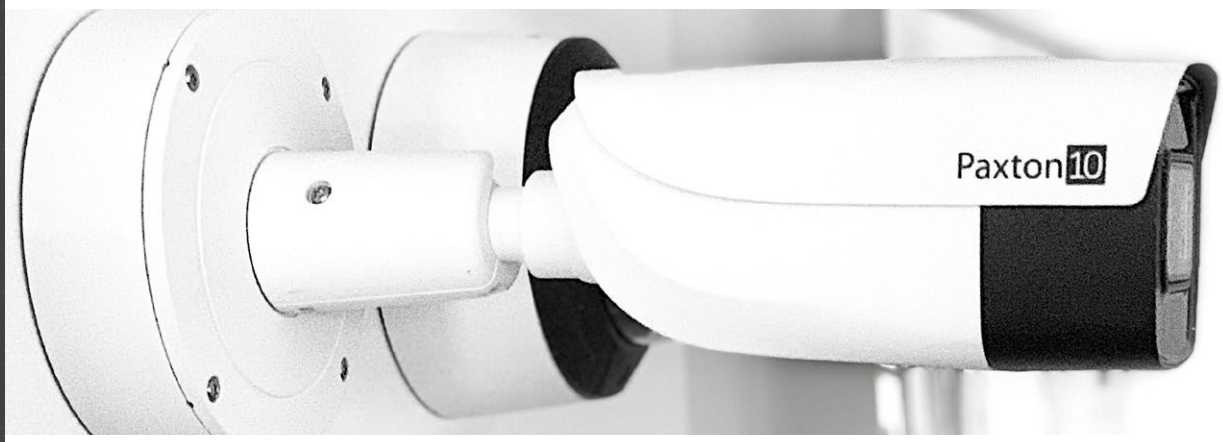


Cameras and Video, a beginners guide

Overview

Video surveillance has existed for many years, but with many advancements in technology you wouldn't be alone if you couldn't tell your codecs from your bitrates, or your domes from your turrets. This guide walks through the basics of video, cameras, the video management systems and their storage.

Analogue vs Digital

Analogue CCTV cameras capture images and then send the signal over a coaxial cable to a Digital Video Recorder (DVR). The DVR then converts the analogue signal to digital format and saves it to disk.

Traditionally, digital IP cameras, convert their images to digital at the camera and then connect directly to a network. Footage is processed and recorded by a Network Video Recorder (NVR) and can then be viewed using a monitor connected to the NVR or using software installed on a specific client.

For the purpose of this document and for their ease of use and integration into Access Control and Building Management systems, we will be focusing on Digital IP cameras.

Cameras – Which type do I need?

Before we even think about resolution, codecs, or features, there are a number of different types of camera to choose from, each with their own advantages and disadvantages. Below we'll focus on 4 of the most common types:

Dome camera

Dome cameras are most commonly used for their vandal resistance. The lens is fully covered by a vandal proof glass dome, with no external movable parts.

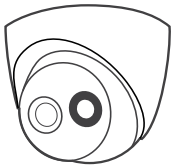
<u>Advantages:</u>

- Vandal resistant
- Discrete
- Not obviously directional

<u>Disadvantages:</u>

- Water marks can sometimes form on the glass dome, blurring the image
- IR refraction from the glass dome at night can create dots on the video image

Turret camera



Turret (also known as 'Eyeball') cameras contain their IR emitter separate from the camera lens, allowing them to be more powerful. Turret cameras resolve many pitfalls of the Dome camera, however at the cost of not being as vandal resistant and more obviously directional.

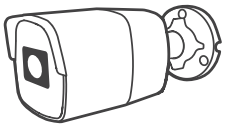
Advantages:

- Extended IR capability (night vision)
- No IR refraction

Disadvantages

- Less vandal resistant than a Dome
- Can be aesthetically challenging

Bullet camera



Bullet cameras are highly visible which can be a deterrent in itself. Additionally, Bullet cameras often contain increased zoom abilities, as well as good infrared.

