MAKE THE
WORLD SEE

July 20 , 2023

White Paper

Edge Storage with flexible retrieval

Prepared by:
John Rasmussen, Platform Architect

milestone

Table of Content

Introduction

In video surveillance, Edge Storage is a technology that stores video and audio recordings in onboard storage media inside cameras. An onboard storage consists of memory cards, built-in flash memory, or hard drives.

Milestone XProtect Corporate, XProtect Expert and XProtect Professional+ support retrieving recordings from the camera's Edge Storage media after system failures, on events, by time schedules, or by manual requests from users of the XProtect Smart Client. Using Edge Storage, cameras can function as failover/redundancy devices and increase the overall availability of the video system. Cameras can also function as the primary recording device where the XProtect VMS' recording server only retrieves the recordings per configured settings, defined rules, or when manually requested by the users of the system.

In this document, the three XProtect products that support Edge Storage (XProtect Corporate, XProtect Expert and XProtect Professional+) are referred to as "XProtect VMS products".

Purpose and target audience

The purpose of this white paper is to give a general overview of:

- The Edge Storage implementation in the XProtect VMS products
- The technology behind Edge Storage
- The benefits of using Edge Storage

This white paper should enable the reader to understand the architecture and the technology behind Edge Storage in the XProtect VMS products, and how to design and implement an XProtect surveillance system using Edge Storage. The white paper assumes that the reader has a general understanding of the XProtect VMS products and IP video surveillance cameras.

The primary audience for this white paper might include (but is not limited to) the following audiences:

- Surveillance system architects/designers
- Surveillance project consultants
- Companies, organizations, and governments with surveillance projects/installations

Central vs. Edge Storage architecture

Support for Edge Storage in IP video cameras enables a different type of video surveillance architecture than the traditional VMS architecture where recording servers are centrally placed. This means that there are now three main ways to store recorded video and audio:

- Centrally in the video surveillance system's recording servers using a dedicated storage system
- At the edge of the surveillance system in the camera's Edge Storage device
- As a combination of edge and central storage

Both central and Edge Storage architecture have their strengths and weaknesses when used exclusively, but in a combination, the architectures provide a more robust solution with higher performance and more flexibility in the VMS and network design. For example, the combination supports scenarios where cameras are not online all the time, such as cameras installed in trains, trams, busses or other vehicles.

Central recording using recording servers

Advantages:

- Storage system technology can be chosen freely from different storage vendors. This allows the surveillance system designer or administrator to choose the storage system and technology that best fits their needs and budget
- The storage can be scaled and expanded to virtually infinite size, by using the right storage technology
- The performance of the storage system can be tailored to the exact needs of the video system
- Standard storage redundancy technologies can be used to ensure that the storage system is always online and that data in the form of recordings is not lost in case of failures

Disadvantages:

- Video and audio will not be recorded if the connection to the camera is lost
- Video and audio will not be recorded if the recording server is down, either due to a system failure or due to maintenance, unless the surveillance system is protected by a failover recording solution like the failover recording server offered by XProtect Corporate and XProtect Expert

Recording in camera's Edge Storage

Advantages:

- Reduces or eliminates the need for a central recording server and storage solution
- The network is not burdened by video and audio being continuously transferred to a central recording server to be recorded
- Enables recording of video in higher quality than what the network connection to the camera can carry since video and audio retrieval can be limited to relevant sequences that can be retrieved later at a slower speed, instead of a constant stream of video and audio that may or may not be recorded

Disadvantages:

- Lower reliability since cameras are more likely to fail, be stolen or vandalized - in which case all recordings might be lost
- Edge Storage may not have the needed capacity to store video recordings in the desired quality for the desired period
- Users cannot view recorded video from the camera if the network connection to the camera is down
- Event-based video recording is more complicated to configure in Edge Storage-enabled cameras compared to a centrally configured VMS. For example, controlling when to record in multiple Edge Storage-enabled cameras based on events from third-party solutions, for access control, building management systems or other purposes
- Slow retrieval and playback of recordings stored in the camera during incident investigation, making the investigation process slower and more cumbersome

Combined edge and central recording

Milestone XProtect VMS products with Edge Storage support provide the ideal combination maximizing the advantages of both central and Edge Storage recording, while minimizing or eliminating the disadvantages of relying on only one storage architecture and technology.

How this is achieved is covered in detail in the following sections.

Technical overview

Edge Storage in video surveillance is the ability for a camera to record video and audio to an onboard storage media component such as memory cards inside the camera. These Edge Storage recordings can later be retrieved by the surveillance system.

Milestone XProtect VMS products can retrieve these Edge Storage recordings upon three conditions:

- Upon the VMS reestablishing a lost connection to the camera
- Upon an event or a time schedule triggering a retrieval rule
- Upon a manual request from users of the XProtect Smart Client

The VMS can lose the connection to the cameras for various reasons. This can for instance happen when cameras that are mounted in vehicles or are body-worn cameras, are temporarily outside of network reach. Another reason can be in case of faults or maintenance of network or servers where the VMS either cannot reach the camera or the VMS service is not running. In all these cases, the missing recordings can be retrieved automatically from the camera's Edge Storage to the central recording server once the connection to the camera is reestablished.

In addition to functioning as a kind of failover recording devices, Edge Storage cameras can also be used as the primary recording location by storing the recordings in the camera until needed by the VMS or its users, at which point it can be retrieved from the camera.

Edge Storage used as failover recording

Connection to camera is lost

In case the network connection to a camera is lost, the recording server will register the time the connection was lost. Once the connection is reestablished, the recording server will automatically retrieve all recordings made during the period where the camera was out of reach. This ensures continuous seamless recording even for periods where the connection to the camera was lost.

Recording server is down

When the recording server is down, either due to a hardware or software fault or due to planned maintenance, recordings will be retrieved automatically for the period the recording server was offline once it is online again, just as in the scenarios about lost connection to camera described above.

