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WHITE PAPER

Hitachi Video Management Platform

The Most Viable Converged Solution for Video Security and Monitoring

By Hitachi Insight Group

August 2016

Contents

Executive Summary

Advances in technology over the last 30 years have transformed the video surveillance industry. The first solutions, based on CCTV, were analog and used video cassette recorders connected to cameras at the end of coaxial cable. Each camera was assigned a dedicated physical connection, limiting the ability of these systems to scale, and with obvious implications to running large amounts of coax cable within the monitored environments.

The move to DVR (digital video recorder) technology solved many of the issues experienced with tape-based VCR systems, which included the need to manually monitor the replacement of tapes themselves. DVRs improved the recording process; however, the move to Ethernet networks for connecting cameras to servers running video management system software, really transformed the industry. IP-based connectivity allowed for data to be passed over shared physical network infrastructure (much of which could already have been in place) and for operators to take direct control of cameras. This changes the ability of systems from a static to much more dynamic mode of operation, as system operators could zoom, pan and tilt cameras, receiving both video and audio data.

Today's video systems go far beyond traditional surveillance: They enable advanced video analytics, image processing, and real-time intelligent machine monitoring and alerts. These applications demand consistent high-quality real-time and recorded video, so modern video management systems need to be fast, reliable and never lose a frame. Designing the infrastructure for modern video security and monitoring systems requires an understanding and focus on the issues of dealing with large volumes of sequential streamed data. I/O profiles are typically 90-95% write, with only a small amount of sporadic read activity (typically replaying content). Over time, video data ages and becomes less frequently accessed, allowing it to be archived to cheaper storage media. This means systems need to be capable of implementing efficient tiering processes. Finally, there are requirements of scalability. Adding cameras to a video security and monitoring system increases the number of servers and storage capacity needed.

Hitachi Video Management Platform (VMP) is a comprehensive solution, architected with the needs of modern video security and monitoring. Storage is provided by the trusted and highly available Hitachi Virtual Storage Platform (VSP) G series. Rack optimized server for solutions options, offered by Hitachi, run industry-standard VMware vSphere, to provide the ability to run video security and monitoring software as virtual machines. Virtualization provides the scalability to increase system capacity on-demand as requirements grow over time.

Data management functionality is provided within VSP. Storage can be tiered, using Hitachi Dynamic Tiering. This can be used to automate the archive of data from high-performance to high-capacity storage.

Hitachi packages the entire solution as a converged appliance, including all hardware and software licenses [including video management system or (VMS) software]. As a converged offering, Hitachi includes software to manage the entire infrastructure and has validated the capabilities of the system to scale to the capacities quoted. As a standalone solution, VMP makes it easy to meet compliance requirements, while being as easy to manage as a traditional data center infrastructure.

Introduction

Objective

This white paper looks at the evolution of video security and monitoring technology and how Hitachi Video Management Platform (VMP) has been designed from the ground up to meet the challenges of data storage and processing that new video systems present. The paper provides background on the features expected of modern video technologies, with a deep dive into VMP, including product specifications.

Audience

Decision-makers in security teams looking to deliver highly efficient video security and monitoring solutions will find the content of this report provides detailed background and information on positioning VMP against other products in the marketplace. The document also offers some background for storage administrators looking to understand how the VMP solution integrates with Hitachi storage offerings.

Contents of This Paper

- **Executive Summary** – a summary of the background and conclusions of this white paper.
- **Evolution of Video Surveillance** – a discussion on how video technology has evolved and developed.
- **VMP Architecture and Deep Dive** – an in-depth review of the Hitachi Video Management Platform.
- **VMP Offerings** – details of the hardware solutions offered by Hitachi.
- **Conclusions** – a summary of the findings and observations in this white paper.

Hitachi Video Management Platform (VMP) has been designed from the ground up to meet the challenges of data storage and processing that new video systems present.

Evolution of Video Surveillance

Video surveillance, or more specifically video management systems (VMS) have been in existence for over 30 years. The technology started out with implementations that were initially fully analog, as CCTV (Closed Circuit Television) solutions that connected analog cameras to video recorders using coaxial cables.