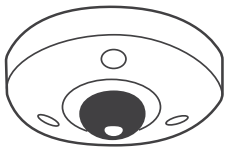
Advantages:

- Highly visible and directional
- Deterrent
- Extended IR capability (night vision)
- No IR refraction

Disadvantages:

- Highly visible and directional
- Not vandal resistant

Fisheye and Multi-Sensor cameras



Fisheye cameras and Multi-Sensor cameras are unique in their capabilities – instead of pointing in a single direction, these cameras record video from multiple directions, covering up to a 360 degree view. Because of their view, they are often impossible to 'sneak up' on, and their lens can be protected by vandal resistant glass.

Advantages:

- Field of view
- Vandal resistant
- Digital Pan, Tilt and Zoom (PTZ)

Disadvantages

- Lower quality video
- Distorted image (Fisheye)
- Increased storage requirements
- Requires specialised software to view

Resolution – What resolution do I need?

Video resolution, in its simplest form, is the number of pixels used to represent a captured image.

Think of a grid of squares, where each square can be a single colour. If the grid is 10x10 squares, it is very difficult to make any decipherable image. Increase the grid to 100x100 and you can start creating basic shapes, increase it further and you can have complex imagery.

Using the Paxton logo as an example below, the higher the resolution (number of pixels) used, the clearer the image will be, and the more detail that can be seen.

When referring to resolution, the left number refers to the number of horizontal pixels, and the right number refers to the number of vertical pixels.

Some resolutions are used more widely than others in video. The most common resolutions are listed below:

Resolution	Also known as	Comments
7680x4320	8K or 4320p	On the upper end of video resolutions. Support for 8K is becoming more common, especially where additional detail or face recognition is required.
3840x2160	8MP, Ultra HD, 4K or 2160p	High end cameras supporting 4K are becoming more common.
2560x1440	4MP, Quad HD	Seen as an upgrade to standard HD, but not as commonly used following the release of 4K.
1920x1080	2MP, HD or 1080p	HD became widely adopted in the late 2000s and is still used as one of the most popular standards today.
1280x720	1MP, HD Ready or 720p	
640x480	VGA, SD or 480p	Unlike the other resolutions above which are classed as widescreen (16:9), SD had an aspect ratio of 4:3.

Choose a resolution based on the amount of detail that the video needs to show, but keep in mind that a higher resolution equates to higher network bandwidth and storage requirements.

Frame rate – What is it?

Frame rate is the number of pictures, or frames, that are taken each second.

For example, a camera with a frame rate of 1 Frame Per Second (FPS) would take a photo every second, and a frame rate of 30 FPS would take 30 photos each second.

Generally, the higher the frame rate, the smoother the video. The human eye cant notice the frame rate and therefore perceives smooth movement at anything 20FPS or above.

For an idea of where different frame rates are used, see the table below:

Application	Frame rate
Slow motion recording / Fast actioned scenes	60+ FPS
Live TV broadcast and Sports	30 FPS
Recorded TV and Film	24 FPS
Smartphones and consumer products	20 FPS

The frame rate used for security and CCTV depends on a number of factors, including the storage available and network bandwidth, but most of all on the environment being recorded.

