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Video Surveillance White paper Series

***Video Storage
A formidable challenge for
NVR and DVR***

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Contents

NVR and DVR evolution and technology3

Are NVRs and DVRs up to today’s booming storage demands?3

 Increasing retention periods4

 Storage capacity.....4

 Storage scalability.....5

 Shared storage5

 Performance6

 Reliability7

Rasient Solution7

 High capacity and highly scalable7

 High performance7

 Highly Available8

 Simple to use and install9

 Shared storage for NVR/DRV storage consolidation.....9

Summary.....9

NVR and DVR evolution and technology

Video surveillance is in a state of evolution. Only a few short years ago Video Surveillance was being recorded on a VCR with very low resolution cameras. There are probably still a few banks and casinos using VCRs.

The next technology step was to Digital Video Recorders (DVRs) and there are still a larger number of DVRs deployed today. Digital Video Recorders use analog cameras to capture the image and store it digitally on an internal hard disk in a proprietary system. This gave a huge improvement in video quality and retention periods.

Now, DVRs are the old technology and are being replaced in larger applications by Network Video Recorders (NVRs). NVRs are usually PC server based with 1 to 4 internal hard drives and use windows OS typically XP or server 2003. They support IP cameras and offer much better performance than DVRs.

The difference between a DVR and NVR is:

- DVRs typically support Analog cameras only while NVRs support IP Cameras and some still support analog cameras
- DVRs typically support 8 to 32 analog cameras while NVRs typically support 64 or more IP cameras
- The Frames Per Second (FPS) Total for a typical DVR is 64 and max is 480 and for a NVR typical is 300 and max is 2,000
- The FPS per camera for a typical DVR is 4 and max is 30 and for a NVR FPS typical is 10 and max is 60+
- The resolution FPS per camera for a typical DVR is 320 x 240 and max is 640 x 480 and for a NVR typical is 320x240 and max is 2,500 x 1,600

NVRs are taking over a larger percentage of the new deployments, while DVRs are still being used in small locations.

Cameras are rapidly changing too! They are migrating from analog to IP based cameras. It does not make economic sense to have IP (Digital) cable and analog coax cable run in the same conduit going to the same places. This also requires that support groups, IT and security departments manage and support the 2 different technologies. IP cameras can use the existing IP infrastructure. This significantly reduces the cost of management, deployment and the infrastructure of the Video Surveillance system.

Are NVRs and DVRs up to today's booming storage demands?

There are many examples of crimes committed which are captured by a Video Surveillance camera. The problem is the image quality is so bad or the frame rate so low that the criminal cannot be identified. This poor image quality is due to poor camera resolution. Camera technology in this respect has changed significantly in the last few years. The camera resolution has increased by leaps and bounds. Megapixel cameras are becoming common place. Part of this push for higher resolution is consumer cameras. Today you can buy a 10 mega pixel camera today for under \$200. While a similarly

priced surveillance camera only supports 1.3 megapixels. Video surveillance consumers are demanding that their cameras track with the consumer camera market.

Increasing retention periods

A few years ago retention for a day was the norm and that has changed to today where it is more typical to see 2 weeks to a month of retention. After 9/11 everyone has become much more security minded. City, States and governments are mandating longer and longer retention periods for the Video Surveillance data. You can find retention periods as much as a year now with these new government requirements.

The combination of rapidly increasing resolution and retention periods is increasing the demand for significantly larger storage.

Storage capacity

Today’s NVRs and DVRs are not up to the challenge of higher resolution cameras and much longer retention. They do not provide the capacity or scalability required in the modern video surveillance market place.

A NVR today is typically a Microsoft Windows based server that can support up to 4 hard drives. This will provide a maximum 4 TB of storage. A DVR will offer even less capacity. Once configured the NVR and DVR cannot be increased in capacity.

Camera resolution

	User type	Resolution	Compression	FP/s	Days	Cameras	Bandwidth Mb/s	Storage TB
1	Low end	352x240 CIF	MPEG4	15	14	20	7	1
2	Mid range Typical	704x480 4CIF	H.264	15	14	20	9.4	1.4
3	Mid range Typical	704x480 4CIF	MPEG4	15	14	20	28.1	4.2
4	Mid range Typical	704x480 4CIF	MJPG	15	14	20	119	17.6
5	Mid range Typical	1280x1024 1.3MP	H.264	15	14	20	39	5.9
6	Mid range Typical	1280x1024 1.3MP	MJPG	15	14	20	464	68.5
7	High Performance	2048x1536 3MP	MJPG	15	14	20	900	132.9
8	Very high Performance	2048x1536 5MP	MJPG	15	14	20	1451	214

The above table illustrates how increasing resolution affects the amount of storage needed in a typical installation.

