

White Paper

Edge Storage with flexible retrieval

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Introduction

In video surveillance, Edge Storage is a technology that stores video and audio recordings in onboard storage media inside cameras. This 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 cameras' Edge Storage media after system failures, on events, by time schedules, or by manual requests of users of the XProtect Smart Client. This enables cameras to function as failover/redundancy devices and it increases the overall availability of the video system. Cameras can also function as the primary recording device where the Recording Server only retrieves the recordings when they are needed or requested by the users of the system.

Throughout this white paper, 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 a XProtect surveillance system using Edge Storage. The white paper assumes the reader has a general understanding of XProtect Corporate, XProtect Expert and XProtect Professional+ and of 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 with centrally placed recording servers. This means that there now are 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, however combining them provides a more robust solution with higher performance. In addition, it adds more flexibility in the VMS and network design and provides support for scenarios where cameras are not online all the time, such as cameras installed in vehicles like, trains, trams, busses etc.

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 fits their needs and budget best
- The storage can be scaled and expanded to an infinite size virtually, 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 to maintenance - unless the surveillance system is protected by a failover recording solution like the failover recording server that XProtect Corporate and XProtect Expert offer

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 there
- 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 complexed to configure in Edge Storage enabled cameras compared to in a centrally configured VMS. For example, controlling when to record in multiple Edge Storage enable cameras based on events from third-party solution's like for instance access control or building management systems
- Slow retrieval and play back 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 provides the ideal combination maximizing the advantages of both central and Edge Storage recording while minimizing or eliminating the disadvantages of relying on only one technology.

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

Technical overview

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

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

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

Cameras can be offline for different reasons. Mobile cameras such as vehicle-mounted or body-worn cameras can be temporarily out of network reach, or a system fault or maintenance of network or servers can disconnect a camera. In these cases, the missing recordings can be retrieved from the camera's Edge Storage to the central recording server automatically once the connection to the cameras 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 cameras until needed by the VMS or its users, at which point it then can be retrieved from the camera.

Edge Storage as Failover

Connection to camera is down

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 server will automatically retrieve all recordings made during the period where the camera was out of reach, in order to achieve a seamless surveillance recording.

Normally in a VMS, in order to save on storage space, video is only recorded when motion is detected in the video. If the same should be applied for failover periods covered by the recordings stored in the cameras Edge Storage, many IP cameras that support Edge Storage support to only store video in the Edge Storage when motion has been detected by the camera itself. This ensures that only relevant video is being recorded and later transferred to the VMS. In addition, this will result in a faster transfer once the failure is resolved.

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 scenario described above.

To know what time periods to retrieve missing recordings for in case of a failure, the recording server keeps track of the last time the recording server was operational before it went offline, so once it is operational again it knows what period it missed and needs to retrieve Edge Storage recordings for.

Edge Storage retrieval principle – system or network failure

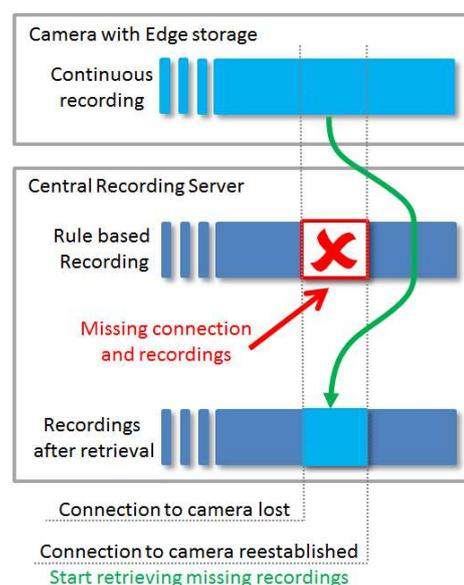
In the above failover recording scenarios, the principle is very simple: The camera records to the Edge Storage, either continuously or based on the cameras motion detection, schedule, or external events.

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

Retrieval of the recordings can take some time to complete:

- The missing video 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 recordings

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



Scheduled, event-based or manual retrieval

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 camera's recordings until after working hours.

