

## HDTV (High Definition Television) and video surveillance

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## Introduction

The TV market is moving rapidly towards high-definition television, HDTV. This change brings truly remarkable improvements in image quality and color fidelity. HDTV provides up to five times higher resolution and twice the linear resolution compared with traditional, analog TV. Furthermore, HDTV comes with wide screen format and DVD-quality audio.

Growth in the consumer market for HDTV is impressive. In 2007 the HDTV household penetration in the U.S. was approximately 35%. According to estimates, 85% of all viewers will have an HDTV set at home by 2012. Already today, virtually all major television productions are HD.

The two most important HDTV standards today are SMPTE 296M and SMPTE 274M, which are defined by the Society of Motion Picture and Television Engineers, SMPTE.

### 1. HDTV impact on video surveillance market

This development is now starting to have an impact on the video surveillance market, as customers ask for higher image quality standard. The possibility of clearer, sharper images is a long sought quality in the surveillance industry, i.e. in applications where objects are moving or accurate identification is vital.

It can be argued that some of these requirements can be met with megapixel network cameras. However the notion of "megapixel" is not a recognized standard but rather an adaptation of the industry's best practices and it refers specifically to the number of image sensor elements of the digital camera. With high resolution follows huge amounts of image data, which more often than not leads to compromises on frame rate. A megapixel camera alone is therefore not synonymous with high image quality.

In contrast, a network camera that complies with any of the given HDTV standards is guaranteed to provide a certain resolution, frame rate and color fidelity, thereby ensuring video quality at all times.

### 2. Development of HDTV

The basic difference between HDTV and traditional analog TV is the number of pixels that make up the image information on each screen. During the second half of the 20th century two different standards dominated the market: PAL and NTSC.

PAL, or Phase Alternating Line, is found in Europe and the greater part of Asia. It is a system with 576 active TV lines (TVL) at 50 Hz and a frame rate of 25 frames per second (fps). North and Central America as well as some parts of Asia opted for NTSC, National Television System Committee. This system broadcasts 480 active TV lines at 60 Hz (30 fps).

High-resolution television can be said to go as far back as 1958. The first to develop a technique that gave extremely clear and crisp images was the soviet military. Their system for televised conferences, Transformator, was capable of producing an image composed of 1,125 lines of resolution. A decade later the Japanese state broadcaster, NHK, developed the first system for commercial use.

The lengthy development process was not related to indifference or lack of public demand. On the contrary, HDTV and the prospect of vastly improved image quality stirred consumer interest globally. The industry realized the potential of a rising mass market. But to get there one problem remained to be solved: A far more effective compression technique was inevitable to make it possible to broadcast the vast amounts of data that comes with HDTV.

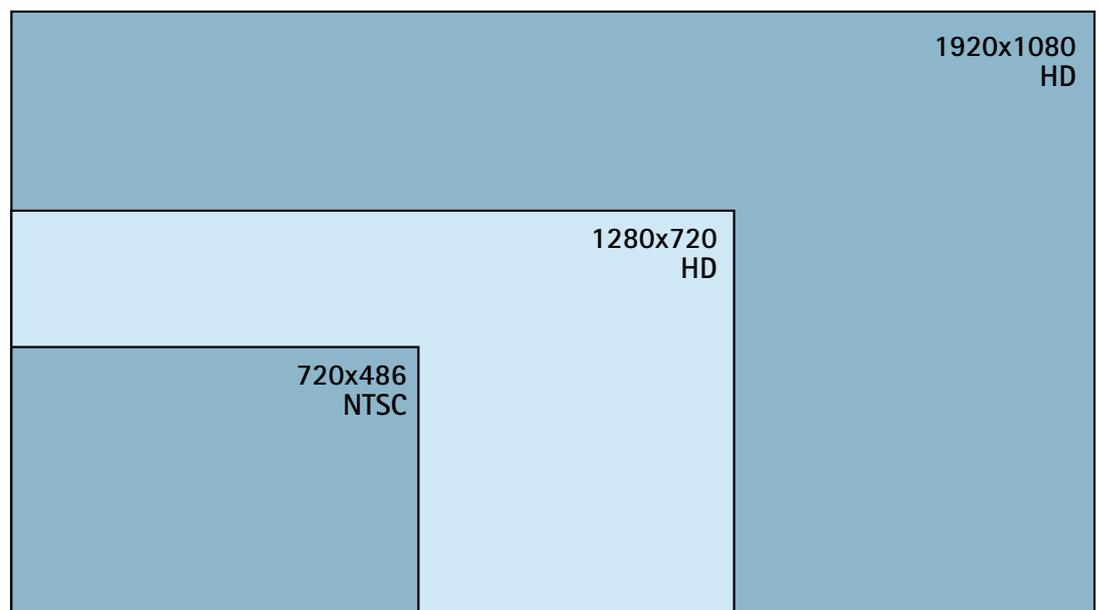
Experimental HDTV systems in, for example, the U.S. were all rejected because of their high bandwidth requirements. Typically, early broadcast systems required between two and four times the bandwidth of a standard-definition broadcast, making it only possible to distribute by satellite. It soon became evident that a successful HDTV standard required better efficiencies.

