



Technical Report

# Bosch Video Recording Solution with NetApp E-Series Solution Architecture

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# 1 Introduction

## 1.1 The Bosch Company Overview

### About the Bosch Group

The Bosch Group is a leading global supplier of technology and services. In fiscal 2012, its roughly 306,000 associates generated sales of 52.5 billion euros. Since the beginning of 2013, its operations have been 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 roughly 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. Bosch spent some 4.8 billion euros for research and development in 2012, and applied for nearly 4,800 patents worldwide. The Bosch Group's products and services are designed to fascinate, and to improve the quality of life by providing solutions which 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](http://www.bosch.com) and [www.bosch-presse.de.com](http://www.bosch-presse.de.com)

### About Bosch Security Systems, Inc.

The Bosch division Security Systems is a leading global supplier of security, safety, and communications products, solutions and services. More than 12,100 associates generated sales of 1.5 billion euros in fiscal 2012. Protecting lives, buildings and assets is our 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](http://www.boschsecurity.com)

## 1.2 Bosch and NetApp Overview

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

Bosch Security Systems and NetApp, Inc. (NASDAQ: NTAP) have formed a strategic, global collaboration to capitalize on the rapid development of the IP video surveillance market. Under terms of the agreement, Bosch will sell and support cobranded NetApp® storage devices as part of its closed-circuit television (CCTV) portfolio. To meet Bosch solution performance requirements, extensive engineering work has been accomplished 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.
- Seamless integration in Bosch configuration management.
- Trained Bosch support and sales organization on NetApp technology.
- 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?

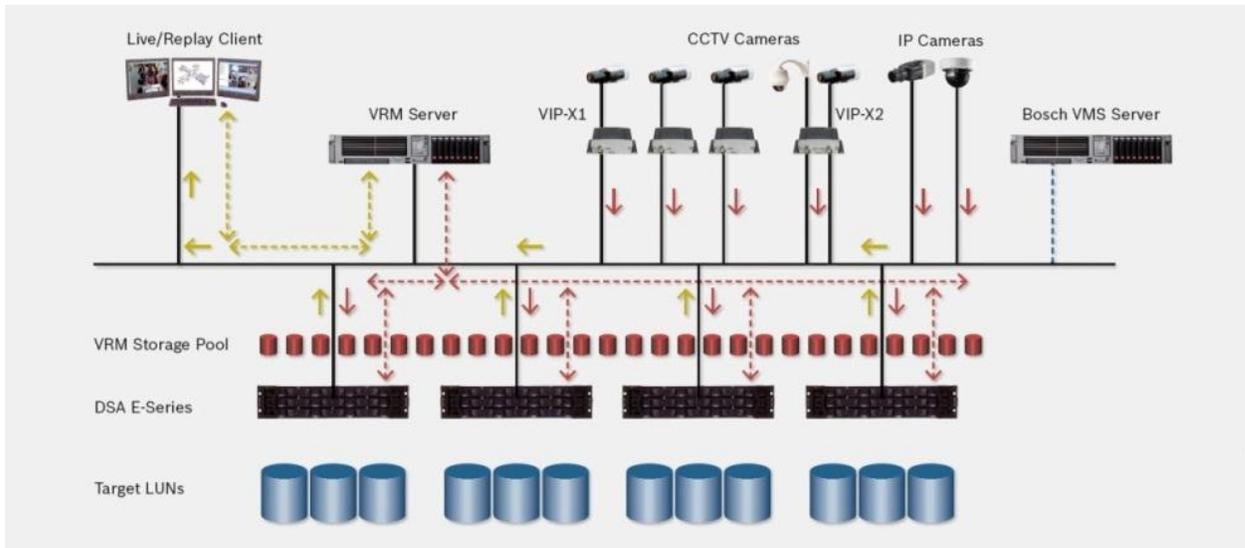
- Bosch is a global leading full video surveillance solution provider.
- Lower cost of ownership and ease of setup by reducing footprint.
- Turnkey solutions that provide:
  - Highly customized storage from NetApp to support video surveillance-specific workloads and tight integration of cameras, recording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

### 1.3 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, herewith offering a 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 for 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 the 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 manager, and the VRM monitor. The Bosch video client or the Bosch VMS operator client may 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, it creates alarm messages that are visualized in the VRM monitor or SNMP traps that can be retrieved by third-party systems.

