Digital Video Surveillance Archive

Large-scale video surveillance archives with Scality RING Object Storage, Milestone XProtect VMS, and HPE Apollo 4000 series Servers

Technical White Paper
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A whitepaper done in collaboration with Scality partners Hewlett Packard Enterprise (HPE) and Milestone

Hewlett Packard Enterprise
The Open Platform Company
Digital Video Surveillance Archive

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Introduction

This white paper delves into the new era of digital video surveillance archives. Digital video is quickly replacing analog systems, driven by requirements for high quality images for enhancing detail under a variety of visual conditions such as motion, low-lighting, and distance. Digital video creates very large files that agencies may need to store indefinitely, exceeding the capacity and performance of legacy archive systems. This paper discusses a solution for lowering the costs of very high capacity archive storage using software-defined object storage, industry standard x86 hardware, and an open-platform VMS (Video Management System). These are the foundations upon which large scale digital video surveillance can be achieved with most efficient cost, scale, and performance.

The landscape of large-scale video surveillance is changing rapidly. A spectrum of differing surveillance systems such as ALPRs (Automatic License Plate Reader), body cameras, and multi-site IP videos with 24/7 coverage are more common today than ever. Advances in camera resolutions (full-HD to 4K), faster data transfers and immediate access to recordings, high data reliability without high data replication costs, high availability, limitless scalability, and deterministic performance are transforming the surveillance data centers. Critical to law enforcement and regulatory policies, the surveillance data are required to be retained for long durations to support the investigation and analysis of incidents. Rich metadata support in digital footage and object storage allows instant search and access to relevant information. Most VMSs have the ability to pull out video and create a “case” or “incident”, saving the video clip to long term storage (different tier) for years.

A robust digital video surveillance solution entails a substantial investment in storage for preservation and recall of video footage, especially at today’s petabyte scale. According to a 2016 Gartner report, storage represents at least 40% of the total cost of a video surveillance solution, and it continues to remain a challenge for large scale deployments. Airports, cities, manufacturing floors, traffic and transportation, government complexes, public safety, law enforcement, and multiple enterprises increasingly rely on digital video surveillance for every critical infrastructure.

With this urgent need for cost-effective storage, scaling to billions of files over several years, traditional or legacy file systems or databases are no longer viable; organizations must turn to unstructured, object-based storage for archiving video surveillance data. Legacy solutions face numerous challenges: surveillance images may lack clarity, have gaps in areas of coverage, or even delete footage, all due to storage constraints. These shortcomings can cause significant delay and/or loss to businesses and law enforcement organizations. Scalable capacity is not the only challenge; retrieval is critical as well, and retrieving video from tape-based solutions can be slow and costly, and data retrieval delay can impede forensics and legal compliance.

Advances in storage, digital surveillance cameras, and image quality have all helped to lower TCO, while integration with intelligent analytics and automation provide immense savings and fast response to incidents – well beyond the limits of human operators. Implementing a scalable pool of archive video supports the needs of modern video surveillance. For archive, software-defined object storage architecture can start small and scale to multi-petabyte
archives at a fraction of the cost of legacy storage. By deploying highly scalable software-defined object storage on open platform systems, one can inexpensively store and recall months or years of high resolution footage, with extreme data reliability and fast access to archived records. Incrementally increasing storage only when required and future-proofing with standard x86 servers is already well proven by its success in enterprises across multiple industries, including video-intensive media and entertainment workflows.

What are the most important needs and features in video surveillance? The IFSEC Global Video Surveillance Report gathered input from hundreds of heads of security, control room operators and facilities managers. When asked to rank video surveillance features, large storage capacity and ease of storage ranked 5th out of 13 concerns, preceded only by features for high video quality and analytics.

Main Components and Architecture

The integrated solution is built upon Milestone’s XProtect Corporate software for capturing and managing live digital video surveillance footage, Scality RING object storage for large scale active archives, and HPE Apollo 4000 family systems with high-density standard servers to hold petabytes of archived video footage.

Video is initially written to a live database via recording servers. These recording servers receive the video from cameras, and everything that should be retained goes straight to disk storage. This is a process that is highly dependent on IOPS and CPU cycles. The live database is archived at least once a day, or more frequently as dictated by policies and configured by the VMS. The Scality RING deployed on HPE Apollo 4000 servers can be an ideal archive, scaling to petabytes of capacity, with virtually unlimited expansion.
potential. Users have a choice of archiving complete raw footage or, to reduce total archive requirements, archiving frame-reduced footage. This is configurable using the Milestone XProtect product. The Scality RING can also serve as the tertiary video storage, or cold storage tier, eliminating the need to create and manage separate repositories of off-site records.

