Technical Report

Bosch Video Recording Solution with NetApp E-Series
Solution Architecture

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Implementation Overview and Usage Considerations

This document outlines the reference architecture of the Bosch Video Recording solution with NetApp® E-Series storage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Executive Summary

1.1 Introduction

Bosch and NetApp jointly developed this reference architecture to guide successful deployments with E-Series storage to deliver a powerful video recording solution.

1.2 About NetApp

NetApp creates innovative products: storage systems and software that help customers around the world store, manage, protect, and retain one of their most precious corporate assets: their data. We are recognized throughout the industry for continually pushing the limits of today's technology so that our customers never have to choose between saving money and acquiring the capabilities they need to be successful.

We always find ways to enable our customers to do things they couldn't do before at a speed they never thought possible. We partner with industry leaders to create the most efficient and cost-effective solutions optimized for their IT needs and to deliver to and support them worldwide. Leading organizations worldwide count on NetApp for software, systems and services to manage and store their data. Customers value our teamwork, expertise and passion for helping them succeed now and into the future.

http://www.netapp.com.

1.3 Overview of The Bosch Group

The Bosch Group is a leading global supplier of technology and services. In 2014, its roughly 357,400 associates generated sales of €64.2 billion. Its operations are divided into four business sectors: Automotive Technology, Industrial Technology, Consumer Goods, and Energy and Building Technology. The Bosch Group comprises Robert Bosch GmbH and its more than 360 subsidiaries and regional companies in some 50 countries. If its sales and service partners are included, then Bosch is represented in roughly 150 countries. This worldwide development, manufacturing, and sales network is the foundation for further growth. In 2014, the Bosch Group invested some €5.6 billion in research and development and applied for over 5,000 patents in 2015. The Bosch Group's products and services are designed to fascinate and to improve the quality of life by providing solutions that are both innovative and beneficial. In this way, the company offers technology worldwide that is "invented for life."

Additional information is available online at www.bosch.com and www.bosch-presse.de.com.

1.4 About Bosch Security Systems, Inc.

The Security Systems division of Bosch is a leading global supplier of security, safety, and communications products, solutions, and services. Roughly 12,000 associates generated sales of €1.5 billion in fiscal 2013. Protecting lives, buildings, and assets is Bosch Security Systems' aim. The product portfolio includes video surveillance, intrusion detection, fire detection, and voice evacuation systems as well as access control and management systems. Professional audio and conference systems for communication of voice, sound, and music complete the range. Bosch Security Systems develops and manufactures in its own plants across the world. Additional information can be accessed at www.boschsecurity.com.

1.5 Overview of Bosch and NetApp

Bosch and NetApp Collaboration: Providing Customers with Proven Storage Solutions for IP Video Surveillance

Bosch Security Systems and NetApp (NASDAQ: NTAP) formed a strategic global collaboration to capitalize on the rapid development of the IP video surveillance market. Under terms of their agreement, Bosch will sell and support cobranded NetApp storage devices as part of the Bosch video surveillance portfolio. To meet Bosch solution performance requirements, extensive engineering work was done by

NetApp performance engineering and the NetApp Bosch technical account team to identify system configurations that meet those requirements.

Bosch pioneered the development of IP cameras and encoders that stream directly to RAID arrays or storage area networks (SANs). This award-winning, efficient approach to video recording is made possible with the use of an IP-based storage standard, the Internet Small Computer System Interface (iSCSI).

Under terms of the collaboration, NetApp will assist Bosch associates with presales support for the cobranded products. The company will also deliver training and certification to Bosch technical support groups. As a NetApp authorized provider, Bosch will provide customers with postsale technical support for the storage devices. This level of integration will provide a streamlined experience for customers during and after the sale of the cobranded products.

Why NetApp and Bosch?

- Global collaboration aligns leaders in storage and video surveillance.
- Agreement links research and development, sales, and support teams.
- Companies are positioned for success in IT and security market segments.
- Bosch and NetApp have collaborated since 2006.
- Unique enhancements for Bosch iSCSI cameras provide seamless operations.
- There is seamless integration with Bosch configuration management.
- Bosch support and sales personnel have been trained on NetApp technology.
- The two companies have proven stability and reliability.
- The Bosch and NetApp Video Recording Manager (VRM) solution provides a high-performance, flexible, scalable, and highly reliable storage management solution for IP network video recording.

Why Choose the Bosch Video Surveillance Solution?

- Bosch is a leading global full-video-surveillance solution provider.
- The solution enables a lower cost of ownership and ease of setup by reducing the footprint.
- The turnkey solution provides:
  - Highly customized storage from NetApp to support video surveillance–specific workloads and tight integration of cameras, recording application, and storage infrastructure
  - Full integration with Bosch video management applications, the Bosch video management system (VMS), and the Bosch video client
  - A large global installed base resulting from collaboration between Bosch and NetApp since 2006
  - Certified recording solutions for third-party Genetec video management solutions and third-party cameras and encoders

1.6 Introduction to the Bosch VRM Solution

Bosch, the market leader in video security, has made a strategic commitment to NetApp, a market leader in storage. Bosch has bet on one of its fastest growing divisions, Security Video Surveillance Systems based on NetApp storage, to create the Bosch VRM solution, offering next-generation NVR technology. The Bosch VRM solution provides a high-performance, flexible, scalable, and highly reliable direct-to-iSCSI storage management solution for IP network video recording.

