White Paper

NetApp E-Series Storage for Video Surveillance

The advantages of simple, reliable block storage in video surveillance environments

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Abstract

This white paper presents the advantages of NetApp® E-Series' block SAN storage over scale-out NAS file systems in video surveillance environments.

Given the rapid growth in video surveillance data, organizations need reliable, affordable storage solutions that can scale quickly without complex management overhead. Complexities inherent in scale-out file system architectures can cause performance and management bottlenecks and introduce security vulnerabilities. E-Series offers advantages in video surveillance environments, including modular scalability, lower risk, and simplified management.

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1 Introduction

From on-body police cameras to 24/7 monitoring of major transportation hubs, video has become a strategic source of information, insights, and intelligence. Major cities throughout the world are mounting video surveillance cameras to watch over streets, subways, mass transit, parks, and other public places.

Although physical security continues to be the primary use case for video surveillance, the advent of intelligent video is expanding the use of video surveillance imagery for new use cases in operational efficiency, marketing and demographic analysis, and true business intelligence. More and more, line-of-business stakeholders use video surveillance images to affect net-new revenue and measurably reduce costs.

These new intelligent video surveillance cameras and analytical applications are capturing more information than ever, causing an increase in requirements for bandwidth, write speeds, and storage capacity. And as video resolution and retention requirements increase, the volume and size of media content are growing quickly.

As a result, retail enterprises, governments, and other public entities are faced with serious challenges with respect to media storage. Traditional storage architectures are not designed for massive amounts of big video content. And with more cameras, expanding retention periods, and rising camera bitrates, traditional standalone network video recording (NVR) solutions are becoming costly and inefficient.

Organizations now look to enterprise storage vendors to help them handle the rapid increase in data volumes. Two architectures dominate the storage space for video surveillance solutions: scale-out file systems (SOFSs) and block-based architectures.

Although scale-out file systems can address video surveillance workloads, even modern implementations introduce unnecessary complexity that can reduce reliability and increase management overhead. This paper explains how block storage—NetApp E-Series, in particular—provides advantages for video surveillance workloads.

2 Block I/O in Video Surveillance

2.1 Workload Requirements

Surveillance environments have a unique set of requirements that can be challenging for any storage environment. Unlike typical enterprise workloads that are characterized by a high proportion of read operations, surveillance environments are dominated by write-intensive workloads. In such an environment, as much as 99% of the workload is writes. Multiple streams of video are captured and sent concurrently to storage. Each stream is sent as a sequential write, but because there are so many streams, they appear random to the storage. From there they are grouped and stored per retention requirements, which could be anywhere from 30 days to over 1 year. During that time, data continues to fill the storage volume. When the retention period is over, the oldest data is overwritten.

Data management is largely handled by video management software (VMS). As a result, the storage array needs to be fast enough to receive the data and retain it for the specified retention period, making advanced features and functions in the storage array largely unnecessary. Once the storage is presented to the operating system and the VMS provisions the storage for the cameras, there might be no interaction with the dataset for years.

Video surveillance is a “set-it-and-forget-it” workload that runs like an embedded application or engineered appliance. As such, it requires high performance to support read workload spikes, security and high availability for nonstop operation, and affordable scalability to support massive growth.

2.2 NAS Versus SAN in Video Surveillance

As enterprise storage becomes more critical to the security, reliability, performance, and cost of video surveillance, organizations must decide between two fundamentally different storage approaches: SAN and NAS.