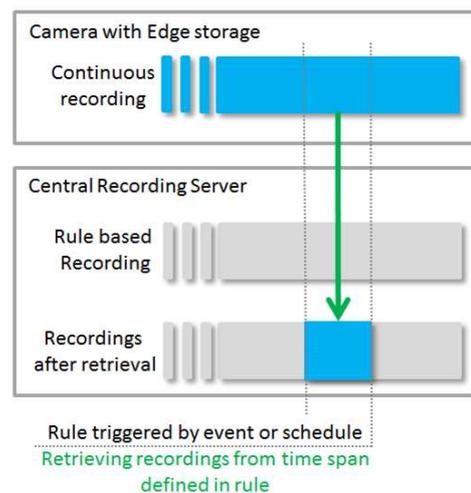
This is done by creating a rule in the XProtect VMS product, telling the system to retrieve the recordings according to a configured schedule, for example, retrieve the recordings during the night when there is no other business-related communication.

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 a robbery or other required investigation. This can be done via a second rule that retrieves the recordings when an event is triggered e.g., a shop's alarm, or alternatively it can be achieved by a Smart Client user manually requesting the recordings to be retrieved.

Edge Storage retrieval principle – event, schedule or manual

The principle in this scenario is like the previous failover scenario, retrieval is in this case 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 cameras Edge Storage, while sending a second low-quality "reference" video stream to the XProtect VMS products 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 when needed by the users of the XProtect VMS product, 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 streams are referred to as low-quality and high-quality.

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

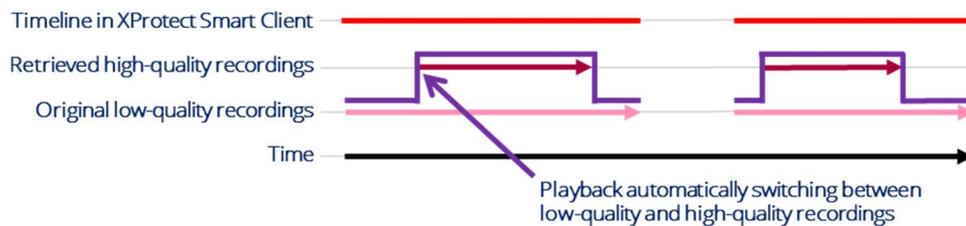
The low-quality stream is streamed from the camera to the XProtect VMS products' recording server where it is recorded based on the VMS' motion detection, events, or schedule.



When high-quality recordings are needed in the VMS, in times of an investigation for example, 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, automatically on events.

The retrieved recordings are then stored in parallel with the existing low-quality recordings and can be played back seamlessly with the existing 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 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 had 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 optimally, it is very important that all cameras and servers in the XProtect VMS products system 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 products' servers and the cameras to continually retrieve the current time via the NTP protocol and thus ensure proper time synchronization.

If the system is running in a network without a domain controller or dedicated NTP server the VMS' management server can be used as a NTP server, either by enabling the NTP service built into the OS running the management server (if the server runs Microsoft® Server®) or by installing a third-party NTP server.

If the servers in the surveillance installation are members of a domain, the domain will normally include a NTP server. The surveillance servers and cameras can then be configured to synchronize the time with the domain NTP server.

If it is not possible for the cameras to reach the domain's NTP server due to network design, the same method as described for a setup without a domain can be used, with one small change: The management server must be set up to synchronize its time, and thus the server's NTP server's time, with the domain NTP server's time.

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, Milestone releases updated device packs regularly, therefore, it is recommended to make sure the device pack is up to date. This can be done via Milestone's download center on the Milestone website.

A list of supported cameras with Edge Storage can be found [here](#).

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 since 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 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 time 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 cost-saving substitute compared to a dedicated failover recording server. This is because the result is similar, once the user playback the recordings, and because the cost of an extra server dedicated to function as a failover recording server can be saved.

Installations that wish 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 on the cameras Edge Storage, and later retrieved by the recording servers when needed by the system or a user.

Installations that wish to conserve bandwidth during working hours

In installations where cameras are installed in several remote locations and recording servers are installed in a central location, for instance a series of small shops or kiosks 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 opening hours.

In these cases, it is desirable that the cameras do not load the internet connection by continuously sending video to the central recording servers during work hours. Here, Edge Storage can be used to initially record the video in the cameras' Edge Storage removing the load on the internet connection. The recorded video and audio can then be retrieved to the central recording servers at night or outside opening 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 it 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 playback low quality recordings to review or investigate incidents. Since a low-quality video stream requires less bandwidth, it therefore saves on bandwidth and cost. Once an investigation or an evidence export is required, the high-quality recordings can be retrieved from the camera's Edge Storage on demand when 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 cameras Edge Storage is fully transparent to the XProtect Smart Client users as the retrieved recordings and the video and audio recorded directly by the recording server are stored in the same media database in the recording server.