Figure 1 illustrates the VRM environment and recording concept.

Figure 1) VRM recording concept.
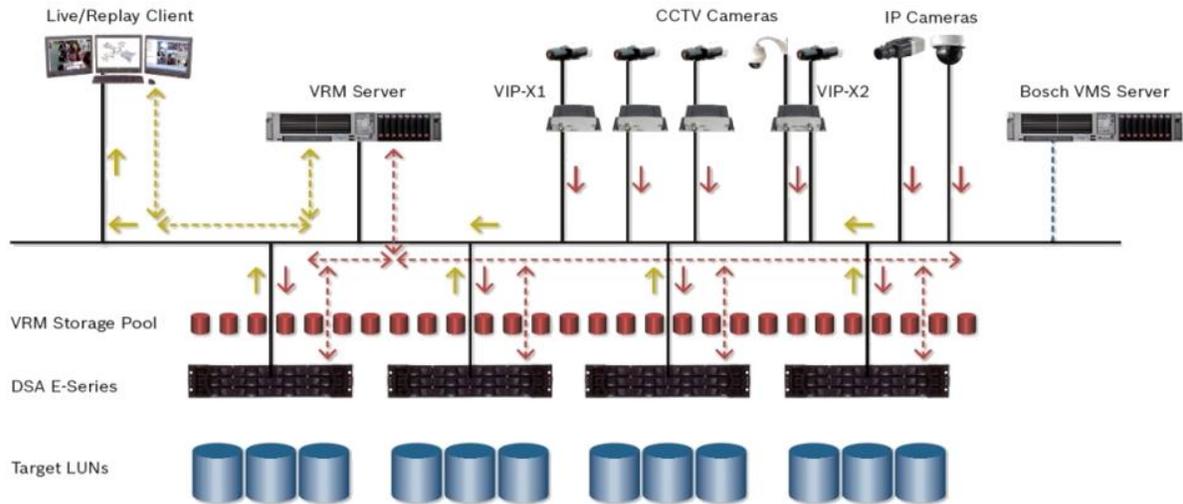
The Bosch VRM solution is designed to meet the needs of the video security market. It is a flexible second-generation IP network video recording technology solution that provides scaling, robustness, and reliability while offering state-of-the-art standard IT components.

2   Solution Architecture

2.1   Bosch VRM Solution Architecture

The VRM recording solution is fully integrated into enterprise video management solutions such as the Bosch VMS and Genetec video management software.

Architecture and Components

The Bosch VRM solution consists of E-Series storage and the Bosch VRM solution. The VRM solution consists of the VRM server, the Bosch configuration client, and the VRM monitor. The Bosch video client or the Bosch VMS operator client can be used as playback clients.

VRM Server

The VRM server manages configuration details and system settings and also acts as a centralized orchestration service for the interaction of individual modules. The VRM server monitors the availability of all system components. In case of a failure, the server creates alarm messages that are visualized in the VRM monitor or SNMP traps that can be retrieved by third-party systems.

Configuration Client

The configuration client configures the VRM system, including the recording management of the IP cameras and/or encoders, the iSCSI storage systems, and the user and alarm management.

The configuration client offers full integration of the E-Series storage. The configuration client allows E-Series storage to be configured (for example, creating the LUNs and allocating storage) without using additional programs.

VRM Monitor

The VRM monitor module monitors the VRM system. The web-based module is automatically installed with the VRM server. The monitor displays information about the connected IP cameras and/or encoders and storage systems and information about the recordings.

The VRM solution is composed of the components listed in Table 1

Table 1) VRM solution component list.

VRM Solution Component	Description
Storage Array	One 12-drive storage chassis with Simplex controllers and up to seven 12-drive storage expansion chassis Or One 12-drive storage chassis with Duplex controllers (in dual Simplex configuration) with up to three 60-drive storage expansion chassis (both include 1/10GbE iSCSI ports)
Array Firmware	Bosch-specific firmware
Hard Drives	Up to 92 x 3.5" 6TB near-line SAS (NL-SAS) with DE1600 expansion chassis And Up to 180 x 3.5" 6TB near-line SAS (NL-SAS) with DE6600 expansion chassis + 12 additional near-line SAS (NL-SAS) in the controller chassis (Refer to the Bosch product page and product datasheet for current supported disk configurations.)
Volumes	2000GB LUNs RAID 5/RAID 6
Cameras	800 IP cameras per controller, with a maximum of 1,600 IP cameras per array
Video Recording Manager	Centrally manages direct-to-iSCSI recordings from Bosch IP cameras and encoders (maximum 2,048 channels, with a maximum of 1PB net storage per VRM instance)
VRM Server	VRM server (running as a service)
VRM Monitor	Displays overall system status information, including uptime, bit rate, and retention times Provides status information on recordings and storage
Bosch Configuration Client	Allows configuration of the iSCSI storage subsystem Allows configuration of recording parameters Includes schedules, data rates, frame rates, streams, and privileges Allows management of users and groups with privileges and roles Allows configuration of load-balancing parameters (bandwidth and iSCSI connections) per disk array (IP address)

2.2 DSA 2700 Architecture

The DSA E2700 is based on one 2U controller unit with 12 internal 3.5", 7.2 K, NL-SAS (Serial Attached SCSI) enterprise HDDs (near-line SAS). The controller unit is available as a standard Simplex controller configuration and as a dual Simplex controller configuration for high-capacity and extreme performance requirements.

