Video Surveillance Technology Brief

RASILIENT PixelStor®
Advanced Video Surveillance
IP Storage Technologies

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The Rapidly Changing Physical Security Market Place

Physical security is one of the fastest growing and demanding markets today. Physical security is widely used in transportation, government, financial, education, gaming, and retail among other market segments. The most common tool for physical security is video surveillance technologies.

Video Surveillance and its associated technologies are evolving quickly. This evolution is being driven by the desire to monitor more locations (e.g., more cameras), to see clearer with higher resolution cameras and higher frame rates (e.g., megapixel camera), to automatically analyze large amount of data (e.g., analytics technologies), convert from proprietary analog cameras and networking to IP cameras and networking, to serve large geographic areas (e.g., IP networks), and to manage data effectively while providing longer retention periods (e.g., retain longer with video management).

RASILIENT's high performance IP storage products are being deployed in large and sophisticated video surveillance environments today. From our customer's feedback, we see the need for purpose-built high performance IP storage appliances for the video surveillance market.

We have developed the PixelStor® Big Block Optimized Storage System technologies.

This document outlines the challenges for storage systems in video surveillance environments, and our patent-pending technologies that address these challenges.

Today's Challenges for Video Surveillance

General-purpose storage is inadequate for video surveillance applications. Most storage products are designed for the enterprise IT market, for applications like DB, file and print, email and so on. In IT applications, the traffic patterns are diverse from small to large files, different read write mix, and various sequential and random patterns. Storage products from major manufacturers are especially designed for enterprise DB applications, which is their bread and butter business.

The general-storage systems miss the following video surveillance characteristics:

- Write focus. Data from cameras in the video surveillance is mainly write traffic, typically more than 95% of the time. This is in contrary to general storage, which is normally 70% read vs. 30% write.
- Large blocks for video streams. Each video stream is sequential in nature, and is written into files. The files are generally large and the disk is formatted into large blocks (typically 64kB). While in general storage the file sizes are small and the Hard disk is formatted into small blocks (Typically 4kB).
- Multi- camera video streams and the need for low "cost/camera stream." Due to increasing demand for more and more cameras, the total camera video streams can grow to hundreds and even to thousands. As each file is written in different physical location on disks, the disk heads are jumping around to write to all files concurrently. As a result, the combined pattern becomes random even though each camera video streams is sequential in nature. The typical general-purpose storage system performs poorly in this environment. Because of this problem, general-purpose storage products become very difficult to scale with more cameras, higher resolution cameras and longer retention periods. This results in high cost per camera video streams.
- Assumes IT service model. The IT storage products assume that skilled IT staff is available to install, monitor the health and diagnose problems. The video surveillance market is in rapid

transition for Analog to IP; so this normally is not the case for video surveillance deployments.

- In an IT environment if the storage system takes a long time to write something to a disk, the storage system can signal a "please wait" all the way back to the desk top computer that issued the write and the person simply waits a few seconds longer for the data to be written to the storage product. In the video surveillance environment data is written to disk from a camera. The cameras will output video frames at up to 30 per second. If the storage cannot write the Video to disk fast enough video frames will be dropped. Dropped video frames due to this problem, is common with general purpose storage products.
- Limited storage visibility for multi-stream video. For video traffic, the key question is whether the video frames are saved into the storage system. The NVR software can discard the storage frame for many reasons. The lack of critical visibility results in integration difficulties, especially adding more streams into the system.

PixelStor Advanced Video Surveillance Storage Technologies

PixelStor Advanced Video Surveillance Storage technologies – include the following:

- Advanced Caching for Video Surveillance (FlowThrough® and VAN®) to reduce access latency
- Storage Load Indexes (BusyPlot®) for better system integration
- Linear Stream Scaling Algorithm (StreamAlign®) to improve streaming performance
- Self Healing Technologies significantly reduce maintenance cost and to better serve the video surveillance service model
- Disk drive auto power-down when not in use is a green technology to reduce energy cost
- HA IPSAN for reliable and high available solution

We will focus on the patent-pending FlowThrough®, VAN®, and BusyPlot® technologies in this document.