If recordings stored on the cameras 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 cameras' Edge Storage to make the recordings available for playback in the respective XProtect Smart Client dialogs.

Because retrieval of Edge Storage recordings can take some time, it should be considered how long a 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 the XProtect Smart Client user to have permissions to retrieve the Edge Storage recordings for the cameras.

If the user has permission for retrieving recordings and the camera have 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 pattern instead. The grey pattern 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 recordings from the camera's Edge Storage can be retrieved just like selecting video to export.

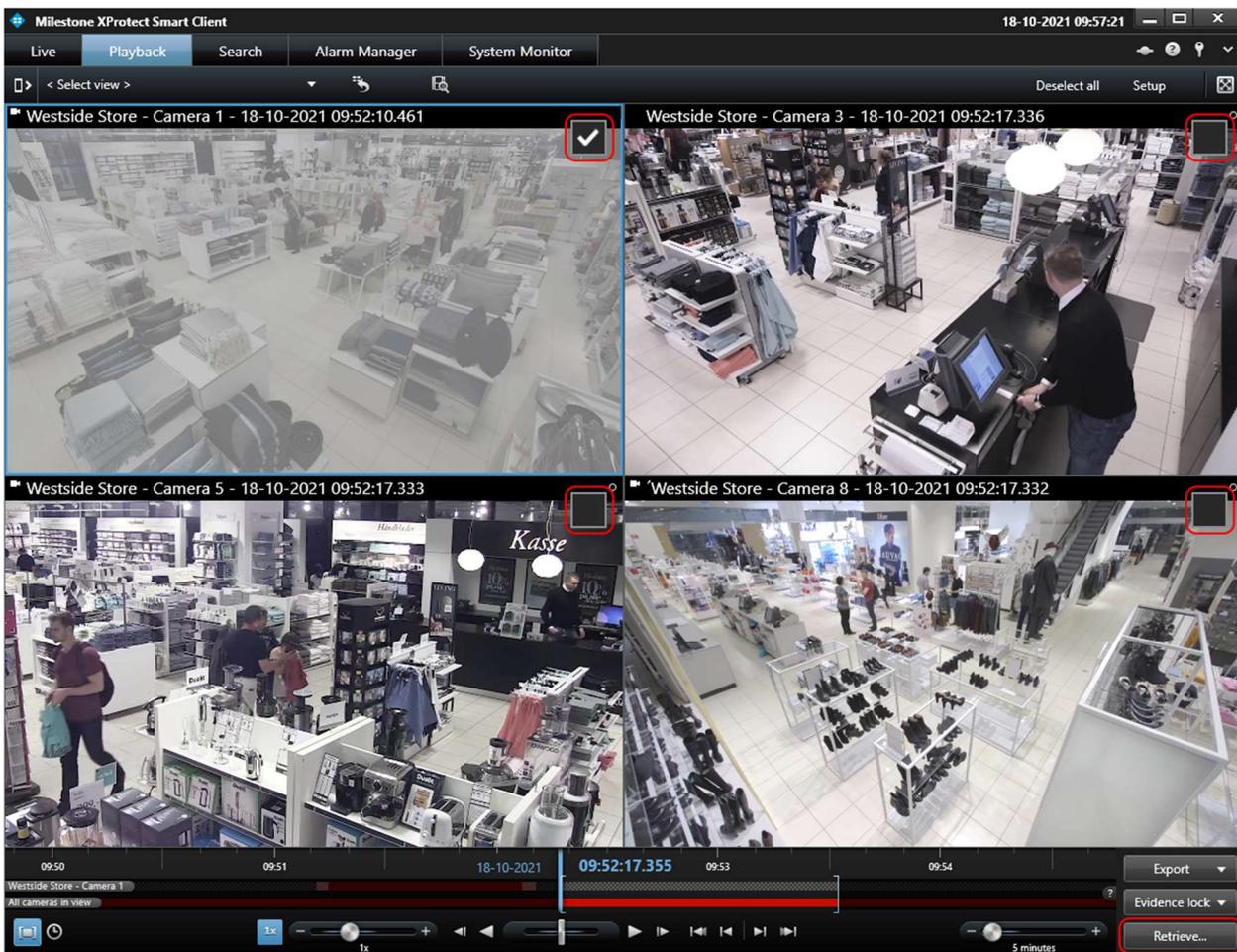
Either - Click the  button and select the desired timespan graphically on the timeline:



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

| Start time | End time |
|--|--|
|  oktober 2021 |  oktober 2021 |
| ma ti on to fr lø sø | ma ti on to fr lø sø |
| 27 28 29 30 1 2 3 | 27 28 29 30 1 2 3 |
| 4 5 6 7 8 9 10 | 4 5 6 7 8 9 10 |
| 11 12 13 14 15 16 17 | 11 12 13 14 15 16 17 |
| 18 19 20 21 22 23 24 | 18 19 20 21 22 23 24 |
| 25 26 27 28 29 30 31 | 25 26 27 28 29 30 31 |
| 1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 |
| 09 : 52 : 17 | 09 : 53 : 32 |
| OK | |

Once the time span has been set, the cameras from which the recordings will be retrieved can be selected by clicking on the checkboxes displayed for each camera (the current camera is checked by default).



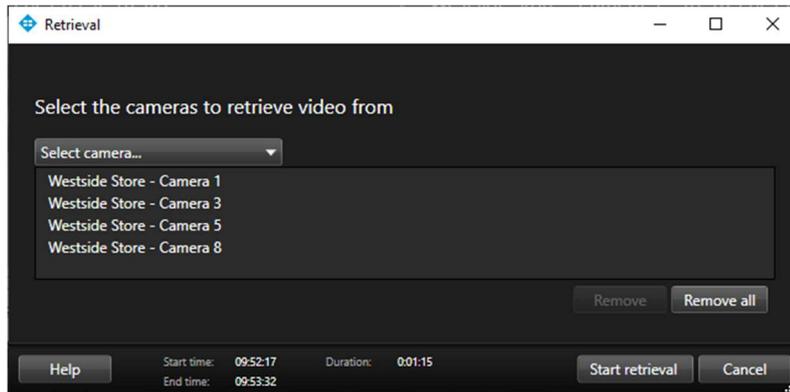
The screenshot displays the Milestone XProtect Smart Client interface during a playback session. The main area shows four camera feeds from a store named 'Westside Store'. The feeds are labeled as follows:

- Westside Store - Camera 1 - 18-10-2021 09:52:10.461 (checked)
- Westside Store - Camera 3 - 18-10-2021 09:52:17.336 (unchecked)
- Westside Store - Camera 5 - 18-10-2021 09:52:17.333 (unchecked)
- Westside Store - Camera 8 - 18-10-2021 09:52:17.332 (unchecked)

The playback timeline at the bottom shows the current time as 09:52:17.355. The 'Retrieve...' button is highlighted with a red box, indicating the next step in the retrieval process.

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:

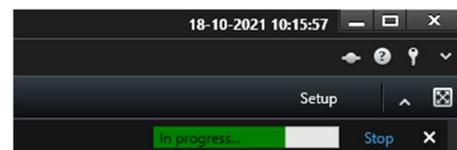


Sequence retrieved:

When the retrieval job is complete, the timeline will show the retrieved recordings with the standard red color and areas that didn't have any recordings on the remote system by showing these segments with the standard black unpatterned background.