This storage system is a high-performance solution designed with robust flexibility that makes it a great fit for wide-ranging video surveillance requirements. Its balanced performance is designed for supporting high-bandwidth and I/O-intensive workloads. The DSA E2700 disk shelf option with a standard 12-bay expansion unit with 12 x 3.5", 7.2 K, NL-SAS, enterprise HDD (2U) or a high-density 60-bay expansion unit with 60 x 3.5", 7.2 K, NL-SAS, enterprise HDD (4U) enables custom configurations that can be optimized for any standard midsize to enterprise environment. The DSA E2700's fully redundant I/O paths, advanced protection features, and extensive diagnostic capabilities deliver high levels of availability, integrity, and security.

The Bosch VRM solution is built on the NetApp E2712 E-Series storage system. This storage system features a single or dual E2700 RAID controller with one to seven DE1600 2U 12-disk shelves or one to three DE6600 4U 60-disk shelves as expansion. Each DE1600 2U 12-expansion shelf is populated with 2TB, 3TB, 4TB, or 6TB near-line SAS (NL-SAS) drives, and each DE6600 4U 60-expansion shelf is populated with 3TB, 4TB, or 6TB near-line SAS drives.

2.3   NetApp E-Series E2700 Storage System

The NetApp E2700 storage system delivers configurable, streamlined performance for midsize application-driven SAN storage environments.

The scalable E2700 provides application-driven storage for remote, branch, and midsize organizations. Configurable with the 2U/12- or 4U/60-disk shelf and three forms of connectivity—FC, iSCSI, or SAS—the E2700 integrates with key applications such as VMware, Exchange, SQL Server, and Oracle systems. **Note:** The Bosch VRM solution is available only in a 2U/12-disk shelf with iSCSI connectivity.

With the E2700, you can:

- Gain best-in-class performance efficiency for a wide range of database and other transactional applications.
- Reduce the cost and complexity of high-throughput data management through a configurable architecture that is easy to use and install.
- Attain streamlined high performance with low latency and high bandwidth and IOPS.
- Achieve seamless operations with flexible application integration.
- Scale capacity as needed to support business growth.

Like all NetApp E-Series systems, the E2700 uses robust, easy-to-use, and lightweight NetApp SANtricity® storage management software. This software enables performance efficiency, dynamic drive rebalancing, RAID management, intelligent cache tiering, and extended data protection, including data replication and disaster recovery.

Overview

NetApp E2700 storage systems address wide-ranging requirements with balanced performance that is equally adept at handling throughput for sequential I/O applications and high-IOPS requirements for transactional databases. The E2700 brings together the following advantages:

- Modular host interface flexibility (SAS, FC, and iSCSI)
- Excellent storage density
- High reliability
- Intuitive management

Together, these features create an entry-level midrange storage system. The system is perfectly suited for data-intensive solutions, high-bandwidth-intensive streaming applications, transaction-intensive workloads, and high-performance file system requirements without sacrificing simplicity and efficiency. In addition, its fully redundant I/O paths, advanced protection features, and extensive diagnostic capabilities deliver a high level of availability, integrity, and security.

E2712 Storage System

The E2712 disk shelf is a 2U tray that holds up to 12 3.5" drives. The shelf features dual RAID controllers, dual power canisters, and dual fan canisters with two fans in each canister. An E2712-based storage system supports a maximum of 192 drives and a mix of expansion drive tray models.

Refer to Table 4 for more details on the E2712 technical specifications.

The E2712 has a proven track record of reliability in remote dedicated environments.

Figure 2 and Figure 3 show the front view and the rear view, respectively, of the E2712 storage controller drive tray.

Figure 2) E2712 front view without bezel.

Figure 3) E2712 rear view.

DE1600 and DE6600 Expansion Shelves

The DE1600 is a 2U expansion shelf that holds up to 12 3.5" drives. The shelf supports two environmental service modules (ESMs) with 6Gbps SAS connectivity and dual hot swappable power canisters.

A DE1600-based disk shelf supports a maximum of 180 drives (15 shelves) or 192 drives by using a mix of expansion drive tray models.

Figure 4 illustrates an example of Simplex controller expansion using the DE1600.

The DE6600 is a 4U expansion shelf that holds up to 60 3.5" or 2.5" drives in 5 horizontal drawers (12 drives per drawer). The shelf supports two environmental service modules with 6Gbps SAS connectivity, dual hot swappable power canisters, and dual hot swappable fan canisters with two fans in each canister.