FlowThrough® Technologies

Resource locking is common programming technique used in system design. It provides the data protection when there are multiple accesses to the same resources. In our case, the shared resources are the cache. For a typical design, once the first request to the resource is granted, the resource is locked, and the subsequent accesses to the same location have to wait. This introduces latency.

RASILIENT's FlowThrough® technology removes all address locking latency due to multiple accesses to the cache regardless read or write. It eliminates the latency completely. The following figures shows the impacts of the FlowThrough® technologies.

All Figures below are taken from the Windows 2003 host. The host runs Milestone NVR software that has 65 IP 4CIF MJPEG CBR cameras running at 30 fps traffic coming in. We intentionally set each stream to be around 1MBps to stress the storage.

The display is from Windows, which captures the following real-time info:

- Write bandwidth to the drives (black)
- Write queue depth (Yellow)
- Read latency (Blue)
- Others (see Figures)

Figure 1 shows the typical outcome of the storage system that does not have cache. We include this figure to be used as a reference point for the typical general purpose storage performance

- Show only 9 MJPEG cameras running at 30 fps with constant bit rate
- Video data being written (in black) frequently goes to zero
- Write cache (in yellow) has frequent spikes
- The above is caused by the storage products inability to keep up with the data coming from the cameras. Video is being lost in this example.

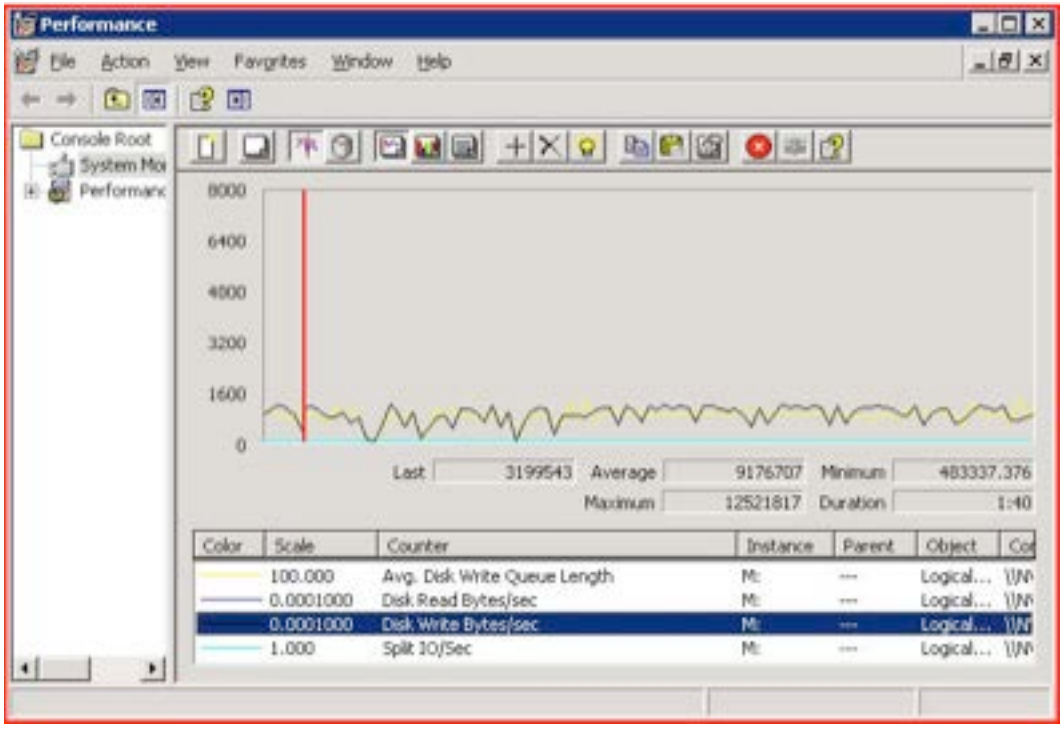

Figure 1

Figure 2 uses the current PS5000 official release software. There are several key discoveries:

- The performance improves from the previous storage example due to our caching algorithms
- However, we also observe that the write bandwidth is up and down. From time to time, the performance would drop more than 50%. The average bandwidth is around 65MBps
- When the performance drop happens, we see large write queue builds up and long read latency

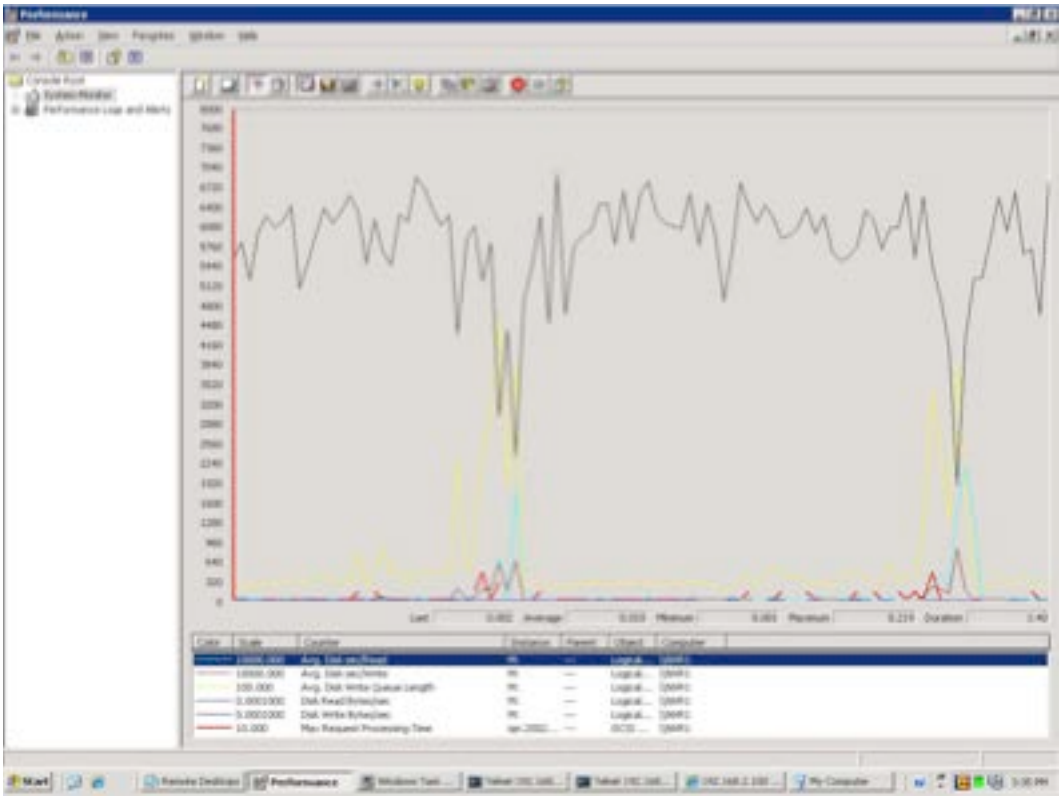

Figure 2

Figure 3 uses the improved Rasilient software with FlowThrough® Technologies. There are several things worth noticing:

- The up and down write bandwidth has been reduced
- The write queue (yellow) is now at zero and is flat
- However, we still see long read latency (blue) happens during the "smaller" dips