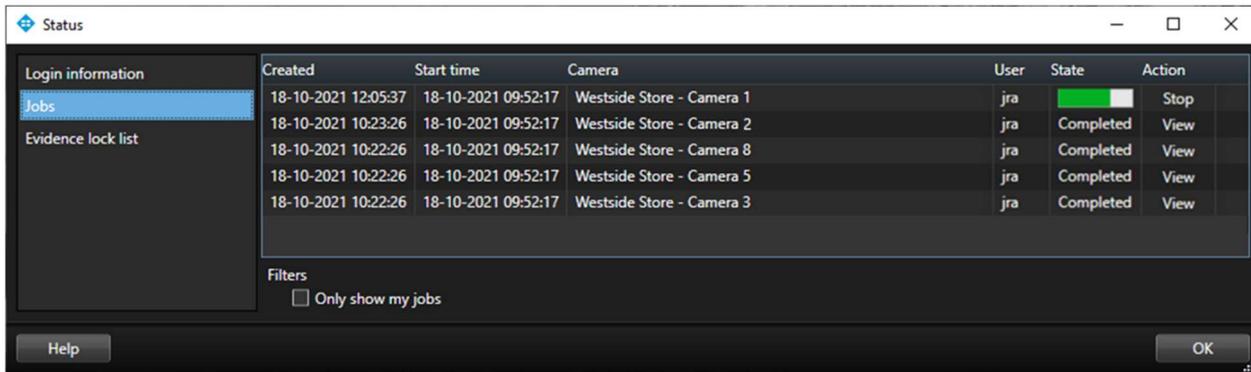
Retrieval Jobs

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

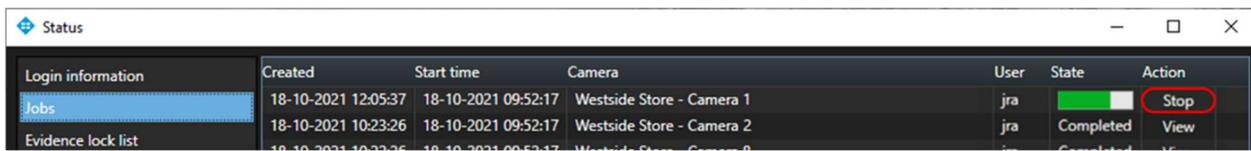


You can hide/show jobs by clicking on the  /  button or remove the job entirely from the list by clicking on the  button (it will not cancel the retrieval job, just remove it from the notification area). To cancel an ongoing job, click the 'Stop' button.

For a complete overview of all jobs, pending, in progress, stopped or completed, the 'Jobs' overview in the 'Status' dialog can be used, which can be found by clicking the  button.



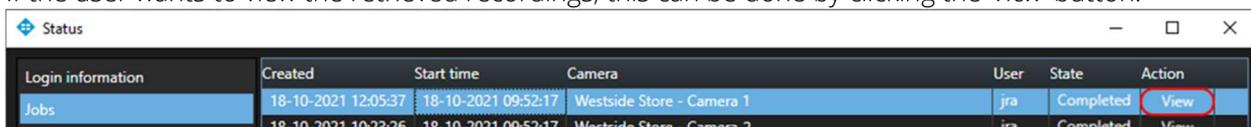
If necessary, the ongoing or pending retrieval jobs can be cancelled by clicking on the 'Stop' button.



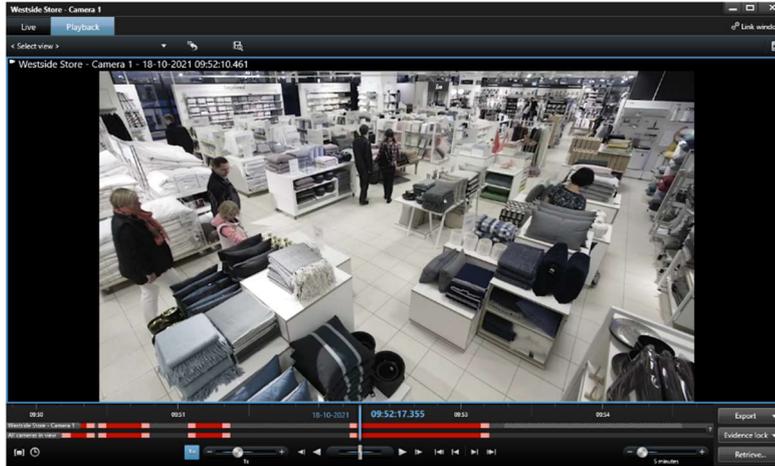
Users will be prompted to confirm that the retrieval should be stopped.

Note: If an ongoing retrieval job is stopped, the recordings that have been already 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 time period. The user can now playback the recordings easily or export them for other purposes.

