FROST & SULLIVAN

USING VIDEO SURVEILLANCE AS EVIDENCE

CAPTURING AND STORING THE BEST VIDEO FOR EVIDENCE

A Frost & Sullivan White Paper

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WHITE PAPER OBJECTIVE

1. Background on the state of video surveillance for the purpose of forensics
2. Evolution and the state of the industry with regard to technology solving the problem
3. Establishing a corrective action for performance going forward

VIDEO SURVEILLANCE HAS BECOME A LIABILITY

CASE 1

It is early morning in a United States courtroom where the judge bangs his gavel, bringing the court into session. The assistant district attorney (ADA) gets up to present his case. His star witness is video from an industry standard digital video system. The ADA plays the video clip to reveal pixilated images of a person that may or may not be the defendant being challenged by the arresting officer to perform DWI exercises on the side of the highway. The defendant's attorney objects to the video being used due to lack of detail in the images, while submitting a motion to dismiss all charges for lack of evidence. The judge agrees, sustains the objection, and dismisses all charges.

CASE 2

Holiday shoppers create a mob scene that force retailers' doors open for early morning bargains, resulting in a store employee being trampled to death in the human stampede. The video captured by the camera above the door will be challenged to provide enough detail to determine who was responsible for removing the hinges on the doors to the store. The video will not reveal enough facial detail to serve as primary evidence in the case. Investigators resort to interviewing individuals' for hours on end, comparing opinions and attempting to thread together the facts. The video captured will be a validating piece of evidence vs. leading and immediate.

CASE 3

A circuit court judge located in the Midwestern United States recently served on an expert panel, in front of a body of professional investigators and first responders. He comments that the court system is "not keeping pace with the changes or the understanding of technology for video surveillance". His current position is that video surveillance is becoming a liability with its present state of capability:

WHAT DOES THIS ALL MEAN TO THE SURVEILLANCE INDUSTRY?

Private Citizens are now challenging organizations like retailers and building management organizations in court, for failing to properly maintain security and/or surveillance systems. The consequence of this is the inability to capture proper detail, leading to arrest and conviction. In other words, if an organization has cameras installed and evident, they have provided "intent" to protect. The public then has an expectation of protection. If this intent exists, there is liability associated with it. The citizens that are taking this position are winning in court.

THE PROBLEM WITH LEGACY SURVEILLANCE SYSTEMS

Users and consultants of video surveillance systems and their design have been attempting to overcome the lack of video forensic detail by saturating the target footprint with grids of cameras. Unfortunately, the intent many times results in ineffective video, and costly capture, transmission, and storage systems.

Most legacy systems globally are analog systems, aided with pan/tilt/zoom functionality intended to provide live and focused views within a region of interest and improve the ability to capture additional video detail. If an organization is fortunate enough to have a monitored video surveillance system, and fortunate enough to capture an evolving event or incident, zooming in on the target may result in pixilation vs. detail to confirm or convict. And in most cases, the natural response in a live event is to pan/tilt/zoom into an area of interest, and if the activity were to be a diversionary tactic, it is now impossible to preserve a file of situation awareness for further investigation. The true incident is prevented from being captured and archived—lost forever.. In a significant majority of investigations, archived video after the fact is searched in a forensic fashion, where pan/tilt/and zoom capability is not an option. Using this tool of investigation, in its present form, results in a low probability of success.

Changing the capture and delivery system of video surveillance has not changed the outcome nor improved the percentage of successful investigations. Since the mid-1990s, convergence network options have been available with video surveillance utilizing Internet Protocol (IP) cameras. The IP camera is a combination of a camera and a computer processor, capturing videos and transmitting IP signals over the network, enabling authorized users to access videos more conveniently locally or remotely. When coupled with Network Video Management Systems (NVMS) software, this video footage can also be used to store, search, and manage surveillance video over the IP network infrastructure. IP cameras have certainly aided in the deployment and flexibility of surveillance systems design and deployments, by sharing the IT network, and by being deployable by way of wireless networks. This flexibility often leads to deployment cost sharing for higher return on investment (fewer dollars dedicated to investigations) and lower cost of ownership (capital budget sharing between the IT and the surveillance departments).

However, the conventional NVMS approach of networking dozens, hundreds, and even thousands of cameras has not proven to elevate the video quality for forensic investigation, and when managing this immense network of content collection (video) the systems often sputter under the load.