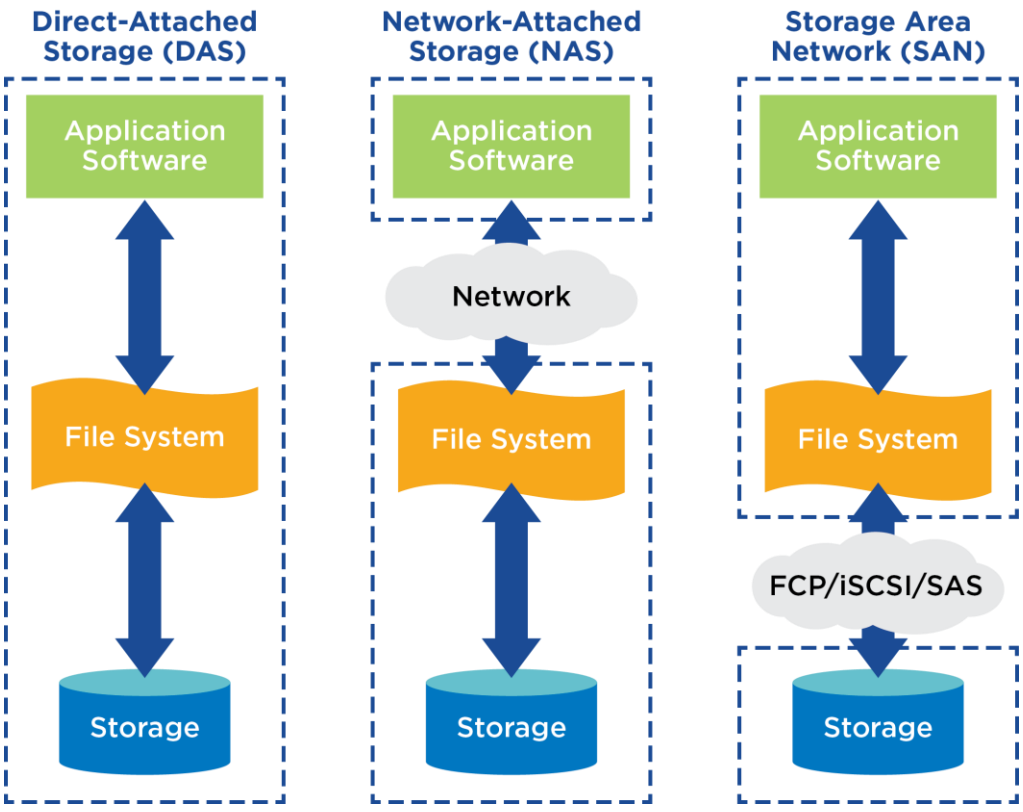
NAS systems store data as files and present those files in a file system. With NAS, applications communicate to the storage device through TCP/IP. With SAN, multiple devices are connected by a dedicated network and data is accessed as block storage. SAN presents volumes or logical units to the operating system directly through Fibre Channel, iSCSI, or SAS.

Scale-out NAS file systems might claim simplicity and high availability, yet complexities inherent in the scale-out architecture can cause management bottlenecks and introduce security vulnerabilities that are unacceptable in a surveillance environment.

With NAS connectivity, the storage is directly accessible through the TCP/IP connection. Because the file system resides in the NAS box, the operating system does not read or write files—the application does it directly. This approach offers universal access, which can be convenient in some use cases but can pose significant risks for security applications. As a result, file I/O requires additional layers of certifications and architectural features to prevent unauthorized access to information. These layers can add complexity, decrease security and reliability, and drive up the total cost of ownership. The added layer of NAS protocols, such as CIFS and NFS, might also affect the performance and add delay in the path of the I/O.

With block I/O, the storage is not accessible through TCP/IP, making it difficult to gain unauthorized access. The file system does not live in the storage; it lives in the operating system. Furthermore, access to the storage is controlled by the operating system, so unauthorized access to the storage does not threaten the dataset directly. This fundamental architectural difference makes block I/O simpler and easier to secure.

Figure 1) Storage architecture differences.



3 NetApp E-Series Solutions for Video Surveillance

Through dedicated storage and simple data management, NetApp E-Series block storage systems deliver the performance, capacity, and availability that surveillance workloads require. E-Series is a proven platform with a 20-year history of development and optimization. With more than one million systems shipped, NetApp E-Series technology is found in enterprise SAN application environments that support workloads of every size, from the smallest mixed-workload environment to the world's largest computing systems.

