



IHS Markit™

# Caught On Tape, Now Keep It Secure

LTO Technology and Video Surveillance: Benefits and Best Practices



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## Introduction

The video surveillance industry has evolved dramatically over the last 50 years. From the days of whirring VCRs, where individuals were literally, “caught on [VHS] tape”, to the introduction of digital video recorders and spinning hard disks – and now, an era of network-based video surveillance and associated IT infrastructure. During this transition, the hard disk drive displaced VHS tape as the typical media for storing video surveillance footage. However, with the number of higher megapixel cameras on the rise and longer retention requirements end-users are struggling to deal with the data and cost requirements associated with storing this amount of footage. In systems with long-term data retention, end-users can now use file-based tape storage such as LTO (Linear Tape Open) technology in combination with disk, to effectively meet their requirements in a cost effective manner without compromising on the quality of the video stored or the length of time the video footage is retained.

The purpose of this whitepaper is to explore and discuss;

### This whitepaper evaluates:

- The three main drivers of greater video surveillance storage requirements.



- Requirements specific to storing video surveillance footage.
- The benefits and best practices of using file-based tape and LTO technology to store video surveillance data.

## Greater number of video surveillance cameras

The number of video surveillance cameras sold globally in the last decade has increased year-on-year. In the 2017 calendar year, IHS Markit forecasts there will be over 127 million video surveillance cameras sold via professional channels<sup>1</sup>.

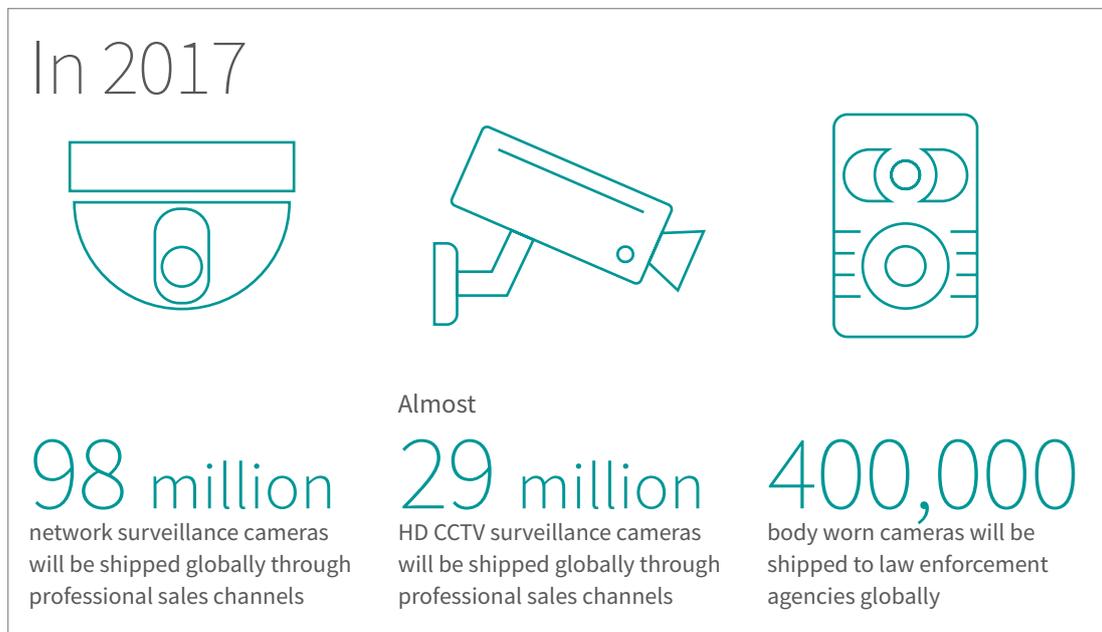


Figure 1

<sup>1</sup> IHS Markit Technology – Video Surveillance Intelligence Service, December 2016

There are many factors driving demand for video surveillance cameras. Figure 2 ranks these factors by their level of influence on market demand.

## What factors are driving demand for cameras



Figure 2

### Legislation

The level of legislation and regulation that applies to the installation and operation of video surveillance systems varies both nationally and internationally. Typically in North America and Western Europe there is little legislation relating directly to the general installation or use of video surveillance equipment. In these regions specific industries such as critical national infrastructure<sup>2</sup> or casinos and gaming<sup>3</sup> may be subject to specific regulations.

Compliance with privacy and data protection laws tend to have a large influence on video surveillance installations and their data retention policies. In May 2017 the German government responded to an increase in security threats and the lack of video evidence available in public places including stations and city centers, by introducing new legislation altering current privacy laws to allow greater installation of video surveillance cameras<sup>4</sup>.

Legislation and regulations are particularly influential in the Middle East. These can dictate which organizations must install video surveillance equipment, the level of coverage and include equipment specifications, such as, minimum camera resolutions, frame rates, and footage retention times. For example, in Qatar, hotels and shopping malls must store footage for a minimum of 120 days<sup>5</sup>. Some Middle-Eastern countries, for example, Saudi Arabia, have fewer regulations on video surveillance equipment but projects in these countries often follow specifications from countries with more regulation, like Qatar, Kuwait, and the UAE<sup>6</sup> where regulations are frequently updated.