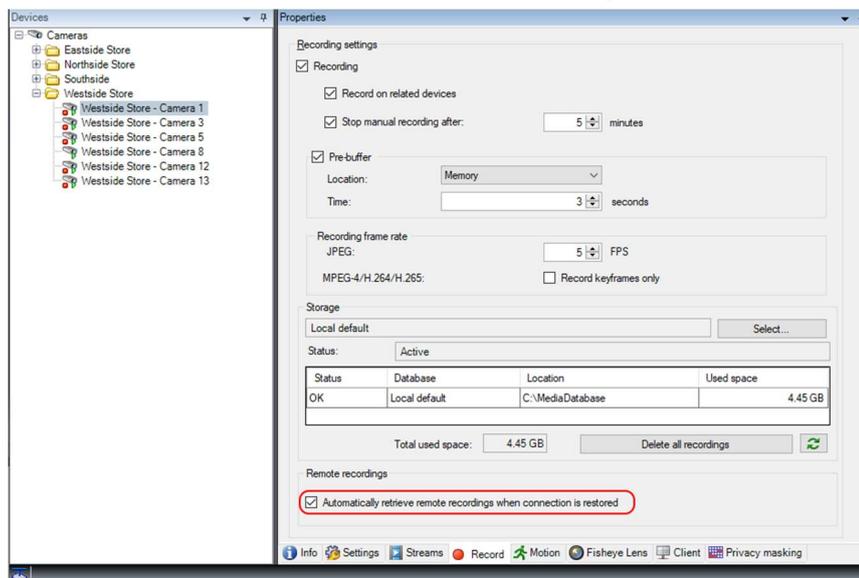


Edge Storage configuration

Edge Storage configuration is done using the standard XProtect Management Client.

Enable Edge Storage

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

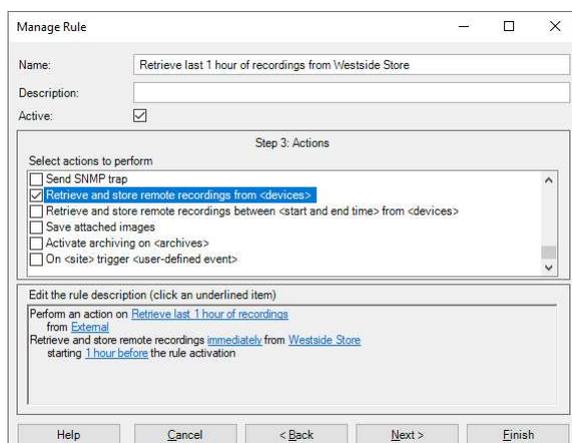


Retrieve Edge Storage recordings on event or time schedule

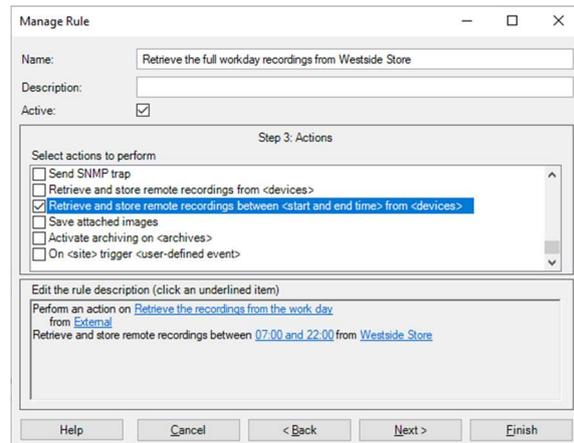
Edge Storage recordings can also be retrieved on event or schedule. This is done by configuring a rule that retrieves the Edge Storage recordings on event and/or time schedule.