NetApp E-Series storage systems use a modular architecture that offers a true pay-as-you-grow solution to address the new big video data storage requirements. E-Series storage offers both entry-level and midrange arrays:

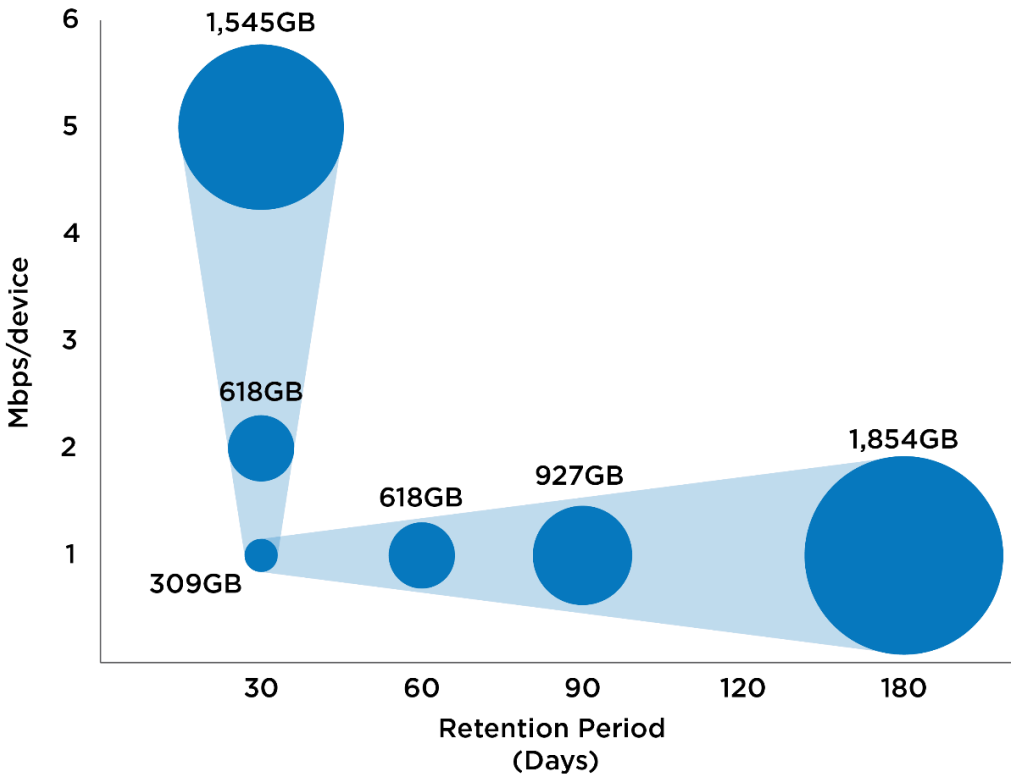
- E2800: The NetApp E2800 storage system offers disk, all-flash, and hybrid configuration options to streamline IT infrastructure and drive down costs. Pay-as-you-grow flexibility makes the E2800 an ideal entry-level storage system for surveillance environments that need to start small and grow to several hundred cameras.
- E5600: The E5600 storage system is ideal for large video surveillance installations in which the number of cameras, the type of cameras, and the retention periods require a high-performance, large-capacity storage system.

With fully redundant I/O paths, advanced data protection features, and extensive diagnostic capabilities, all E-Series storage systems deliver greater than 99.999% availability and provide data integrity and security. E-Series' modular architecture makes it easy to size and scale the storage environment for capacity and performance based on three variables:

- Number of cameras streaming data to recorders
- Average sustained throughput per camera over a 24-hour period in millions of bits per second (Mbps)
- Retention requirements (days)

Figure 2 shows the relationship among these variables. For example, one camera sending 2Mbps with a 30-day retention period requires 618GB of storage capacity. The capacity requirement scales linearly with throughput and retention requirements, making it simple to size and plan your environment.

Figure 2) Simple sizing with E-Series: storage required for a single camera with a given throughput and retention period.



