

## **Axis' Zipstream technology**

More video, less storage



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# 1. Introduction

Most networked video surveillance systems today are limited by the amount of video that can be stored for later use. Camera technologies such as sensors, optics and embedded image processing have evolved rapidly over the last 10 years, resulting in video with higher resolution, frame rate and dynamic range, capturing more details of a scene. The development has improved the quality of video evidence and forensic analysis such as face identification, but only when it is possible to retrieve the video from the right place, the right time and with the right quality. A high quality video source is of no value if storage was limited and the system was configured to remove valuable information before it was needed.

There are various methods to limit storage needs by reducing the video bit rate, such as limiting the storage retention time, saving video in a lower resolution, reducing the frame rate and compressing video harder. In all these methods, information about something critical might be missing when really needed.

Optimized for video surveillance, Axis' Zipstream technology is a radically more efficient H.264 implementation, lowering bandwidth and storage requirements by an average 50% or more. Axis' Zipstream technology adds a module inside the video compression engine of the network camera that ensures that important details in the image get enough attention in the video stream while unnecessary data can be removed. Axis' Zipstream technology cuts the reduced storage cost by an average of 50% or more without costly and complicated integration.

## 2. Background

Before video from surveillance cameras can be efficiently stored on any media it has to be processed to fit into the allowed space. To fit video with high resolution and full frame rate onto SD cards, which are the most popular and cost-efficient media for embedded applications, the original information has to be encoded. This is done using video compression algorithms that encode video data by reducing and removing redundant information.

See Section 7, Useful links, 'Video compression', for more information on video compression.

### 2.1 Video compression algorithms

Video compression algorithms are used to find regions in the video that already has been transferred and do not need to be sent again in the next image frame. Another task for the algorithm is to identify where in the video details can be removed without reducing the visual quality.

State-of-the-art video compression algorithms that function well together are grouped into an international standard, which is a video stream syntax created for storing, sharing and viewing video. Today, the most used video compression standard is called H.264, which is a method that is efficient enough to reduce several days of surveillance video onto one single SD card.

The algorithm used to compress video according to H.264 is not part of the standard, only the syntax and the method to perform playback is standardized. This enables improved H.264 encoding solutions to be created while keeping the file format for interoperability (video decoder compatibility).

Axis' Zipstream technology is a more effective implementation of an H.264 video encoder for surveillance applications. It includes various surveillance-unique methods that enable networked cameras to produce video with markedly lower bit rate.

### 3. How does Axis' Zipstream technology work?

Axis' Zipstream technology is a collection of algorithms in the camera that analyzes the video stream in real-time. Interesting details and motion are preserved with the given video quality while the Axis-unique module can filter other areas harder to optimally use the available bandwidth.

Axis' Zipstream technology is not in any way a replacement for High Efficiency Video Coding (HEVC)/ITU Telecommunication Standardization Sector (ITU-T) H.265, which was jointly developed by ISO/IEC Moving Picture Experts Group (MPEG) and ITU-T Video Coding Experts Group (VCEG). Zipstream is a video coder enhancement, which can be applied on many video compression standards with minor adaptations.

#### 3.1 Configuration options

Axis' Zipstream technology adapts the compressed video stream based on four factors:

- > Scene motion
- > Scene content
- > Ambient light level
- > Configuration options

Configuration options that affect Zipstream:

- > Compression parameter
- > Group of Pictures (GOP) length
- > Frame rate
- > Strength parameter
- > Dynamic GOP parameter
- > Dynamic GOP limitation parameter

The effort level for Zipstream is defined by the strength parameter, as follows:

Strength parameter	Effort level	Explanation
Off	-	Zipstream disabled
10	Low	No visible quality degradation in most scenes
20	Medium	Limited visible quality degradation in areas without any priority in some scenes
30	High	Visible quality degradation in areas without any priority in many scenes

All strength parameter settings are compatible with all existing applications, while still reducing the bit rate.

