

Reduce Bandwidth Consumption by GOP Settings

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Introduction

The GOP (Group of Pictures) refers to the type of setting in camera firmware by which it is possible to further **reduce the bandwidth and storage consumption of video stream up to 10 times**. This article will introduce the meaning of GOP, and its possible values, and its relation to other settings.

Understanding I-Frames and P-frames

In MPEG-4 and H.264 compressions, the video stream consists of I-frames and P-frames. I-frame is a self-containing frame that does not need references to other frames. P-frame uses reference to previous I- or P-frame, and will contain only information about the content that is different compared to previous frame.

P-frame can be created either by pixel-level analysis, block-level analysis, or vector analysis. Predicting the new location of a moving block by analyzing the moving vector can significantly reduce the size of a frame, compared to sending the information about every pixel that has changed since last frame. Normally, there is one I-Frame per second, and the number of following P-frames depends on the settings of frame rate (frames per second).

Length of GOP

By definition, the **length of the GOP** stands for the number of frames between two I-frames. By default, the Frame Rate and length of GOP have the same value in our cameras. By increasing the length of GOP, there will be less I-frames per a certain amount of time. Since I-frames are much bigger than P-frames by size, longer gaps between I-frames can optimize the bandwidth consumption and storage space consumption a lot.

1st second	2nd second	3rd second	4th second	Frame rate	GOP
I P P P P	I P P P P	I P P P P	I P P P P	5	5
I P P P P P P P	I P P P P P P P	I P P P P P P P	I P P P P	5	8
I P P P P P P P P P P P P P P	I P P			5	17
I P P P P	I P P P P	I P P P P	I P P P P	5	0
I I I I I I I I I I I I I I I I I I				5	1

On the diagram above, you can see the different lengths of GOP. While keeping the same frame rate, we can achieve the reduced bitrate (more small sized P-frames and less big sized I-frames) by increasing the GOP value.

Please note that the default GOP value in ACTi cameras is 0. GOP = 0 means that the camera can detect current frame rate and automatically make GOP length to be equal to frame rate. By setting GOP = 1 you can achieve the situation where only I-frames are produced. It basically would mean M-JPEG compression.

Benefits of GOP

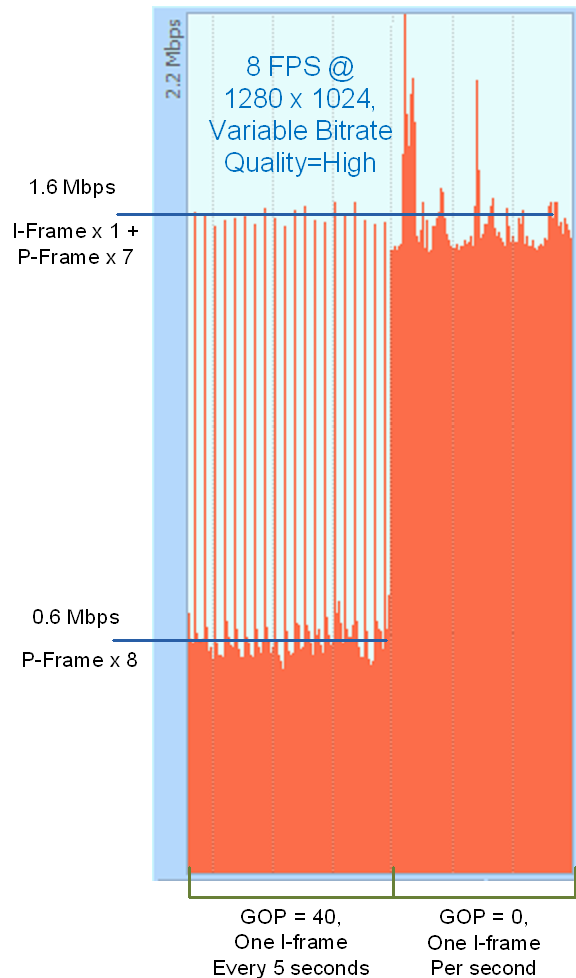
The main benefit of using higher GOP length is to **minimize bandwidth consumption** and **minimize storage space consumption** (reduce bitrate) under same frame rate. It is especially powerful in the applications with less motion.

Many IP-camera manufacturers do not support the option to adjust GOP length yet. It means, even if the camera is installed in the location with few motion, it keeps producing unnecessarily high bitrate video. ACTi camera firmware however supports GOP length adjustment so that the customer can conveniently minimize the consumption of bandwidth while keeping the video quality.

Here we can more easily visualize the savings enabled by a longer GOP setting. The graph on the right is an actual data flow recording. Each vertical line shows the amount of data flow for one second.

The scenario is a mostly static scene with minor movements, captured at 1280 x 1024 @ 8FPS, using Variable Bit Rate-Quality High.

With GOP set at 40, the left half of the graph shows that only one second out of every five contains the I-Frame. The four seconds that has only P-Frame without I-Frame used only about 35% of the bandwidth compared with the seconds that included I-Frame.



When we use the normal setting, with GOP setting at 0, or one I-Frame per second, the bandwidth remains high at all times, fluctuating slightly with motion in view. The same view is recorded with slightly less than half the storage space, and we're only using moderately high GOP number!

Notice: **Actual Bit Rate and P-Frame / I-Frame size ratio may vary depending upon scene complexity.** For example, forests are complex, and plain walls are simple.

Use GOP Only Under Variable Bitrate Mode

The concept of **Constant Bit Rate (CBR)** stands on the principle that the bitrate level will be fixed regardless of other settings. Therefore, if we increase GOP value and extend the gap between I-frames then under CBR we cannot enjoy the benefits of optimal bandwidth consumption. Therefore GOP should not be used in combination with CBR. GOP should be used under **Variable Bit Rate (VBR)** mode instead. The GOP range for ACTi cameras is **0 ~ 60**.

Recommended Settings of GOP

Notice: **Do not adjust GOP for the scenes with lots of motion or under poor lighting conditions** because it may influence the video quality. For other situations, the GOP settings are shown below:

Resolution	Environment		Bitrate Mode	Frames per second	Suggested GOP
	Lighting	Motion			
Any resolution	Normal	Much	CBR		N/A
		Few	VBR (Medium, High)	1	6
				4	24
				8	48
	15 or more	60			
	Low	Much	CBR		N/A
Few					

Smart GOP

With the help of special Event Handler system in ACTi cameras it is possible to adjust GOP value automatically as a response to specific events on camera site.

For example, the camera is monitoring a site with restricted access. The whole camera viewable range is set as a video motion detection area. Because normally there are no people moving around the restricted area, the recommended GOP value is high, for example 60. This way, there is an enormous saving of bandwidth and storage space consumption.

However, when an intruder enters the site, the motion detection system immediately detects it, and takes needed actions through Event Handler system of the camera. Among other actions, there is a possibility to set lower GOP value (for example 2 which is the smallest possible GOP value while keeping motion detection system running), so that the video quality of a moving intruder would be the highest.

As a result, we will be using a **Smart GOP** – its higher value will help us save storage and bandwidth consumption up to 10 times under normal conditions and it will automatically switch to lower value (less P-frames between each high-quality I-frame) for superior video quality in case of an appearance of a moving object.

The graphs below illustrate the performance Smart GOP.