3.1 Simplicity

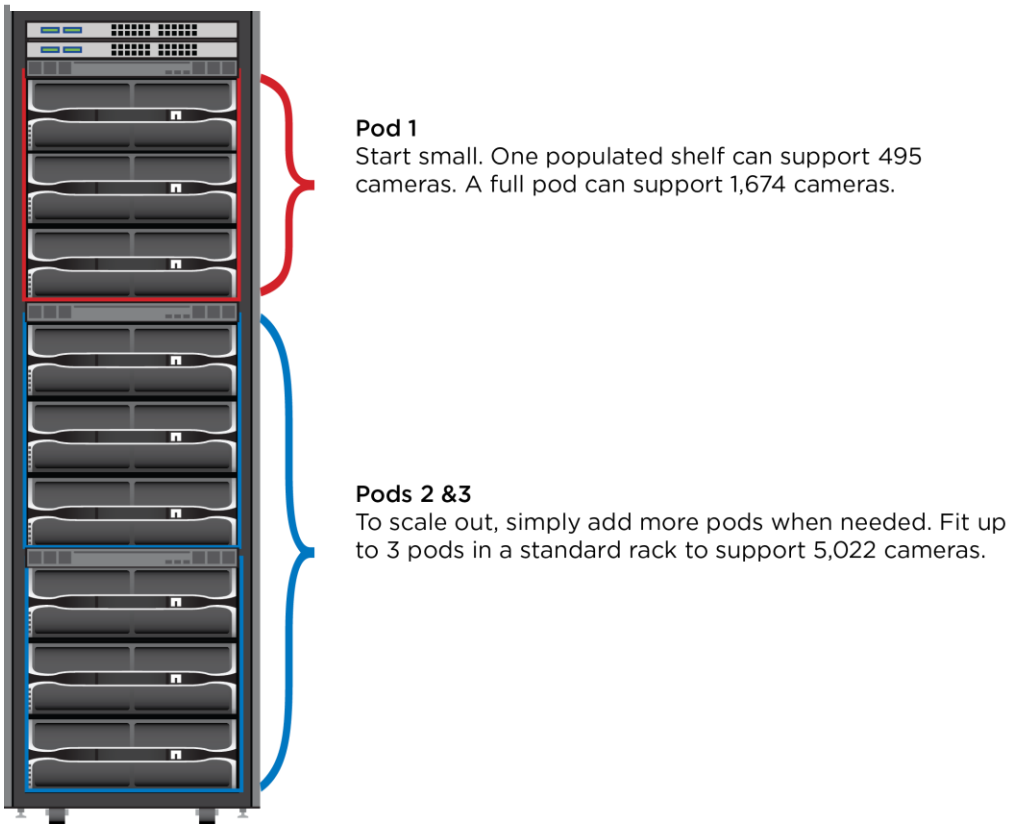
In a video surveillance environment, simplicity is critical. Because the environment does not require complex architectures, features, or functions, unnecessary complexity only serves to reduce reliability, slow performance, and increase costs.

Furthermore, surveillance environment administrators are often more experienced in the VMS than in enterprise storage systems. Complexity in the storage environment could require additional training for features that are not needed for video surveillance workloads.

Simple Scalability

NetApp E-Series offers a granular, building-block approach to growth. You can start as small as one half of a standard 12-drive shelf, which provides 40TB capacity[1] and can support 61 camera streams,[2] and grow to tens of petabytes of storage. E-Series is also available in high-density, 60-drive shelves that can support 558 cameras each.[3] Additional capacity can be added seamlessly in any increment—one or multiple drives at a time. Capacity can also be added nondisruptively with or without additional controllers, enabling organizations to scale capacity independent of performance for scale-up or scale-out as the specific deployment warrants.

Figure 3) E-Series provides reliability at scale.



Whereas some scale-out architectures might require multiple platforms and identical models to scale, E-Series' modular scalability provides maximum density, performance, and reliability in a single architecture. And unlike scale-out file systems that can require weeks or months to rebalance clusters after adding nodes, E-Series enables seamless scalability without lengthy rebalancing or downtime.

E-Series has no single pool or cluster size limits and no minimum number of equivalent class nodes. Drives can be added individually using Dynamic Disk Pools (DDP) technology. DDP distributes data, parity information, and spare capacity across a pool of drives. A key feature of DDP is the capability to dynamically rebalance data across all the drives in the pool when drives are added or removed.

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[1] Drive size: 8TB in a RAID 6 configuration
[2] Assumes 2Mbps streaming rate for 30 days
[3] 8TB in a 30-drive Dynamic Disk Pool

Unlike the rigid configuration of a traditional RAID volume group, which has a fixed number of drives, with DDP, multiple drives can be added or removed in a single operation. In this way, DDP makes it easy to add small numbers of cameras without overprovisioning. Adding capacity for additional cameras in a traditional RAID environment means adding a group of drives. DDP makes it possible to add a single drive to the pool to accommodate a few additional cameras.