A DE6600-based storage system supports a maximum of 180 drives (3 shelves) or 192 drives by using a mix of expansion drive tray models. A minimum of 20 drives must be installed in the DE6600 expansion shelf. These drives must be installed in the four front drive slots in each drawer.

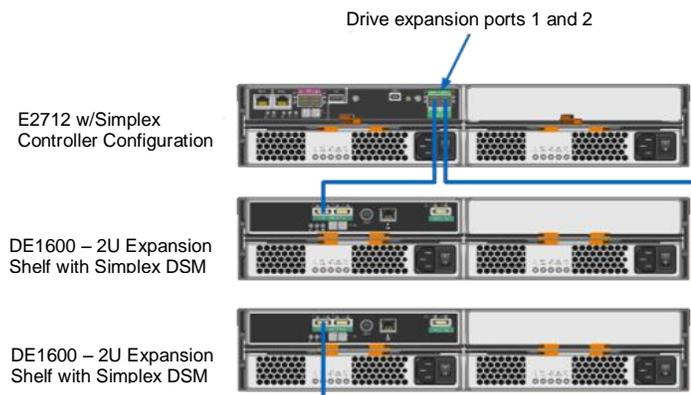Figure 4) Example of DE1600 Simplex expansion configuration.

Figure 5) DE6600 front view without bezel

Bosch VRM Solution Supported E2700 Hardware Specifications

The E2700 controller has the following base hardware features for the Bosch VRM solution:

• Dual Ethernet ports for management-related activities

• iSCSI ports for host connection

Table 2 lists the technical specifications of E2700-based storage systems.

Table 2) E2700 technical specifications.

Specification	E2712
Maximum raw capacity	96TB; 1.5PB with expansion shelves
Maximum number of drives	12; 192 with expansion shelves
Form factor	2U—12 drives
Drive types supported	2/3/4/6TB NL-SAS 7.2K FDE/non-FDE
System memory	8GB/16GB
Onboard I/O	2-port 12Gb SAS per controller canister
Optional I/O	2-port or 4-port 12Gb SAS per controller canister
Drive trays supported for expansion—drive offerings	DE1600 (2U—12 drives): 15 trays max; supports same drive types as E2712
	DE6600 (4U—60 drives): 3 trays max; supports same drive types as E2712
High-availability (HA) features	Dual active controllers with automated I/O path failover
	Support for RAID levels 0, 1 (10 for 4 drives or more), 5, 6, and Dynamic Disk Pools

Specification	E2712
	Redundant, hot-swappable storage controllers, disk drives, power supplies, and cooling fans
	SANtricity proactive drive health monitoring to identify problem drives before they create issues
	Automatic drive fault detection, failover, and rebuild by using global hot spare drives
	Mirrored data cache with battery backup and destage to flash
	SANtricity Persistent Monitor, for making periodic copies of the storage system configuration

For complete information on the NetApp E2700, refer to the [NetApp E2700 Technical Specifications](#).

SANtricity Software Specifications for E2700 Hardware

Table 3 lists the SANtricity software specifications for E2700-based storage systems.

Table 3) SANtricity software boundaries for E2700-based storage systems.

Components	Maximum
Storage Hardware Components	
Trays (system and expansion)	16
Drives (system and expansion)	192
SSD cache capacity	5TB
Logical Components	
Partitions	128
Volumes	512
Volumes per consistency group	32
Thin volumes per system	512
Disk pools per system	20
Snapshot Copies	
Per NetApp Snapshot® group	32
Per volume	128
Per storage system	512
Snapshot Volumes	
Per Snapshot copy	4
Per system	256

Components	Maximum
Snapshot Groups	
Per volume	4
Per system	256
Mirrors	
Legacy mirrors per system	16 (synchronous only)
Mirrors per system	32
Mirrors per volume	+1
Mirrors per asynchronous mirror group	32
Asynchronous mirror groups per system	4

Table 4 describes the guidelines for E-Series disk expansion for the Bosch VRM solution.

Table 4) E-Series disk expansion guidelines.

Specification	E2712 with DE1600	E2712 with DE6600
Form factor	2U/12 drives + 2U/12 drives	2U/12 drives + 4U/60 drives
Maximum number of drives	96	192
Controller shelf	1	1
Maximum number of expansion shelves	7	3
Total number of disk shelves	8	4

For more information, refer to the individual product pages for the Bosch DSA E-Series.

3   Solution Overview

3.1   Bosch VRM Solution

The Bosch VRM solution provides a distributed network video recorder (NVR) solution, thus signaling the second generation of IP network video recording. VRM supports iSCSI-based storage systems and Bosch video-over-IP cameras and video encoders. VRM introduces the concept of a storage virtualization layer. This abstraction layer enables VRM to manage all of the individual disk arrays in the entire system as a single virtual common pool of storage that is intelligently allocated as needed. Because the IP

cameras and encoders record directly to the iSCSI storage and are managed only by VRM, the need for server hardware, operating systems, antivirus software, and the ongoing software patches and updates these systems require is greatly reduced. This new technology makes installation, operation, and maintenance easier while reducing the total cost of ownership.