To know what period to retrieve missing recordings for, in case of a failure or maintenance, the recording server keeps track of the last time it was operational. When the recording server is started again after a failure or after being stopped, it knows what period it has not been running, and thus what period to retrieve Edge Storage recordings for.

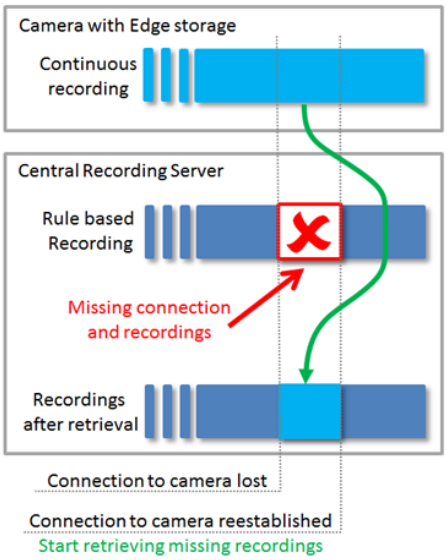
This principle also works in case a failover recording server has been configured to cover for the standard recording server. With a failover recording server configured, there will still be a small gap in the recordings for the period between the standard recording server failing or stopping and the failover recording server starting to record. This small gap can also be covered by the camera's Edge Storage via the automatic retrieval of the missing recordings once the standard recording server starts again.

Record on motion

Normally in a VMS, to save storage space, video and audio is only recorded when motion is detected in the video. If the same should apply for failover periods covered by recordings stored in the camera's Edge Storage, motion detection must be configured in the camera itself, and recording to the camera's Edge Storage must be configured to only record when the camera detects motion. This ensures that only relevant video and audio is being recorded and later transferred to the VMS. In addition, this will result in a faster transfer once the failure is resolved.

Edge Storage retrieval illustration – system or network failure

The camera records to its Edge Storage, either continuously or based on the camera's motion detection, schedule, or external events.



When the VMS detects that recordings are missing for a period due to a failure or missing connection to the camera, the recording server retrieves the recordings from the camera's Edge Storage once the failure is resolved or the connection restored.

Retrieval of the recordings can take some time to complete:

- The missing video and audio may cover a larger period and thus constitute a sizeable amount of data
- Live and/or recording streams are being continuously retrieved at the same time, which may prolong the time it takes to retrieve the camera's Edge Storage recordings

Once recordings are retrieved, they will be stored in the recording server's media database and be available for seamless playback in the clients.

Edge Storage used as primary recording

Sometimes bandwidth from the cameras to the recording server is limited or the bandwidth should be reserved for business-related communication during working hours. In this case, it might be desirable to postpone retrieval of the cameras' Edge Storage recordings until after working hours.

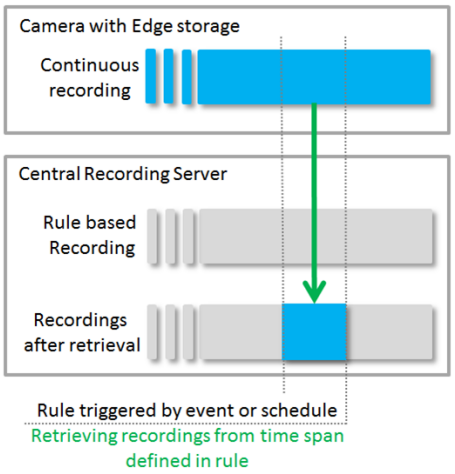
This is done by creating a rule in the XProtect VMS product, telling the system to retrieve the recordings according to a configured schedule, for example to retrieve the Edge Storage recordings during the night when there is no other business-related communication.

Even though the system is configured to retrieve recordings on a schedule, it is sometimes needed to override the defined schedule and retrieve recordings on demand, for example in case of an urgent investigation. This can be done via a second rule that retrieves the recordings when an event is triggered, for example by a shop's alarm, or alternatively it can be achieved by a Smart Client user manually requesting the Edge Storage recordings to be retrieved.

Edge Storage retrieval illustration – event, schedule or manual

The principle in this scenario is like the previous failover scenario. In this case, retrieval is just triggered on a time schedule, by an event or manually by a user.

Like in the failover scenario and for the same reasons, retrieval of the camera's Edge Storage recordings may take some time to complete.



Scalable Video Quality Recording (SVQR)

SVQR is a technology that extends the functionality of Edge Storage and enhances the existing synergies of recording video and audio in both the camera's Edge Storage and the XProtect VMS product's recording server.

SVQR does this by making it possible to record high-quality video in the camera's Edge Storage, while sending a second low-quality "reference" video stream to the XProtect VMS product's recording server where it can be viewed and recorded.

In the event of an incident or an investigation, the initial assessment can be made using the centrally recorded low-quality reference video, while allowing the user to retrieve the high-quality video sequences from the camera's Edge Storage when needed.

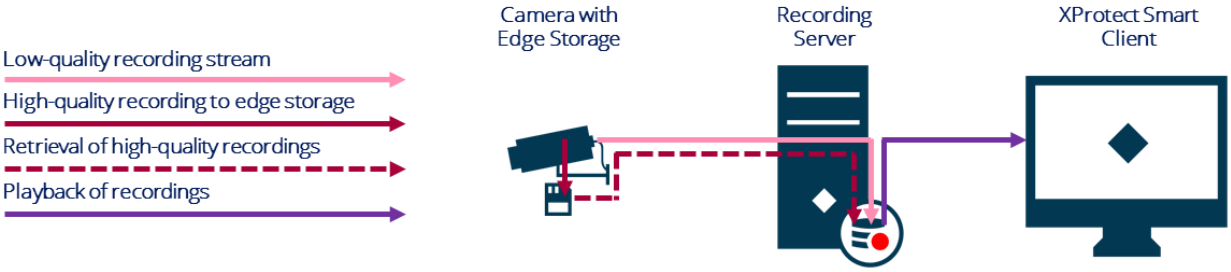
By recording high-quality video on the camera's Edge Storage and low-quality video in the VMS recording server and given the option to retrieve the high-quality recordings only when needed, SVQR significantly reduces the network and storage requirements and cost while still providing users of the XProtect VMS products access to high-quality recordings when they need it.