<sup>2</sup> United States Nuclear Regulatory Commission - <https://www.nrc.gov/reading-rm/doc-collections/cfr/part073/part073-0055.html>

<sup>3</sup> Nevada Gaming Commission - <http://gaming.nv.gov/modules/showdocument.aspx?documentid=2944>

<sup>4</sup> Die Bundesregierung - (original source in German) - <https://www.bundesregierung.de/Content/DE/Artikel/2016/12/2016-12-21-bessere-videoueberwachung.html>

<sup>5</sup> Qatari Ministry of Interior Technical Specifications - <https://info.publicintelligence.net/QAT-CCTV-HotelsApartments.pdf>

<sup>6</sup> UAE – Dubai Police Service Technical Specifications - <https://portal.dps.ae/images/pdf/Annexes.pdf>

## Multi-use video surveillance

Multiple uses beyond that of traditional security or loss-prevention applications is driving demand for video surveillance equipment. Some of these uses include:

- Monitoring, control and recording of business operations. For example monitoring production lines and the use of video analytics for logistics tracking or timekeeping.
- Health and safety - crowd monitoring and control. Analytics for industrial safety – slip and fall, fire and smoke alarm validation.
- The collection of consumer marketing information. For internal purposes in retail such as customer counting, customer profiles and store heat mapping. Retailers can use the same marketing data for external purposes such as differential pricing for products based on position and footfall in store.
- Anti-litigation purposes. Collection of potential video evidence in case of lawsuits.

The multiple uses of video surveillance systems has assisted in the propagation of the network surveillance camera as another Internet of Things (IoT) sensor which can be integrated into more complex and larger systems. For example safe/smart city systems, which through enterprise IT infrastructure network thousands of sensors (not just video) to provide situational awareness of a city. From a storage demand perspective, this has meant some installations with multi-use storage pools aggregating different feeds of data.

In addition to traditional video surveillance footage storage, some systems are combining other storage such as:

- Digital evidence management archives for law enforcement and judicial staff containing video and photos from fixed video surveillance, vehicular, body-worn and cell phone cameras as well as digital documents all collated into digital case files.
- Traffic monitoring and enforcement systems.
- Operator incident recording in monitoring or CAD centers – which can include recordings of a camera operator’s workstation, recordings of their VOIP and other communications. This provides a complete record of what information was available to them and how they managed an incident.

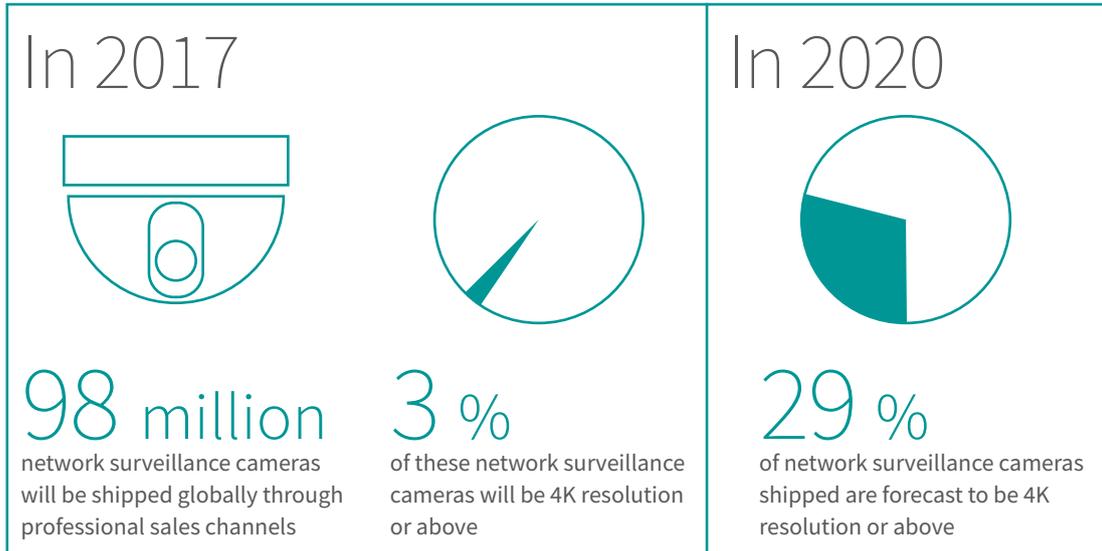
## Decline in video surveillance camera prices

One of the most influential factors driving camera shipment market growth is a decrease in average selling prices. Lower prices are enabling end-users to obtain the technology more cheaply than ever before and in some examples achieve a larger return on investment for the cost of the equipment. IHS Markit data shows that since 2012 the average price of a network surveillance camera in the American market has more than halved. The rate of price decline is not unusual in technology markets. However, in the video surveillance industry over the last five years the composition of the competitive environment has changed significantly through the growth of many Chinese video surveillance vendors. These companies typically sell cameras and recording devices at prices below their Western competitors. The two largest vendors of video surveillance equipment by revenue in 2015 were Hangzhou Hikvision Digital Technology and Zhejiang Dahua Technology who between them accounted for over 25% of market revenues for branded video surveillance equipment sold in professional channels<sup>7</sup>.

<sup>7</sup> IHS Markit Technology – Video Surveillance Intelligence Service – Market shares June 2016

## Higher specification of cameras

One of the most important requirements of a video surveillance camera is be able to automatically adapt to changing environmental conditions and produce consistently usable images. Image quality is complex with many different components. Several of the components of a better quality image can be measured through the camera's specifications. IHS Markit has measured an uplift in the specification of cameras across several different parameters. Figure 3 shows the uplift in one element: resolution. Currently the most common network camera shipping is 1080p resolution but there will be continued growth in shipments of higher resolution cameras. Four megapixel cameras are increasing in popularity and with vendors marketing 4K resolution cameras for wide area surveillance even higher resolution cameras are expected to gain market share. Equivalent 4K resolution video is four times the file size of 1080p.