**Milestone XProtect Corporate** is a powerful open IP VMS platform designed for large-scale and high-security deployments. Its single management interface enables efficient administration of the system, including all cameras and security devices, regardless of the system’s size or if it is distributed across multiple sites. Supporting a flexible architecture, the platform integrates with best-of-breed solutions for large-scale deployments.

**Scality RING Software Defined Storage (SDS)** deploys on industry-standard x86 servers, uniquely delivering performance, 100% availability and data durability, while integrating easily in the datacenter thanks to its native support for directory integration, traditional file applications and over 45 certified applications. Designed to run on open platforms (x86, Linux, Ethernet) and to use standard interfaces (SMB/CIFS, NFS, S3, REST), Scality RING meets bandwidth, scalability, and access requirements, to excel in Video Surveillance applications. Used together with Milestone XProtect VMS and HPE Apollo high-density servers it’s ideal for large-scale surveillance deployments with thousands of high-definition cameras running 24/7.

Scality RING’s ability to consolidate and protect data and support multiple workloads in a single namespace, with cost-efficient and durability-enhancing erasure coding across a distributed architecture delivers robust, durable storage at a 50–70% lower cost than traditional storage. And, using centralized management across multiple sites, Scality RING supports virtually limitless scalability and extreme reliability as it future-proofs surveillance archives.

![Figure 2: Large Scale Video Surveillance Archive Workflow](image-url)
**HPE Apollo 4000 systems** lower the cost of object scale storage in standard rack formats while meeting the demands for high density, scale, storage optimization, and performance for the Scality RING. These open systems allow you to build precisely the configuration you need, with the right balance of processing power to storage density. The Apollo 4000 family of systems offer considerably more disk density per rack unit than typical x86 rackmount servers, while utilizing the built-in manageability and reliability of HPE ProLiant-class servers.

A typical reference surveillance system topology includes the following components:

- **XProtect Live Recording Server**: The live recorder is connected to the digital video cameras over IP, running on Microsoft Windows x64 based Server 2012 R2
- **XProtect Corporate Management Server**: running on a VM or physical host
- **Live Database Storage**: The live database storage is local on the Live Recording Server, and typically uses block storage
- **Archive Database Storage**: Scality RING Software Defined Storage running on open platform nodes (x86 hardware and Linux OS) provides the SMB shares
- **SMB Connector**: The Scality RING archiving storage connects via Scality SMB connector(s). The connector(s) can run on a separate server or on the storage nodes with Scality RING
- **Network Connectivity**: Active redundant network ports, 2x10 Gbps interfaces on each server

Video streams are sent across the IP network and captured by the live recording server in internal storage. Recordings are later archived on the Scality RING storage.

Milestone recommends configuring a live database storage tier and an archive database storage tier. The XProtect Recording Server is configured as the live volume. Video from
cameras is initially written to the live database, and periodically moved to the archive storage tier. Once the archive storage is full, the oldest data will be deleted based on the retention policy; incoming data will be stored. These configurations provide optimal rate of read/write performance for video recording and storage performance.

Live database storage size assumes data will be moved to archive 24 times per day. If archive intervals will be more frequent or less frequent, live database storage requirements and/or archive database storage requirements may need to be adjusted. Live database storage should be configured to use a large drive stripe size of 256KB or 512KB and the live and archive windows volumes should be configured using 64K segment size for best performance. Array controllers should also be configured with battery-backed cache with write-back cache settings enabled.

**Example Requirements and Recommendations**

**Digital Video Surveillance Requirements**

The typical storage workload for video surveillance is write-intensive, with a large number of parallel writes to scale with the number of cameras. Live recording servers initiate parallel threads to transfer data to the archive storage, and require bandwidth that can scale to meet the completion windows. A spike in read-intensive operations is encountered when incident analysis is required, and the storage architecture must meet the read-intensive operations on demand, without impacting the ongoing writes to the archives. The storage architecture must be designed for scale while meeting deterministic performance.
Table 1: Example Digital Video Surveillance Requirements

This table provides example requirements that you may see for typical deployments: a real-world expectation for surveillance recording and archives. Using the following reference as an example, Milestone calculates, estimates and makes a deployment recommendation for your specific solution. This reference specification can be scaled up or down incrementally as your specific solution demands.