Early systems were clearly limited by their physical attributes. These included the need to run dedicated cabling for each camera into the recording device, the use of tape media, and the quality of the video images themselves. Early solutions weren't scalable from either a hardware or management perspective. Tapes in VCRs had to be changed manually and if not regularly monitored could result in the loss of data if the tape reached the end before replacement. VCR tapes were never really designed for heavy usage and so would have a tendency for the recording quality to deteriorate over time. Of course it was also very easy to misplace, overwrite or damage tape media, with significant effort required to keep media in order and re-used on a structured basis.

Analog systems suffered from many other issues. Analog video management implementations scaled at best to 16 cameras and eight hours of (uncompressed) video. There were no analytics options for looking at content itself, and each feed would either require a dedicated or shared cathode ray tube (CRT) screen, with no multiple window or split feed views.

Digital video recording (or DVRs) provided a great leap forward for video surveillance. Now data could be digitally recorded onto hard disk rather than tape, providing a more reliable and consistent media. However, initial products were hampered by the capacity of hard drives, which meant solutions had poor bandwidth, frame rates and image resolution.

As DVRs transitioned to using IP networks, cameras, recording devices and replay of video could all be achieved over the network, making the deployment of video surveillance solutions much easier. Data could use either existing or dedicated Ethernet infrastructure. Video encoders provided the ability to mix analog and digital systems. These devices take input from analog (coaxial) based cameras and translate it into a digital feed. This approach made possible the reuse of existing camera technology as systems transitioned from analog to digital recording. Displays transitioned from CRT to digital monitors, making it easier to see multiple images on the same physical screen.

IP connectivity provides both a data transport and control mechanism. Modern cameras support the ability to both receive video and audio feeds and to control the position of the camera through features such as tilt, pan and zoom. Cameras can detect (and record) on movement in the recorded data as well as perform analytics such as facial recognition.

As technology has improved, todays video surveillance professionals are less concerned with the physical aspects of implementing monitoring solutions and are able to focus on more important features, such as the quality of images, retention and access policies. This means not just who can look at recorded video, but also who has permissions to control cameras in operation. Modern security and IT professionals are also focusing on what can be done with the video data itself: everything from supporting automated monitoring and alerts to gaining insights from video analytics and image processing. These innovations in video analysis and technology have exciting applications far outside traditional surveillance. They are being used to optimize factory processes to ensure quality control, count crowds for building and transportation management, analyze shopper preferences in retail environments, or automatically alert users if a boundary has been crossed. Because of these innovations, even the name "video surveillance" no longer encapsulates the tasks that many of these systems are employed to perform; many industry players are changing to "intelligent video" or "video security and monitoring," which we will use to describe these systems throughout the remainder of this paper.

Modern systems are based around a "master server and archiver" architecture, with Microsoft® Windows® the dominant operating system platform. Companies such as Milestone, OnSSI, Genetic, Verint and NICE Systems have emerged to deliver VMS solutions that take advantage of this new architectural design. End users access systems through client software installed on their local desktop, providing more a scalable solution compared to the original VMS technology.

Today's video security and monitoring environments look more like traditional IT infrastructure. Video applications run on virtualized servers that enable systems to more easily scale than could be achieved when components such as archivers and master servers were bound to physical hardware. Video security and monitoring solutions benefit from the typical efficiencies that come with using platforms such as VMware's vSphere. Server hardware utilization increases and significant savings can be made from reducing the space, power and cooling hardware footprint in the data center.

The improvements that have been achieved in recording technology mean any solution must be architected to meet the demands of streaming, recording and managing large volumes of data. Without proper design, systems won't scale, resulting in poor performance or worse, frame and data loss.

Modern security and IT professionals are also focusing on what can be done with the video data itself: everything from supporting automated monitoring and alerts to gaining insights from video analytics and image processing.