**Figure 3**

A video surveillance camera installed to capture a specific scene running 24/7 may only capture minimal changes in activity e.g. people moving in its line of sight. Therefore much of the information it captures is largely irrelevant. Various compression technologies have been developed to mitigate some of the effects of an increase in camera image quality and the associated demands on network transmission, compute and storage. The typical compression used in the surveillance industry in 2017 is based on the H.264 AVC (MPEG-4 Part 10) standard. Many vendors have released innovative proprietary updates in the last 18 months often marketed as some form of “H.264+” and “smart bandwidth management”. These compressions tend to filter out static areas of a frame not of interest while dynamically adjusting the frame rate of areas of interest to reduce bitrate compared with standard H.264 compression. The next generation H.265 (HEVC) compression is still some way off mass market adoption in the video surveillance industry. This is largely due to lack of clarity with license fee payment, backward compatibility with existing video management software (VMS) programs and the uplift in processing power required to encode and decode. Therefore, while there is an increasing volume of cameras marketed as “H.265” and “H.265 ready” shipping in 2017, IHS Markit believes there is still much progress required in the integration of H.265 in the video surveillance ecosystem before it displaces the use of H.264.

**Despite advances in compression technologies demand for storage continues to increase.**

## Video analytics

IHS Markit estimated there was a 61% increase in the 2016 shipments of network cameras with embedded advanced analytics.<sup>8</sup> Cameras with more advanced motion detection analytics can be used to set multiple “areas of interest” for more efficient recording only when motion is detected. Object recognition can determine whether identified motion is relevant and can be used to further refine alerts made to live operators or to trigger recording. However, no video analytics are 100% accurate. In many scenarios, a camera’s function to record on motion might not be used due to the potential for events to be missed; this is especially prevalent in mission critical scenarios.

## Increased value of data & longer retention times

The vast majority of recorded video surveillance footage is never reviewed. As much detail as possible should be retained until it can be determined which parts are relevant or valuable. For security purposes the value usually relates to the recording of a security incident. However, the uncertainty of which parts of recorded video are going to be useful often means trade-offs between the quality at which video is stored and the length of time it is stored.

### Why are retention times increasing?

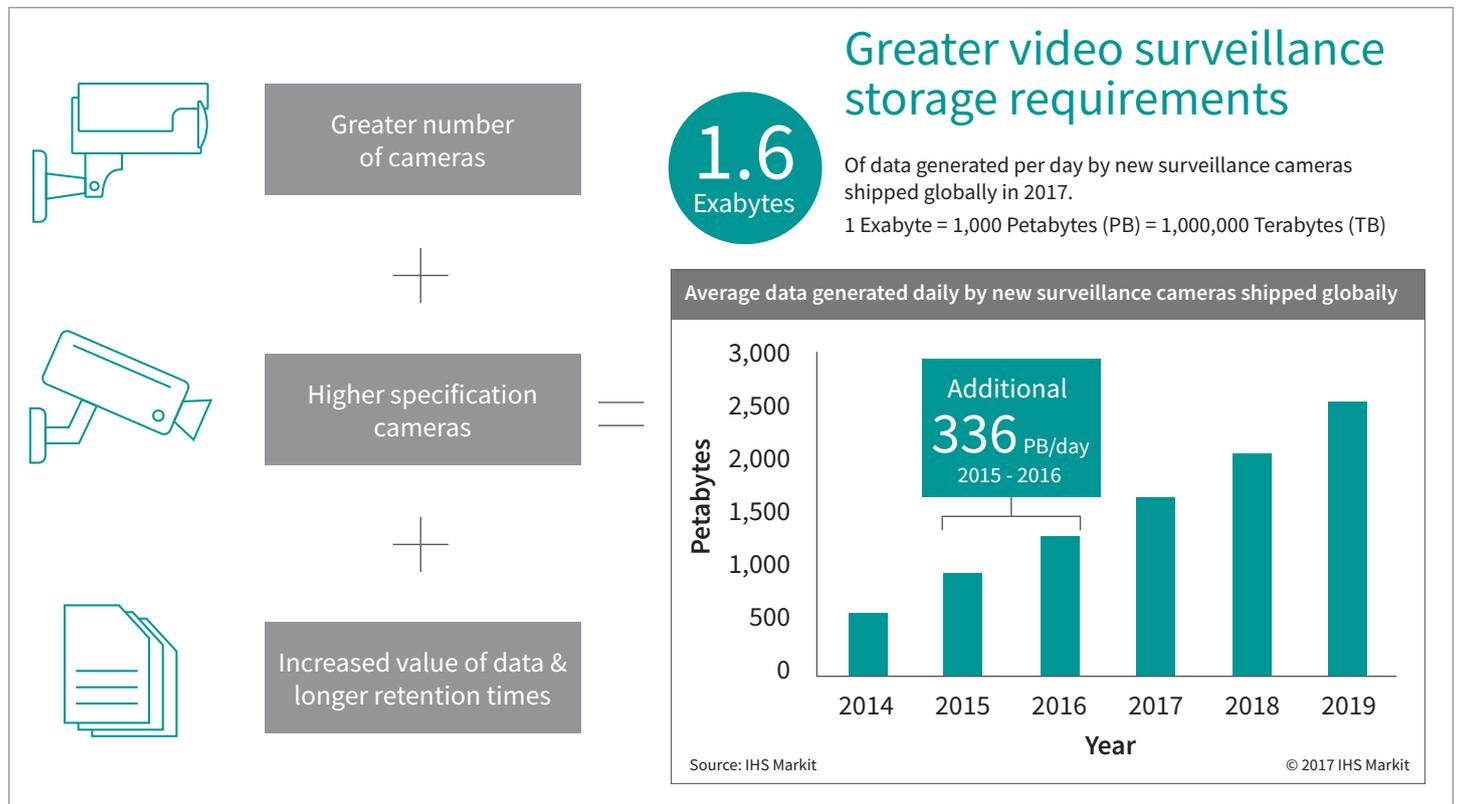
Typically, extending the retention time for video surveillance data is justified by the perceived increase in the value of video surveillance data. As end-users are realizing the full value of this data they wish to retain it for longer periods of time. This may be due to a new application for video surveillance data, or a perceived security threat has increased. Sometimes, retention is not increased uniformly across a system. Strategically important or mission critical cameras may have a different policy to other cameras.