#### Configuration Manager

The configuration manager is used to configure 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 manager offers full integration of the E-Series storage. The configuration manager 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 is provided to monitor the VRM system. The module is automatically installed together with the VRM server. This is where information about the connected IP cameras and/or encoders and storage systems, as well as about the recordings, is displayed.

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

Table 1) VRM solution component list.

VRM Solution Components	Description
Storage array	<ul style="list-style-type: none"> <li>One 12-drive storage chassis with Simplex controllers and up to seven 12-drive storage expansion chassis</li> </ul> Or <ul style="list-style-type: none"> <li>One 12-drive storage chassis with Duplex controllers with up to three 60-drive storage expansion chassis</li> </ul> (Both include 1/10GbE iSCSI ports)
Array firmware	Bosch specific firmware
Hard drives	<ul style="list-style-type: none"> <li>Up to 92 x 3.5" 2TB near-line SAS (NL-SAS) with DE1600 expansion chassis</li> </ul> And <ul style="list-style-type: none"> <li>Up to 180 x 3.5" 3TB near-line SAS (NL-SAS) with DE6600 expansion chassis + 12 x 2TB in the controller chassis</li> </ul> (Refer to the Bosch product page for current disk configurations)
Volumes	2000GB LUNs RAID 5/RAID 6
Cameras	400 IP cameras per controller, with a maximum of 800 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 manager	<ul style="list-style-type: none"> <li>Allows configuration of the iSCSI storage subsystem</li> <li>Allows configuration of recording parameters</li> <li>Includes schedules, data rates, frame rates, streams, and privileges</li> <li>Allows management of users and groups with privileges and roles</li> <li>Allows configuration of load balancing parameters (bandwidth and iSCSI connections) per disk array (IP address)</li> </ul>

## 2.2 E-Series 2600 Architecture

The Bosch VRM solution is built on the E2612 E-Series storage system. This storage system features a single or dual E2600 RAID controller with one to seven DE1600 2U 12-drive shelves as expansion or one to three DE6600 4U 60-drive shelves. Each DE1600 2U 12-drive shelf is populated with 2TB near-line SAS (NL-SAS) drives, and each DE6600 4U 60-drive shelf is populated with 3TB near-line SAS drives.

The E2612 is a fifth-generation storage array that includes patented mechanical engineering and provides dense, scalable, and highly reliable bandwidth and capacity. The disk controller firmware supports an optimal mix of high-bandwidth large-block streaming and small-block random I/O, making it one of the fastest storage systems in the market. The E2600's fully redundant I/O paths, advanced protection features, and extensive diagnostic capabilities deliver high levels of availability, integrity, and security.

In addition, a base E2612 may be expanded with the addition of one or more corresponding DE1600 or DE6600 disk expansion shelves. These are daisy-chained to the E2612 to provide expansion storage behind the RAID controllers in the base unit. With this capability, the Bosch VRM solution can be architected to scale capacity and bandwidth independently to best meet customer requirements.

The 2U 12-disk shelf is a great fit for cost-conscious organizations that need to deploy both performance and capacity drives, enabling optimized configurations that best meet performance, capacity, or cost requirements.

The industry-unique, 4U 60-disk high density shelf supports up to 60 NL-SAS drives in just 4U of height. It is perfect for environments with vast amounts of data and limited floor space.

As shown in Figure 2, the E2600 controller with the E2612 shelf package supports single- and dual-controller canister, power supplies, and fan units for hardware redundancy. This shelf is sized to support 12 disks.

**Note:** Empty slots in any attached disk shelf are counted as drives when calculating the total drive count on an array (maximum of 7 x DE1600 or 3 x DE6600 extension shelves).

Figure 2) E2612 controller/DE1600 disk shelf.