DDP dynamically rebalances across the remaining (or additional) drives more quickly than traditional RAID does. This faster rebalancing also applies in the event of a rebuild. If additional drives fail, faster rebuilds on failed drives reduce the exposure window for data loss from days to minutes.

Video Surveillance as a Service: The Advantage of Block Storage

With the rise of video surveillance as a service (VSaaS), management simplicity and reliability are more important than ever. With multiple tenants and multiple customers, setting up storage can carry significant management overhead for service providers. Quotas must be set up and IP addresses must be assigned for every customer. Management complexity can slow provisioning and customer serviceability, leading to a loss of profits. Reliability is an even greater concern in a VSaaS environment in which service providers must deliver on service-level agreements for uptime and availability.

Scale-out file systems might claim to offer management simplicity through a single pool of storage. However, in a multitenant VSaaS environment, scale-out file systems require additional management to set up and manage storage containers. Administrators must set and manage quotas and IP addresses for multiple directories and subdirectories, which can require constant attention. With E-Series block storage, setting up a container is as easy as assigning a Windows volume to a tenant.

Some SOFSs measure availability in terms of “mean time to data loss,” making empirical data on availability difficult to obtain. Upgrades can be disruptive, and nodes can take months to rebuild following a failure. E-Series delivers 99.999% availability or higher with built-in redundancy at the node level and Dynamic Disk Pools technology to enable exception performance in the event of a failure.