The only value that changes row to row in the table above is the resolution and compression type of the cameras. Row 1 shows CIF 352 x 240 resolution and 2 weeks of retention only generates 1 TB of stored video. This is easily handled by today’s NVRs. As the resolution grows the storage requirements grow significantly. The storage quickly

outpaces the capacity of a typical NVR/DVR with the limit of 4 TB of storage. This limit is easily passed in row 3 with 4CIF MPEG4 which consumes 4.2 TBs of stored video. In the highest scenario (row 8) with very high resolution the storage requirement will be 214 TB.

It is important to show how each row fits in today's world of VS. The first row using CIF resolution and MPEG4 compression is the least demanding scenario but is slowly dying out and is only used in older DVR installations. The next three rows using 4CIF with H264, MPEG4 and MJPEG are most commonly used today. The 1.3MP (rows 5 & 6) are becoming more and more popular in highly demanding video surveillance areas. The last 2 rows illustrate the highest technology available today. Most people would not use the retention period or frame rate that is selected as it requires a significant amount of storage.

H.264 is the latest MPEG standard for video encoding. H.264 is expected to become the video standard of choice in the coming years. This is because a H.264 encoder can, without degrading image quality, reduce the size of a digital video file by more than 80% compared with the Motion JPEG format and as much as 50% more than with the MPEG-4 standard. This means that much less bandwidth and storage space are required for a video file. This is clearly illustrated in the two rows that include H.264. It is important to note that only a quarter of the new cameras support this compression and it will take time to see wide spread deployment.

It is clear from the above discussion that NVRs and DVRs do not provide sufficient capacity for medium to large video surveillance solutions and cannot meet the ever increasing resolutions and storage needs of the future.

Storage scalability

Increased retention periods have the same effect as increased resolution. If the retention period doubles, the amount of storage requirement will double too. For example in the first example (row 4), the storage requirement will increase from 17.6 to 35.2TB. This multiple increase is the same for all of the other examples.

To meet the scalability needs, the vendors will just push more NVR/DRVs instead of providing a means to increase storage for the servers.

It is clear from the above table that NVRs and DVRs do not provide sufficient capacity sufficient capacity and will not provide scalability for future expansion as will be illustrated in the following.

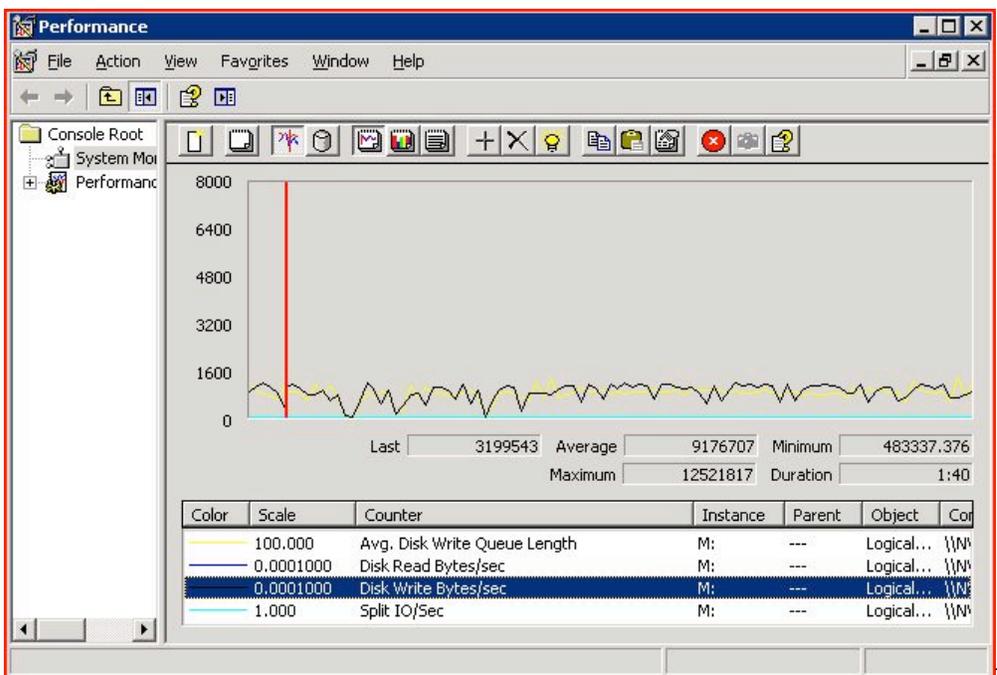
Shared storage

If you want more cameras, higher resolution and/or longer retention period you must buy more NVR/DVRs to add more storage capacity. All of the storage for a typical NVR/DVR is contained within the NVR/DVR itself and cannot be expanded or shared. Shared storage is one common storage pool that many NVR/DVRs can share, for all of their storage needs. NVR/DVRs have no concept of shared storage.