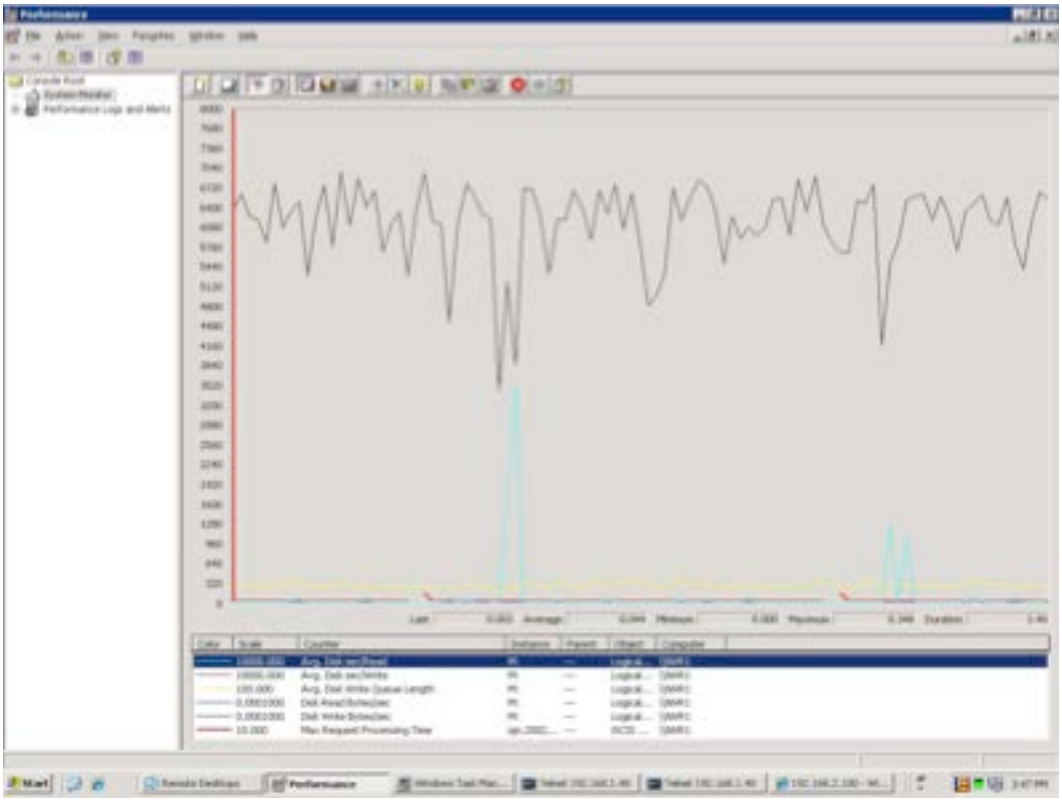

Figure 3

VAN® Technologies

We found that some read latency will have an effect on the NVR write performance. Even though video surveillance uses more than 95% write requests, we see overall performance impact with long read latency. The reason is that some of the NVR write requests will not complete until a read is finished. This is especially true if the read is related to the File System metadata.

RASILIENT's VAN® technologies can capture the per-stream large block pattern as well as the small block metadata under mixed traffic condition. With this capability, the system can treat each case differently. With VAN technologies, we can continuously feed large, sequential video data blocks down to the storage RAID layer. This process is extremely efficient.

Figure 4 shows the result by speeding up the small-block metadata for read.

- When this is done, we see the following:
- The performance dips have nearly disappeared.
- The overall write bandwidth performance increases (virtually zero video frames lost at NVR). The top line can go up to 73MBps
- The read latency has been eliminated. We believe some writes were held waiting for read IO to complete and VAN eliminates this problem.