VMP Architecture and Deep Dive

System Requirements

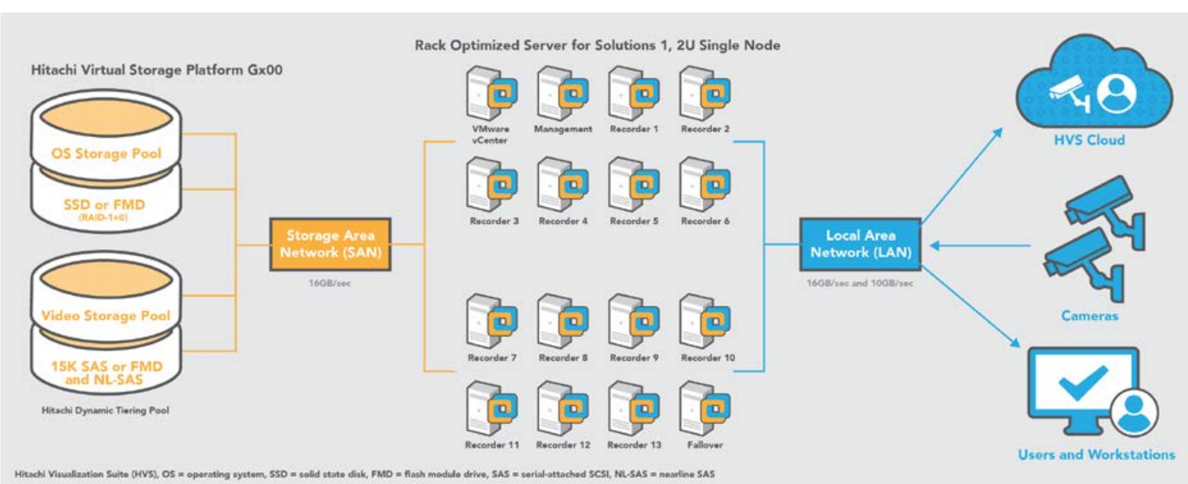
Hitachi Video Management Platform is a converged hardware and software solution that has been specifically architected for managing video data. The I/O profile of data streamed from IP cameras is very different from traditional OLTP and batch workloads that are managed in the typical IT organization. This means that each component of a video security and monitoring solution must be designed with these requirements in mind. Some specific issues include:

- **Data rate:** Modern cameras now are equipped with 5 megapixels and up with higher bandwidths. The amount of bandwidth required in a solution will scale with the number of cameras (and data streams) being processed.
- **Random I/O profile:** Each camera in a system will produce data at a different frame rate, based on the capabilities of the camera and the activity being recorded. Cameras watching (for example) a busy traffic intersection will stream more data than one monitoring access to a building. The result is that the stream seen by the recorders will be a mix of effectively random data.
- **High write profile:** Cameras continually produce data that has to be recorded to disk; however, access to the content is only possible after some specific event occurs. As a result, I/O can be 98% write and 2% read, with read activity being sporadic or spiky.
- **Video data can be highly fragmented:** Over time, video is groomed or erased, and storage can become fragmented, resulting in poor performance compared to contiguously allocated files.
- **Archiving capabilities:** Some VMS software vendors implement data tiering or archiving within their application. Others assume the underlying storage platform will manage the performance of data using features such as caching active files.

The architecture of Hitachi VMP is shown in Figure 1.

The key components include: server virtualization through the VMware vSphere platform; storage provided by Hitachi Virtual Storage Platform G series systems, including VSP G200, VSP G400, VSP G600 and VSP G800; and dedicated networking.

Figure 1. Video Management Platform Architecture



Virtualization

Server virtualization is implemented using the VMware vSphere platform. The use of vSphere provides key features of the architecture, implementing high availability, redundancy and scalability for the software components at the heart of the platform. Virtualization allows the individual software components (such as recorders) to be implemented as virtual machines and scaled accordingly. As more logical server capacity is required, additional VMs can be created and brought online. The use of server virtualization removes the operational effort associated with creating and deploying new physical hardware, as would be the case if individual components were running on dedicated physical infrastructure.

The ability to use virtual deployments of the VMP software components is achievable because of the continuing increasing in processing power we see in the server market today. The amount of data produced by a 1600 x 1200 2-megapixel camera, which is a standard high-quality device, hasn't changed much over recent years. This means video security and monitoring software can be supported on virtual environments where previously dedicated infrastructure would have been required.

VMP uses rack optimized server for solutions from Hitachi. These solutions are available as either a 2U single node or 2U four-node configuration. All servers ship with the latest Intel Xeon processors and up to 24 DDR RDIMM modules.

Storage

The storage component of VMP is delivered through a dedicated storage area network (SAN) using Fibre Channel switches. Hitachi VSP (provides the storage capacity, which is tiered into two pools: faster disk storage for initial storage of data and a second capacity tier for archiving of video content over time.