Bosch VRM software provides virtualization and recording management services, enabling Bosch IP cameras to stream directly to NetApp network storage. VRM pools all disks to allocate storage on demand and balance loading across your network, fully utilizing available storage and squeezing the maximum possible return from your investment.

VRM's redundancy and automatic failover capabilities deliver unmatched reliability. If an array fails, VRM immediately redirects camera traffic. This concept combines and controls advanced video recording solution features in the application and eliminates the need for expensive intelligent storage capabilities, such as mirroring, virtualization, high availability (HA), scalability, and so on.

3.2 Features of the Bosch VRM Solution

VRM offers systemwide recording, monitoring, and management of Bosch iSCSI storage, video servers, and cameras and acts like a "traffic cop" by distributing video across the storage devices.

Key Features

- Uses second-generation IP NVR technology
- Replaces the traditional dedicated NVR approach with the revolutionary concept of storage virtualization
- Enables:
  - Direct communication between the camera and the storage without involving a server
  - The camera to decide about where to record
  - Automatic redundancy on storage and recording level; "hot standby (N+1)" configuration is not required
  - Automatic load balancing with respect to bandwidth and connected cameras
  - The "pay-as-you-grow" concept; it is easy to add extra storage or cameras with an automatic balanced upgrade
  - Simultaneous recording of two camera streams with different recording qualities to physically separated locations
  - Integrated long-term video archiving

Storage Failure Handling with the VRM

- There is continuous recording even when the "traffic cop" fails.
- Each IP camera can independently stream to its current iSCSI targets.
- If an iSCSI drive or LUN fails, VRM provides access to another iSCSI drive.
- Data streams are reallocated to free storage sections.

VRM Features

- Optimized storage utilization
- Failover for extra reliability
- Automatic load balancing between connected disk arrays with respect to the bandwidth and the number of iSCSI connections
- Is configurable as per IP address
- Support for Bosch DSA disk arrays (NetApp portfolio systems)
- Improved logging functionality

VRM Limitations

- Firmware 3.5 or higher is required for the Bosch video-over-IP cameras and encoders.
- Up to 2,000 cameras per VRM are supported.
- The maximum LUN size supported is 2000GB.
- A maximum of 1PB net capacity of storage is supported per VRM server.

4 Benefits

The Bosch and NetApp VRM solution provides a high-performance, flexible, scalable, and highly reliable storage management solution for IP network video recording. The Bosch VRM solution offers many benefits. These benefits include huge cost savings through storage consolidation and harmonization, footprint reduction (cooling, power, space) with maximum storage scaling, and reduction of management overhead using Bosch's management software.

4.1 Unique Selling Points

- The setup is easy because of fewer hardware components.
- The pay-as-you-grow concept makes it easy to add extra storage without requiring a "balanced" upgrade; upgrades are not "unbalanced" when adding cameras or storage.
- There is automatic failover when there are more than two iSCSI targets and sufficient iSCSI sessions/bandwidth is available.
- The intelligence is located in the camera (camera-centric system). This means that the decision about where to record is made in the camera.
- Every camera/encoder adds additional computer power.
- Virtualization does not take place on physical hardware (server/storage).
- "Hot standby (N+1)" is not required.

4.2 Value for Your Money

Bosch's VRM software adds systemwide recording management for direct-to-iSCSI RAID storage. The software enables IP cameras and encoders to stream directly to the disk and distributes video to different arrays on the network. VRM pools all disks on your system and allocates storage on demand. VRM balances video loading across your network, making full use of available space to maximize the return on your storage investment. You also gain added flexibility because you can easily add storage as your surveillance system grows.

4.3 Reliability

VRM's redundancy and automatic failover capabilities can deliver unmatched reliability. If an iSCSI disk array fails, VRM immediately redirects camera traffic. VRM also prevents gaps in recording because of network outages.

4.4 Video Storage Arrays for Ultimate Flexibility and Massive Storage

The demand for storage capacity is growing at an unprecedented rate, fueled by increasing camera resolutions, longer data retention policies, and security through data replication. The Bosch range of video storage arrays is tailored to meet the unique demands of video surveillance and offers one of the highest levels of RAID redundancy.

Bosch and NetApp RAID 5 technology can deliver peace of mind about your video storage without compromise. A RAID 6 configuration can be used for greatly enhanced data protection against any two disk failure events.