Implementation of SVQR with Edge Storage

The use of SVQR requires at least two streams of different quality to be enabled and configured on the camera with Edge Storage – in the example below, the two streams are referred to as low-quality and high-quality.

The high-quality stream is recorded in the camera's Edge Storage, based on the camera's own motion detection, events, or schedule.

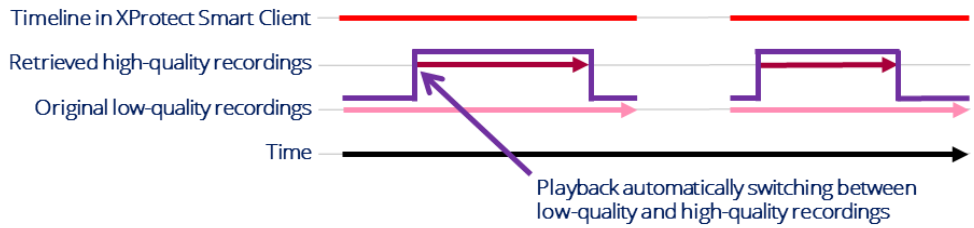
The low-quality stream is streamed from the camera to the XProtect VMS product's recording server where it is recorded based on the VMS' motion detection, events, or schedule.



When high-quality recordings are needed in the VMS, for example for an investigation, the high-quality recordings from the camera's Edge Storage can be retrieved on demand by the users of the XProtect Smart Client, or alternatively, via the rule system on events.

The retrieved high-quality recordings are then stored in parallel with the existing low-quality recordings in the recording server's media database. The retrieved high-quality recordings can then be played back seamlessly with the exiting low-quality recordings without the users having to do anything. The users will simply see the quality of the recordings go from low to high quality when they reach periods where high-quality recordings have been retrieved.

The same applies if the recordings are exported. The quality of the recordings in the export will be the same as the quality experience in playback.



As shown above, the low-quality recordings are not deleted or overwritten when high-quality recordings are retrieved from the camera's Edge Storage but stored in parallel with the existing recordings.

The reason for not deleting or overwriting the recordings is that it would break the digital signature of the existing recordings, making it look like the recordings have been tampered with. Storing the high-quality recordings in parallel with the existing recordings allows the high-quality recordings to have their own digital signature, making it possible to verify the digital signatures of both existing low-quality recordings and the retrieved high-quality recordings.

Time synchronization

For a combined VMS and camera Edge Storage recording system to work properly, it is required that all cameras and XProtect VMS servers are time synchronized.

The best method for doing this is to install and configure a time server. A time server makes it possible for the different XProtect VMS servers and the cameras to continually retrieve the current time via the NTP protocol and thus ensuring proper time synchronization.

If the system is running in a network without a domain controller or dedicated NTP server, the VMS' management server and/or recording servers can be used as the NTP server(s) for both the other VMS servers and for the cameras. This is done by enabling the NTP service built into the OS running the VMS server (if the server runs Microsoft® Server®) or by installing a third-party NTP server.

If the XProtect VMS servers in the surveillance installation are all joined to a domain, the domain will include a time server, and the VMS servers will be synchronized with the domain's time. The surveillance cameras can in this case be configured to also synchronize their time with the domain's time. If this is not possible for the cameras, for instance due to network design, the same method as described for a setup without a domain can be used where an NTP service is enabled or installed on the management server and/or recording server(s).

Edge Storage support in cameras and camera drivers

XProtect VMS Products use camera drivers installed on the recording servers to communicate with the cameras. These camera drivers are installed via a device pack that is included in the recording server.

However, to maximize system-device compatibility and support newly released cameras, Milestone releases updated device packs regularly. Therefore, it is recommended to make sure the device pack is up to date. The updated device packs can be downloaded from Milestone's Software Download center.

A list of supported cameras with Edge Storage support can be found on our Supported Devices page.

Benefits of using Edge Storage

Edge Storage provides a range of benefits when used in different scenarios:

- Increased fault tolerance in all types of installations
- Conserve bandwidth on the network or Internet connection in periods where other traffic should be prioritized by postponing retrieval of the recordings to off-peak hours

- In scenarios where there is limited bandwidth available from the camera, video can be recorded in a higher quality compared to streaming the video continuously and letting the recording server choose what to record
- Using SVQR, recordings can initially be done in low quality in the VMS, while still allowing users to retrieve high quality recordings later if needed

Installations with cameras on wireless or public connections
When cameras are connected to the surveillance system over a public network like the Internet or a potentially unstable network like wireless, recording servers might experience a lost connection to the camera from time to time. In this situation, Edge Storage is an ideal solution to ensure recording are not lost, as the camera will record to the Edge Storage autonomously. Once the connection is restored, recordings will be transferred to the recording server, thus ensuring continuous recording of video even over an unstable network.

Larger installations with failover recording servers
In large installations, failover recording servers normally handle the task of ensuring continuous video surveillance. They can take over for standard recording servers in times of failure. In such a setup, a small gap in the recordings will be seen due to the time it takes for the failover recording server to take over from the normal recording servers.

However, this gap can be covered by using Edge Storage in the cameras. The system will know which period was not covered by either the recording server or the failover recording servers, and therefore retrieve the missing recordings from the camera's Edge Storage.

Smaller installations without failover recording servers
In smaller installations that are not monitored live, Edge Storage can be a good substitute compared to a dedicated failover recording server, as the result is similar, once the user plays back the recordings. Furthermore, it can also be a cost-effective solution as the cost of an extra server dedicated to function as a failover recording server can be saved.

Installations that want to transfer recordings on events or by user request
In installations with distributed cameras, where video should be recorded only in rare cases, it is desirable that the camera does not load the network by continuously sending video to the central recording servers.

In these installations, Edge Storage can be used for an initial recording in the camera's Edge Storage, and later the recording can be retrieved by the recording servers when needed by the VMS or a user.