The use of Fibre Channel as the back-end storage network between the virtual infrastructure and storage provides two benefits. First, it offers a lossless, high-capacity, high-performance and low-latency network compared to using iSCSI and Ethernet switches. Second, the use of Fibre Channel host bus adaptors (HBA) offloads significant processor overhead from the server infrastructure compared to running iSCSI software-based adaptors, in some cases reducing processor overhead by 10%.

There are specific design points that need to be considered in ensuring the correct back-end storage solution is used for video content.

- **Data protection:** Video data has now become a data asset to many organizations. As a result, this data needs to be protected effectively. At scale, with the large capacity of modern drives, dual parity protection (RAID-6) is the best choice to balance both performance and resiliency. This is the protection level recommended by most VMS companies. Other protection mechanisms include RAID-5 (not resilient to multiple disk failures) or RAID-10 (data mirroring), which has a low effective capacity (50% of the physical capacity).
- **Disk throughput:** Storage performance can easily be affected by the block size used to store data. Larger block sizes typically provide better throughput for video content and result in the need to install fewer physical disks to manage the throughput rate of what is essentially write-intensive I/O. Hitachi's VMP uses a 512KB block size.
- **Storage capacity:** Modern IP-based security and monitoring cameras use data compression technologies (like H.264) to reduce the amount of data transmitted across the network. The degree of compression is dictated by the level of activity in the stream; active streams (like road intersections) generate more data than static views (such as monitoring a building access point). Tools are available to assist in calculating storage capacity requirements, based on estimating the type of traffic for each camera, rated by manufacturer, model, activity, image quality and recording time.

Hitachi's VMP solution optimizes storage by using two tiers of disk capacity. Video data is initially written to a pool [known as the live database (DB) pool] of fast disks that are capable of managing the high write I/O throughput rates. This tier also supports live viewing of video content without compromising on the constant write activity. Over time, data is migrated to cheaper NL-SAS drives in the archive pool that has a better cost-performance profile for more inactive data. As files are moved down to the archive pool, the data is written contiguously, to reduce the impact of file fragmentation.

Figure 1 highlights the use of dedicated storage pools for incoming video streams and archived data. Hitachi Dynamic Tiering (HDT) on VSP ensures that data is placed on the most cost efficient and performing storage for I/O requirements as the video data ages over time.

Networking

IP networking is implemented using either 1GbE or 10GbE connectivity, depending on the bandwidth required (based on the number of cameras supported). The use of 10GbE provides both lower latency and higher throughput compared to 1GbE solutions. Physical ports on each server will be dedicated to management and vSphere vMotion [to manage virtual machine (VM) migration within the solution], with the remainder dedicated to servicing incoming video traffic. Typical 2-megapixel cameras will produce between 1.5-2.0Mb/sec of throughput, which means the customer's local area network must be capable of supporting the number of cameras expected to be deployed in the solution.

Standardization

VMP uses standard Hitachi products: VSP for storage, rack optimized server for solutions and industry-standard IP and Fibre Channel networking. As such, VMP can be managed and operated by traditional IT teams. However, as a converged platform, Hitachi integrates the components into a single solution that doesn't need expert skills to administer. Deployment as a converged solution means VMP can be segregated from a business as usual infrastructure in the data center, meeting the needs of data compliance regulations.

VMP Offerings

Currently three Hitachi Video Management Platform solution options are available depending on the scale of requirements, as shown in Table 1 below. The VMP 150 entry model supports up to 300 2-megapixel cameras at 30 frames per second (FPS). The VMP 500 supports up to 1000 2-megapixel cameras at the same frame rate. The VMP 1000 supports up to 10,000 2-megapixel cameras. Each model varies in the number of physical hosts, storage and networking deployed in the solution.

Table 1. Hitachi Video Management Platform Models and Capabilities

VMP 150	
Capacity	Up to 300 2-megapixel cameras at 30 frames per second (FPS)
Server Hardware	Two rack optimized server for solutions models, with a maximum of two hosts supported
Server Processors	2x Intel Xeon E5-2620 V3 6-core 2.4GHz processors per host
Server Memory	64GB DRAM per host
Server Networking	6x 1GbE or 4x 10GbE Ethernet NICs per host
Server Storage Networking	2x 8Gb/sec Emulex Fibre Channel (FC) host bus adapters (HBA)
Server Local Storage	2x 300GB 10K 2.5" serial-attached SCSI (SAS) drives
Storage Networking	Brocade 320 or Cisco MDS 9148S Fibre Channel switch fabric (dual redundant fabrics)
External Storage	VSP G200, VSP G400, VSP G600 and/or VSPG800 with up to 16.3PB of storage
Hypervisor Software	VMware vSphere 6 Standard, VMware vCenter Server 6 Foundation and Microsoft® licenses included (specific maintenance options based on customer choice)
VMS Software	Optional (can be supplied and supported by Hitachi)