5 Summary

The Bosch VRM solution provides a high-performance, flexible, scalable, and highly reliable direct-to-iSCSI storage management solution for IP network video recording. The solution combines the following features:

- **Optimal performance.** Such performance is obtained by using intelligent addressing on a block level, which also allows load balancing of video recording to all available storage blocks on any storage array in the system.
- **Load balancing.** This capability is provided with respect to the bandwidth and number of iSCSI connections and is configurable per IP address (iSCSI target).
- **Logical virtualization.** The VRM virtualization layer allows scalability of storage beyond the physical limits of a single storage subsystem. This logical abstraction layer means that each camera can use any storage space it actually needs, rather than an allocated, arbitrary, discrete chunk ahead of time. Retention times of video data can be adjusted as required.
- **Fast recording and retrieval.** VRM provides fast and flexible retrieval using a search database of recordings and metadata. Metadata is a form of data that describes other data such as events, ATM/POS information, and video content analysis data. The metadata is recorded with the video data and provides a fast and an efficient way for the search engine, in the playback client, to quickly locate specified video clips. The database also keeps track of the location of recording blocks. If this database is lost, VRM can recreate the database by reading the stored metadata, thus providing a self-healing capability.
- **Distributed storage.** VRM provides redundant management of metadata and also significantly enhances overall reliability and availability. When redundancy for storage provisioning and a failover design for the central recording management service are provided, there is no single point of failure. In addition, unlike NVR systems, VRM scales without requiring additional PCs. This capability greatly reduces the risk of system failure.

 A glossary of terms used in the VRM solution is described here.

Table 5) Glossary of terms.

Term	Definition
VRM	Video Recording Manager
iSCSI	Internet Protocol: Small Computer Systems Interface
IP	Internet Protocol
LUN	Logical unit number
BVIP	Bosch Video over IP
HIC	Host Interface Card
H.264/MPEG‑4	ITU-T H.264: Advanced video coding for generic audiovisual services
RAID	Redundant array of independent disks
NVR	Network video recorder

Term	Definition
ANR	Automatic network replenishment
ATM/POS	Automatic teller machines/point of sale

5.1 VRM iSCSI Recording

Figure 6 shows the VRM iSCSI recording feature.

Figure 6) VRM iSCSI recording.
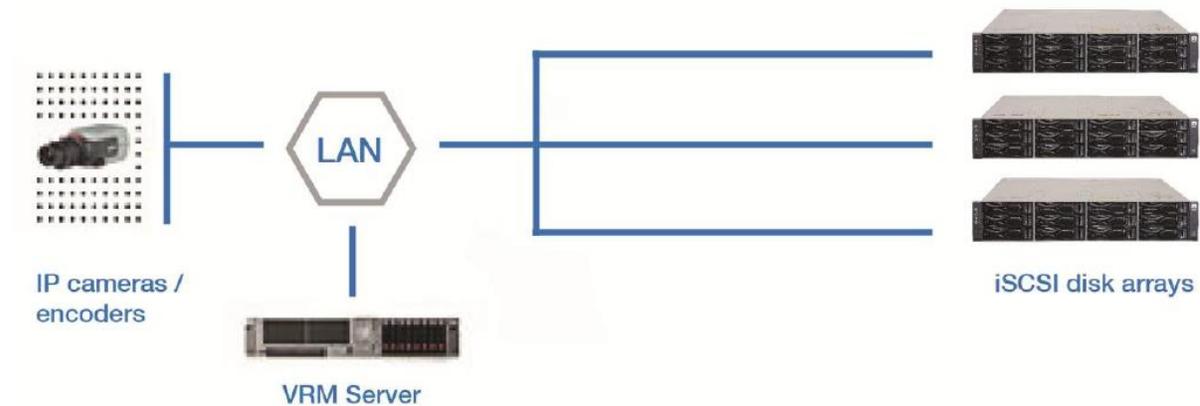
Application

IP cameras need to be recorded for long-term archiving, for example, 30 days. A recording solution is cost critical and needs to have a low TCO. Recordings are extremely business critical and must run 24/7 without fail.

Solution

Groups of IP cameras or encoders record data directly to the iSCSI disk arrays. The need for PC servers in the recording chain is overcome and results in creation of a system that has a lower TCO and is easier to maintain. In addition, one PC server is added to the IP video network that regulates video distribution. When a recording stops or fails, the server redirects the recording to another available iSCSI disk array. Full redundancy is created, and the cameras and encoders still function if the iSCSI disk array fails when the VRM server is not available.

Notes

1. When one iSCSI disk array fails, the recording is redirected to another iSCSI disk array.

2. Load sharing is accomplished among the iSCSI disk arrays.

3. When the VRM server fails, the cameras and encoders still know where to record or fail over for an average of two days (the actual time depends on the bitrate).

5.2 Large-Scale VRM System

Figure 7 shows a large-scale VRM system.

