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# Shadow Archiving in Video Surveillance Systems

## Fail Safe Recording Options for IP Edge Devices



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### Executive summary

IP video systems can be vulnerable to interruptions caused by network faults, server failures or power outages, and the cost of mitigating these risks has traditionally been high. Shadow Archiving™ introduces a high level of fault tolerance at an economical cost. Onboard memory in IP cameras and encoders is utilized to provide distributed video redundancy and enable direct client software access, as well as compile a mapped directory on the VMS – the Shadow Archive.

### Introduction

Shadow Archiving is an innovative feature that offers significant benefits to video surveillance systems, and establishes a path for the future development of virtual storage technology.

The Shadow Archive is defined as a directory that maps the video of all onboard edge device storage to a central VMS and is accessible via client software.

That is, it forms a 'shadow' on the central VMS archive of all the video data available on IP cameras and encoders with onboard storage or a direct NAS connection.

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### Background

Several manufacturers have announced IP cameras with a built-in DVR. For the most part, however, these cameras

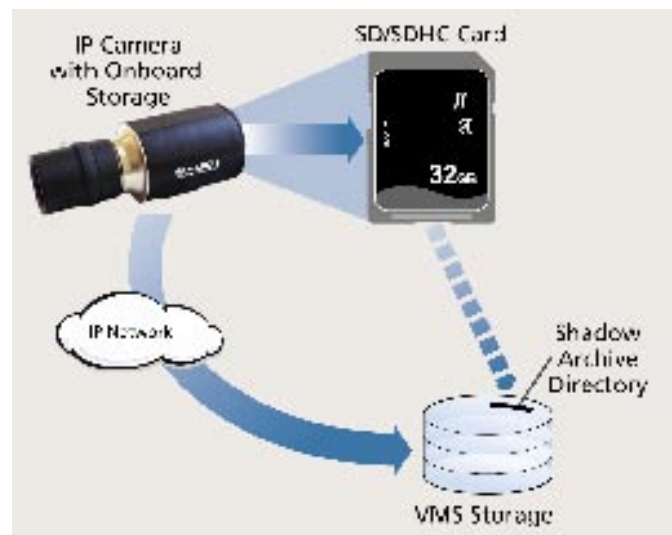


Figure 1: The Shadow Archive

are passive devices that simply have onboard memory. In fact, in some instances the memory is only accessible by manually removing the storage, such as an SD card. Imagine a network outage, or a storage server crash lasting a couple of hours, and then having to physically retrieve the video from 50 or more cameras, some of them in remote locations. The solution is simply impractical. Other camera manufacturers enable access over the network via a web browser interface, and while this may be practical for up to a few cameras, it is hardly a scalable solution. Shadow Archiving eliminates the need to extract video from the cameras manually or to switch to a different software application to retrieve the data.

Newer edge devices enable automatic recovery of any missing video by transferring it to the central storage server

once network connectivity is restored. Again, for a few devices, this solution undoubtedly functions well, but with many more devices or longer duration outages, such a solution can significantly increase peak network loading, the very issue that manufacturers are trying to avoid by touting distributed storage at the edge.

The implementation of a Shadow Archive avoids such problems, while still permitting the user to download important video evidence either on demand, or according to user-selectable system policies that effectively control network loading.

Shadow Archiving can automatically synchronize the video stored on the edge device with that of the VMS central storage according to well-defined user policies. Access to the SD card video is also possible via the central directory. This is the essence of virtual VMS storage.

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### DVR and server-centric solutions

Where some leading DVR and hybrid DVR systems have achieved a level of reliability that is unrivalled in the IT sector, server-centric solutions suffer from certain drawbacks. For example, servers tend to be centralized with higher IP camera counts (typically 30 or more cameras on a single server) and, in large systems, even hundreds of cameras route to a central location on multiple servers. Vulnerability to a network outage, server failure or a power outage is therefore significantly increased. DVRs, on the other hand, generally have fewer cameras (usually between 4 and 16) and are deployed in a distributed architecture such that the risk of a significant failure, and the consequent loss of video, is