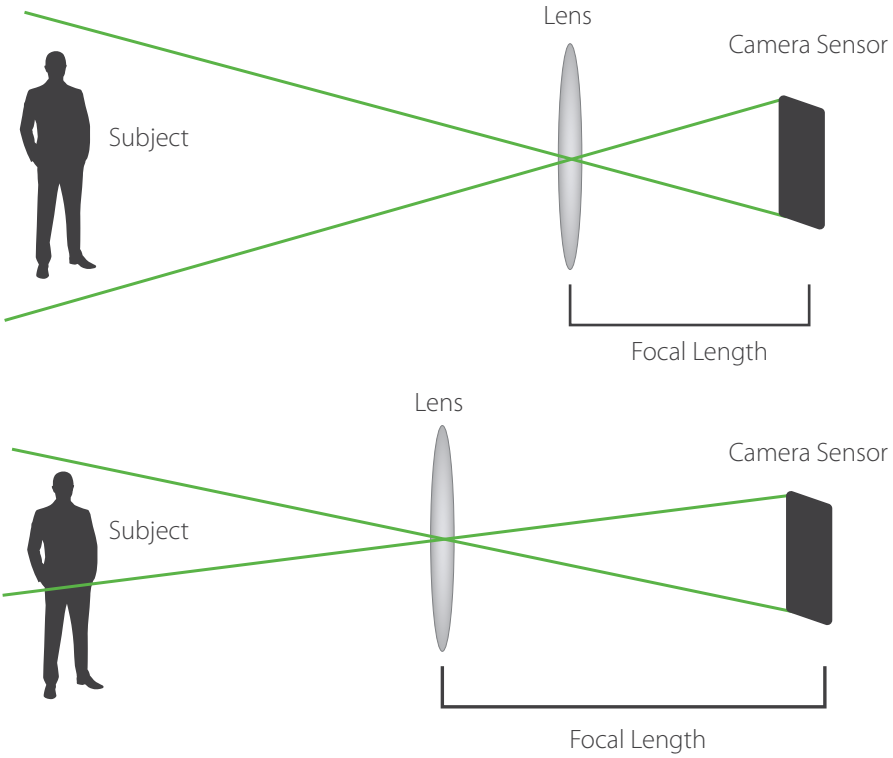
For an average office, a frame rate of 15 FPS will appear visually smooth to most people. For a busy road, a frame rate of 30 FPS may be required to ensure every car is captured with minimal blur.

Focal length – Changing the field of view

The focal length of a camera refers to the distance that the camera lens is located away from the sensor. By changing the distance between the lens and the sensor, the focal point of the image changes, changing the camera's field of view and having the effect of zooming in or out on the image.

Many cameras will come with a set focal length (often 2.8mm), while others have the ability to change their focal length during installation – the latter are referred to as 'Varifocal' cameras.

The focal length you choose should depend upon the environment where the camera is installed and what the video is to be used for. For example, a camera located in a carpark could use a short focal length, maximising the field of view and allowing more of the carpark to be in view of the camera, whereas a camera located in a corridor used to monitor people could have a long focal length, essentially zooming in down the corridor, reducing the wasted space from the walls either side.



Video codecs – What are they?

A codec is a tool that encodes/decodes a video and audio stream.

When a camera records video, the codec is what turns the video stream into a series of 0's and 1's, allowing the video to be processed and saved on a storage device – this is encoding.

When a user wants to view the video on their PC or device, the codec is used to convert the video stream back into a viewable format – this is decoding.

There are many different video codecs available, each providing different benefits and drawbacks.

H.264

H.264 is one of the most common video codecs. It is very efficient, keeping a high video quality, while also providing a good level of compression meaning the file takes us significantly less storage.

For videos that have a .MP4 extension, there is a good chance H.264 encoding is used.

MPEG-4

MPEG-4 was a predecessor to H.264, however newer updates to the codec brings it very closely inline with H.264. It is widely compatible and provides good compression and video quality.

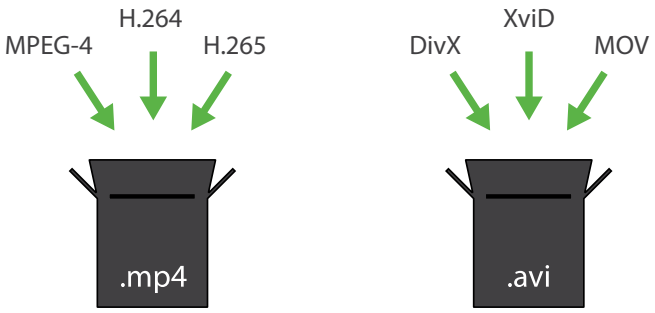
DivX

DivX and XviD are codecs which maximise video quality, however this is at the expense of file size.