Figure 7) Large-scale VRM system.
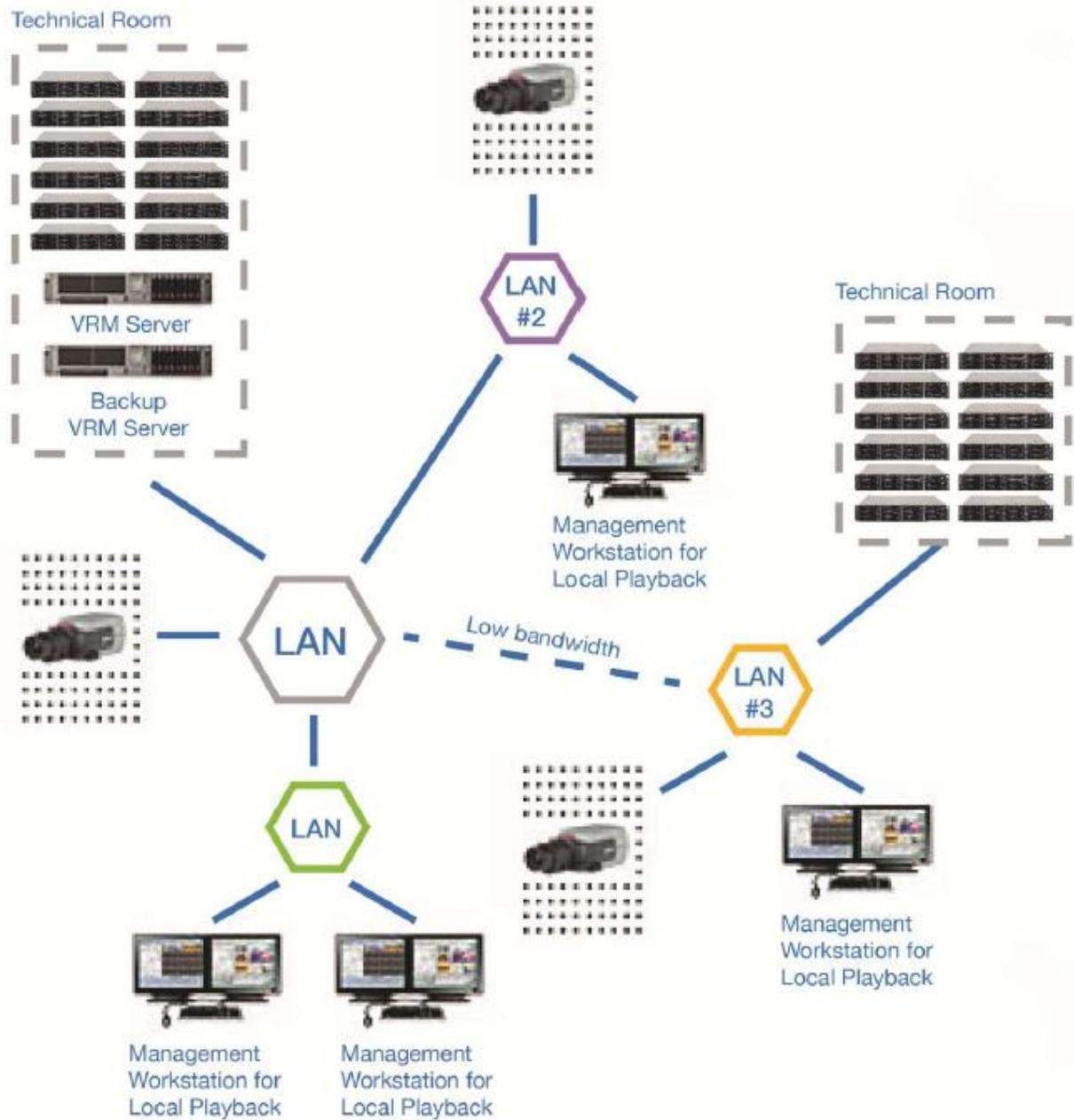
Application

Large-scale, highly redundant IP video recording solution.

Example: deployed at airports.

Solution

VRM servers (including the backup server) are placed in different technical rooms. Video management systems are set up in different network segments.

Notes

The central VRM can redirect cameras to storage over the low-bandwidth link even when the VRM server is not on LAN3.

5.3   Solution Reference Example

This solution demonstrates how VMSs work together with the Bosch VRM solution and the NetApp E-Series E2700. This solution scales up to many thousands of cameras or encoders, for example, for airport or casino deployments. Bosch Security Systems and the NetApp Array Product Group QA department built and tested this solution in their labs.

A single Bosch VRM can handle up to 2,048 camera channels; a single NetApp E2700 dual-controller storage system can support 800 cameras, 2500Mbps, and 470TB usable capacity. Therefore, for example, a scale-out to 3,200 cameras would need only two VRM servers and four NetApp E2700 storage systems.

Reference Test Case

The tests determined that:

- A single E2700 dual-controller system can achieve the write throughput of 2500Mbps with 800 concurrent camera streams using a 10Gb iSCSI connection.
- The E2700 storage system also provides 10% replay throughput capacity.
- The E2700 storage system also meets the preceding performance specifications under a disk rebuild condition.