The following are factors which are causing end-users to extend their video surveillance data retention period:

- Video surveillance end-users may be required to comply with legislation on how long they are required to store video depending on their geographic location and industry.
- Many geographic regions have defined time periods during which a plaintiff can file a lawsuit. In the United States, there is a two-year period (this is known as a Tort Law). Following legal advice, many organizations that feel at high risk of litigation store video for a minimum applicable time period as a defense. In the United States, retail and correctional facilities are two sectors where this practice is particularly prevalent. In addition to defined periods for potential lawsuits, some insurers are demanding video be stored for a certain period of time to comply with specific insurance policies and/or to reduce premiums.
- Increasingly, retail customers are using video surveillance for business intelligence and loss-prevention applications. As this adds an extra dimension of value to the video surveillance data, retail customers may store video surveillance for longer periods of time.
- Privacy and data protection. The general public are increasingly mindful of their digital privacy and there is increasing pressure on governments around the world to ensure there is sufficient protection of privacy. In many countries, data protection laws mean extended video surveillance data retention periods need to be justified.
- In general, retaining footage for longer increases the size of the available potential usable dataset for analysis.

<sup>8</sup> IHS Markit – Video Content Analysis research report – 2015 edition. Advanced analytics excludes basic tripwire, motion detection and camera tamper detection algorithms which are common on many network camera models.

- In criminal investigations having extended footage for forensic video investigations and post-recording analytics available for retrieval can be critical in detaining all involved suspects and preventing repeat offences. Longer retention periods increase the probability in building a full picture of crimes and capturing crucial evidence, especially if there is a probability suspects or collaborators visited a location prior to committing a crime. Using analytics to search previously recorded footage for a particular face, behavioural pattern or vehicle is only possible if data has been retained.



**Figure 4**

Figure 4 shows the three key drivers of greater video surveillance storage requirements. These are:

1. A greater number of video surveillance cameras entering the market – an increase in new camera systems as well as an increase in the average number of cameras being connected in individual systems.
2. Uplift in the camera specification - typical modern surveillance cameras produce a higher quality image and more data than surveillance cameras in the past.
3. More camera footage is being created and the length of time which footage is retained is increasing due to its value for multiple purposes.

The “always on” data stream from video surveillance cameras can present a problem for end-users. With an increased amount of storage required how is best to store this?

## Requirements specific to storing video surveillance footage

### A different approach to traditional IT data storage

General purpose IT storage systems may not be best suited for video surveillance and their use can mean retention is not maximised. Video surveillance storage has some specific requirements and differs from traditional IT data storage in the following ways:

- Video surveillance storage workloads should be configured heavily towards writing data to storage media. Most stored footage is never accessed and is deleted without it being reviewed. Therefore, generally, the requirements to read data are much lower than the requirements to write. This is different to traditional IT workloads which are typically more mixed.
- High performance and flexible demands: video surveillance workloads can be typified as requiring high bandwidth due to the need for multiple concurrent data streams to be recorded at any one time. The throughput should be designed to cope with these requirements particularly during periods of high activity which may cause spikes in bandwidth required. It is critical in events such as these that recording must be maintained from all video streams at the defined quality with no dropped frames and no data loss.
- Often a video surveillance storage system requires a high level of redundancy and failover. No system is 100% redundant. However, in the event of a failure and rebuild process, the system requires enough redundancy to continue performing its primary function: recording video surveillance footage.
- Accessibility: video footage should remain accessible to the video management software regardless of where it is stored. Data retained for long periods of time in separate silos can inhibit users if separate manual interaction is required for access. Keeping latency to a minimum for playback and post recording analytics should also be an objective.
- Where there is a low probability of data access but a need for long-term retention the energy costs of data storage should be a consideration. Treating all data with the same policy and storing all data, regardless of age, in the same manner can have ramifications for energy costs.
- Systems should be designed with the ability to scale and support future expansion in capacity with minimal disruption. Future expansion can come about due to change in: internal policy, legislation/regulations or the video surveillance front-end (additional cameras or upgraded replacement cameras added to the system). Flexible systems where additional capacity is easy to add are required to cope with future changes such as these.

### Could your stored video surveillance data be used as evidence?

In addition to how a video surveillance workload can differ from traditional IT data storage, there are other considerations specific to video surveillance data and its use as evidence in civil or criminal court proceedings.

When storing video surveillance footage there is potential that the data may be used as evidence in court. However, it is not clear until post recording what data is going to be relevant. Therefore storing the best possible quality footage whilst maintaining a chain of custody should always be a primary concern. Reducing quality of footage for budgetary reasons can undermine the purpose of storing it in the first place.

When footage is required as potential evidence there are further considerations:

- Should evidence of a crime be collected, a complete chain of custody to ensure the video evidence has not been tampered with or doctored is required. Keeping data in a unified system, meaning the footage can be replayed by the server which recorded it, can help to keep the chain of custody.
- Chain of custody in the cloud is possible through the use of Criminal Justice Information Services (CJIS) compliant datacenters. However, data storage here can be subject to premium costs which are often negated in a total cost of ownership (TCO) analysis.
- Stored video footage should be able to be exported easily whilst maintaining the chain of custody.
- If a police department has stored evidential video surveillance footage that has been involved in a conviction or a serious crime, they are often required to store this evidence for the duration of any custodial sentence. This has the potential to increase the retention period to decades.