HEVC (H.265)

H.265 is a relatively new codec, introduced to handle the compression of 4K video. H.265 really only used by the CCTV industry and is not supported in browsers such as Chrome or Safari.

Note: Video codecs should not be confused with Video containers. A video container is what holds the video and audio together, as well as any other data such as subtitles. A Video container can be recognised by a video's file type, for example .mp4, .avi, or .wmv. A video container can contain video and audio from a number of codecs.



Night vision and low light – Seeing in the dark

Security cameras are used in many environments and conditions One of the more common being low light, such as an office after everyone has left for the day, or a car park at night.

In the video surveillance world there are a number of solutions available to tackle this.

Integrated IR

Nearly all cameras available today have built in Infrared emitters. When light levels are low the IR emmiters are turned on and an IR cut filter is activated on the camera providing a black and white image even in total darkness.

Advantages:

- Cost effective
- Discreet

Disadvantages

- Black and white image
- IR can attract insects
- IR range is limited
- IR refraction can occur on some cameras

Dedicated IR

If a camera's integrated IR lacks the power to cover the entire area, or the camera doesn't have integrated IR emitters, external IR emitters can be installed.

Advantages:

-
- Can be positioned as required
- Can have multiple
- High power

Disadvantages

- Black and white image
- Additional cost

Increased sensitivity

If IR isn't an option or a colour image is required, increasing the camera sensor's sensitivity can be an option. This is a software option generally found in the camera's configuration.

Advantages:

- 'Software only' solution
- Colour image
- Good for situations which require only slightly more light

Disadvantages

- Increases visible noise
- Requires at least some light

Increased sensor size

The camera sensor is the part of the camera which captures light (and thus the image). Cameras with larger sensors take in more light, making them more effective in low light conditions.

Advantages:

- Genuine image improvement
- Better for all conditions
- Colour image

Disadvantages

- Expensive
- Increased camera size

Protocols and Communication – RTSP, ONVIF and Paxton10

RTSP, or Real Time Streaming Protocol, is a communication protocol for sending and receiving video over a network. The majority of network security cameras will support RTSP communication. To view video from an RTSP camera, simply enter the camera's RTSP address into a video management system or RTSP compatible player such as VLC media player.

ONVIF is an industry standard used for communicating with IP devices across a network. 'ONVIF Profile S' defines the standard used for a networked device to query a camera's name, its settings, and its video streams. If a camera is ONVIF compliant, it can be detected by the video management system automatically, and the system can display and even configure the camera's settings.

Paxton10 cameras use Paxton's own proprietary communication methods. Unlike the above, Paxton10 cameras cannot be added to third party video management systems or have their video viewed by media players.

A Paxton10 system will automatically detect all Paxton10 and ONVIF compliant cameras that are on the same network. To add an RTSP camera, the 'Manual add' option must be used and the camera details entered.

Video bitrate – What is bitrate and why is it important?

Bitrate is the amount of data (bits) that is sent from the camera to the recorder or client.

The bitrate can be estimated based on the camera's settings and the desired video quality:

Bitrate = Resolution x Frame rate x Video Compression ratio

For example, if the camera is recording HD (1920x1080) at a frame rate of 25 FPS, with H.264 high compression, the bitrate would be 1920 x 1080 x 25 x 0.01 = 518400 bits per second, or 518 Kb/s.

The bitrate determines the required network bandwidth. Or thought of the other way around, the resolution, frame rate, and codec used should be chosen to give a total bit rate of all your cameras combined that is within your network bandwidth.

In the video management software, often a 'Maximum bitrate' can be set. This is used to ensure the video compression used is appropriate to meet the bandwidth limitation. If the bandwidth is exceeded, setting a maximum bitrate for each of your cameras will increase the video compression, reducing the bitrate, however also reducing video quality.