You can see the reference setup for this test case in Figure 8

Figure 8) Reference setup.
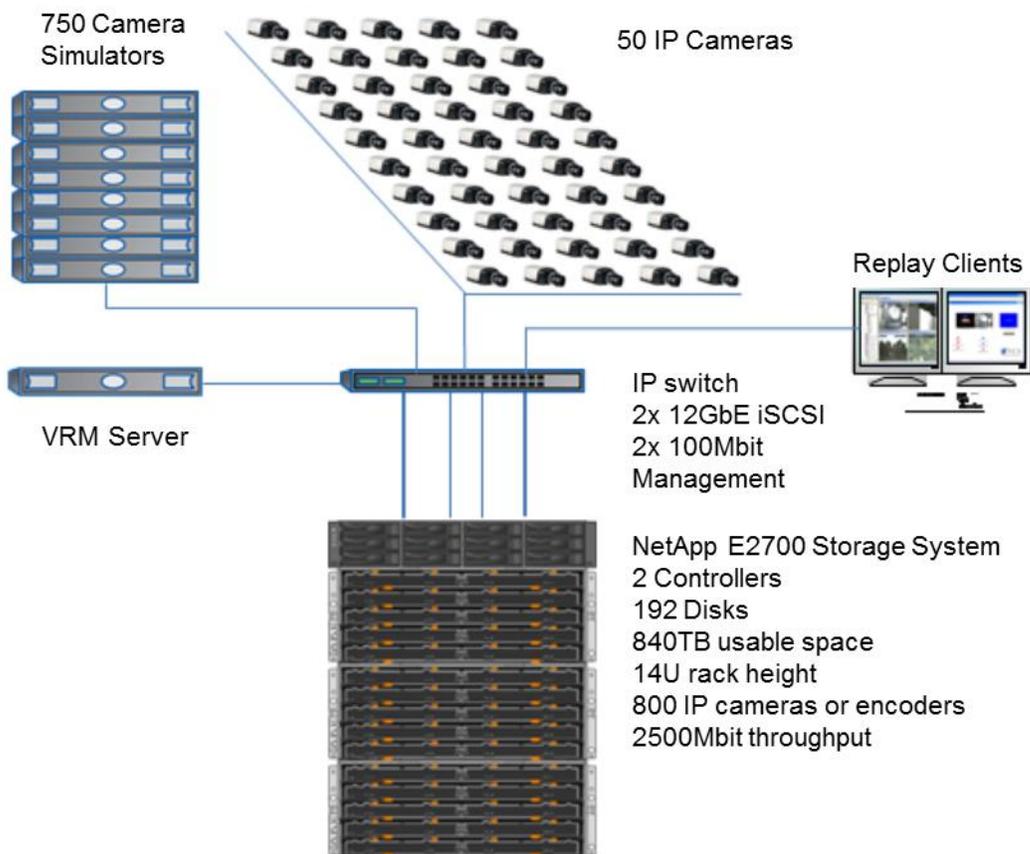
The configuration seen in Figure 9 is a typical setup for a large-scale environment using a video management system such as the Bosch VMS.

Figure 9) Typical setup for a large-scale environment using the Bosch VMS.
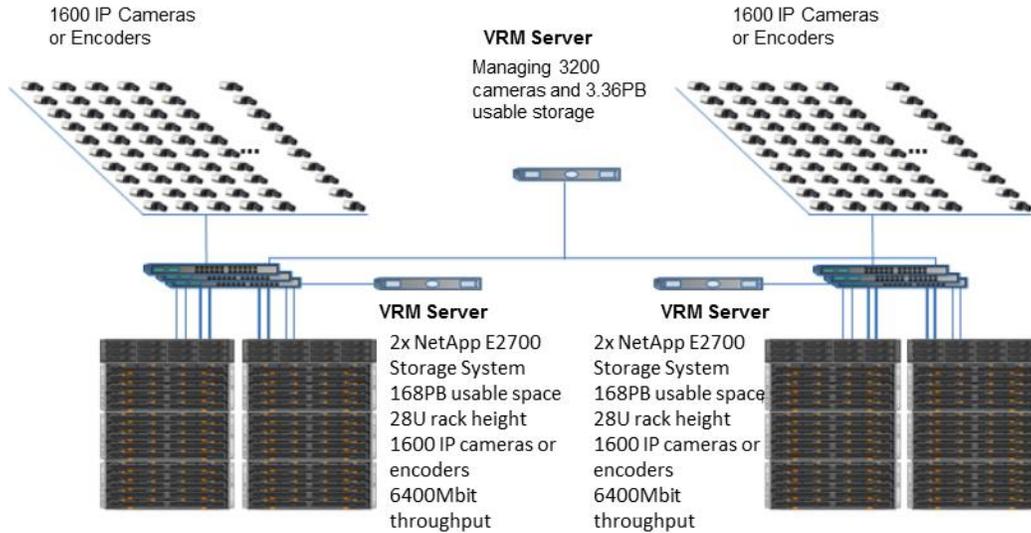
The Bosch VRM solution also works with other video management systems such as Genetec's, giving you the advantage of having a simple and highly scalable recording solution.

6   References

The following references were used in this document:

Bosch Worldwide
http://www.bosch.com/worldsite_startpage/en/default.aspx

Bosch Media Service
http://www.bosch-presse.de/presseforum/?locale=en

Bosch Security Systems Worldwide
http://www.boschsecurity.com/startpage/html/index.htm

6.1   NetApp E-Series Documentation

Refer to the following link for NetApp E-Series documentation:

https://mysupport.netapp.com/info/web/ECMP1658252.html

6.2   Bosch Documentation

Refer to the following link for Bosch documentation:

http://www.Bosch.com

Refer to the [Interoperability Matrix Tool (IMT)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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