## LTO technology and video surveillance

### No one-size fits all approach to video surveillance storage

A huge range of storage requirements span different video surveillance end-user groups. Therefore, treating all video surveillance data with a one-size fits all approach can lead to inefficiencies. The value and requirements for video surveillance data often changes over its lifetime - so configuring a storage solution with one type of storage and the same storage policy can be inefficient.

Commonly, when choosing a storage solution, a trade-off between budget and mission ensues. Often to meet a budget the quality of video surveillance footage or duration it is stored is compromised. This does not always need to be the case. Often performance, capacity and retention can be balanced whilst minimising sacrifices of redundancy, access or scalability.

Using multiple tiers of active storage can help achieve this.

In general IT and in some video surveillance storage systems where a two-tier approach of (active storage and archival) has been implemented, often the visibility and integration between the two tiers through a single file system and application has been problematic. Once data was moved to the archive tier it became inactive. For users to gain access IT staff had to be involved to manually retrieve the data. If using a tape archive, the entire contents were manually copied back to disk and it then needed manually searching through.

This approach is outdated as multiple tiers of active storage, across different storage media (disk, tape and flash) can be connected in one system. This means the characteristic of each storage tier is utilized to best fit to the video surveillance storage requirements and the entire system remains accessible by the user and any software applications.

File-based magnetic data tape storage can provide an important tier for the storage of video surveillance data in an active multi-tiered storage approach.

## What is LTO technology and LTFS

Linear tape open (LTO) technology is an open format of magnetic tape data storage jointly developed by HPE, IBM and Quantum.<sup>9</sup> In the non-video surveillance wider IT market, LTO technology is primarily used for data back-up, disaster recovery and long term data retention. It is often used for making multiple copies of data and for cold storage offsite in vaults. Since the 2010 release of the fifth generation, LTO technology has included the linear tape file system (LTFS). LTFS utilizes partitioning to create an index which points to the requested file positions on the tape. This means that data can be dragged-and-dropped and viewed in a similar way to hard disk drives.

The LTFS format provides a self-describing cartridge which means applications do not require any additional information to read the data stored. In the event of a disaster where loss of data occurs, data can be recovered from tape.

In a tape library configuration used for long-term retention the time to locate and start reading data is slower than a disk array. However, this is offset by the potential to offer tape as a lower-cost, high-capacity alternative to hard disk drive arrays for longer term retention. Tape does not substitute disk as primary storage.

The LTO format has a published technology roadmap with future specifications<sup>10</sup>. Figure 5 shows what the LTO technology roadmap means in terms of video surveillance storage.