Installations that want to conserve bandwidth during business hours
In installations where cameras for instance are installed in a series of small shops or kiosks, and are recorded and managed from a central office, the Internet connection for each shop or kiosk may not be reserved for just the camera streams, but also be needed for business-critical data during business hours.

In these kinds of installations, it is desirable that the internet bandwidth is reserved for business communication in the business hours, and not used for continuously sending video to the centrally placed recording servers. Here Edge Storage can be used to initially record the video in the camera's Edge Storage, thus removing the load on the internet connection during business hours. The video recorded in the camera's Edge Storage can then be retrieved to the central recording servers at night or outside of business hours.

Installations with limited and/or costly bandwidth
In transportation installations there might be limited bandwidth available from the vehicle to the recording server while the vehicle is in operation, or it could be costly to use the bandwidth that is available.

In these cases, SVQR can be used to provide a constant low-quality video stream directly from the vehicle for live viewing and for being recorded in the recording server. This allows users to view what is happening in the vehicle in real-time, and to play back low-quality recordings to review or investigate incidents. Since a low-quality video stream requires less bandwidth, bandwidth and costs are saved. When an investigation or an evidence export is required, the high-quality recordings can be retrieved from the camera's Edge Storage on demand once the vehicle has better access to faster or cheaper bandwidth.

User Experience in XProtect Smart Client

The retrieval, synchronization and playback of video and audio initially recorded to the camera's Edge Storage is fully transparent to the XProtect Smart Client users as these recordings and the video and audio recorded directly by the recording server are stored in the same media database in the recording server once the Edge Storage recordings are retrieved.

If recordings stored on the camera's Edge Storage are to be used as recordings related to alarms, access control events, bookmarks, evidence lock, or time critical investigations, it is necessary to create a rule that automatically retrieves the needed recordings from the camera's Edge Storage to make the recordings available for playback with the respective XProtect Smart Client features.

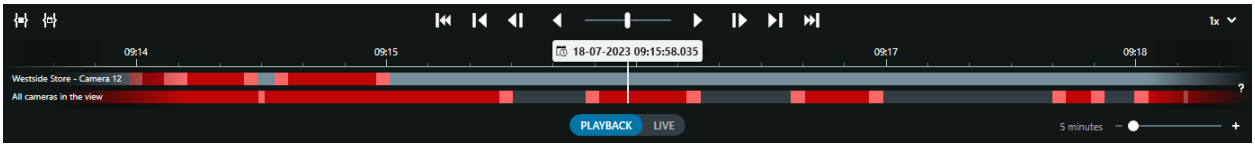
Since retrieval of Edge Storage recordings can take some time, it should be considered how much retrieval time is acceptable for the user. If the retrieval time is too long for the user, it is recommended that the recording is done only by the recording server and not the Edge Storage in the camera.

Manual retrieval of recordings

When cameras are enabled to use Edge Storage, it is possible to retrieve the recordings manually using the XProtect Smart Client. Access to this function requires that the XProtect Smart Client user has permission to retrieve the Edge Storage recordings for the cameras.

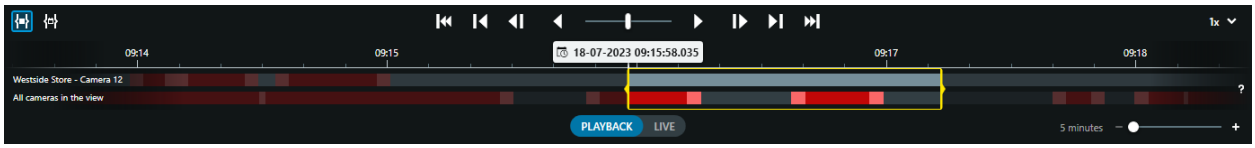
If the user has permission to retrieve recordings and the camera has Edge Storage enabled, the camera timeline will display additional information and will have an option to retrieve the Edge Storage recordings.

The possibility to retrieve the Edge Storage recordings is visualized by replacing the normally black space between recordings on the timeline with a grey color. The grey color indicates that there might be recordings on the Edge Storage camera that can be retrieved by the XProtect Smart Client user.

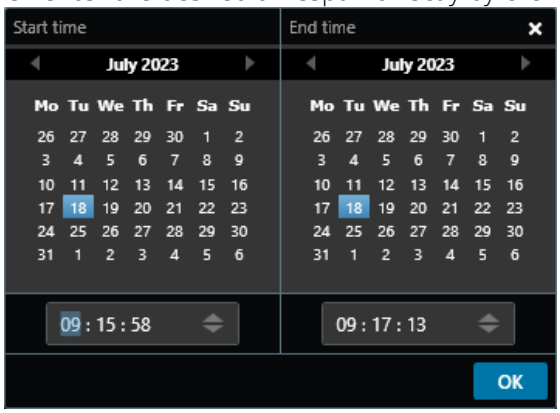


For these Edge Storage cameras where the user has '*Retrieve remote recordings*' permissions, the timespan to retrieve recordings from the camera's Edge Storage can be selected just like selecting video to export.