<table>
<thead>
<tr>
<th>Video Surveillance Attributes</th>
<th>Reference Specification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Number of cameras</td>
<td>2000</td>
<td>Same resolution for all cameras</td>
</tr>
<tr>
<td>2 Codec</td>
<td>H.264</td>
<td></td>
</tr>
<tr>
<td>3 Recording Resolution</td>
<td>HD1080 @ 2.1MP 1920x1080</td>
<td>Full HD cameras</td>
</tr>
<tr>
<td>4 Record on Event / Motion</td>
<td>No</td>
<td>Live recording server</td>
</tr>
<tr>
<td>5 Recording Hours per Day</td>
<td>24</td>
<td>Live recording server</td>
</tr>
<tr>
<td>6 Percent of Motion / Event</td>
<td>70</td>
<td>Live recording server; 100% if recording all images</td>
</tr>
<tr>
<td>7 Constant Frame Rate FPS</td>
<td>25</td>
<td>Live recording server</td>
</tr>
<tr>
<td>8 Event Frame Rate FPS</td>
<td>25</td>
<td>Live recording server</td>
</tr>
<tr>
<td>9 Ave. Image Size KB - Event</td>
<td>25</td>
<td>Live recording server</td>
</tr>
<tr>
<td>10 Ave. Image Size KB - Constant</td>
<td>20</td>
<td>Live recording server</td>
</tr>
<tr>
<td>11 Calc. Bit Rate per Camera</td>
<td>5 Mb/s</td>
<td>Camera to live recording server</td>
</tr>
<tr>
<td>12 Calc. Bit Rate Total Cameras</td>
<td>10,000 Mb/s or 10 Gb/s</td>
<td>Cameras to live recording tier</td>
</tr>
<tr>
<td>13 Retention Days</td>
<td>30</td>
<td>How long do you want to retain the footage in the archive tier?</td>
</tr>
</tbody>
</table>

Table 2: Example Milestone Estimation and Recommendations

This table provides an example of proposed deployment based on the requirements in the previous table.

Assumptions

- This solution assumes that approximately 100 cameras of the type specified are supported on one recording server. Depending upon the number of cameras supported on each server, a different set of specifications can be configured. How much video is viewed simultaneously by the system can alter this specification as well.

- For the purpose of this solution, it is estimated there could be 500 cameras that are viewed 24x7, and footage is archived hourly, i.e., 24 times per day.

- Taking into account that there are at least 20 different live recording servers writing to the archive tier, the specification for the live recording servers used could support about 100 cameras on each server, thus 2000/100 = 20 recording servers. While a solution with different number of recording servers could be supported, that would require different hardware and storage sizing.

- Milestone has passive failover servers that can support a group of active recording servers. For a deployment of this size, it would be wise to deploy a few failover servers to meet critical needs.

- Milestone has redundancy for the management server in the form of clustering,
hence an additional two servers for the cluster will help support passive failover for enhanced reliability.

- Bandwidth estimates determine that at least 900 MB/s of simultaneous WRITE to the archive tier is possible, and at least 100 MB/s of READ throughput from the archive tier can be achieved.

- The READ operation from the archive tier (viewing/playback of recorded video) is variable, thus should be estimated based on available bandwidth and the archive storage capability to serve the READ requests based on file sizes. A detailed understanding of usage pattern can help determine more accurately the number of parallel READs from the archive tier. XProtect does not READ from the archive tier unless the user is reviewing the recorded video.

- The aggregate READ throughput for the archive tier can be estimated more accurately provided the number of maximum simultaneous streams is determined. Normally only during the investigation of incidents the videos are READ from the archive tier, which influences the system throughput for READs.

- XProtect can define the file WRITE sizes for the archive tier to help optimize the performance. It is controlled by the configuration of each individual live recording server.