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

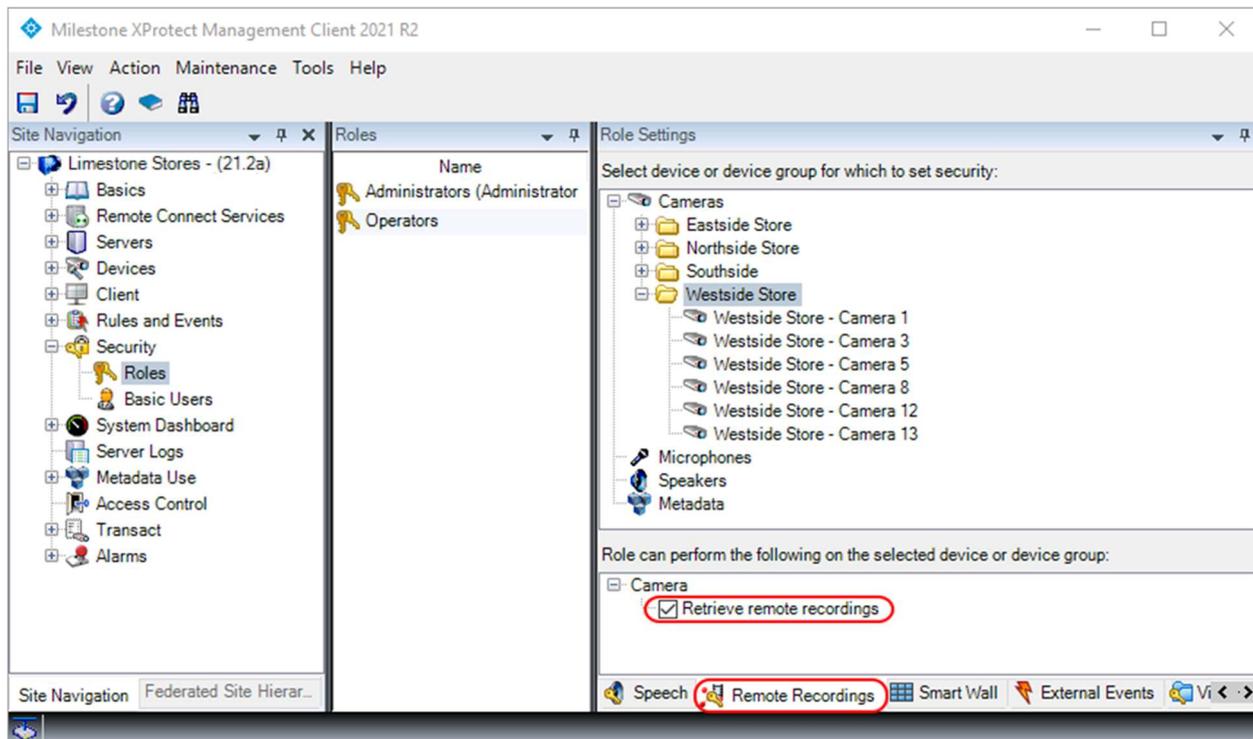


Rule example: Retrieve recordings from 7.00 to 22.00

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

Retrieve Edge Storage recordings on manual user request

In addition to the standard user permissions for cameras, the Edge Storage enabled cameras have a dedicated tab called 'Remote Recordings' in the roles definition. Here the permissions to retrieve Edge Storage recordings can be set, allowing users of the XProtect Smart Client to create Edge Storage retrieval jobs for the selected cameras.



Edge Storage in comparison to Milestone Interconnect

Milestone Interconnect is a unique system concept that allows all 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 VMS systems are connected to the central XProtect VMS system as a kind of multichannel video encoder with Edge Storage support. The user experience in the XProtect Smart Client using Milestone Interconnect is comparable to Edge Storage as it offer the same basic recording retrieval functionality for both Edge Storage and Milestone Interconnected cameras. However, in extension to the basic recording retrieval functionality, Milestone

Interconnect also offer more advanced functions like, direct playback of the recordings on the remote VMS and support for system events.

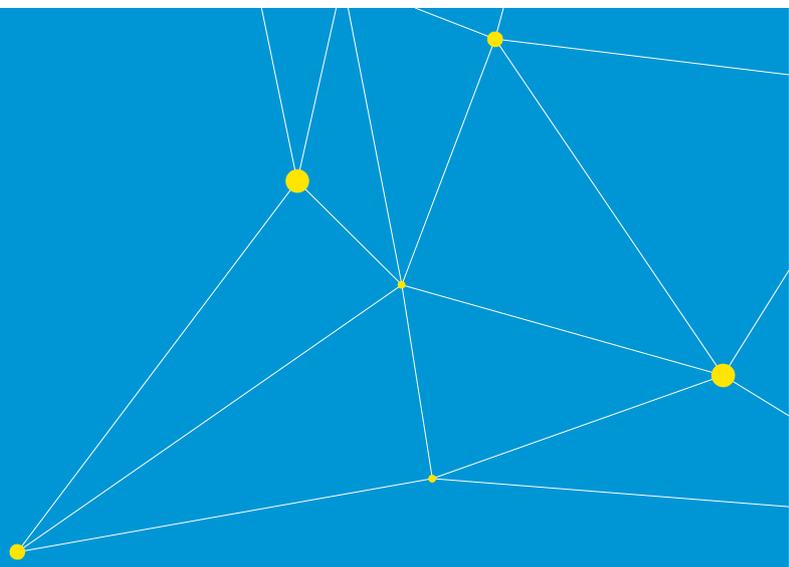
More can be read about Milestone Interconnect in the [Milestone Interconnect whitepaper](#).

Summary

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

- 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 users seamless access to the recordings whether they have been recorded by the recording server or 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.