The problem remains that as the industry has been involved with iterative technology changes, the users of these systems are not able to depend on video surveillance as *a highly effective and primary tool of investigation.*

DEFINING "PIXELS-ON-TARGET" AS A UNIT OF MEASUREMENT TO IMPROVE VIDEO FORENSICS

Let's approach this problem as a process engineer would approach improving production capability. After all, that's exactly what we want to do with video surveillance, improve the collection of information, minimize the cost of collection and investigation, and add productivity, for the purpose of saving lives and property. If we are able to solve this problem, we can also add functionality to the collection process, such as using a video surveillance system as a business tool for validation of conformance, training and retention, quality, time and motion study.

We'll use the concept of Six Sigma, which seeks to identify and remove the causes of defects and errors in manufacturing and business processes and apply this to the improvement of video content collection and management. Six Sigma uses a process methodology with five steps involved (DMIAC):

- **Define**- process improvement goals that are consistent with customer demands
- **Measure**- key aspects of the current process
- **Analyze**- the data to verify cause-and-effect relationships
- **Improve**- or optimize the process based upon data analysis
- **Control**- to ensure that any deviations from target are corrected before they result in defects

We've **Define**d the problem above. Now we need to turn to identifying the unit of **measure**ment.

CHART 1.1: UNITS OF MEASUREMENT FOR VIDEO SURVEILLANCE

Reference Point	Purpose	Pixel Width x Height	Megapixel Value	
CGA	First standard color computer graphics card 1981	320×200	0.064	
EGA	Computer display standard 1984	640×350	0.224	
VGA	Video graphics array, 1987	640×480	0.3	Standard analog and IP surveillance camera
SVGA	Super video graphics array, 1989	800×600	0.5	
XGA	Extended graphics array, 1990	1024×768	0.8	
SXGA	Super extended graphics array, 1990	1280×1024	1.3	Megapixel consumer and surveillance camera, 327% more pixels than VGA

UXGA	Ultra extended graphics array	1600×1200	1.9	379% more pixels than VGA
QXGA	Quad extended graphics array	2048×1536	3.1	924% more pixels than VGA
WHSGA	Widescreen aspect ratio	4872x3248	15.8	5051% more pixels than VGA

In the digital world, capturing and reproducing images is defined by the pixel. Pixel definition is used broadly by various industries to define the clarity of an image— consumer cameras, television displays and surveillance cameras are measured in this manner. A megapixel is 1 million pixels, and is a term used not only for the number of pixels in an image, but also to express the number of image sensor elements of digital cameras or the number of display elements of digital displays. For example, a consumer camera with an array of 2048×1536 sensor elements is commonly said to have "3.1 megapixels" (2048 × 1536 = 3,145,728). A dot per inch, or DPI, is essentially the same measurement concept utilized in the graphics and printing business.

Now that we can measure, let's **analyze**. A camera is an information capturing device, what we want to define for the purpose of video forensics, is the target. Just what is it that we want to capture? And what level of detail? The logic suggests that the more pixels that we collect, the better the definition of the target. However, collecting more pixels than necessary (cause) will result in wasteful systems design of over engineering network bandwidth, storage devices and similar infrastructure costs (effect).

The best metric to approach this analysis is referred to as pixels per foot; it measures the number pixels being captured by the image sensor divided by the horizontal width of the scene being covered. For example if you're viewing a scene that's 10 feet wide with a camera that has a horizontal resolution of 1000 pixels you would have 1000/10, 100 pixels per foot of definition in the captured image. If we define carefully what we want to capture, say license plates, we have from experience and research measured that you will need approximately 40 pixels per foot to adequately and confidently identify the detail of the fonts for visual character recognition. In order to capture the detail of a face (not to be confused with facial recognition, which is a video analytics capability), it is essential to capture approximately 50 pixels per foot for the purpose of video forensics definition. Now we can design a video surveillance capture device (camera) that is fit for a specific purpose.

CHART 1.2: COMPARISON OF LEVEL OF DETAIL OF FACES AND LICENSE PLATES

Now we are ready to **improve** the video quality captured. When designing a system with the pixels on target concept, we begin with defining what it is we want to capture (see illustration). Add to this, the dimensional references to camera placement, distance to target, height above target, and the width of the target. Once it is understood what level of detail that you desire with a commissioned video surveillance system, and the placement of the cameras from the target, you can set expectations of what exact detail that you will gather prior to the budgeting and procurement of the system. Results are predictable and accurate (see illustration). Some camera manufacturers offer calculators that will identify the camera pixel value necessary for the proper value engineering and fit for purpose application.