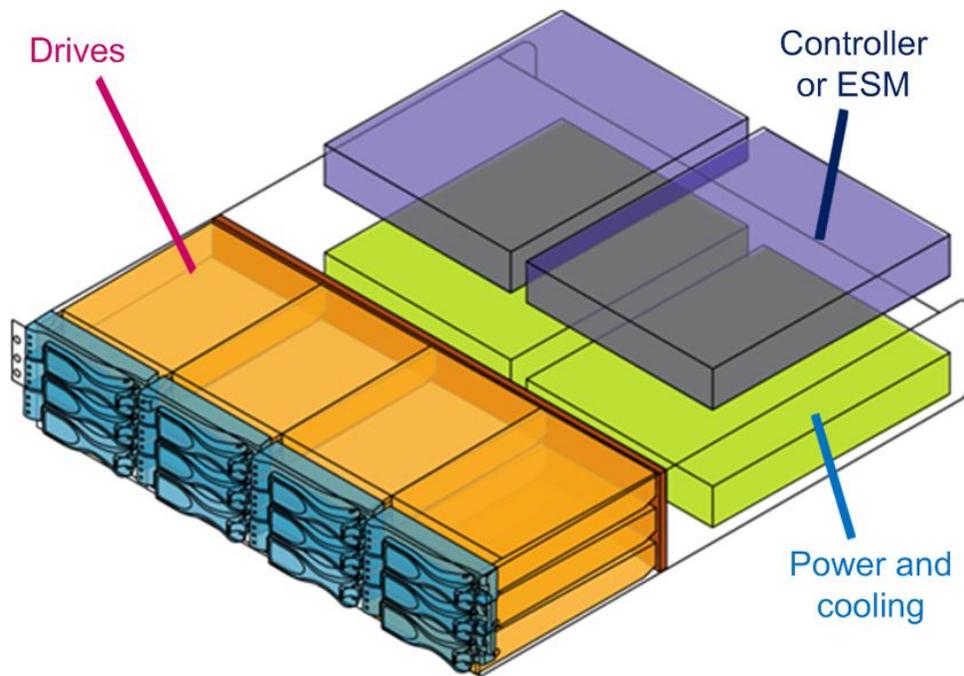


By default, each E2600 controller supports one 10Gb iSCSI port for video traffic. The disk shelf supports both controllers or ESMs, as seen in Figure 3 and Figure 4.

Figure 3) E2612 controller.



Figure 4) DE1600 disk shelf components.



The 4U 60-drive enclosure is seen in Figure 5.

Figure 5) 4U 60-drive enclosure.



The DE6600 enclosure only supports ESMs, as seen in Figure 6.

Figure 6) DE6600 disk shelf components.

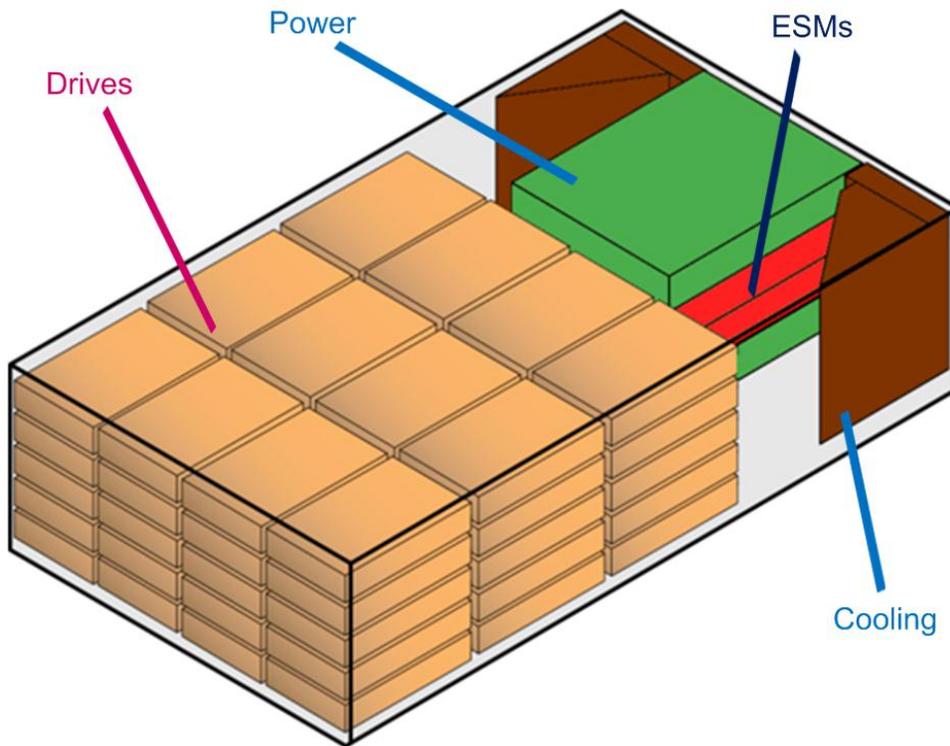


Table 2 describes the guidelines for E-Series disk expansion.