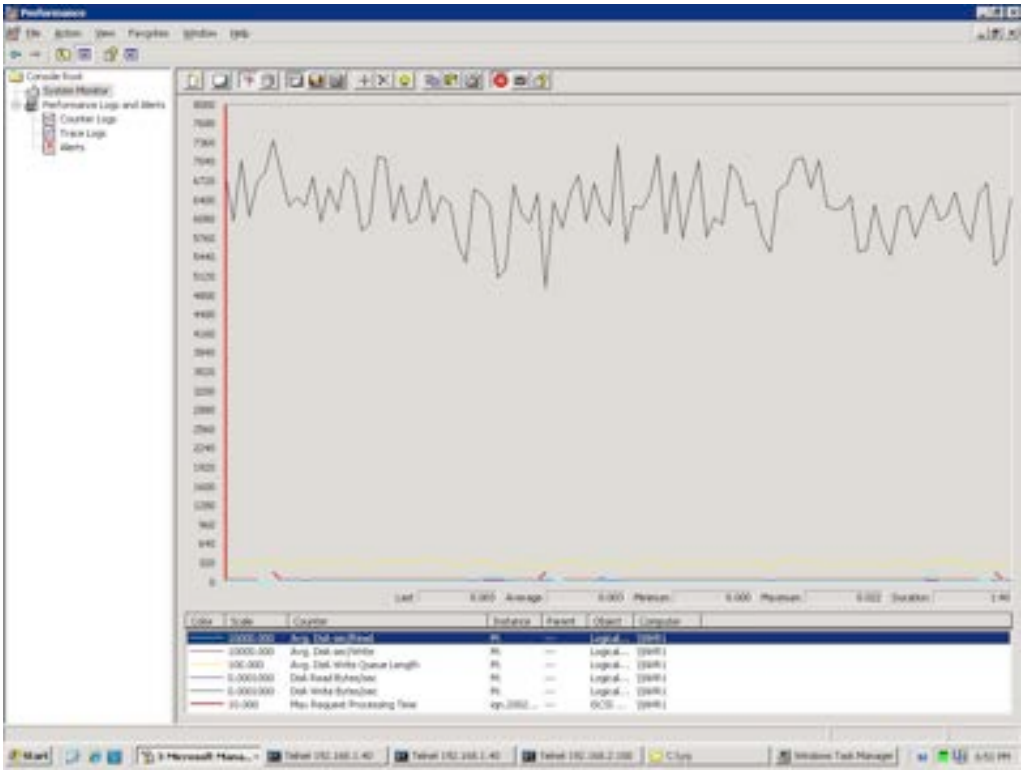

Figure 4

With the improvements, the performance is now limited by the Windows host. We added two additional hosts and NVR. With full FlowThrough® and VAN®, we can achieve around 240MBps per controller in our IP Storage Appliance. This equates to 240 IP 4CIF MJPEG CBR cameras running at 30 fps.

BusyPlot® Technologies

Integrating a SAN product with an NVR/DVR is not a simple task. It is difficult to know if optimal performance is being achieved. When things do not work correctly, or performance is poor, the problem can be caused by a number of difference sources including the host computer, the NVR/DVR application, the networks, or the storage. Without the visibility into the system and proper tools, the source of the problem is nearly impossible to find, to trouble shoot and correct.

Today's NVR/DVRs provide very little information about its actual performance and how well it is storing the video information. This is also true for the storage products; there is no Storage product today that provides this kind of visibility in video surveillance applications.

When an NVR/DVR cannot store video fast enough it will discard frames, we need tools to know why the NVR/DVR cannot store fast enough and whether it is due to lack of NVR compute power, network bandwidth, long latency, or storage performance.

The Rasilient PixelStor BusyPlot® is a suite of tools to diagnose these challenges; one of which can display the IO performance (read and write) that the storage fails to handle during the selected periods. We can then identify any hot spots on the storage, and the conditions that create them.

With this level of visibility, the application developers can tune their software for higher performance, and the system integrator can select a higher performance server, reduce the number of cameras, frame rate, or camera resolution.

Conclusion

This technology brief describes the challenges of using general-purpose storage system for video surveillance. RASILIENT's patent-pending technologies such as FlowThrough®, VAN®, and BusyPlot® were introduced to break through these challenges. We provide significant performance gain, which results in lower cost.

Furthermore, RASILIENT addresses the storage visibility issue when NVR is integrated with an IPSAN. The specific "load" indexes allow the application developers to easily tune their software, and the system integrators to select best configuration and hardware for their video surveillance environment.