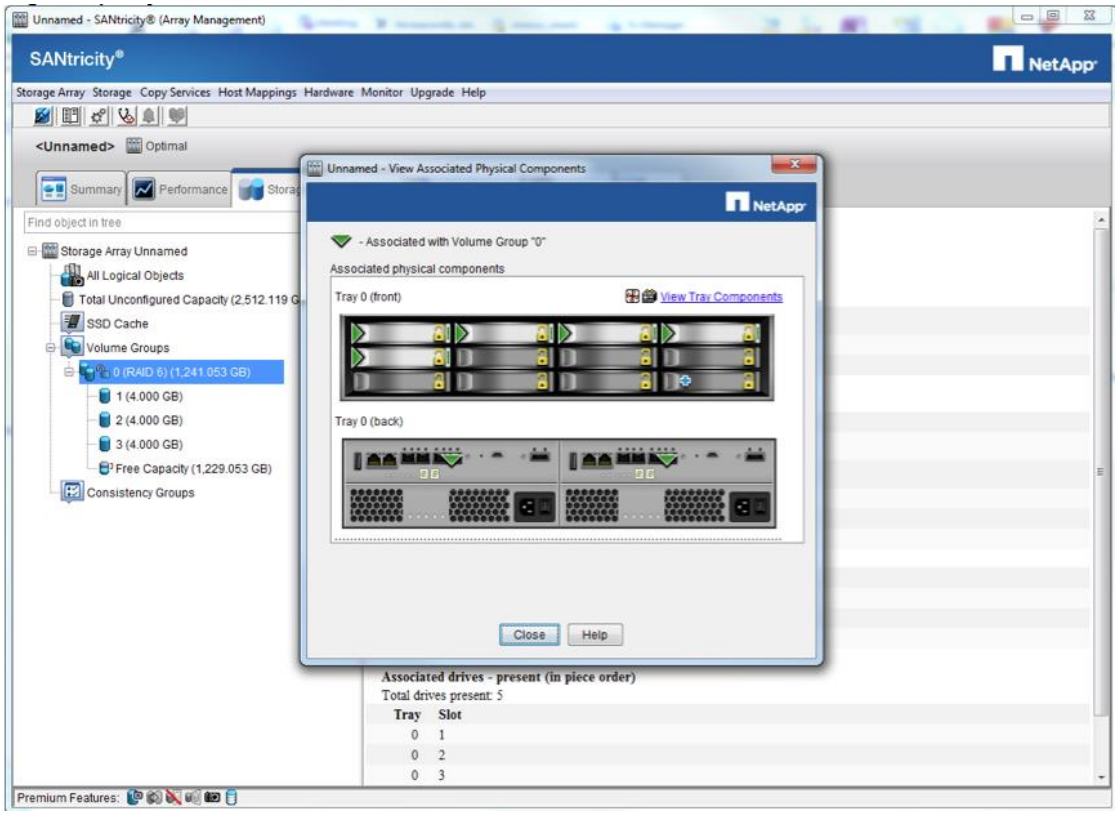
Easy Manageability

As video surveillance data continues to grow, organizations find themselves managing petabytes of video data. Easy manageability can help these teams grow capacity without adding significant headcount.

NetApp E-Series SANtricity® software enables storage administrators to manage 90+ storage arrays—more than 270PB[4]—from a single pane of glass. SANtricity Storage Manager provides an easy-to-use, intuitive interface for managing multiple E-Series systems at one time. Graphic displays enable administrators to monitor, fine-tune, and optimize system performance.

[4] Based on 8TB drives

Figure 4) SANtricity Storage Manager enables management from a single pane of glass.



Although SOFSs offer limited application integration, E-Series' application-aware plug-ins for VMware and Microsoft enable seamless integration into many of the most popular environments. These plug-ins treat storage as a native component of the application and infrastructure setup. They allow the infrastructure administrator to perform storage-related tasks, such as volume creation, volume mapping, and error log reviews, without leaving the application's user interface.

E-Series' simple scalability through a block-based modular architecture also makes it easy to install and manage, particularly from a cabling perspective. For instance, the E5600 requires only one pair of array controllers for every five storage shelves. Because only controller shelves are required to connect to the data and management networks, the solution requires 10 network/host cables for every 6 shelves. This feature reduces port requirements on the storage side as well as the access layer of the network.

In SOFSs, best practices require every box to connect to the network. Compared to one scale-out architecture, E-Series can reduce the active port requirements from a networking perspective by up to 70% and reduce passive cabling by up to 80% in a 40U rack. This reduction in cabling alone leads to significant improvements in management and cost.

Efficiency

With E-Series, volumes can be designed in accordance with best practices and camera throughput requirements to optimize capacity planning. E-Series requires a minimal amount of reserve capacity for a rebuild in the event of a drive failure but it can utilize 100% of usable capacity. Capacity is allocated and managed by the SANtricity operating system, with DDP distributing data, parity information, and spare capacity across the pool of drives.

SOFSs require room for the clusters to function. With the file system spread over clusters, SOFSs operate best up to a maximum of 90% of the entire cluster capacity. For large installations, this capacity requires significant overprovisioning and results in a considerable cost burden.

Considerations for Deployment

- **Does the solution require multiple platforms to manage it?**
  Multiple platforms can increase management complexity. E-Series can scale to hundreds of petabytes within the same platform.
- **What happens if you run out of free space in the pool?**
  Best practices for certain scale-out file systems recommend that a minimum of one node's worth of free space be kept in the pool. If additional nodes are added, it can take weeks or months to rebalance the cluster. E-Series provides 100% usable capacity and makes it easy to seamlessly expand the storage system with no downtime.
- **Which application integrations does the solution offer?**
  Although SOFSs offer limited application integration, E-Series' application-aware plug-ins for VMware and Microsoft enable seamless integration into many of the most popular environments.

3.2 Reliability and Security

Reliability is a fundamental requirement in video surveillance, for which every minute of downtime is one that can never be recovered.

Cybersecurity is also a growing concern. Camera recording takes place behind the firewall, yet the cameras themselves are external to the facilities, which means that unauthorized access can take place through the camera environment. As a result, video surveillance environments are implementing hardware-based solutions and paying more attention to cybersecurity.

Security

Security is a fundamental difference between block and file systems. With block I/O, the file system lives in the operating system, which is a controlled environment. The storage is simply an extension of the server and its operating system, not a parallel or separate file system. The operating system security protocols prevent unauthorized access.

SOFSs, on the other hand, leave storage vulnerable to direct access through a TCP/IP connection. Individual files can be accessed directly through the application. Additional layers of certifications and features are required to secure the storage, duplicating functions that already exist in modern operating systems.