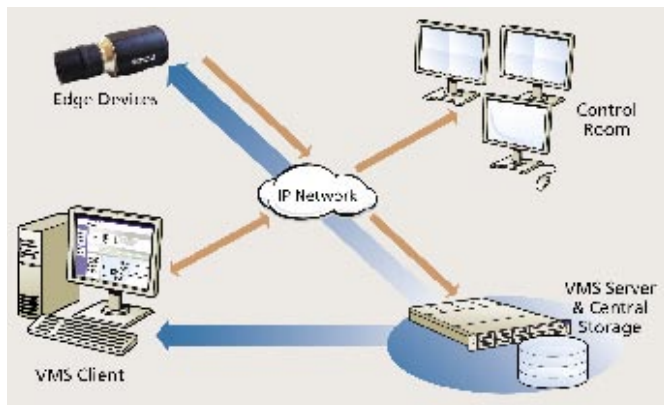


Figure 2: Server-Centric Architecture

considerably reduced. Figure 2 illustrates the risk associated with a server-centric solution.

- The server connects to the edge device and requests the video stream.
- The VMS records the stream to its local storage.
- The server receives a request from the client and streams either live or recorded video.
- In the case of a server failure or a network outage, the link between the VMS and edge device is broken and the recording is lost.
- With this architecture, server or network redundancy is the only option to ensure that the system keeps recording, which increases cost significantly.

### Shadow Archive solution

Where a server-centric system can potentially suffer from catastrophic failure, the introduction of a Shadow Archive mitigates this risk by distributing a portion of the video storage at the edge. Moreover, Shadow Archive-enabled devices proactively establish contact with the VMS rather than the other way around. As a consequence, the edge device is ‘network aware’, and essentially operates as a VMS in its own right – an important distinction from standard edge devices with embedded storage. See Figure 3.

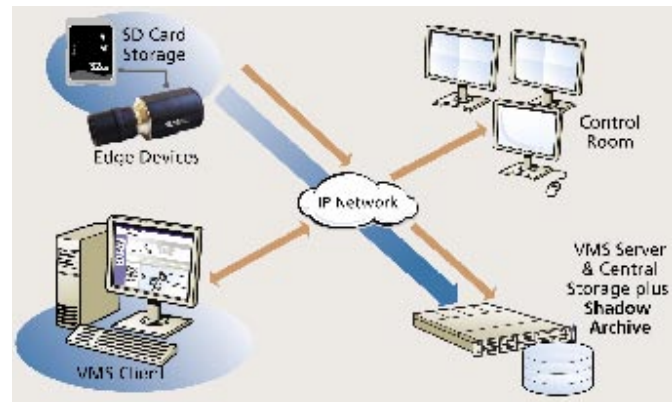


Figure 3: Shadow Archive Architecture

- Edge devices are equipped with local storage on SD cards.
- Edge devices call the VMS and transmit their status.
- The central server automatically detects and maps the devices’ local storage.
- The client connected to the VMS is aware of the current edge device configuration.

### Storage at the Edge

The use of Shadow Archive-enabled devices makes a system particularly robust in the event of a network or

server outage. Because of the inherent, standalone capability of such devices, the client software is able to access each edge device independently, not only for live viewing, but also for searching and downloading the video data stored onboard. In addition, video may be streamed to a NAS unit as an alternative storage solution. This differs from server failover because a central VMS is not required, a far simpler method of providing backup storage in the event of longer duration outages. See Figure 4.

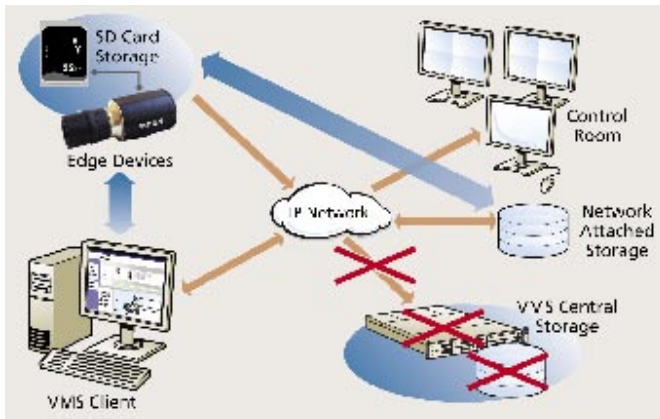


Figure 4: Robust Storage Architecture

- In case of server failure or a network fault, a direct connection between the client and the edge device is established, allowing transparent access to all the resources even with the server offline.
- An alternative or parallel network path may be established between the edge device, a NAS unit and the VMS client.