<table>
<thead>
<tr>
<th>Deployment Attributes</th>
<th>Reference Specification</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Data generated by a single high-definition camera</td>
<td>36.05 GB of data generated in 1 day</td>
<td>See Glossary section on Camera Data Generation calculation based on Milestone tool</td>
</tr>
<tr>
<td>2 Number of cameras supported by a live recording server</td>
<td>100 Based on camera resolution and server specification outlined in the requirements</td>
<td></td>
</tr>
<tr>
<td>3 Total number of live recording servers needed to support 2000 cameras</td>
<td>20 live recording servers Recommended server types:</td>
<td>Each live recording server is capable of supporting 100 cameras.</td>
</tr>
<tr>
<td>4 Minimum internal storage per live recording server</td>
<td>66 TB for live recording server</td>
<td>Sufficient for holding 8 hours of video footage on the live database.</td>
</tr>
<tr>
<td>5 Minimum internal storage per archive tier server</td>
<td>192 TB HPE Apollo 4200 server 512 TB HPE Apollo 4510 server</td>
<td>The vast majority of the storage volume is on the archive tier to maximize efficiency.</td>
</tr>
<tr>
<td>6 Minimum sustained aggregate throughput for simultaneous operations</td>
<td>910 MB/s write 100 MB/s read</td>
<td>Minimum aggregate throughput for the archive tier</td>
</tr>
<tr>
<td><strong>Deployment Attributes</strong></td>
<td><strong>Reference Specification</strong></td>
<td><strong>Comments</strong></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| 7 Network connectivity and bandwidth | 1Gbe - camera network  
10Gbe - archive network | 1Gbe between camera and live recording server  
10Gbe between live recording server and archive tier |
| 8 External storage connectivity and expansion if required for live recording storage | Direct attached storage options for low-capacity recording servers:  
HPE D6020, up to 70x8TB 6GB SAS HDD, 12GB SAS external  
Max Capacity 8TBx70=560TB | Choice of high-capacity HPE Apollo 4200 or 4510 servers eliminates the need for external direct attached storage |
| 9 Operating System | Windows Server 2012 x64 Standard/Data Center | 64 bit instance for recording server |
| 10 OS and application volume - disk configuration | 2 x 146GB Minimum - SATA or SAS, RAID 1 | Boot disk |
| 11 Storage connectivity | 10GbE | All archive storage nodes |
| 12 Storage protocol | SMB 2.0 | |
| 13 Min file size writes to archive tier | 1 MB | Configured by XProtect, and configurable |

**Table 3: Example Archive Tier Storage Recommendations**

**Assumptions**
- Live recording storage is moved to archive 24 times a day
- Number of parallel writes to the archive tier is calculated for worst case operation; this number may be less depending on the archiving policies

<table>
<thead>
<tr>
<th><strong>Archive Storage Attributes</strong></th>
<th><strong>Specification</strong></th>
<th><strong>Comments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Archive storage protocol</td>
<td>SMB / CIFS</td>
<td>Live recording to archive tier</td>
</tr>
<tr>
<td>2 Parallel writes to archive tier</td>
<td>20 streams</td>
<td>Live recording to archive tier</td>
</tr>
<tr>
<td>3 Parallel reads from archive tier</td>
<td>500 requests for READs (viewing) from the archive</td>
<td>Archive to client tools</td>
</tr>
<tr>
<td>4 I/O operations percent - writes</td>
<td>75</td>
<td>Live recording to archive tier</td>
</tr>
<tr>
<td>5 I/O operations percent - reads</td>
<td>25</td>
<td>Archive to client tools</td>
</tr>
<tr>
<td>6 Min write file size in MB configurable</td>
<td>1</td>
<td>Live recording to archive tier</td>
</tr>
<tr>
<td>7 Min agg. throughput write MB/s</td>
<td>910</td>
<td>Live recording to archive tier</td>
</tr>
<tr>
<td>8 Min agg. throughput read MB/s</td>
<td>100</td>
<td>Archive to client tools</td>
</tr>
<tr>
<td>9 Min required useable storage PB</td>
<td>2.5</td>
<td>Archive storage</td>
</tr>
<tr>
<td>10 Number of storage sites</td>
<td>1</td>
<td>No multi-site in this example</td>
</tr>
<tr>
<td>11 Storage server model</td>
<td>HPE Apollo 4200 (224 TB max) or HPE Apollo 4510 (544 TB max)</td>
<td>Archive tier</td>
</tr>
<tr>
<td>12 Storage server HDD capacity TB</td>
<td>8</td>
<td>Archive tier</td>
</tr>
<tr>
<td>13 Storage server HDD disks per server</td>
<td>HPE Apollo 4200: 24 LFF</td>
<td></td>
</tr>
<tr>
<td>Archive Storage Attributes</td>
<td>Specification</td>
<td>Comments</td>
</tr>
<tr>
<td>----------------------------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>14 Storage server workload</td>
<td>75% Write / 25% Read</td>
<td>Concurrent I/Os to archive tier</td>
</tr>
<tr>
<td>15 Storage server average file size</td>
<td>1024 KB or 1MB</td>
<td>Writes to archive tier</td>
</tr>
<tr>
<td>17 Total usable storage required for archive tier</td>
<td>2655.39 TB usable</td>
<td>Archive tier</td>
</tr>
</tbody>
</table>