Performance

Most NVR/DVR storage is optimized for IT data and is not tuned for the video surveillance environment. One of these differences is the way that NVR/DVR writes the camera data to disk. The data is very random and the internal storage has a very difficult time dealing with this type of data. A typical storage system can only support 10MB/s or less in a Video Surveillance work load. This means that fewer cameras can be supported per storage device. If the storage is being overwhelmed, video frames are lost. Most NVR/DVR will not even issue an alert that this is occurring. Users will only know this has happened when they need to retrieve critical video information and it is not there.

Below is a trace that graphically illustrates the poor performance internal storage provides. This test is using well known NVR software. There are 10 cameras running 30 fps, CBR, 4CIF and MJPEG. The black line is the write speed to disk (9.1MB/s) and the yellow line is the disk write queue. The yellow line should normally be at zero. As you can see the internal storage is struggling to keep up with the cameras. When a trace looks like this with the yellow line spiking and crosses the black line, there are frames being lost. Frame loss is a very bad thing in the video surveillance world and is more common than you would think. Adding to the problem the NVR/DVR vendors do not provide statistic or alerts to let the user know there is a problem.



NVR vendors do not provide procedures to optimize the storage which further adds to the problem.

Another challenge for storage products is that cameras do not wait, if the storage system takes longer to write part of the data, the video information is lost. This typically happens over time as the file system gets fragmented. The more the file system is fragmented the harder it is to store the data and more video frames will be lost.

Reliability

Most NVR and DVR vendors only provide internal hard drives for VS storage. This offers the most control and revenue for the NVR vendor. Unfortunately for integrator and the end customer, the NVR vendors are not storage experts and they do not focus on the storage portion of their solution. They focus on video surveillance capabilities and features. This is in spite of the fact that the storage portion of video surveillance solution typically is greater than 40% of the total cost.

There are many drawbacks to internal NVR storage. In addition to the limited capacity as stated earlier, there generally is no protection if one of the drives fails. If a drive fails the video surveillance data will be lost due to the lack of protection. If protection is provided the NVRs will only support RAID 1 which requires all of the data to be duplicated; this doubles the space needed for data. This means that a 4 TB NVR can only support 2 TB with protection. Even in advanced systems where RAID 5 is provided, if a drive fails, video will be lost due to frames being dropped as the storage gives priority to rebuild the failed disk and puts the video storage at a low priority.

To make matters worse, the NVR/DVR vendor to reduce cost will use low quality desk top hard drives. Since there is very little storage and the performance to the disk drives is slow, an NVR/DVR is limited in the number of cameras it can support.

It is clear that today's NVR/DVRs do not provide the reliability needed in a modern video surveillance solution.

Rasilent Solution

Rasilent products are custom built and tuned for the Video Surveillance market.