Video storage – Where should video be stored?

One of the main uses of video surveillance is the ability to go back to a past event and view what happened, using video footage as evidence or simply to uncover what happened. To do this, video must be recorded onto a form of storage.

There are 3 types of storage used for video footage:

Edge storage

Edge storage usually refers to storage that is inbuilt to the camera. An edge storage camera will likely contain flash memory of up to 128GB.

Advantages:

- Convenient
- Resilient – each camera is independent
- Scalable (more cameras = more storage)
- Minimises network bandwidth

Disadvantages

- Vulnerable – video storage in reach of user
- Limited capacity

Network storage

Any storage located on the network (but external to the camera) is considered as network storage, for example a Paxton10 controller, a PC, or a NAS drive.

Advantages:

- Unlimited capacity
- Security and backup

Disadvantages

- Single point of failure
- Requires infrastructure

Cloud storage

A modern approach to storage is to save files and video in the cloud. Cloud storage means your recorded video is available from anywhere with an internet connection, without having to own or manage your own storage hardware.

Advantages:

- Secure and offsite
- Minimises local infrastructure
- Easily accessible

Disadvantages

- Requires internet connection
- Requires high upload bandwidth
- On-going cost

Video storage – How much video do I need recorded?

The storage size you need will depend upon the video resolution, frame rate, amount of video actually recorded, how long you want to retain recorded video for.

Use the Paxton10 Video Storage calculator available at www.paxton.info/5060

According to data protection and legislation, video is only allowed to be stored for a period considered reasonably necessary for its purpose. If the storage capacity available is such that video can be stored past this amount of time, data management settings should be applied in software to automatically erase video exceeding this time.

Video Features and Analytics

Facial Identification and Number Plate Recognition

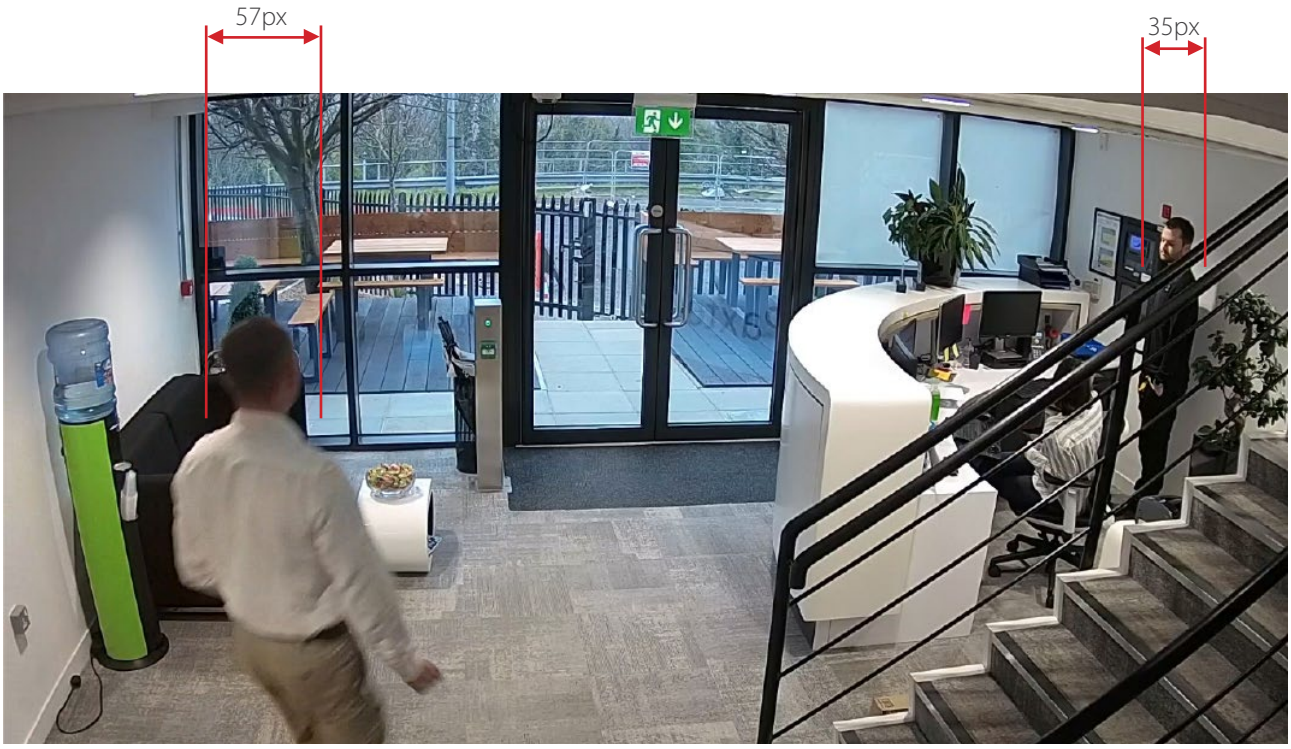
Video surveillance can be used as a method of identifying people or vehicles, making it possible to automatically unlock a door or car park barrier for the person, or raise an alarm for known threats.