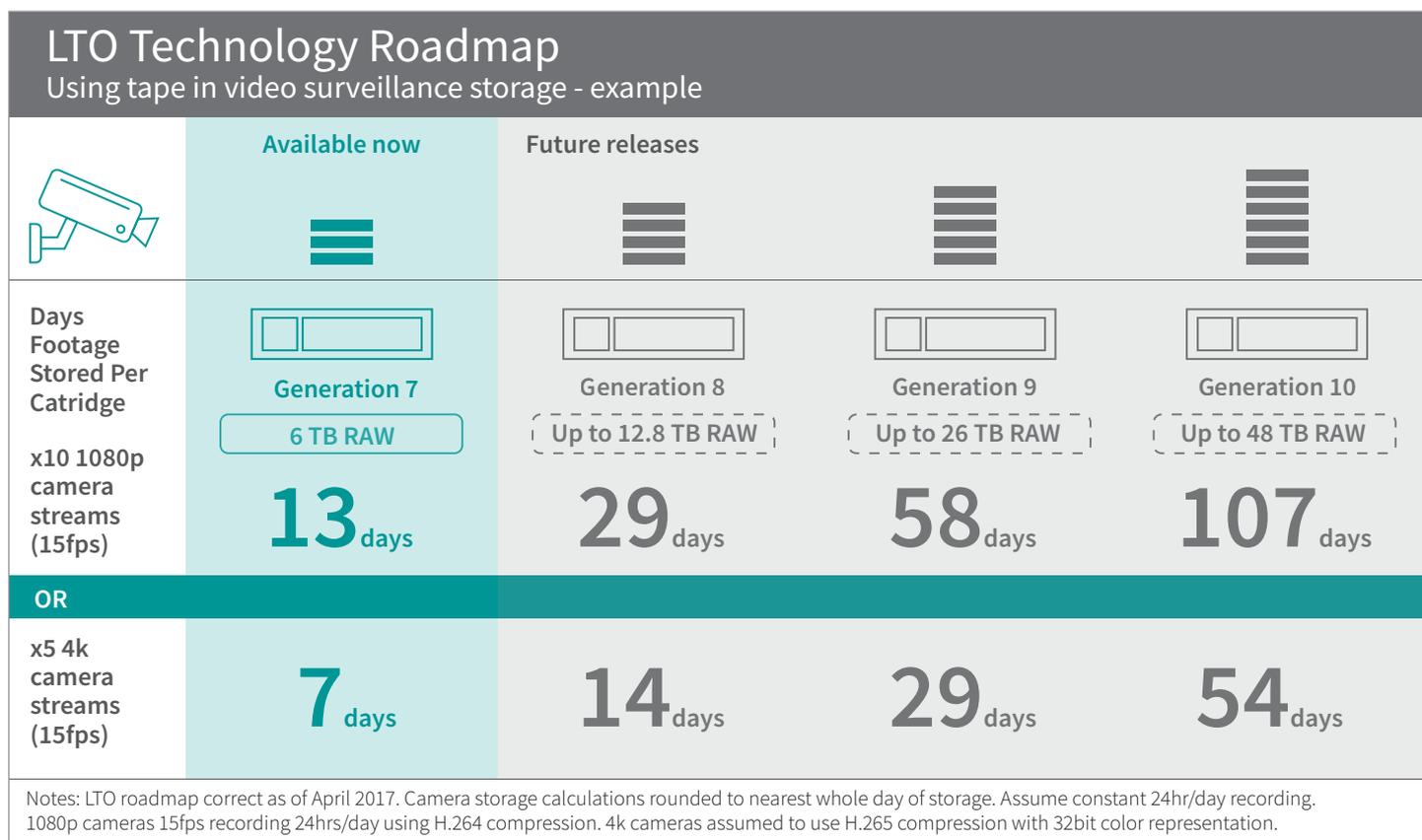


Figure 5

<sup>9</sup> <http://www.lto.org/about-the-lto-program/>

<sup>10</sup> [http://www.lto.org/wp-content/uploads/2015/09/LTO7\\_2C\\_10GenChart\\_0815\\_HP\\_RGB.jpg](http://www.lto.org/wp-content/uploads/2015/09/LTO7_2C_10GenChart_0815_HP_RGB.jpg)

### What can LTO technology offer the video surveillance user?

When utilized in a multi-tiered storage solution, an LTO tape library can be implemented as a cost effective, connected, long-term, high-capacity storage tier. End-users can manage their storage system and remain within budget as tape can provide a larger capacity storage tier and longer term retention for the same cost. This means end-users can compromise less on video quality and retention time by using tape. Every detail can be stored until users can determine later what should be kept.

The utilization of tape to store video will not be best suited for all video surveillance applications. Multi-tiered storage works well with a high number of camera feeds which require extended storage retention at maximum quality. Data is transferred automatically between storage tiers based on pre-defined policies. The capacity of each tier and policy governing data transfer between them is typically based on the likelihood of requiring the highest performance. For example, the most recent video may be kept on the highest performing disk tiers in the initial 7-14 days post-recording when access is most likely to be required. After this, it is moved to a tape tier (at which point it is deemed unlikely to be required for review). However, the key point about this configuration is that data remains available through the VMS should review be required. In addition, any video flagged up in a security or operational event of interest may have a different policy and may be retained for longer. Where events are required to be kept long term or video evidence is used, a copy may be automatically transferred to a particular tier or even duplicated to offsite storage.

Figure 6 shows a simplistic example for video surveillance storage.