Table 2) E-Series disk expansion guidelines.

Category	E2612 with DE1600	E2612 with DE6600
Form factor	2U/12 drives	2U/12 drives + 4U/60 drives
Maximum disk drives	96	192
Controller shelf	1	1
Maximum expansion shelves	7	3
Total number of disk shelves	8	4

For more information, refer to the datasheet 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, which is intelligently allocated as needed. As the IP cameras and encoders record directly to the iSCSI storage and are only managed by VRM, the need for server hardware, operating systems, and antivirus software, as well as 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 system-wide 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 a revolutionary concept of a storage virtualization
- Enables:
  - Direct communication between the camera and the storage without involvement of a server
  - The decision where to record is taken in the camera
  - 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
- “Pay as you grow” concept; easy to add extra storage or cameras with 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**

- Continuous recording even when the “traffic cop” fails
- Each IP camera can independently stream to its current iSCSI targets
- In case an iSCSI drive or LUN fails, VRM provides access to another iSCSI drive
- Only reallocates data streams 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)
- Support for Contour Shuttle Pro
- 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 provides a high-performance, flexible, scalable, and highly reliable storage management solution for IP network video recording. The Bosch VRM solution offers many benefits such as huge cost savings by 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 (USPs)

- Ease of setup due to fewer hardware components.
- "Pay as you grow" concept; easy to add extra storage without requiring a "balanced" upgrade; upgrades not "unbalanced" when adding cameras/storage.
- 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 where to record is taken in the camera itself.
- Every camera/encoder adds additional computer power.
- Virtualization does not take place on physical hardware (server/storage).
- "Hot standby (N+1)" not required.

### 4.2 Value for Your Money

Bosch's VRM software adds system-wide recording management for direct-to-iSCSI RAID storage. It 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. It balances video loading across your network, making full use of available space to maximize return on your storage investment. You also gain added flexibility as 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 CCTV and video surveillance and offers the one of the highest levels of RAID redundancy.

Bosch and NetApp RAID 5 technology can deliver "peace of mind" 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.** Obtained by the use of intelligent addressing on a block level, which also allows for load balancing of video recording to all available storage blocks located on any storage array in the system.
- **Load balancing.** 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 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 for redundant management of metadata and also introduces a significant enhancement of 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 greatly reduces the risk of system failure.

A glossary of terms used in the VRM solution is described in Table 3.

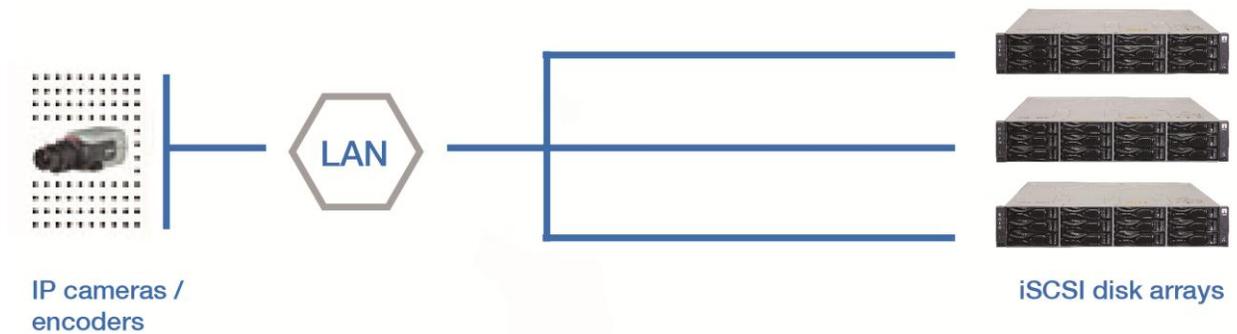
Table 3) Glossary of terms.

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
CCTV	Closed-circuit television
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
ANR	Automatic Network Replenishment
ATM/POS	Automatic teller machines/point of sale

### 5.1 Direct-to-iSCSI Recording

Figure 7 shows the direct-to-iSCSI recording feature.

Figure 7) Direct-to-iSCSI recording.



## Application

IP cameras need to be recorded for long-term archiving, for example, 30 days. Recording solution is cost critical and needs to have a low TCO.

## Solution

Groups of IP cameras or encoders record data to the iSCSI disk arrays directly. 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.