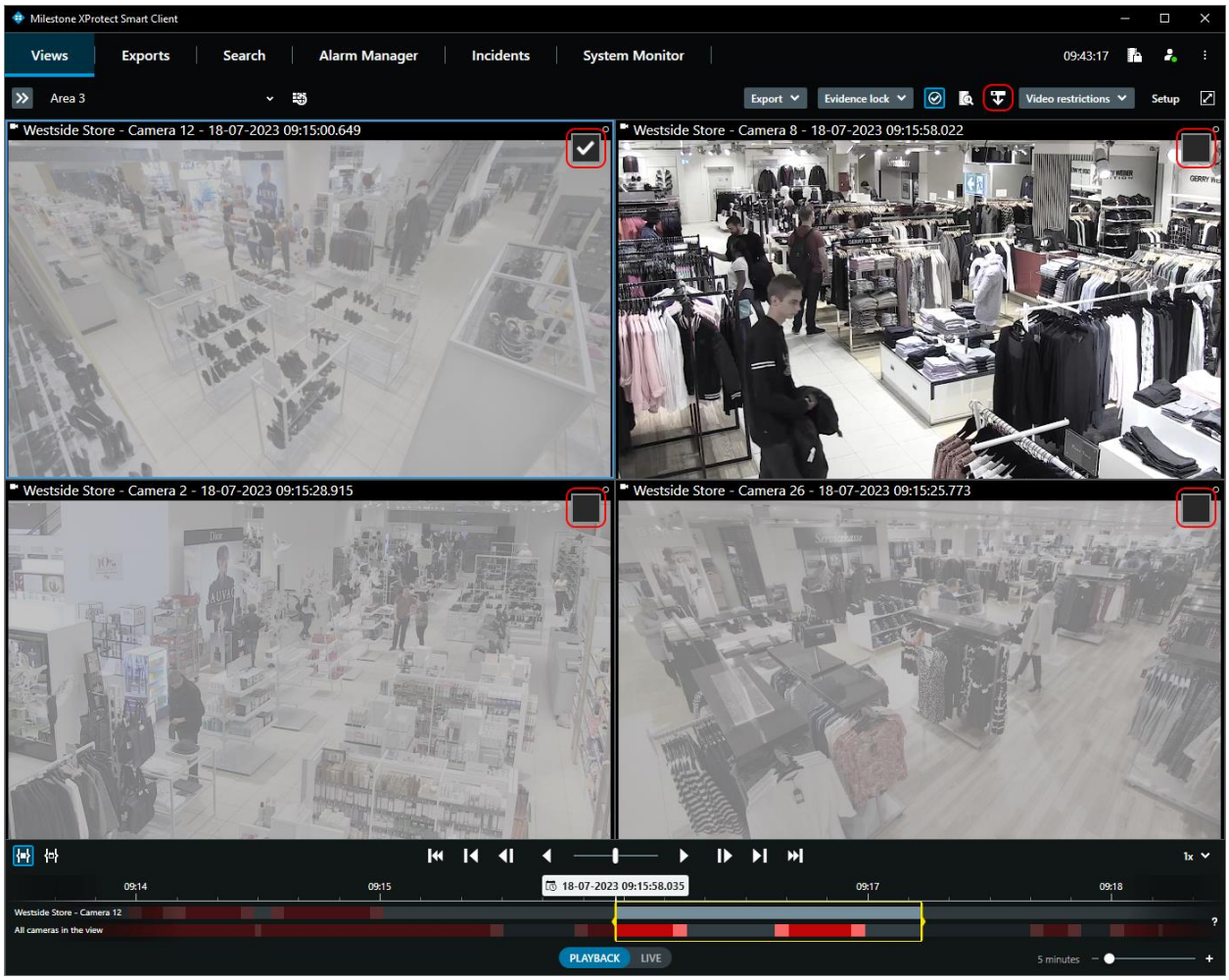
Either - Click the button and select the desired timespan graphically on the timeline:



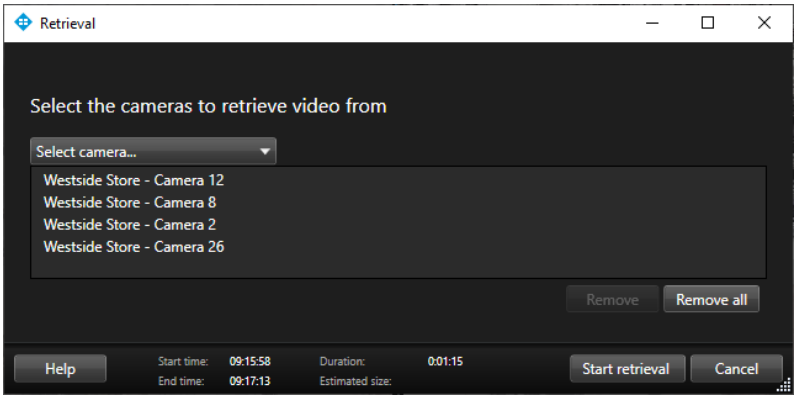
Or enter the desired timespan directly by clicking the button and setting the start/end time:



Once a timespan has been set, the cameras from which the recordings will be retrieved can be selected by clicking on the check boxes displayed for each camera (the current camera is selected by default).

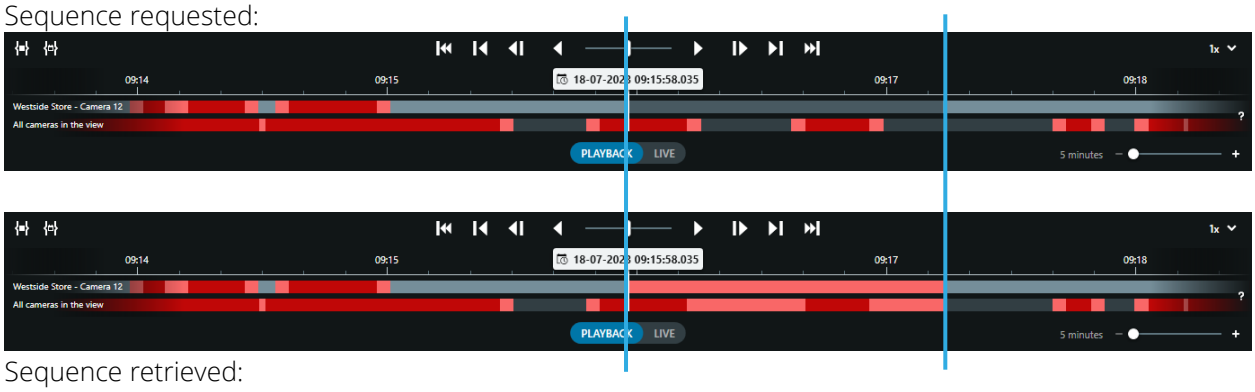


Once the timespan and cameras in the view have been selected, the retrieval job can be created by clicking the '*Retrieve...*' button. This will open the '*Retrieval*' dialog where additional cameras can be selected.