Dynamic GOP parameter:

Dynamic GOP parameter	Explanation
Off	Dynamic GOP adjustments, disabled
On	Dynamic GOP adjustments, enabled

Dynamic GOP limitation parameter:

Dynamic GOP limitation parameter	Explanation
Actual value	Maximum allowed dynamic GOP length

By default, networked cameras supporting Axis' Zipstream technology are configured with the strength parameter set to 10 and dynamic GOP disabled. The default setting is compatible with all existing applications, while still reducing the bit rate.

### 3.2 Bit rate reduction

The bit rate reduction can be derived from either the dynamic Region of Interest (ROI) of Zipstream or its dynamic GOP.

#### Dynamic ROI

The dynamic ROI optimizes bandwidth in real-time by analyzing where available bits will give the maximum benefit from a forensic perspective. This process is performed for all image content, resulting in a totally flexible dynamic ROI. This dynamic ROI automatically expand, shrink, change shape, split, merge, disappear and reappear depending on content, for the benefit of tuning the instant bandwidth.

Since it is unknown in which parts of the image relevant information may appear, Zipstream prepares the system for unexpected events. This dynamic automatic ROI is much more convenient than other traditional ROI implementations where the region is set manually.

#### Dynamic GOP

The dynamic GOP reduces the bit rate by avoiding storage consuming I-frame updates. Typical surveillance scenes with limited motion can be compressed to an extremely small size without any loss of detail. This algorithm makes a real-time adaption of the GOP length on the compressed video according to the amount of motion. All clients or Video Management System (VMS) solutions may not support smooth playback of video with this algorithm enabled even though the compressed video stream conforms to the H.264 standard.

### 3.3 Expected reduction rates

Axis' Zipstream technology reduces the average bit rate by using real-time scene information. One method to estimate total savings is to look at the bit rate savings from each method independently and multiply the reduction factors.

Zipstream method	Bit rate reduction	Influenced by
Dynamic ROI	10-50%	Zipstream strength parameter, scene motion and content
Dynamic GOP	0-50%	Scene motion

The example in Figure 1 plots the instant bit rate from a video with four different motion scenarios A, B, C and D, with two different Zipstream configurations compared to when Zipstream is disabled. All streams are Variable Bit Rate (VBR) streams with GOP length=32. Each I-frame update is clearly visible as bit rate spikes and the instant bit rate can be read on the vertical axes.