In fact, any number of cameras may be connected to a single NAS, offering a cost-effective alternative to numerous SD cards inside each camera. Further still, the NAS may also be accessed directly via the VMS client software, and performs exactly the same function as the SD card for the purpose of Shadow Archiving. One obvious exception to this solution would be the loss of a network connection to the NAS array.

Shadow Archiving combined with NAS recording strengthens system redundancy and video access dramatically, and together serve as early indicators of the evolving importance of edge-based IP video architectures.

## Increased reliability through Shadow Archiving

There are a number of standard methods used to mitigate the potential loss of critical video evidence in server-centric systems. Shadow Archiving provides a powerful and economic solution.

System Problem	Standard Remedy	Cost	Shadow Archiving Solution	Cost
Storage server down	Redundant or fail-over server	Moderate	Provides storage redundancy and reduces need for redundant or failover servers. NAS units provide a further storage option.	Low to Moderate
Power outage	UPS or generator back-up	High	Most edge devices use PoE. De-voicing backup power for PoE devices is far less costly to install and distribute.	Low to Moderate
Network outage	Network redundancy or independent video network	High to Very High	Operates independently of the network. Network redundancy can be reduced to a minimum.	Low
Network congestion	Reduce data rates or increase bandwidth	Low to High	Dual streaming from edge devices means high quality or cood recording and optimizes bandwidth streaming utilizing available network capacity.	Low

Table 1: Standard Measures for Protecting Video Systems versus Shadow Archiving

## Onboard storage capacity

So what storage capacity is typically required for Shadow Archiving purposes? The maximum capacity of SD cards available today at a reasonable cost is 32GB. For continuous, high quality recording with H.264 compression, Table 2 shows approximate storage times on a 32GB card.

Bit Rate (Mbps)	Storage Time (Hours)	Frame Rate / Resolution Equivalent
8	9	1080p or 2 MP @ 30 fps
4	18	720p or 1 MP @ 30 fps
2	36	720p or 1 MP @ 15 fps
1	71	3' @ 30 fps
0.5	142	3' @ 15 fps

Table 2: Storage Capacity of a 32GB SD Card

At medium quality, storage time practically doubles. Therefore edge device recording policies could include such options as:

- High quality, continuous recording.
- Alarm or motion recording only.
- Reduced frame rate and/or quality when an outage occurs.

These video retention times will cover most disruptions in service. For example in North America, carrier network outages of two minutes or more are typically registered for immediate action, and any outage over 30 minutes is considered severe. Of course, many issues can occur on the LAN, which will depend on corporate resources to restore service in a timely manner. Shadow Archiving is not intended in its primary form to replace local or central (long-term) storage devices, although such a concept is easy to envision in the future as flash memory, such as SD cards or micro SD cards, increase in capacity and decrease in cost.

## Retrieving the Shadow Archive

Fast access to the video stored in onboard memory is an important characteristic of Shadow Archiving. In general terms, users should experience little delay in accessing recently recorded video. For short duration outages of less than two minutes, which might occur upon a VMS server reboot

or failover for example, the Shadow Archive on the VMS enables normal user access via the client software and the VMS Shadow Directory. A single click opens the edge device's recording window to enable the immediate review or retrieval of the video.



**Figure 5: Accessing the Shadow Directory**

In instances of longer duration outages without a VMS, the client software connects directly to the individual devices, from which the video may be viewed live or downloaded. Furthermore, upon restoration of the VMS server, a number of user-selectable policies ensure that network traffic is carefully controlled through automated recovery sequences using intelligent streaming. Such policies might include downloading the last X minutes or downloading alarm or motion-triggered video footage only, in addition to the option of downloading all video recorded during an outage. The sequence would include automatic insertion of the specified video segments into the main VMS archive, an important feature for compliance with video retention policies that exceed the capacity of the SD cards on the edge devices.

**Shadow Archiving combines the scalability of central archiving with the fault tolerance of distributed archiving**

### Conclusions

Shadow Archiving combines the scalability of central archiving with the fault tolerance of distributed archiving. It is an effective and economical method for reliable video backup in server-centric video surveillance systems.

#### Its key benefits are:

- Network fault tolerance.
- Redundant video storage at the edge.
- Rapid access to critical video evidence.
- Automated video recovery. ■