VMP 500	
Capacity	From 500 to 1000 2-megapixel cameras at 30 FPS
Server Hardware	Two rack optimized server for solutions models, with a maximum of three hosts supported
Server Processors	2x Intel Xeon E5-2680 V3 12-core 2.5GHz processors per host
Server Memory	128GB DRAM per host
Server Networking	6x 1GbE or 4x 10GbE Ethernet NICs per host
Server Storage Networking	2x 8Gb/s Emulex FC HBAs
Server Local Storage	2x 300GB 10K 2.5" SAS drives
Storage Networking	Brocade 320 or Cisco MDS 9148S FC switch fabric
External Storage	VSP G200, VSP G400, VSP G600 and/or VSPG800 with up to 16.3PB of storage
Hypervisor Software	vSphere 6 Standard, vCenter Server 6 Foundation and Microsoft licenses included (specific maintenance options based on customer choice)
VMS Software	Optional (can be supplied and supported by Hitachi)

VMP 1000	
Capacity	1000+ 2-megapixel cameras at 3 FPS
Server Hardware	Three rack optimized server for solutions models, with a maximum of 32 hosts supported
Server Processors	2x Intel Xeon E5-2680 V3 12-core 2.5GHz processors per host
Server Memory	128GB DRAM per host
Server Networking	6x 1GbE or 4x 10GbE Ethernet NICs per host
Server Storage Networking	2x 16Gb/s Emulex FC HBAs
Server Local Storage	2x 300GB 10K 2.5" SAS drives
Storage Networking	Brocade 6505 or 6510 or Cisco MDS 9148S FC switch fabric
External Storage	VSP G200, VSP G400, VSP G600 and/or VSP G800 with up to 16.3PB of storage
Hypervisor Software	vSphere 6 Standard, vCenter Server 6 Foundation and Microsoft licenses included (specific maintenance options based on customer choice).
VMS Software	Optional (can be supplied and supported by Hitachi)

Additional Notes:

- Additional virtual machines may be used for license plate recognition (LPR) cameras, video analytics, access control and any other virtual machines pertaining to video infrastructure, including HVS.
- Higher resolution cameras are supported with lower camera qualities with each solution.
- Lower resolution cameras are supported with fewer physical host resources, allowing more cameras to be added per physical host.

Conclusions

Modern video management systems have transformed into fully digital environments that produce large volumes of streamed data and require unprecedented levels of availability and fault tolerance. In order to cope with this level of I/O demand, systems have to be architected to scale and deal with the specific requirements of data from IP cameras, namely almost 100% write data.

Hitachi has built a solution using Ethernet-based networks and traditional storage platforms. Virtualization has added the ability to scale the software components used within VMS solutions, removing many of the barriers involved in seamlessly adding more system capacity. Hitachi Video Management Platform addresses all of the requirements of modern day video management systems. It offers scalable storage based on the trusted Hitachi Virtual Storage Platform. Video functionality can be scaled through the use of the VMware vSphere ecosystem, which is an industry standard for server virtualization.

Throughout the infrastructure, bandwidth is catered, with the use of 8Gb/sec and 16Gb/sec Fibre Channel for shared storage connectivity. Incoming data connectivity from cameras and interserver networking is delivered through multiple 1GbE and 10GbE connections per physical server, connecting to an organization's own existing IP network.

Tiering within the storage layer provides the capability to address the needs of information lifecycle management (ILM), moving data to cheaper tiers of storage over time and making way for new data.

From a software perspective, Hitachi supports all of the major video security and monitoring software companies in the market today. This includes Milestone, OnSSI, Verint, Avigilon, FLIR and NICE/Qognify.

Overall, Hitachi Video Management Platform is a compelling solution for IT organizations looking to deploy scalable IT infrastructure to meet the needs of modern video security and monitoring. As an added benefit, VMP can be deployed and managed by existing data center staff, freeing video management professionals to do what they do best – managing, monitoring, and gaining insights from their video data.