Table 4: Scality Software Defined Storage (SDS) Recommendation for Archive Tier

**Assumptions**
- Storage archive will be deployed on a single site
- Recommended file size write operations to the archive tier is 1MB
- Rate of archive operation is once every hour by XProtect VMS
- Write operations to the archive tier include open, write, close. No append operations performed.
- Estimated 75% Write, 25% read operations

**Scality RING configuration assumptions**

- Average object size: 1,000 KB (Fixes needed amount of RAM and SSD)
- Volume taken by large files: 100% (Large files are > 60 KB)

**2PB Usable storage hardware requirements, using 8 X HPE Apollo 4510 (32 U)**

**Per Server:**

- CPU: 2 X E5-2630 v4 (2.4 GHz/10 cores)
- RAM: 256 GB
- RAID CACHE: 2 GB non volatile cache using On-board P844ar card
- NIC: 2 X 10 Gb/s active-backup
- OS disks: 2 X 12TB SATA in RAID 1
- SSD disks: 4 X 960GB (Enterprise grade, no RAID)
- 3''5 data disks: 64 X 8 TB (RAID 0 per disk)

**Total storage (432 disks X 8 TB):**

- Raw storage: 4,096 TB
- Overhead (100% ARC14+4): 34%
- Usable storage: 2,713 TB

**Data protection configuration**

100% of the volume is protected with ARC14+4, on MONO-SITE.

Your overhead is: 34% i.e. RAW = 1.34 X USABLE.

With this configuration, you can lose simultaneously up to 4 servers without losing any data.

**Capacity planning**

Scality best practice is to start ordering new hardware when system is 80% full, so in this example, when it reaches 534 TB of usable capacity available.
Incremental units

<table>
<thead>
<tr>
<th></th>
<th>RAW</th>
<th>USABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Enclosure =</td>
<td>512 TB</td>
<td>338 TB</td>
</tr>
<tr>
<td>1 Rack =</td>
<td>4,096 TB</td>
<td>2,713 TB</td>
</tr>
</tbody>
</table>

2PB usable storage hardware requirements, using 18 X HPE Apollo 4200 (36 U)

Per Server:

- CPU: 2 X E5-2630 v4 (2.4 GHz/10 cores)
- RAM: 160 GB
- RAID CACHE: 2 GB non volatile cache using On-board P844ar card
- NIC: 2 X 10 Gb/s active-backup
- OS disks: 2 X 1TB SATA in RAID 1
- SSD disks: 2 X 960 GB (Enterprise grade, no RAID)
- 3”5 data disks: 24 X 8 TB (RAID 0 per disk)

Total storage (432 disks X 8 TB):

- Raw storage: 3,456 TB
- Overhead (100% ARC14+4): 23%
- Usable storage: 2,667 TB

Data protection configuration

100% of the volume is protected with ARC14+4, on MONO-SITE.

Your overhead is: 23% i.e. RAW = 1.23 X USABLE.

With this configuration, you can lose simultaneously up to 4 servers without losing any data.

Capacity planning

Scality best practice is to start ordering new hardware when system is 80% full, so when it reaches 534 TB of usable capacity available.

Incremental units

<table>
<thead>
<tr>
<th></th>
<th>RAW</th>
<th>USABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Enclosure =</td>
<td>192 TB</td>
<td>148 TB</td>
</tr>
<tr>
<td>1 Rack =</td>
<td>4,032 TB</td>
<td>3,125 TB</td>
</tr>
</tbody>
</table>

Scality RING supervisor, using 1 X HPE DL360 G9

- CPU: 1 X E5-2630 v4 (2.4 GHz/10 cores)
- RAM: 32 GB
- OS disk: 2 X 1 TB in RAID 1
- NIC: 2 X 1 Gb/s active-backup

Scality RING connector servers, using 2 x HPE DL360 G9

<table>
<thead>
<tr>
<th>Type</th>
<th>#Connectors</th>
<th>Running on</th>
<th>Config</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMB</td>
<td>2</td>
<td>HPE DL360 G9</td>
<td>2 X E5-2630 v4 (2.4 GHz/10 cores) - 32GB RAM - 2X10 Gb/s</td>
</tr>
</tbody>
</table>
Table 5: Benefits of Apollo Series with Scality RING

Scality RING is designed to work with mixed server deployment. Transitioning from Apollo 4200 to a higher density Apollo 4510 is seamless, and the storage continues to operate with zero downtime as both models of servers are used for incremental addition or transition.