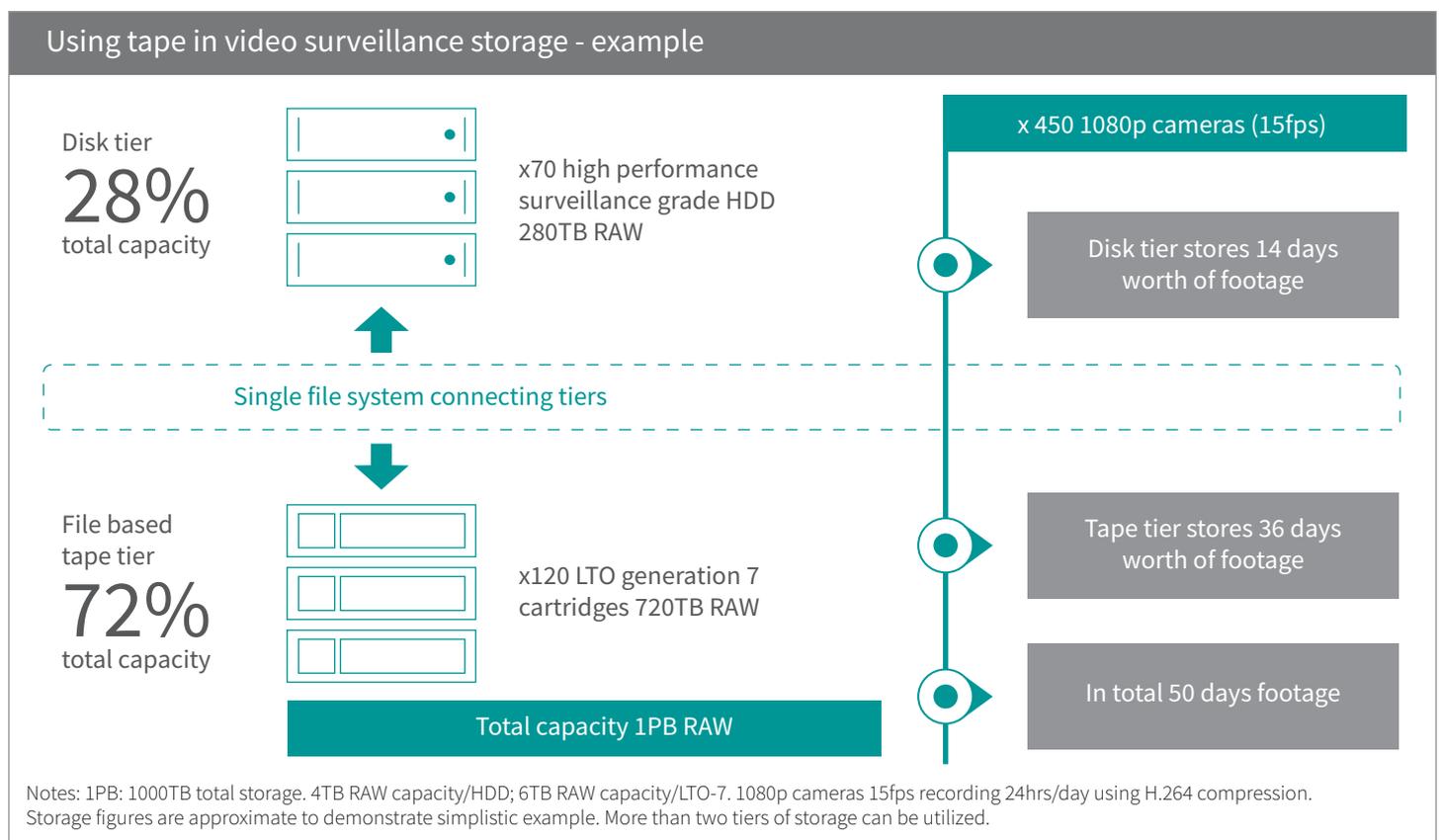


Figure 6

The approach shown in Figure 6 is well suited to systems with large capacity and retention requirements for video surveillance.

**Tape storage for high capacity, low use and long-term retention used in combination with disk provides lower total cost than all-disk or disk-cloud hybrids.**

Using tape in a multi-tiered storage solution for long-term retention can mean that rather than pushing data to the cloud for storage, users can retain full ownership and access to their data for minimal cost. Cloud storage can be used as an effective storage tier, particularly in collating data from small camera count multiple site installations, or as an offsite backup of a small amount of mission critical camera feeds. However, as a storage tier for high capacities or long-term retention, often there are additional costs to cloud storage which reduce its viability. For example, high bandwidth costs, access and retrieval charges. Chain of custody is also a key concern as there are often significant premiums beyond a list price for the use of a government (for example CJIS) certified secure data center.

Total cost of ownership (TCO) analysis should be used in conjunction with performance analysis to make a purchase decision for storage. A balance between cost and performance is often necessary. In many scenarios the speed of data recall offered by a tape library is not sufficient and it should be discounted. Yet, for some users if they can trade off immediate, for near immediate access speeds to their oldest data, tape can bring high capacity, long-term retention storage at price points they would otherwise have been unable to afford. Once the disk tier is configured further disk storage may only be required if additional bandwidth or camera streams are added. When only increasing the length of time data is retained building out capacity on tape can become even more economical as capacities scale.

In one example of a TCO analysis<sup>11</sup>, when maintaining a storage system over a decade the comparison between a LTO tape library, an all-disk and a disk-cloud hybrid solutions found that the TCO for the LTO library solution was nearly seven times lower than the all disk solution and over five times lower than a disk-cloud hybrid solution.

As an approximate cost comparison of individual media, a recent LTO technology cost audit found an average retail price of \$0.02/GB RAW, for a LTO generation 7 cartridge.<sup>12</sup> IHS Markit's HDD market tracker estimates a typical enterprise grade HDD price at \$0.06/GB.<sup>13</sup>

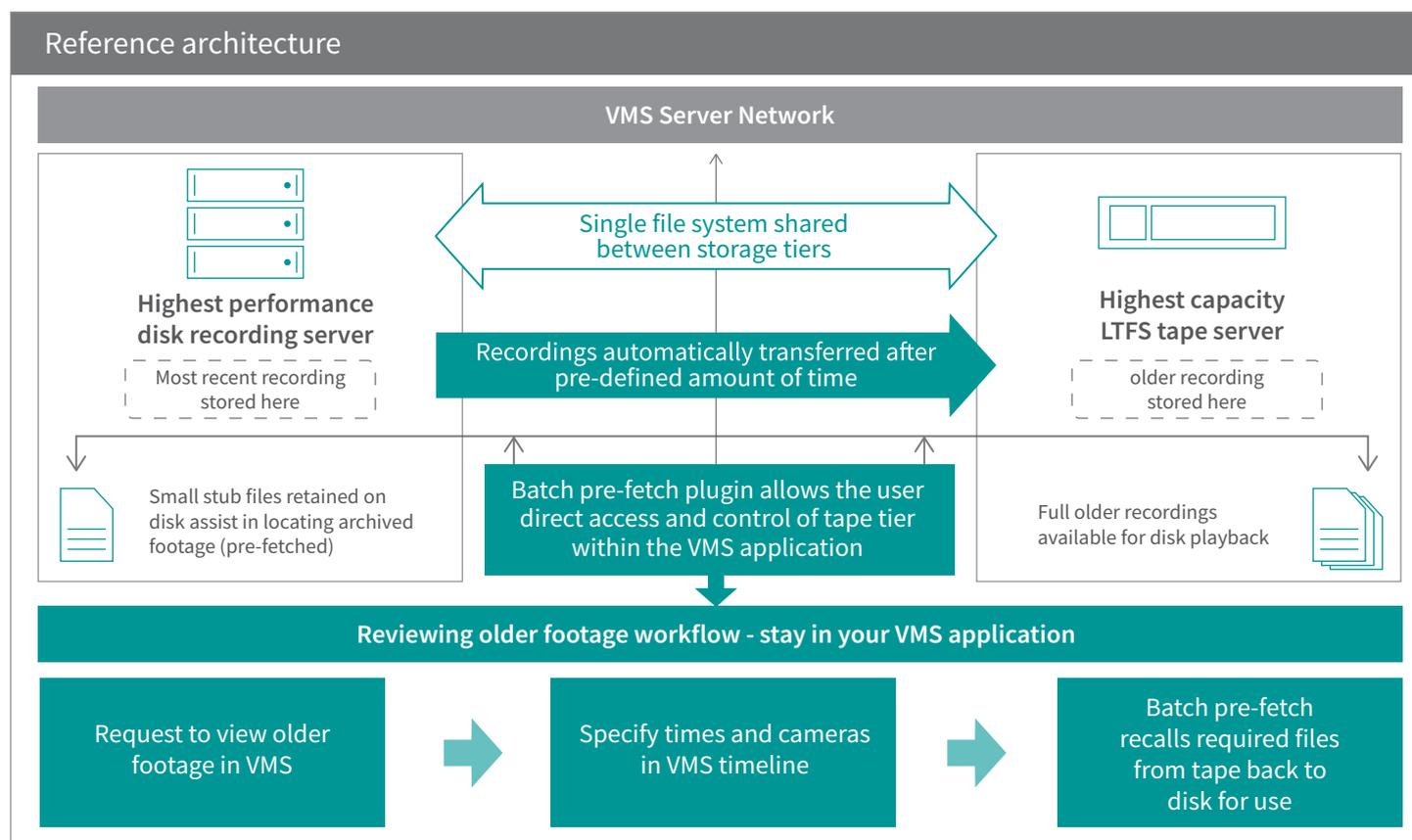
**Access all your recordings without leaving the VMS application. No need to think of tape as a separate archive.**

