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The Benefits of IP-Surveillance over CCTV + DVR

1. Introduction:
The past few decades have witnessed market standardization on analog Closed Circuit Television (CCTV) systems. With the advent of the Digital Video Recorder (DVR), CCTV technology has been given a life extension. However, the DVR can only be considered an interim step on the path to a fully digital surveillance solution. The DVR adds some digital benefits to the CCTV system, but its analog cameras and coax transmission network leave the resulting integration largely analog. The focus of this white paper is a comparison of the DVR enhanced CCTV systems (CCTV + DVR) to full digital, or IP-Surveillance, systems. We do not address analog CCTV systems, as they are no longer competitive or effective for new enterprise installations.

2. Evolution of CCTV: Analog to Digital
Early physical surveillance was accomplished by having people standing in position, or patrolling a route to watch particular assets. With the advent of the closed circuit television system (CCTV), a person could be seated at a central location and watch from one to many television monitors to see what was going on. This monitor-only CCTV system was the affordable state-of-the-art technology until the 1970s when the advent of the VCR made recording affordable. For more than twenty years, the VCR-based recording plus monitoring CCTV system was the standard and its functionality became entrenched in the security industry. The dissatisfaction with the VCR-based systems was based on the problems with, and expense in, handling the videotapes. The process of changing the tapes was labor intensive, the tape archives took up valuable real estate, and the tapes degraded over time. In addition, in order to retrieve information from a videotape it had to be rewound and viewed serially. There was no adequate method of indexing to quickly identify and replay a specific recorded event.

In the late 1990s, hard disk drives were used to replace the videotape in the CCTV system, eliminating the magnetic tape problem, but not improving the surveillance methodology. The new black box, called a Digital Video Recorder or DVR replaced the recording mechanism, but guards still had to sit at their monitors and watch. Later in the 1990s, motion detection was added, either to the camera or to the recorder management software, allowing the guard at the monitor to be alerted to motion at a particular camera.

Two forces came together in the late 1990s that would propel a new, more functional surveillance technology. The first was the ubiquitous nature of the IP-based Local Area Network in conjunction with the Internet. PCs, switches, router, storage devices, and software became cheaper. It seems that everyone was on the web. At the same time, Charged-Coupled- Device, or CCD, technology enjoyed a major leap forward driven by the consumer camcorder market. These now inexpensive CCDs replaced the analog tubes in cameras and the digital surveillance camera, or network camera, became economically viable. (note: not all CCD cameras are digital. Signal processing is necessary). Now, a CCD-based surveillance camera could provide a packetized digital video stream onto the LAN via Cat-5 cable. A computer could manipulate the digital video stream, and the data could be analyzed, displayed, or stored using open architecture computer and networking equipment.

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IP-Surveillance, also called Networked Video, is now fully digital. Digital IP cameras have replaced analog cameras, and the analog coax network from camera to recorder has been replaced with IP based, wired or wireless Ethernet networks. The recording medium is now a digital "computer" storage device or format, and the monitor is a standard PC monitor. We are now seeing the rise of this IP-Surveillance technology. Its impact on the security industry is just now being felt. We evolved from feet (actually eyes) on the street, to security personnel seated at monitors (CCTV and CCTV + DVR), to the ability to automate intelligent surveillance. All of the base technologies for IP-Surveillance are standards-based, stable, and subject to Moore's Law. As such, we can expect the cost of the IP-Surveillance to continue to decrease over time.

3. Why the DVR isn't the answer:
Today's Digital Video Recorder (DVR) is widely regarded as a digital device; after all it does use hard disk drives as its recording medium. But the DVR is more complicated. Besides recording the video, it performs the analog to digital (A/D) conversion and compression in an otherwise analog network. It is in fact both analog and digital and is a bridge between the two technologies. The primary defining specification in the DVR is the number of frames per second (fps) that the A/D converter(s) can convert. Typical frame rates for DVRs are 120 fps, 240 fps, and 480 fps. The higher the frame rates, the more video processing power in the DVR, and the higher the cost. These fps numbers are shared across all of the camera inputs. DVRs typically come in multiples of 8, 16, or 24 camera inputs. So a 120 fps/ 16 channel DVR can average only 7.5 fps per camera, although most DVRs allow the user to allocate "bandwidth" to particular cameras at the expense of the remaining cameras.

This frame rate issue is only an objective part of the story. There remains a subjective part as well. Beauty is in the eye of the beholder. Most of the people who behold the digital image from a digital camera feel it has higher fidelity than an image from an analog camera that has been digitized either within a DVR or via a video server. This is due in part to the fact that each network camera performs the A/D and compression functions internally, instead of the DVR performing the A/D and compression for all 16 cameras. The network camera optimizes the combination of the optics, CCD, and Digital Signal Processing to transmit a high quality digital image into a loss-free Ethernet network. The analog system, with its various cameras, and variable coax cable lengths, causes the DVR to digitize suboptimal signals yielding a suboptimal digital image.