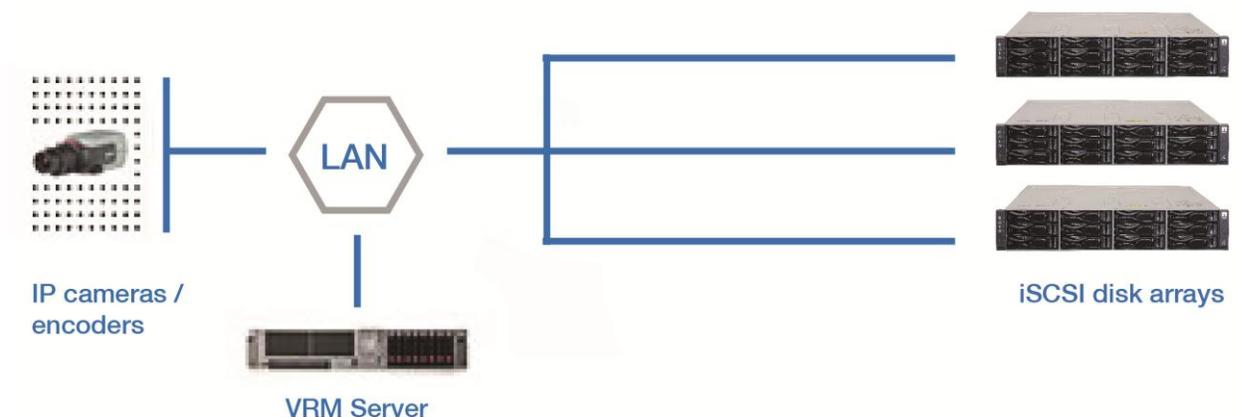
## Notes

When one iSCSI disk array fails, a recording group of cameras can stop recording. Using a VRM-based system is advised in this scenario.

## 5.2 VRM iSCSI Recording

Figure 8 shows the VRM iSCSI recording feature.

Figure 8) 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 to the iSCSI disk arrays directly. 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/fails, the server redirects the recording to another available iSCSI disk array. Full redundancy is created, and the cameras/encoders still function if the iSCSI disk array fails when the VRM server is not available.