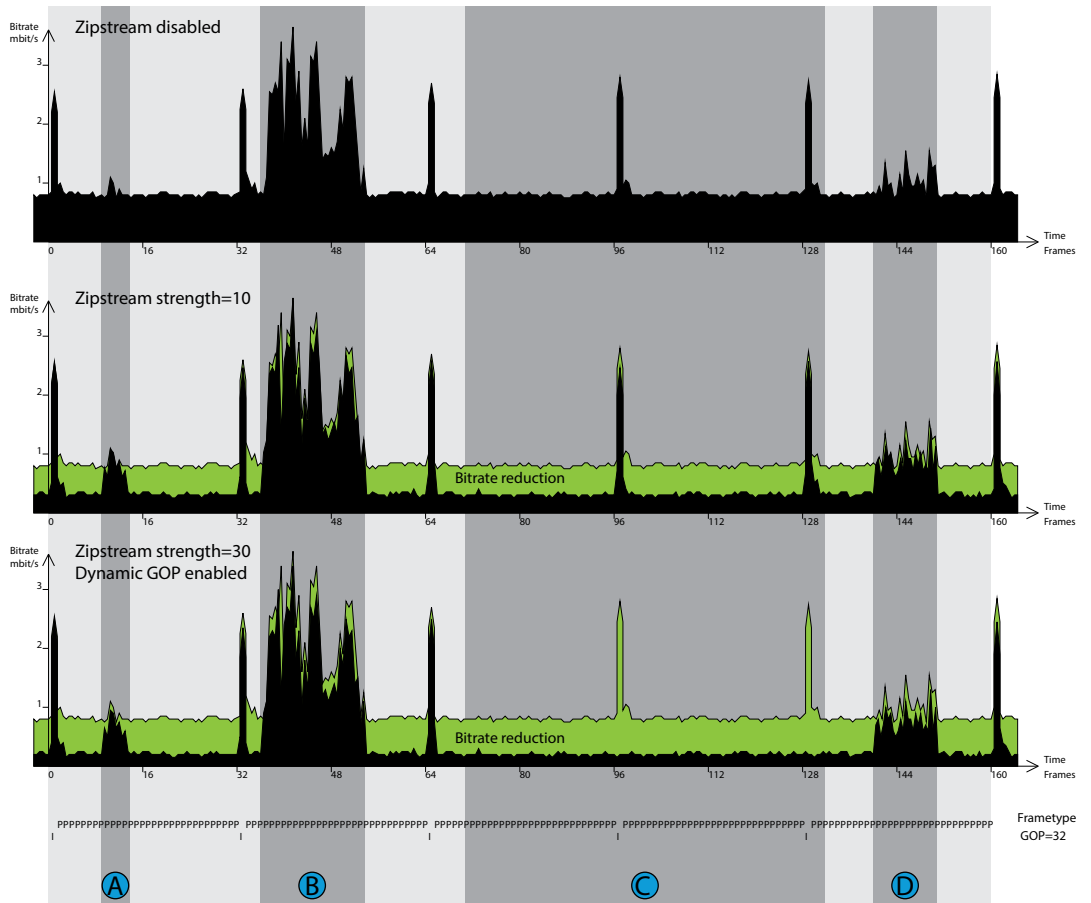


Figure 1: Illustration of instant bit rate in four different scenarios.

This example has been created to highlight the behavior of Axis' Zipstream technology under different conditions:

- A. Time period with short small motion. The small motion is detected, and adding bits in that region can preserve the moving part of the video.
- B. Period with large longer motion needs more space but still it is possible to save storage during this motion, since the dynamic region detects areas where non-prioritized information can be removed.
- C. Periods without motion are detected and the dynamic GOP algorithm removes unnecessary I-frame updates.
- D. Period with small longer motion.

### 3.4 Parameter settings

The original compression parameter is still used when Axis' Zipstream technology is enabled. This parameter controls the amount of compression applied to important forensic details. Compression is usually set to 30 and this value is recommended also when Zipstream is enabled.

The bit rate controller built into the encoder can be combined with Zipstream to enforce a Maximum Bit Rate (MBR) limit. MBR is a VBR configuration with includes an upper limit to protect the system from temporary bandwidth spikes. However, the MBR limit must be sufficient to capture the details of moving objects in the scene to enable the full potential of Axis' Zipstream technology and VBR.

To limit the bit rate for increased storage time, cloud-connected cameras or cameras using edge storage should be configured with the strength parameter set to 30 and dynamic GOP enabled. This setting is suitable to combine with motion detection triggering and/or MBR systems where the bit rate is allowed to adapt to changes in complexity. Edge storage is a development in Axis network cameras and video encoders that enables video recording directly to an on-board SD card or a Network-attached Storage device (NAS).

See Section 7, Useful links, 'Edge storage', for more information on edge storage.

The dynamic GOP algorithm of Zipstream can be used to compress low motion sequences. When using dynamic GOP, the GOP length will vary, which might pose a problem for some VMS and other types of client software. To improve support in existing software solutions that do not optimally implement playback of H.264 video with dynamic GOP, either a shorter maximum GOP length could be selected or dynamic GOP could be disabled.

### 3.5 Comparison measurements

Figure 2 shows examples of surveillance scenes where Axis' Zipstream technology can reduce storage needs. The table shows the Zipstream strength value and whether dynamic GOP was enabled, as well as the total bit rate reduction.




	<b>Retail:</b> Well-lit indoor detailed scene, sparse medium-sized movements.		
	Zipstream strength:  <b>10</b>	Dynamic GOP:  <b>Off</b>	Total bit rate reduction:  <b>25%</b>
	<b>City surveillance:</b> Daytime overview, many small car movements most of the time.		
	Zipstream strength:  <b>30</b>	Dynamic GOP:  <b>On</b>	Total bit rate reduction:  <b>50%</b>
	<b>Constant recording:</b> Overnight very noisy scene with sparse small and fast car movements.		
	Zipstream strength:  <b>30</b>	Dynamic GOP:  <b>On</b>	Total bit rate reduction:  <b>90%</b>

Figure 2: Examples of surveillance scenes where Zipstream can reduce storage needs.<sup>1</sup>

<sup>1</sup> The bit rate reduction will vary depending on the light and movement conditions and details of the scene.