The use of tape storage in the video surveillance industry has suffered from several misconceptions. One of the more prominent is that a tape library is disconnected from the rest of the system. When tapes are used in a modern multi-tier storage configuration the tier is not disconnected and can be accessed through a single file system shared between tiers. The file system is storage media agnostic and operates as "one drive". The tape tier will typically have slower performance than the disk storage tiers and this has caused problems with application access in the past. Some video management software (VMS) programs have search time-outs and if files cannot be found instantly may return errors or even move to a database repair mode which can impair performance. However, many current leading VMS programs are now directly able to access and control tape libraries with a plug-in. This enables users, without leaving their VMS application, access to a timeline of footage. A reference architecture and example workflow for the "batch pre-fetch" plug-in is shown in Figure 7.

<sup>11</sup> Analyzing the Economic Value of LTO Tape for Long-term Data Retention - [http://www.lto.org/wp-content/uploads/2014/06/ESG-WP-LTO-EVW-Feb\\_2016.pdf](http://www.lto.org/wp-content/uploads/2014/06/ESG-WP-LTO-EVW-Feb_2016.pdf)

<sup>12</sup> LTO technology cost audit - March 2017 - [http://www.lto.org/wp-content/uploads/2014/06/LTO-7-CPG\\_3.14.17.pdf](http://www.lto.org/wp-content/uploads/2014/06/LTO-7-CPG_3.14.17.pdf)

<sup>13</sup> IHS Markit Technology - SSD and HDD Storage Market Tracker – Q1 2017. Approximately 20% retailer mark-up applied to manufacturer pricing.



**Figure 7**

The batch pre-fetch plugin unlocks the full value of tape storage in a video surveillance solution as it enables the user of the chosen VMS application a simple workflow to tap into a huge data pool within the application. Providing users with all recorded video in one place could make a critical difference in forensic investigations and video analytics. Often, older recordings stored in public cloud solutions and cold store libraries cannot be accessed and controlled directly from a VMS application. In these cases, to achieve the same level of functionality, a VMS user or IT personnel may manually have to recall data and import to the VMS. The batch pre-fetch plugin alleviates the additional time and cost and retains the metadata to connect to the full files.

### Use cases

The use of tape storage in a multi-tiered video surveillance environment has been successfully deployed in city surveillance projects, is popular with police departments to store both fixed video surveillance cameras and body worn camera video and has been deployed in the private sector. The concepts described here could be suited to any video surveillance application with extended retention requirements which face budget challenges.

When choosing a video surveillance storage solution, analysis should go beyond basic capacity calculations. Integrators and end-users should assess how the usage and value of recorded footage can change over time and how retaining access to all data in a single system can change the TCO analysis. Despite some misconceptions, tape as an element of a modern storage solution can provide some specific cost benefits when used to build out capacity for long-term retention.

## Conclusion

The evolution of the video surveillance industry is causing a video surveillance data explosion. The multiple uses of cameras and lower prices mean there are now a greater number of video surveillance cameras entering the market than ever before. The greater number of cameras and higher specification new models are producing increasing amounts of data. The length of time this data is being retained for is also increasing. These factors have placed greater demands on storage systems and on budgets to be capable of securely retaining large amounts of video surveillance data for extended periods.

The requirements of certain video surveillance environments for high capacity, long-term retention with infrequent recall of older footage mean file-based tape such as LTO technology paired with disk storage can provide an excellent value proposition as a video surveillance storage solution. LTO technology can offer users full access and control over their data with long-term retention and high reliability whilst keeping costs to a minimum. LTFS and the batch pre-fetch plugins, available for many leading VMS solutions, enable end-users to simply go back in time further within their preferred video management application, gaining valuable insights which may otherwise have been lost due to compromises on stored video quality or retention times.

For more information [technology.ihsmarkit.com](http://technology.ihsmarkit.com)

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### CUSTOMER CARE AMERICAS

**T** +1 800 447 2273  
+1 303 858 6187 (Outside US/Canada)

### CUSTOMER CARE EUROPE, MIDDLE EAST, AFRICA

**T** +44 1344 328 300

### CUSTOMER CARE ASIA PACIFIC

**T** +604 291 3600

**E** [CustomerCare@ihsmarkit.com](mailto:CustomerCare@ihsmarkit.com)

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