E.g. A one megapixel camera might suffice in the lobby of a high school for facial detail, a five megapixel might suffice in the cafeteria to capture the detail and origin of a harassment scene, and a 16 megapixel might suffice to capture the detail of the potential that exists where the children are loading/unloading buses, and where it is desirable to capture license plates of personal cars entering the school grounds. What is additionally beneficial about this methodology is that you can reduce the number of cameras, as you have increased the number of pixels that you are gathering. Reduced installation costs are the result of fewer cameras, fewer line drops, fewer hours of installation, and lower maintenance costs over time.

CHART 1.3: SELECTING CAMERAS BASED ON APPLICATION

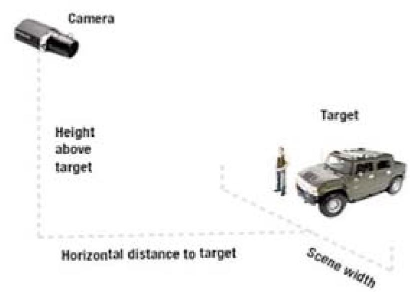
Step 1 - Enter Scene Measurements

Height above target: 20 Feet

Horizontal distance to target: 200 Feet

Scene width: 100 Feet

Horizontal Angle of View: 28 Degrees (°)



Step 2 - Review Camera and Lens Calculation Results

Camera Models	Resolution (Megapixels)	Lens Format	Focal Length (mm)	Pixels/ft	Pixels/m
16MP-HD-PRO-C, 16MP-HD-PRO-M	16	EF	73	49	161
11MP-HD-PRO-C, 11MP-HD-PRO-M	11	EF	73	40	131
4.2MP-HD-PRO-C, 4.2MP-HD-PRO-M	4.2	EF/EF-S	31	20	66
2.0MP-HD-PRO-C, 2.0MP-HD-PRO-M	2.0	EF/EF-S	29	19	62
5.0MP-HD-DN	5.0	C/CS	11	26	85
3.0MP-HD-DN	3.0	C/CS	13	20	66
2.0MP-HD-DN	2.0	C/CS	12	19	62
1.0MP-HD-DN	1.0	C/CS	8	13	43

Step 3 - Select a Camera and Lens

◉ Show camera and lens combinations that give at least 50 Pixels/Foot across the scene width.

○ Show all camera and lens combinations

FROST & SULLIVAN'S ASSESSMENT OF HIGH DEFINITION SURVEILLANCE

High definition surveillance is the future of video surveillance technology. This is the direction the industry is heading. This point is evidenced by the introduction of HD-DSP technology and improvements in compression available for surveillance video. By way of open systems design, encoders that can accommodate any brand of existing asset (cameras), the new generation of NVMS have the ability to enable hybrid systems design and transition from analog to digital and further to HD on your own time and your own dime.

Users can derive very tangible benefits from implementing high definition surveillance systems (multi-megapixel camera systems) such as reduced operating costs, increased ability to use surveillance video for forensics, higher level of detail for advanced video analytics and license plate recognition.

Implementing the right surveillance system for the right application is essential. The most common misconception that prevents systems integrators from recommending megapixel camera systems is the cost of the system. It is assumed that since unit cost of megapixel cameras is sometimes higher than standard resolution IP/analog cameras; the overall cost of the system is higher. However one megapixel cameras can replace multiple IP/analog cameras, reducing the overall cost of surveillance systems.

CHART 1.4: COST COMPARISON BETWEEN IP/ANALOG CAMERAS AND MEGAPIXEL CAMERAS

	No. of Cameras	Cost per Camera ($)	Recording & Management Cost per Camera ($)	Installation Cost per Camera ($)	Installed Cost ($)
Analog Cameras	520	200	500	250	494,000
IP Cameras	520	300	650	225	611,000
5 MP Cameras	33	1,000	1,450	225	88,275
16 MP Cameras	12	10,000	2,450	225	152,100

In the above scenario, a large surveillance system covering a large area, such as a 25,000 square feet parking lot, needs 520 IP/analog cameras to achieve the same resolution of coverage as 33 5MP cameras or 12 16MP cameras.

In conclusion, a note to end users, systems designers, and systems integrator and service organizations: HD surveillance systems have moved out of "niche" into mainstream. Megapixel design can capitalize on application needs particularly in the following vertical applications:

- Education (K-12 and Higher Education Campus Environments)
- Infrastructure (Petrochemical/Water Treatment/Power Stations)
- Government/Defense
- Public Venue (Stadiums/Metropolitan Grids/First Responder)
- Transportation (Rail/Airport/Ports)
- High Value Distribution/Manufacturing (Food Processing/Chips)

High Definition for video surveillance systems is justified as a business tool as well as for the purpose of security and surveillance regardless of application.

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