SOFSs also expose video surveillance environments to added risk of catastrophic failure. In a surveillance environment, there is a direct relationship between storage and compute; the more cameras that connect to a single pool of storage, the greater the risk for a widespread, catastrophic outage. To maintain the highest levels of security, organizations must limit the number of cameras connecting to a single point of failure.

The complexity of a scale-out file system allows potential catastrophic failure or unauthorized access that could compromise all cameras in the cluster. E-Series, on the other hand, is inherently redundant at the node level. E-Series' building-block approach provides functional isolation, protecting against total data unavailability. This compartmentalization is particularly valuable for environments in which safety and security are paramount.

High Availability

Scale-out file systems offer some level of drive failure redundancy by combining nodes, but the nodes themselves are not redundant. In a busy cluster, a node failure could take months to rebuild because intranode communication takes place over the same network that delivers camera data.

Some SOFSs measure availability in terms of "mean time to data loss," making empirical data on availability difficult to obtain. In contrast, data validated by IDC demonstrates that E-Series delivers availability of 99.999% or higher.[5]

E-Series storage systems provide high availability with built-in redundancy at the node level. Dual redundant controllers, multipathing failover, and dynamic features provide high-availability access to video surveillance recordings. With the SANtricity operating system, management tasks can be performed while the storage remains online, with complete read and write data access. This capability enables storage administrators to make configuration changes, perform maintenance, or expand storage capacity without disrupting I/O to attached hosts.

To deliver the highest levels of availability, E-Series uses technologies such as proactive monitoring, background repair, advanced protection, and extensive diagnostic features.

- **Proactive monitoring.** Using predictive failure analysis, E-Series systems issue critical alert messages and take corrective action when any error rate or degraded performance threshold is exceeded.
- **Background repair.** User-initiated background media scans proactively check drives for defects and initiate repairs before they can cause problems.
- **Advanced protection.** E-Series systems use RAID redundancy information to validate data. SANtricity encryption enables data to be secured throughout the drive's lifecycle without sacrificing performance or ease of use.

Dynamic Disk Pools (DDP) technology simplifies the management of traditional RAID groups by distributing data parity information and spare capacity across a pool of drives. DDP enhances data protection by enabling faster rebuilds after a drive failure, protecting against potential data loss if additional drives fail. DDP dynamic rebuild technology uses every drive in the pool to rebuild a failed drive, enabling exceptional performance under failure.

Considerations for Deployment

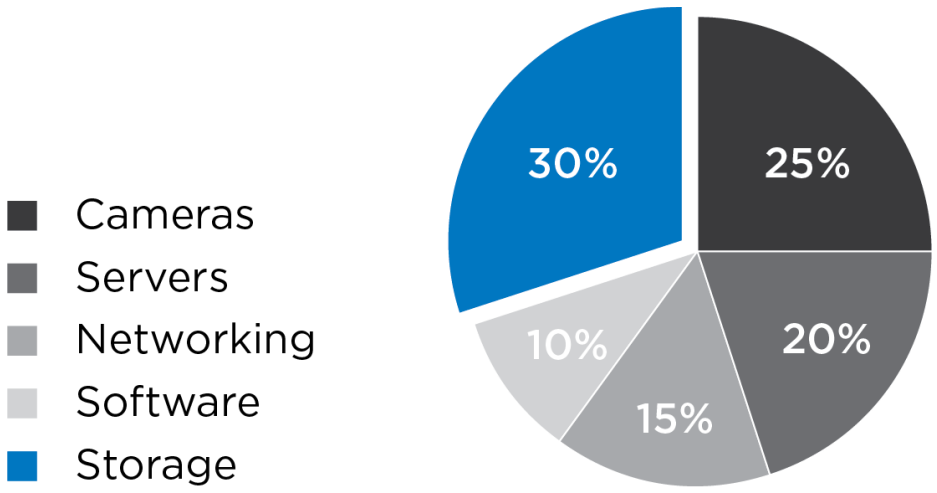
- **What is the solution's failure domain? Is it a node or is it a cluster?**
  For security, the ideal solution would have the smallest possible failure domain. For some SOFSs, the failure domain is the cluster. E-Series' failure domain is at the controller level, preventing total data unavailability.
- **Does the solution require disruptive upgrades?**
  In a video surveillance environment, no time is a good time for a maintenance window. While some SOFSs require rebooting clusters and/or nodes during upgrades, E-Series enables nondisruptive upgrades, demonstrating in excess of five-9s availability.
- **Does the solution expose the environment to cybersecurity vulnerabilities?**
  SOFSs leave storage vulnerable to direct access through a TCP/IP connection. With block I/O, the file system lives in the operating system, which prevents unauthorized access.