Clicking the '*Start retrieval*' button will create the retrieval job. The created job will be indicated on the timeline by a lighter grey pattern as shown below.

Sequence requested:

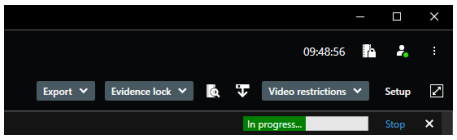


Sequence retrieved:

When the retrieval job is complete, the timeline will show the retrieved recordings with the standard red color. Time periods that didn't have any recordings on the remote system are shown with the standard unpatterned black background.

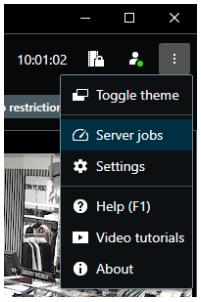
Retrieval Jobs

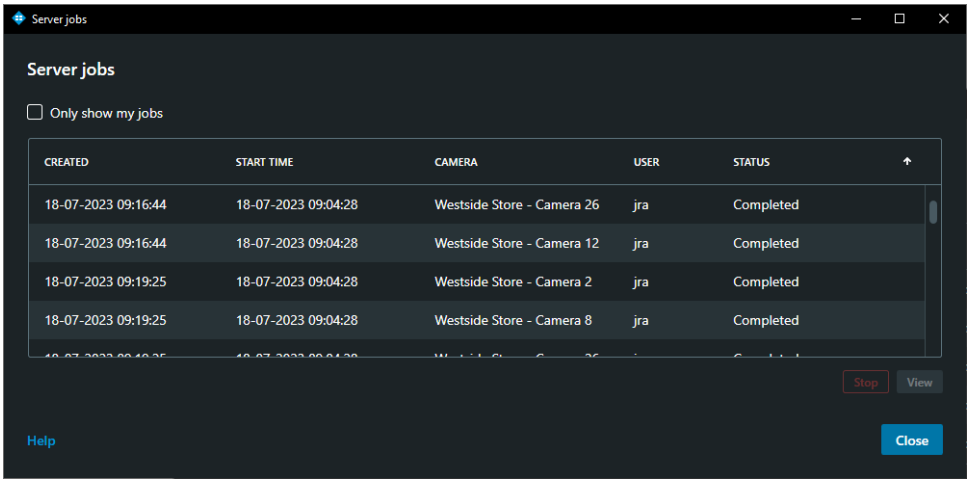
When a retrieval job is created, it will display the progress in the notification area in the XProtect Smart Client in the same way that export jobs are shown.



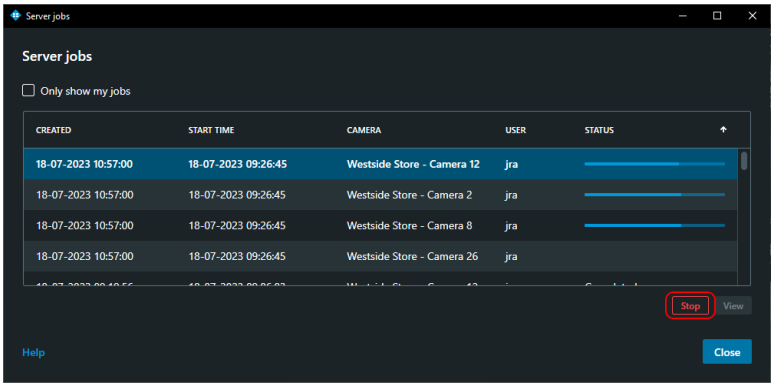
To remove the notification for the job, click the ✕ button. This will not cancel the retrieval job, but just remove it from the notification area. To stop an ongoing retrieval job, click the '*stop*' button.

A complete overview of all retrieval jobs, pending, in progress, stopped or completed, can be seen in the '*Server Jobs*' dialog. The '*Server Jobs*' dialog is opened from the '*Settings and more*' menu.

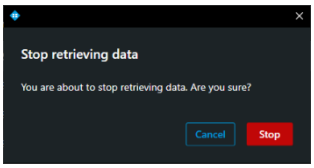




If necessary, the ongoing or pending retrieval jobs can be cancelled by clicking on the '*Stop*' button.

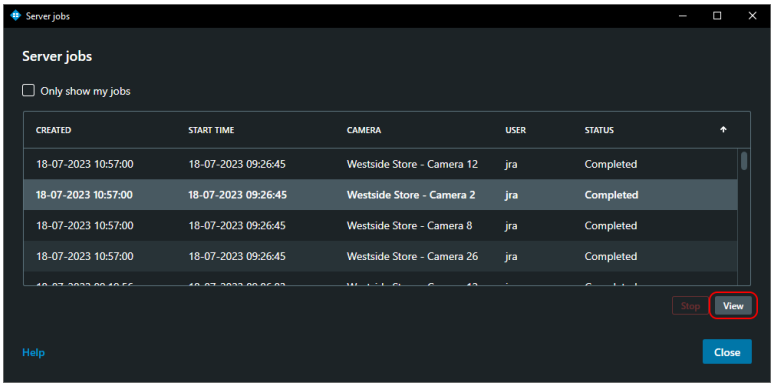


Users will be prompted to confirm that the retrieval should be stopped.