## 4. Application areas

In professional VMS systems, bit rate reduction is desirable while the image quality must be kept for operations on critical sites around the world. These systems must detect even the smallest threat, and enable advanced forensic work after any incident. Axis' Zipstream technology enables high security systems to use continuous recordings due to the low bit rate used for static scenes.

When using AXIS Camera Companion (ACC) an even lower bit rate is desired, since system cost and easy installation is a priority. The aim is to store video of sufficient quality on cost-efficient edge storage. However, video quality should be decreased in a controlled manner, in order to easily find and understand the course of events. Zipstream reduces the amount of missed triggers by allowing longer recording segments for each motion-triggered event without generating excessive data.

Axis' Zipstream technology is relevant for all users that wish to reduce the cost of storage, but the primary application is in small systems using edge storage. Any business with a need for small, stand-alone, easy-to-use video surveillance, such as startup companies or smaller businesses, will benefit from using Zipstream.

### 4.1 Forensic details

Axis recommends using networked video with VBR where quality is adaptive to scene content in real-time. Using Constant Bit Rate (CBR) as a storage reduction strategy is not recommended, since cameras delivering CBR video may have to discard important forensic details in critical situations due to the bit rate limit.

Axis' Zipstream technology makes it possible for the system installer to continue using VBR for optimum video quality while reducing the storage requirements. This way the surveillance system can keep delivering high quality video. Important forensic details such as faces, tattoos and clothing patterns are isolated and preserved, while irrelevant parts such as white walls, lawns and vegetation are smoothed out.

If a storage solution or the network requires an absolute upper bandwidth limit, Zipstream is compatible with MBR, a method which protects the system from temporary bandwidth spikes.

## 5. Conclusion

Optimized for video surveillance, Axis' Zipstream technology is a radically more efficient H.264 implementation, lowering bandwidth and storage requirements by an average 50% or more for many common 24/7 surveillance use cases.

Axis' Zipstream technology makes it possible to use higher resolution and increase forensic detail, while reducing storage cost and enabling longer recordings. It enables high bit rate in scenes with especially interesting events in combination with low bit rate when a scene is relatively static.

Zipstream will initially be available for H.264-based products but there is nothing in the technology that prevent the solution to be migrated to H.265 encoders when that is technically possible.



## 6. Acronyms and abbreviations

ACC	AXIS Camera Companion
CBR	Constant Bit Rate
GOP	Group of Pictures
HEVC	High Efficiency Video Coding
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
MBR	Maximum Bit Rate
MPEG	Moving Picture Experts Group
NAS	Network-attached Storage
ROI	Region of Interest
VBR	Variable Bit Rate
VCEG	Video Coding Experts Group or Visual Coding Experts Group
VMS	Video Management Software

## 7. Useful links

For more information, see the following links:

Axis Communications – 'Video compression':

[www.axis.com/products/video/about\\_networkvideo/compression.htm](http://www.axis.com/products/video/about_networkvideo/compression.htm)

Axis Communications – 'Edge storage':

[www.axis.com/products/video/about\\_networkvideo/edge\\_storage/](http://www.axis.com/products/video/about_networkvideo/edge_storage/)

# About Axis Communications

Axis offers intelligent security solutions that enable a smarter, safer world. As the global market leader in network video, Axis is driving the industry by continually launching innovative network products based on an open platform – delivering high value to its customers and carried through a global partner network. Axis has long-term relationships with partners and provides them with knowledge and ground-breaking network products in existing and new markets.

Axis has more than 1,900 dedicated employees in more than 40 countries around the world, supported by a network of over 75,000 partners across 179 countries. Founded in 1984, Axis is a Sweden-based company listed on NASDAQ Stockholm under the ticker AXIS.

For more information about Axis, please visit our website [www.axis.com](http://www.axis.com).