Appendix A: Glossary

- **Fragmentation** – the physical distribution over time of sequential blocks of data in a file to physically separate parts of a hard drive. Fragmentation increases drive head movement when accessing files sequentially and directly affects performance.
- **Frame Rate** – the number of individual camera images produced in an active video stream, typically measured in frames per second.
- **Video Management System or VMS** – a hardware and software solution used for recording and analyzing digital CCTV content.
- **Video Cassette Recorder or VCR** – an early device for storing video content, based on recordable tape cartridges.
- **Storage Metrics Calculations –** show the calculation of capacity required for a number of camera configurations. A single 2-megapixel camera, for example, may generate 37GB of data in a single day, based on a frame rate of 30 FPS, whereas 100 cameras may generate upwards of 111TB over a 30-day period.

Appendix B: VMP Configuration Examples

VMP Configuration Example for 100 Cameras for 30 days of Storage

VIDEO MANAGEMENT PLATFORM 2.0

CONFIG 1: Camera Requirements/Options	
100	How Many Cameras (1-10,000)
0%	5 Year Growth (%)
2MP (1920x1080)	Camera Resolution
30	Frame Rate (1-60)
100%	Daily Recording (%)
H.264-M	Compression (High, Medium, Low)
Medium	Activity

CONFIG 2: Camera Requirements/Options	DISABLED
50	How Many Cameras (1-10,000)
20%	5 Year Growth (%)
4CIF (704x480) NTSC	Camera Resolution
30	Frame Rate (1-60)
100%	Daily Recording (%)
H.264-M	Compression (High, Medium, Low)
Medium	Activity

CONFIG 3: Camera Requirements/Options	DISABLED
200	How Many Cameras (1-10,000)
0%	5 Year Growth (%)
2MP (1920x1080)	Camera Resolution
30	Frame Rate (1-60)
100%	Daily Recording (%)
H.264-H	Compression (High, Medium, Low)
Medium	Activity

Retention for all Cameas	
Retention Time	Retention by Storage or Time
0	Storage Required (TB)
30	Retention Period (Days)

Compute Requirements/Options	
6x 1Gb	NICS (Front-end Networking)
Storage Solutions	
Brocade	San Fabric (For Back-end Networking)
NL-SAS (6TB) Drives	Drive Size (For Archiving)
2	# of Spare NL-SAS Drives Per VSP (2 min)
Video Management System (VMS)	
100	Number of cameras per recorder
8	RAM (GB) per Recorder
1	Number of Failover Recorders (VMs)
1	Number of Fault-Tolerant VMs
No	SQL Server Requirement
Milestone	Video Management System
Hitachi Visualization Suite (H	**NO VIRTUAL GATEWAY**
151	Number of Concurrent Streams
Hypervisor and OS	
Yes	HDS to provide VMware Licensing
Yes	HDS to provide Windows Licensing
Racks and Power	
No	Include Racks
Yes	Include Power Distribution Units (PDUs)
1 Phase PDU	1 Phase or 3 Phase PDUs
No	Customer will have in-rack UPSs
Support	
Premium	Support Level
60	Support term (36-60 Months)
Yes	Disk Retention Options
Delivery	
Install (No VMS)	Installation and Configuration
3/12/2016	Aprox Purchase Date (Customer Signs PO)
USA/Canada	Locaion of Installation

VMP-150 TOTALS

100	**TOTAL CAMERAS**
137.60	**STORAGE REQUIRED (TB)**
56.80	**EXTRA STORAGE AVAIL (TB)**
0.45	**BANDWIDTH REQUIRED (Gbps)**
Network Throughput	
19	Per Camera Frame Size (KB) Avg
4560	Per Camera Bitrate (kbps/s) Avg
445.3	Total Bandwidth (Mbps)
Storage Totals	
140,899.66	**Storage Required (GB)**
194.40	**Total Storage Available (TB)**
3	**Number of NL-SAS RAID Groups**
1	Total Live Video RAID Groups
1	Minimum RAID Groups Required
4	FC Ports Per Switch Used
2	FC Ports for Hosts (Per Switch)
2	FC Ports per VSP (Per Switch)
Virtual Machine Totals	
1	Number of Virtual Recorders
0	Number of Virtual Gateways
5	Number of VMs
200	OS Storage (GB) 40GB per VM
194.40	Video Storage Per Recorder (TB)
4	Video Volumes Per VM
36	Total RAM(GB) Required
64	Total RAM (GB) Available
Delivery & Installation Predictions	
4/12/2016	Aprox. Equipment Delivery Date
6/25/2016	Aprox. Full Install & Config Date
13	Total U Space Required
USA/Canada	Location of Installation