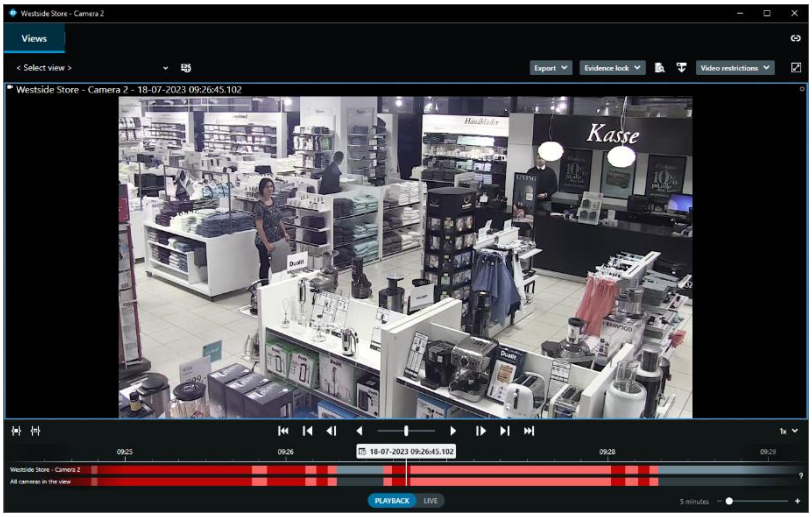


Note: If an ongoing retrieval job is stopped, the recordings that already have been retrieved will not be deleted from the media database.

If the user wants to view the retrieved recordings, this can be done by clicking the '*View*' button.



Once clicked, a floating playback window will open showing the camera at the beginning of the retrieved period. The user can now play back the recordings easily or export them for other purposes.

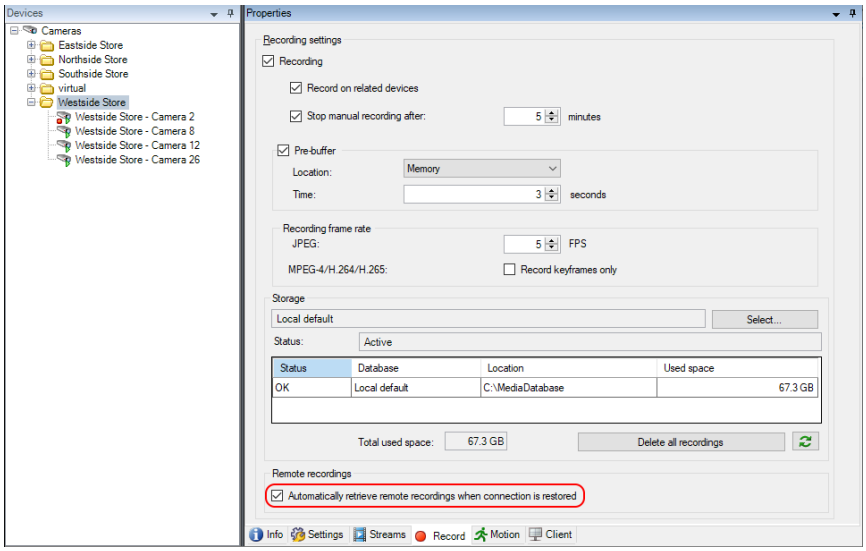


Edge Storage configuration

Edge Storage configuration is done using the XProtect Management Client.

Automatic retrieval of Edge Storage recordings

Edge Storage for failover usage is enabled simply by selecting the '*Automatically retrieve remote recordings when connection is restored*' check box on the camera's record dialog.

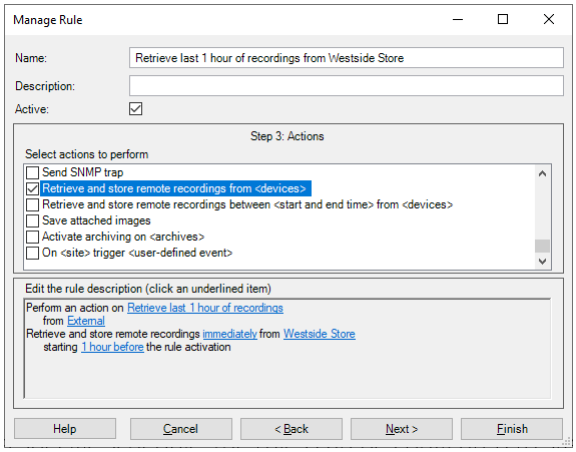


Retrieve Edge Storage recordings on event or time schedule

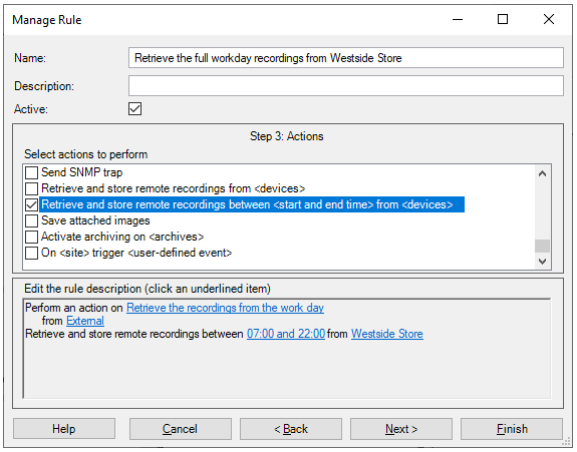
Edge Storage recordings can also be retrieved on event or schedule. This is done by configuring a rule that retrieves the Edge Storage recordings on event and/or time schedule.

When retrieving remote recordings, it is possible to select to retrieve recordings from a specific time interval or a set time before the event occurred or schedule started.

The setup of the rules is done in the XProtect Management Client using the '*Manage Rule*' wizard.