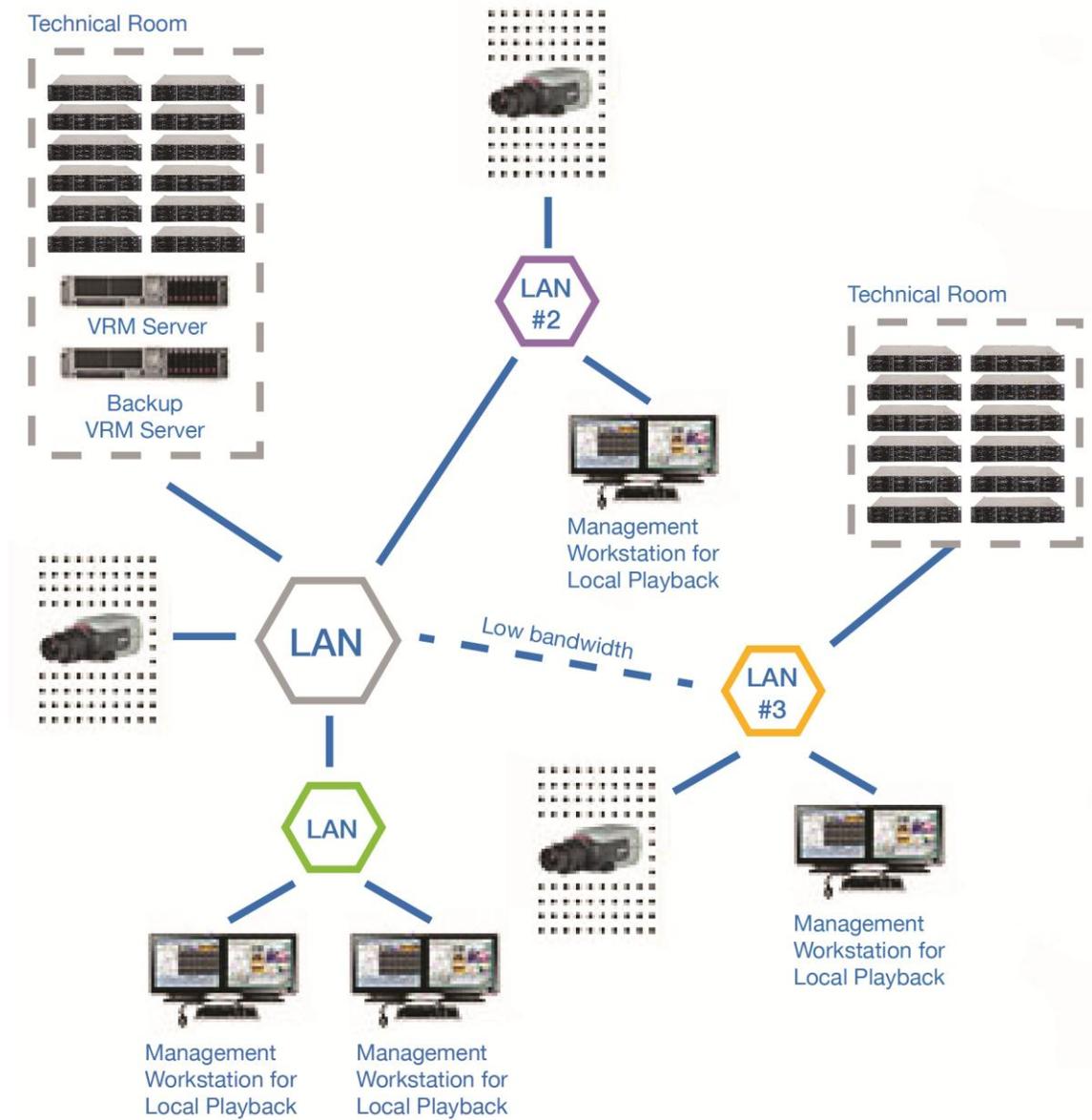
## Notes

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/encoders still know where to record or fail over for an average of two days (actual time is dependent on the bitrate).

## 5.3 Large-Scale VRM System

Figure 9 shows a large-scale VRM system.

Figure 9) Large-scale VRM system.



## Application

Large-scale, highly redundant IP video recording solution.

Example: deployed at airports.

## Solution

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

## Notes

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

## 5.4 Solution Reference Example

This solution demonstrates how VMSs work together with the Bosch VRM solution and the NetApp E-Series E2600. This solution scales up to multiple thousands of cameras or encoders, for example, for airport or casino deployments. Bosch Security Systems and the NetApp Array Product Group QA department have built and tested this solution in their labs.

A single Bosch VRM can handle up to 2,048 camera channels, and a single NetApp E2600 dual-controller storage system can support 800 cameras, 1600Mb/s and 470TB usable capacity. Therefore, for example, a scale out to 3200 cameras would only need 2x VRM server and 4x NetApp E2600 storage systems.

