. JPEG is a standard that works with continuous tone image coding. A lossy compression technique used for full-color or gray-scale images utilizes the fact that the human eye does not detect infinitely small variations in color.

JPEG 2000
Is an ongoing initiative that seeks to provide an image coding system using compression techniques based on the use of wavelet technology.

DV
Is a high-resolution digital video format used primarily with video cameras and camcorders. The standard, an abbreviated form of lossy compression, uses DCT to compress the pixel data. The resulting video stream is transferred from the recording device via FireWire (IEEE 1394), a high-speed serial bus capable of transferring data up to 50 MB/sec.

H.261
Is an ITU standard designed for two-way communication over ISDN lines - video conferencing for example. Data rates, in multiples of 64Kbit/s are supported. The algorithm is based on DCT and can be implemented in hardware or software and uses intraframe and interframe compression. H.261 supports CIF and QCIF resolutions.

H.263
Based on H.261 with enhancements that improve video quality over modems. It supports CIF, QCIF, SQCIF, 4CIF and 16CIF resolutions.

H.264
Also known as MPEG-4 AVC (Advanced Video Coding), is a video compression standard that offers significantly greater compression than its predecessors. The standard offers up to twice the compression of the current MPEG-4 ASP (Advanced Simple Profile), in addition to improvements in perceived quality. The H.264 standard can provide DVD-quality video at under 1 Mbps, and is optional for full-motion video over wireless, satellite, and ADSL Internet connections.

DivX Compression
DivX is a software application that uses the MPEG-4 standard to compress digital video, so it can be downloaded over a DSL/cable modem connection in a relatively short time with no reduced visual quality. The latest version of the codec, DivX 4.0, is being developed jointly by DivXNetworks and the open source community. DivX works on Windows 98, ME, 2000, CE, Mac and Linux platforms.

Appendix – B
Glossary of Commonly Used Terms

Lossy compression - reduces a file by permanently eliminating certain redundant information, so that even when the file is uncompressed, only a part of the original information is still there.

ISO/IEC
International Organization for Standardization - a non-governmental organization that works to promote the development of standardization to facilitate the international exchange of goods and services and spur worldwide intellectual, scientific, technological and economic activity.

International Electrotechnical Commission - international standards and assessment body for the fields of electrotechnology

Codec - A video codec is software that can compress a video source (encoding) as well as play compressed video (decompress).

CIF - Common Intermediate Format - a set of standard video formats used in videoconferencing, defined by their resolution. The original CIF is also known as Full CIF (FCIF).

QCIF - Quarter CIF (resolution 176x144)

SQCIF - Sub quarter CIF (resolution 128x96)

4CIF - 4 x CIF (resolution 704x576)

16CIF - 16 x CIF (resolution 1408x1152