[5] http://www.netapp.com/us/media/wp-foundation-application.pdf

3.3 Cost Efficiency

Storage often accounts for a significant portion of the cost in a typical video surveillance environment. With data growing in size and volume, organizations need a way to quickly scale capacity without increasing operational overhead and costs. Figure 5 shows the cost breakdown for a surveillance system based on a typical 200-camera installation.

Figure 5) Storage represents a significant portion of the cost in a typical surveillance deployment.



Source: NetApp internal calculations based on representative sampling of customer environments.

Lower Capex and Opex

E-Series typically has lower acquisition costs than alternative systems and straightforward invoicing that includes the initial configuration and support, with no licensing overhead. Operational costs for maintenance, power, cooling, and space are lower because of efficiencies in cabling and storage density. Particularly for large installations, having only one controller for every five shelves can dramatically reduce power and cooling requirements compared to scale-out file systems in which a compute and storage node must be added for every capacity addition. Compared to one scale-out architecture, E-Series can reduce the active port requirements from a networking perspective by up to 70% and reduce passive cabling by up to 80% in a 40U rack. E-Series also offers 67% greater storage density than some scale-out file systems.

An SOFS approach is inherently complex, requiring multiple management layers, features, and functions. In addition to having a typically higher acquisition cost than block storage, scale-out file systems have greater operational costs because of management complexity and licensing fees. In a scale-out architecture, every node must connect to the data network and the management network, which can significantly increase active port requirements and passive cabling, resulting in greater management overhead.

Cost of Downtime

In a video surveillance environment, data is often not backed up using traditional methods. Because of the irreplaceable nature of surveillance data, it is important to consider the business cost of data unavailability or loss.

In a block architecture, failures occur at the component level rather than at the cluster level. As a result, E-Series tracks “mean time between failure.” DDP enables rapid recovery in the event of a drive failure, enabling 99.999% availability and no data loss.

In an SOFS environment, failure can be catastrophic and measured in “mean time between data loss.” Users might experience periods of data unavailability during a node or cluster rebuild, which can prove costly to the business when they occur in a video surveillance environment.

Questions to Ask

- **What are the operational costs for maintenance, power, cooling, and space?**
  E-Series has lower operational costs for maintenance, power, cooling, and space than some SOFSs because of efficiencies in cabling and storage density.
- **What are the management costs?**
  With E-Series, video surveillance administrators do not need specialized training to manage their environment. SANtricity Storage Manager provides an easy-to-use, intuitive GUI for managing multiple E-Series systems at one time.
- **What is the cost of downtime to the organization?**
  Data validated by IDC demonstrates that E-Series delivers availability of 99.999% or higher.[6] Some SOFSs do not calculate availability but measure “mean time to data loss,” which is not an acceptable outcome in a video surveillance environment.

4 Conclusion

Given the rapid rise in video surveillance data because of high-resolution cameras and longer data retention periods, organizations need reliable, affordable storage solutions that can scale quickly without complex management overhead.

Scale-out NAS file systems might claim simplicity and high availability, yet complexities inherent in the scale-out architecture can cause performance and management bottlenecks and introduce security vulnerabilities that are unacceptable in a surveillance environment.

NetApp E-Series’ block storage approach offers significant benefits over scale-out file system architectures, including modular scalability for capacity growth in small or large increments, lower risk, and simplified management.

NetApp E-Series’ high-density, high-capacity storage has reasonable lifecycle costs. With over one million E-Series systems shipped and 20 years of operating system hardening, E-Series is a market-leading design that provides outstanding reliability and greater than five-9s availability.

[6] http://www.netapp.com/us/media/wp-foundation-application.pdf

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.