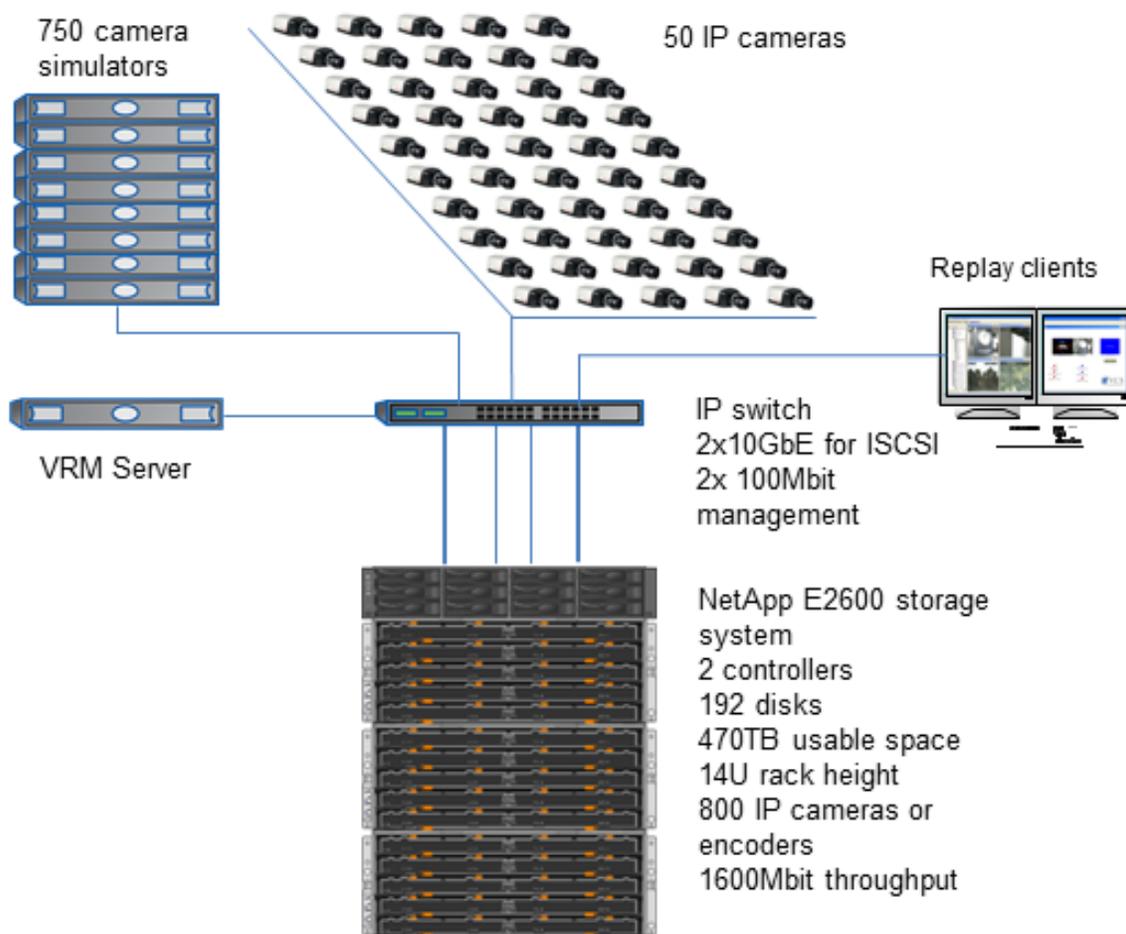
### Reference Test Case

The tests determined that:

- A single E2600 dual-controller system can achieve the write throughput of 1600Mb/s with 800 concurrent camera streams, using a 10Gb iSCSI connection.
- The E2600 storage system also provides 10% replay throughput capacity.
- The E2600 storage system also meets the preceding performance specifications, under a disk rebuild condition.

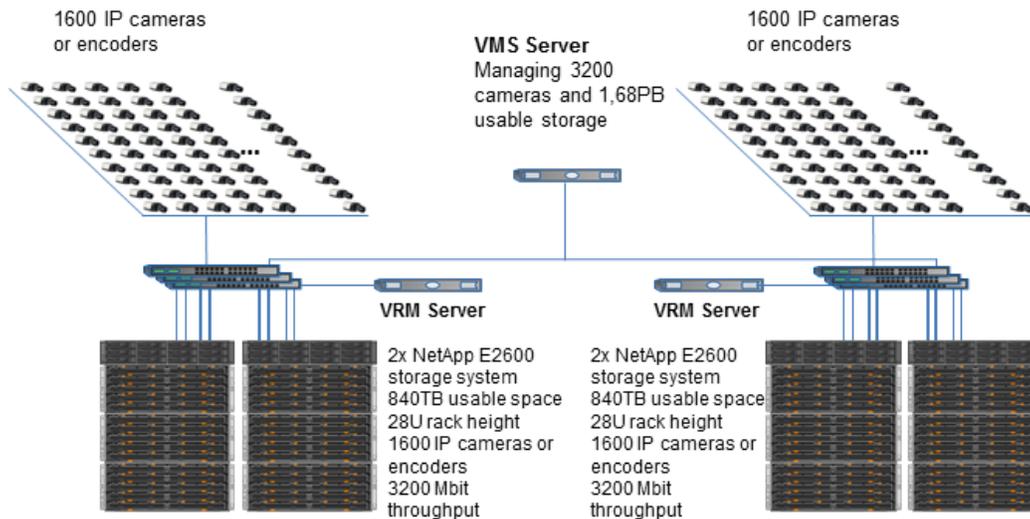
The reference setup for this test case is seen in Figure 10.

Figure 10) Reference setup.



The configuration seen in Figure 11 is a typical setup for a large-scale environment using a video management system such as the Bosch VMS.

Figure 11) Typical setup for a large-scale environment using Bosch VMS.



The Bosch VRM solution also works with other video management systems such as Genetec, giving you the advantage of having a simple and highly scalable recording solution.

## References

The following references were used in this document:

- Bosch worldwide  
[http://www.bosch.com/worldsite\\_startpage/en/default.aspx](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>

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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