VMP Configuration Example for 100 Cameras for 360 days of Storage

VIDEO MANAGEMENT PLATFORM 2.0

CONFIG 1:

Camera Requirements/Options

100	How Many Cameras (1-10,000)
0%	5 Year Growth (%)
2MP (1920x1080)	Camera Resolution
30	Frame Rate (1-60)
100%	Daily Recording (%)
H.264-M	Compression (High, Medium, Low)
Medium	Activity

CONFIG 2: DISABLED

Camera Requirements/Options

50	How Many Cameras (1-10,000)
20%	5 Year Growth (%)
4CIF (704x480) NTSC	Camera Resolution
30	Frame Rate (1-60)
100%	Daily Recording (%)
H.264-M	Compression (High, Medium, Low)
Medium	Activity

CONFIG 3: DISABLED

Camera Requirements/Options

200	How Many Cameras (1-10,000)
0%	5 Year Growth (%)
2MP (1920x1080)	Camera Resolution
30	Frame Rate (1-60)
100%	Daily Recording (%)
H.264-H	Compression (High, Medium, Low)
Medium	Activity

Retention for all Cameas

Retention Time	Retention by Storage or Time
0	Storage Required (TB)
360	Retention Period (Days)

Compute Requirements/Options

6x 1Gb	NICS (Front-end Networking)

Storage Solutions

Brocade	San Fabric (For Back-end Networking)
NL-SAS (6TB) Drives	Drive Size (For Archiving)
2	# of Spare NL-SAS Drives Per VSP (2 min)

Video Management System (VMS)

100	Number of cameras per recorder
8	RAM (GB) per Recorder
1	Number of Failover Recorders (VMs)
1	Number of Fault-Tollerant VMs
No	SQL Server Requirement
Milestone	Video Management System

Hitachi Visualization Suite NO VIRTUAL GATEWAY

151	Number of Concurrent Streams

Hypervisor and OS

Yes	HDS to provide VMware Licensing
Yes	HDS to provide Windows Licensing

Racks and Power

No	Include Racks
Yes	Include Power Distribution Units (PDUs)
1 Phase PDU	1 Phase or 3 Phase PDUs
No	Customer will have in-rack UPSs

Support

Premium	Support Level
60	Support term (36-60 Months)
Yes	Disk Retention Options

Delivery

Install (No VMS)	Installation and Configuration
3/12/2016	Aprox Purchase Date (Customer Signs PO)
USA/Canada	Locaion of Installation

VMP-150 TOTALS

100	**TOTAL CAMERAS**
1,651.17	**STORAGE REQUIRED (TB)**
33.63	**EXTRA STORAGE AVAIL (TB)**
0.45	**BANDWIDTH REQUIRED (Gbps)**

Network Throughput

19	Per Camera Frame Size (KB) Avg
4560	Per Camera Bitrate (kbps/s) Avg
445.3	Total Bandwidth (Mbps)

Storage Totals

1,690,795.90	**Storage Required (GB)**
1,684.80	**Total Storage Available (TB)**
26	**Number of NL-SAS RAID Groups**
1	Total Live Video RAID Groups
1	Minimum RAID Groups Required
4	FC Ports Per Switch Used
2	FC Ports for Hosts (Per Switch)
2	FC Ports per VSP (Per Switch)