Compared to VCRs, DVRs do provide a few of the benefits associated with IP-Surveillance. In addition to eliminating the problems and expense associated with video tapes, DVRs provide easy retrieval of stored images. Many DVRs look to the IP network like an appliance, so access to live and recorded video can be gained via the Local Area Network and, providing the proper network management, via the Internet. However, the DVR is an interim step on the road to an IP-Surveillance system. Besides the number of advantages listed in the next section, IP-Surveillance provides the highest quality images with the highest frame-rates, eliminating the compromises of the DVR.

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4. Growing list of advantages of IP-Surveillance
While some DVRs may be able to provide some of the functionality described below, this list is based on currently available, mainstream systems. These characteristics or capabilities, while possible on some DVRs, are more effective in an IP-Surveillance system.

A. Standards-based Open Architecture
- Inherent cost advantage due to open systems components and architectures
- Interoperable with other network appliances
- Can utilize existing IP infrastructure
- Standard video compression techniques
- Leverage emerging wireless transmission technologies

B. Functional capabilities
- Remote and shared viewing via Internet
- Remote and shared viewing via wireless
- Facilitates Intelligent Surveillance
    - Windows based to integrate with emerging software
        - Facial Recognition
        - GIS
        - Object Recognition
        - License plate recognition
    - Automated alert/response
    - Automated email generation

C. System Benefits
- Scalable – DVR systems must be added in blocks of 16 channels. IP-Surveillance cameras can be expanded one-by-one. Systems can expand with the addition of more disk space and more servers.
- Increased functionality per camera (either at the camera or in management software)
    - Various sensor inputs
    - Relay I/O
    - Motion detection
    - Motion dead areas
    - Selectable frame rates (by event)

5. Cost
The IP-Surveillance system using open standards computing, networking, storage, and monitors has an inherent cost advantage over the single-vendor DVR-based system.

- **Cameras**
  Since the network cameras perform the A/D and compressions functions, they generally cost more than analog cameras. When image quality is taken into consideration, a high-resolution analog camera can still cost more than a network camera. However, the A/D conversion in the DVR degrades the image; so much of the fidelity purchased in the high-end analog camera is lost. Therefore, when high-resolution images are necessary, the digital network camera yields a more cost effective solution.

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- **Transmission Network**
  For new installations, the per foot cost of Cat 5 cable is lower than coax. Additionally, recent price reductions for various wireless Ethernet components make wireless transmission of the digital images practical, especially in difficult camera installations. For example, it is less expensive to deploy wireless connectivity than it is to trench or cut concrete for perimeter camera mounts.

- **Recording**
  It is difficult to compare costs for DVR storage versus computer storage. Generally, the higher the number of cameras, the more cost effective the computer storage. A compelling factor is the lack of scalability of the DVRs, which must be added in 8, 16, or 24 camera blocks. Expanding a 16 camera CCTV+DVR system to 17 cameras requires the addition of another 16 channel DVR, whereas the IP surveillance system can be expanded in single camera increments. The most effective DVR per camera price points occur when all of the channels are utilized. We can also expect the cost of computer storage to continue to drop, whereas the cost of the proprietary, closed system DVRs will remain relatively flat.

- **Monitoring**
  If the surveillance system has a dedicated monitoring station, there is little difference in the monitoring costs between the CCTV+DVR system and the IP surveillance system. Newer DVRs are equipped with network connection, affording them the ability to share their images with PCs on the network. As such, the monitoring costs are similar and not a differentiator.

RMSI's experience indicates in qualitative terms that smaller deployments of less than 24 cameras are more cost effectively accommodated with CCTV + DVR systems. Conversely, larger systems take advantage of the cost benefits already noted and deployments exceeding 64 cameras are typically more cost effective with IP-Surveillance. We have concluded that the crossover price point is dropping rapidly, and with so many variables, it is impossible to pinpoint but it will continue to decrease.

6. IP-Surveillance: beyond parity

A primary theme of this paper is the evolution of CCTV, even with the advent of the DVR, has reached its end. It has provided a bridge from the analog to the digital world. Even the most advanced DVRs offer no evolutionary path as technology progresses. Once installed, the DVR becomes static, unable to adapt and assimilate advancements in hardware and software technologies. IP-Surveillance has become a reality, recently reaching price/performance parity with the DVR in many applications. Since IP-Surveillance is rooted in open and rapidly evolving computing, networking, and communications technologies, it is also rapidly evolving. As advances are made in software and hardware, IP-Surveillance's standards-based open architecture will assure efficient assimilation of the new technologies and capabilities. Once installed, an IP-Surveillance system remains ultimately scalable and upgradeable.

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