<table>
<thead>
<tr>
<th><strong>HPE Apollo 4200 (2.6 PB RING)</strong></th>
<th><strong>HPE Apollo 4510 (2.6 PB RING)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single node, 2U, 24 LFF disks</td>
<td>Single node, 4U, 68 LFF disks</td>
</tr>
<tr>
<td>18 nodes in 36U</td>
<td>8 nodes in 32U</td>
</tr>
<tr>
<td>Fits in standard-depth 1M racks</td>
<td>Higher density, less cabling, lowest $/GB</td>
</tr>
</tbody>
</table>

Conclusion

Enterprises employing digital video surveillance can effectively and economically provide long-term video archives in a private cloud, with maximum privacy and security and virtually unlimited scalability. Scality RING Software Defined Storage object architecture supports rich metadata, and scales linearly to evolve with your storage needs. The RING is proven to deliver 100% availability, data durability, and limitless capacity optimized for large scale storage. Scality RING runs on standard x86 servers, out-of-box Linux OS, and open-platform VMS. Deploying HPE Apollo 4000 systems maximizes storage density for lowered TCO per GB of long-term archive storage. Milestone XProtect provides administrators with policy-defined automatic archiving. Together with HPE and Milestone, the digital video surveillance integration provides a true open-platform solution.

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- HPE Automated Number Plate Recognition (ANPR) analytics platform
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  https://www.gartner.com/doc/3203023/reduce-video-surveillance-storage-costs
  http://www.ifsecglobal.com/video-surveillance/

- IFSEC Global Video Surveillance Report

- Guidelines for Public Video Surveillance, The Constitution Project

- Digital Video Surveillance and Security by Anthony Caputo
Glossary

Percent of Motion

Determined by the environment where the cameras are located. For an estimate to have any degree of accuracy a discussion with the user is required to understand the environment. For example, a 70% motion would be a very active environment like a 24 hr train station.

Constant Frame Rate/Event Frame Rate

XProtect can choose any frame rate that the camera can supply. If the models of the cameras are known, then Milestone can determine what frame rates are supported. Most users will want the full frame rate, but it is generally acceptable to go as low as 15 FPS.

Average Image Sizes

Given an identifiable camera model Milestone can determine the required information as there are many variables in play on the camera side, which will affect the storage system.

Live and Archive Storage

For the purposes of retention period, most surveillance footage can be placed into two buckets, pre-archive and archive. While the practices and guidelines may differ based on the type and location of surveillance, the pre-archive retention period is often a few hours to less than seven days, it is short lived.

For large scale surveillance systems, the number of cameras directly affect the storage requirements. Lower resolution cameras generate less data volume, but the tradeoff comes at the cost of increased number of cameras to cover an area and the lack of higher quality images for faster and accurate analysis and recognition of objects in the footage. The capacity ratio between live, pre-archive, and archive storage is substantial. A primary or tier-one SAN storage is designed for ultra low latency and is more suited for live recording. But tier-one does not meet the needs of pre-archive or archive footage -- massive scalability, capacity optimization, multi-site access, and linear scale throughput.

Storage TCO is affected by retention period (30 to 90 days, longer as required by regulations or governments), minimum aggregate throughput for the archive tier, capacity/throughput for each live recording server, how frequently footage must be moved from each live recording server to the archive storage (e.g. every hour or 24 times a day), number of parallel I/O streams from the live recording servers to the archive storage tier, live recording time (e.g. 24/7), size of the file written to the archive tier is configurable by VMS and larger file size (e.g. 1MB or bigger) allows better utilization of bandwidth and storage.

Camera Data Generation Calculation Example
(Number of images stored per-camera per day)

Based on Milestone Tool:
https://www.milestonesys.com/support/presales-support/Storage-Calculator/

- Number of cameras = 1
- Average image size (kB) = 25
- Image rate (frames per second) = 25
- Days to store (archives and current day) = 1
- Hours recording per day = 24
- Percentage of time with motion (100% if recording all images) = 70
- Disk space (GB) = 36.05
- Bandwidth = 5.12 Mb/s