Virtual Machine Totals

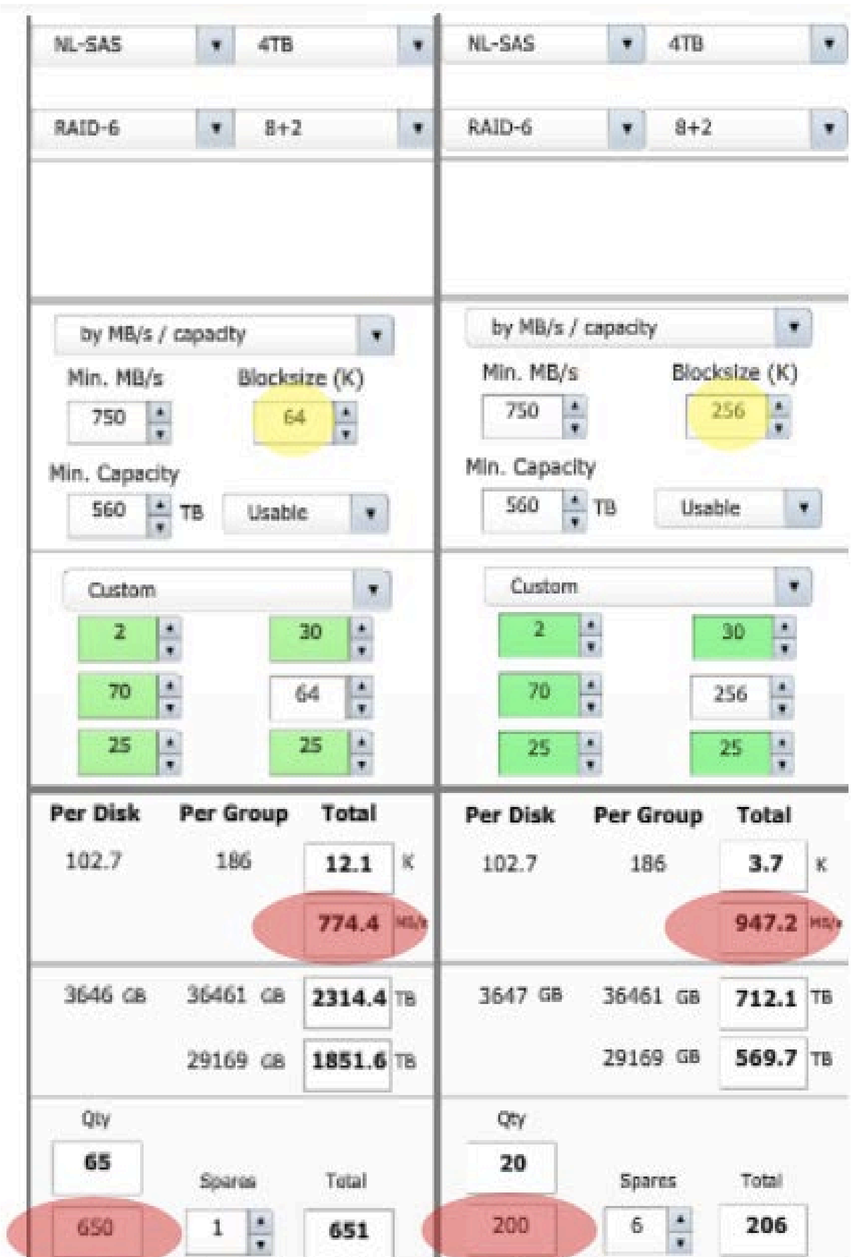
1	Number of Virtual Recorders
0	Number of Virtual Gateways
5	Number of VMs
200	OS Storage (GB) 40GB per VM
1,684.80	Video Storage Per Recorder (TB)
28	Video Volumes Per VM
36	Total RAM(GB) Required
64	Total RAM (GB) Available

Delivery & Installation Predictions

4/12/2016	Aprox. Equipment Delivery Date
6/25/2016	Aprox. Full Install & Config Date
37	Total U Space Required
USA/Canada	Location of Installation

Appendix C: VMP Storage Performance Calculator

The storage performance calculator for VMP shows how disk capacity and performance requirements can be calculated.



Based on HiPace Calculator

Appendix D: The Author

Chris M. Evans has worked in the technology industry since 1987, starting as a systems programmer on the IBM mainframe platform, while retaining an interest in storage. After working abroad, he co-founded an Internet-based music distribution company during the dot-com era, returning to consultancy in the new millennium. In 2009, he co-founded Langton Blue Ltd (www.langtonblue.com), a boutique consultancy firm focused on delivering business benefit through efficient technology deployments. Chris writes a popular blog at http://blog.architecting.it, attends many conferences and invitation-only events and can be found providing regular industry contributions through Twitter (@chrismevans) and other social media outlets.

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