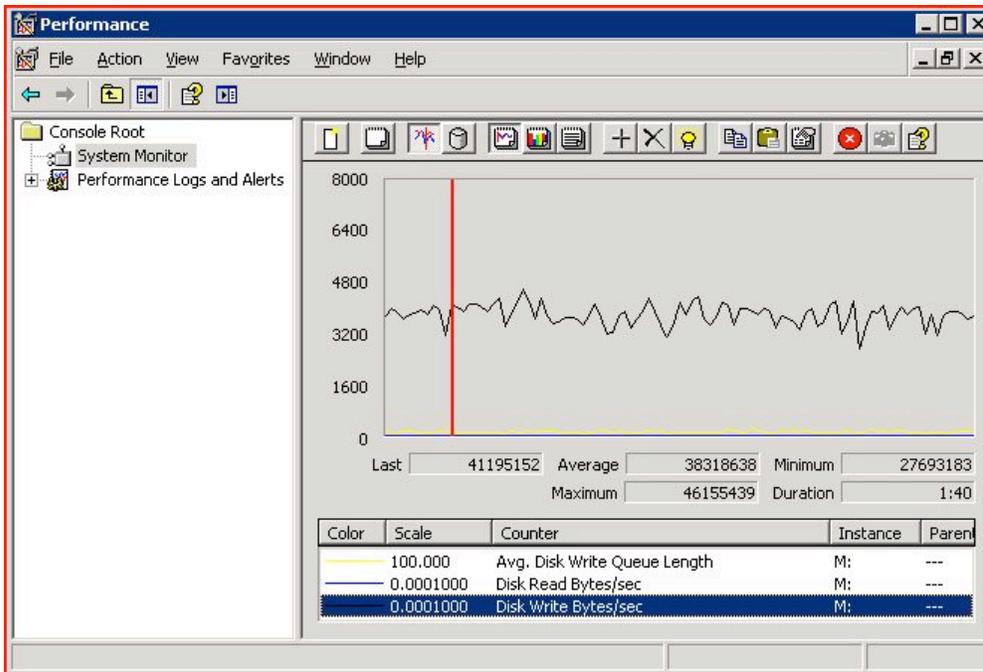
High capacity and highly scalable

Our products provide high capacity and are highly scalable; starting at as little as 9TB and can grow up to 84 TB. If you want to add more cameras, change to higher resolution cameras or increase retention periods it is very simple to expand in a Rasilent IP storage product. Rasilent's storage products ability to grow makes them much more future proof.

High performance

Rasilent products are optimized for Video Surveillance applications to support hundreds of cameras. Rasilent accomplishes this with an advanced caching algorithm specifically tuned for the video surveillance work load.

To illustrate this, the trace below uses all of the parameters as used previous trace except we are using the Rasilent 7500 IP storage product instead of the internal NVR storage and have increased from 10 to 40 cameras.



As you can see the storage is performing very well. The yellow write queue line is at zero where it should be and there is no frame loss taking place. Because of Rasiliant's advanced caching algorithm the write performance is an incredible 4x faster (38.3 MB/s) than the typical NVR internal storage. Rasiliant gives you the peace of mind that your video is not overwhelming your storage and video is not being lost.

Highly Available

Rasiliant only uses the highest quality enterprise class hard drives. This significantly improves the reliability of the storage systems.

Rasiliant products support both RAID 5/6. In the case of RAID 5 one disk is used to protect against a single failure of any of the drives. This drive is generally referred to as the parity drive. In the case of RAID 6 two disks are used to protect against two failures of any of the drives. This grouping of disk drives (RAID Disk Group) generally will be between 12 and 14 disk drives. So, in the RAID 5 case only 7% and RAID 6 case only 14% of the total disk space is used for protection. This is much more efficient than RAID 1 which requires doubling of the disk drives or 50% of the disk space is used for protection. If protection is provided by the NVR/DVR it will typically be RAID 1.

Rasiliant also offers a global sparing. Any drives not assigned to a RAID disk group are automatically used as global hot spares. If a drive fails, the RAID controller can automatically rebuild its data on the spare drive without requiring intervention by the administrator. The rebuild operation occurs in the background while the controller processes normal operations.

All Rasiliant products can be fully redundant. Any fan, power supply, controller or disk drive can fail and the system will recover from this failure without user down time.

Few if any of these High Availability capabilities are offered in the NVR/DRV products.

Simple to use and install

All Rasilient products have a simple and intuitive GUI. It provides a simple 6 step process to configure and install in less than 15 minutes. This is provided so that costly IT personnel are not needed for the installation of this product. Rasilient also offers a best practices guide to optimize performance and to further simplify installation.

Shared storage for NVR/DRV storage consolidation

Rasilient's shared storage solution provides a simple way of adding more cameras, increasing camera resolution and increase retention periods.

With Rasilient we offer shared IP storage. This means that all NVR/DVRs can share the Rasilient IP product as a single storage pool. This is:

- Much more efficient
- Highly reliable
- Lower total cost
- Much easier to manage
- Lower administration costs

It is very easy and cost effective to expand Rasilient storage by adding an expansion enclosure. This provides a fast and easy way to:

- Increase resolution
- Add more cameras
- Increase retention periods

This also provides protection in the future when there are new technology advances in the cameras and NVR/DVRs. All of this adds up to lower CAPEX and OPEX costs.

Summary

Rasilient System products are optimized for the Video Surveillance market place. We offer:

- Capacity that is the right size for medium and large size surveillance network
- The scalability to match the growing retention periods, rapid increasing camera resolution and increasing numbers of cameras needed today and tomorrow
- Performance with Rasilient's advanced caching algorithm keeping pace with the highest performing cameras and heaviest of camera load
- High Availability to ensure that Video Surveillance does not stop and is not lost due to any storage failures
- Simple to use, so that highly trained IT personnel are not needed to operate and install
- Provides storage consolidation greatly lowering CAPEX and OPEX costs

Rasilient Systems provide a high performance, scalable, high capacity and cost effective IP storage solution for all video surveillance needs.