For people and vehicle identification to be possible, the camera resolution and focal length must provide sufficient detail at the distance that the recognition must take place. The higher the resolution and/or focal length, the further away a target can be identified.

As a general rule, the distance that a person or number plate can be identified can be calculated based on the number of pixels available.

For Facial Identification, 40 pixels per foot are required
For Number Plate Recognition, 60 pixels per foot are required

In the example below, the red lines represent 1 foot in the real world. The person in the background takes up a smaller area on the video, meaning less pixels are used to represent them, and identification may be difficult. As a person approaches the foreground, the number of pixels used increases, adding more detail.



Pan, Tilt and Zoom (PTZ)

Some cameras provide PTZ control, meaning they can be positioned (panned and tilted) and zoomed in/out remotely from the software. This can reduce the total number of cameras required to monitor a single area as the camera can be positioned to view multiple areas. PTZ is only possible on live video – the video management system will record where the camera is pointing only.

Digital PTZ is available in some video management systems, including those used with fisheye cameras. Digital PTZ is simply used to zoom in and see an area larger on screen, it does not change the position of the camera or provide a clearer recorded image.

Guard tours

With PTZ cameras, guard tours can be configured to automatically position cameras and run through movement sequences. Guard tours are used to ensure all areas are captured by the camera.

Smart search

Smart search is a tool used for locating when an event or action occurred in a specified area. For example, if an item is stolen from a shop, by highlighting where the item was Smart search is able to navigate the video back to the point that the item was moved.

Motion detection

Motion detection is important, not just to alert when someone or something is in the area, but also to determine when to record footage.

Paxton10 is efficient in when it records, only recording footage when there is motion. If there is no motion, there is no reason to record and use up valuable storage space.

Snapshot and Export

After watching an event occur that requires further investigation or documenting, the clip can be downloaded using Export functionality, or a snapshot image can be saved giving a high resolution screenshot of the video.

Legal

Signage

Following the Data Protection Act 1998, it is a legal requirement to provide visible signs and notifications to those in the area that video surveillance is in operation. It is the installer's responsibility to ensure appropriate signs are in place.

Retention

Video footage can only be stored for the duration deemed required. All recorded video must be stored securely with documented procedures for recording and accessing recordings. It is the customer's responsibility to ensure these legislations are met.

Evidence

To be used as evidence in legal court, video footage must: comply with the requirements above, contain a time and date stamp, be an original / untampered copy, provide sufficient detail and image quality to accurately identify the people or items involved. Increasingly watermarking (watermarking each frame with a sequential number) is needed for video to be accepted as evidence in court.