Rule example: Retrieve last 1 hour

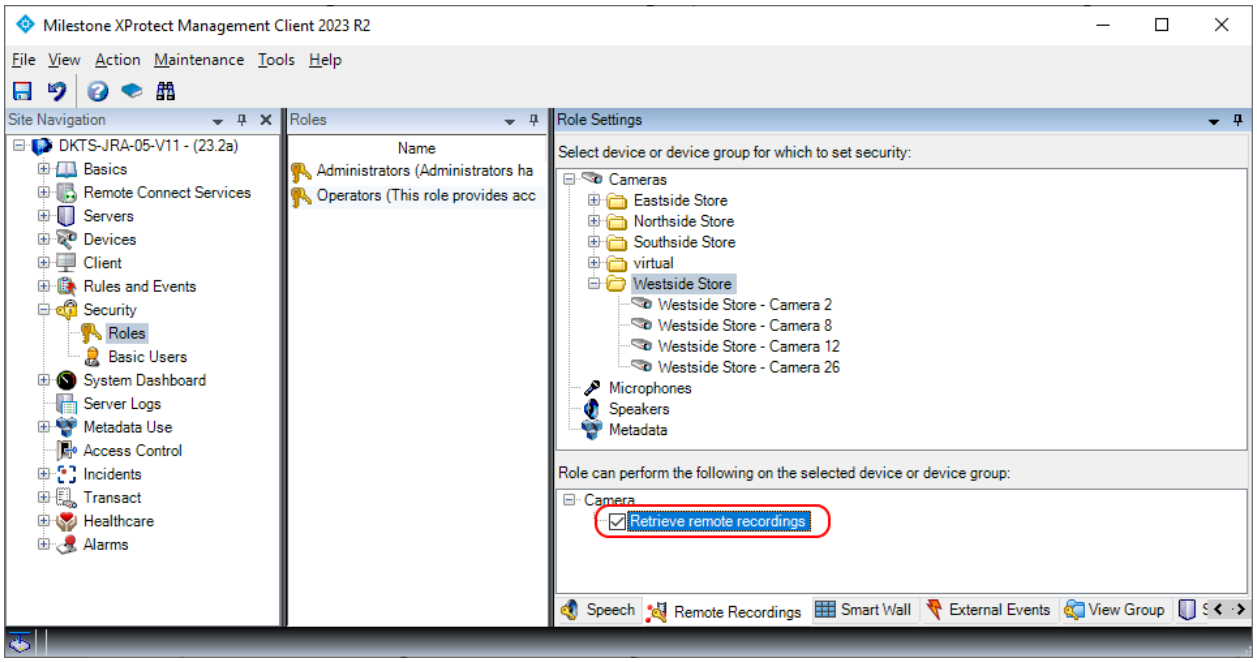


Rule example: Retrieve recordings from 7.00 to 22.00

If the recordings need to be retrieved following a specific schedule, the rules can be configured to start based on a time profile.

Retrieve Edge Storage recordings on manual user request

In addition to the standard permissions that can be configured for cameras, the cameras with Edge Storage support have an additional '*Retrieve remote recordings*' permission. This permission can be set on the '*Remote Recordings*' tab. When enabled, users of the XProtect Smart Client can create Edge Storage retrieval jobs for the camera.



Edge Storage in comparison to Milestone Interconnect

Milestone Interconnect is a unique system concept that allows all paid versions of Milestone XProtect VMS and Husky products to be interconnected with Milestone's premium software, XProtect Corporate. This allows design of large-scale and geographically dispersed video surveillance systems where you for each independent site can chose the XProtect VMS product that best fits the required functionality and budget, while still providing the benefits of a centralized surveillance system.

Milestone Interconnect share the underlying implementation with Edge Storage and can in many ways be seen as a more advanced Edge Storage solution where whole XProtect VMS installations are connected to the central XProtect VMS system as a kind of multichannel video encoder with advanced Edge Storage support.

The user experience in the XProtect Smart Client when using Milestone Interconnect is comparable to Edge Storage as it offers the same basic recording retrieval functionality for both Edge Storage and Milestone Interconnect. However, in addition to the basic recording retrieval functionality, Milestone Interconnect also offers more advanced functions like direct playback of the recordings on the remote XProtect VMS installations and support for system events from the interconnected sites.

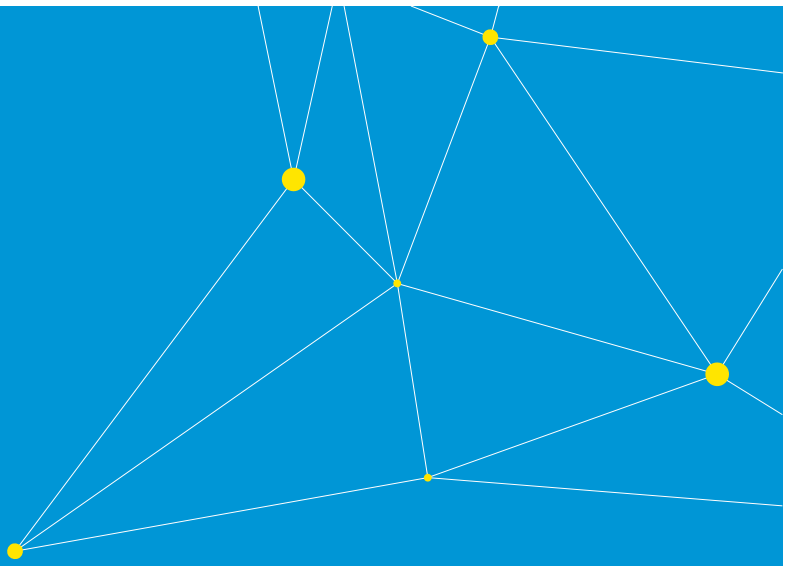
More can be read about Milestone Interconnect here: Milestone Interconnect whitepaper

Summary

Combining central recording in recording servers with recording in the camera's Edge Storage provides many benefits in surveillance installations:

- Leave recordings on the camera until they are needed, conserving network bandwidth and resources on the recording server
- Postpone retrieval of recordings to off-peak hours, conserving network bandwidth for other usage
- Increase system reliability over unstable connections like, for instance, wireless networks
- Provide additional recording redundancy during system failures or maintenance downtime
- Supply a superior solution for handling recordings from mobile units that go in and out of network coverage

With Milestone XProtect VMS products, Edge Storage is simple to configure and use, and once enabled, provides the users with seamless access to recordings regardless of whether they have been recorded by the recording server or initially saved on the camera's Edge Storage.



Milestone Systems is a leading provider of open platform video management software; technology that helps the world see how to ensure safety, protect assets and increase business efficiency. Milestone enables an open platform community that drives collaboration and innovation in the development and use of network video technology, with reliable and scalable solutions that are proven in more than 500,000 sites worldwide. Founded in 1998, Milestone is a stand-alone company in the Canon Group.