It was also understood that only a digital system could possibly deliver the desired results, but such a system had not yet been developed.

The first major breakthrough came in the early 1990's with the MPEG set of compression standards, which was based on pattern-recognition research for cruise missile development at the NASA Jet Propulsion Laboratory. The MPEG-2 standard followed in 1993, spurring the development even further. A joint project between MPEG and the Video Coding Experts Group of the International Telecom Union, ITU eventually resulted in the H.264 standard, also known as MPEG-4 Part 10/AVC. This compression technique not only made HDTV broadcast possible, but also economically viable.

### 3. How HDTV works

HDTV constitutes a tremendous leap forward in image quality by providing up to five times higher resolution than standard analog TV. This means sharper images, better color fidelity and a wide screen format, i.e. 16:9 ratio.



*Different aspect ratios of NTSC and HDTV*

HDTV broadcast systems are identified with three major parameters: frame size, scanning system and frame rate.

#### **Frame size**

Frame size is defined as the number of horizontal pixels times the number of vertical pixels, e.g. 1280x720 or 1920x1080. The number of horizontal pixels is often omitted, since it is implied in the context. Therefore the different systems are usually referred to as 720 or 1080, combined with the letter i or p depending on what scanning method is used.

Given that traditional television normally broadcasts in 704x576i or 704x480i, the visual information on an HDTV is two to five times larger.

#### **Scanning**

There are two techniques for scanning: interlaced and progressive, identified with the letter i and p respectively.

Interlaced scanning was originally introduced as a way to improve the image quality of a video signal without consuming additional bandwidth. The method soon became ubiquitous in traditional, analog television sets. To put it simply, the technique splits each frame into two so-called fields. The scanning starts at the top-left corner and sweeps all the way to the bottom-right corner, skipping every alternate row on the way. Interlaced video thereby reduces the signal bandwidth by a factor of two, allowing for a higher refresh rate and, thereby, reducing flicker and improving the portrayal of motion.

There are, however, some downsides to interlaced video. For instance, if objects are moving fast enough they will be in different positions when each individual field is captured. This may cause what is called motion artifacts. Normally these are not visible but can appear if the video is displayed at a slower speed than it was captured or when presented as a still frame. Another potential problem is called interline twitter. It is an effect that shows up when the subject being shot contains very fine vertical details that approach the horizontal resolution of the video format.

These limitations can be avoided using progressive scanning. This technique captures, transmits and displays all lines in the image in a single frame. Scanning is done line by line, from top to bottom. In other words, captured images are not split into separate fields like in interlaced scanning so there is virtually no "flickering" effect.

In a surveillance application, this can be critical for viewing details within a moving image such as a person running or a vehicle moving. Another benefit of this technique is that single frames can be used to make paper copies with almost photographic quality. This can be crucial if the material is, for instance, to be used as evidence in a court of law. Of course, these potential gains must be weighed against progressive scanning's requirement for somewhat more bandwidth.



*At left, a full-sized JPEG image (704x576 pixels) from an analog camera using interlaced scanning. At right, a full-sized JPEG image (640x480 pixels) from an Axis network camera using progressive scan technology. Both cameras used the same type of lens and the speed of the car was the same at 20 km/h (15 mph). The background is clear in both images. However, the driver is clearly visible only in the image using progressive scan technology.*

### **Frame rate**

Frame rate is defined as the number of image frames per second (fps). For interlaced systems, the number often implies the field rate, which means the number usually is twice as high since there are two fields to every frame.

Historically, one of the thornier issues had to do with a suitable frame/field refresh rate. Countries were divided into two camps – for reasons that very much depended on the frequency of the mains electrical supplies, which in turn affect image stability – favoring either 25/50 fps or 30/60 fps. Nonetheless both systems are compliant with HDTV and consequently also meet the full frame rate requirements of video surveillance.

#### **4. HDTV standardization**

The introduction of the MPEG-1 compression standard provided the foundation for digital TV and spurred the development of modern TV standards worldwide.

Today, the most important HDTV standards body is the Society of Motion Picture and Television Engineers. The group, recognized as the global leader in the development of standards and authoritative practices for film, television, video and multimedia, has defined the two most important standards: SMPTE 296M and SMPTE 274M.

Basically, SMPTE 296M defines a resolution of 1280x720 pixels using progressive scanning, while SMPTE 274M defines a resolution of 1920x1080 pixels using either interlaced or progressive scanning.

With digital compression methods such as MPEG-2 and H.264, the bandwidth for a single analog TV channel is enough to carry up to five regular digital TV channels, or up to two HDTV channels using progressive scanning.

#### **5. HDTV formats**

HDTV usually assumes a wide screen aspect ratio of 16:9 and horizontal resolution of 1920 pixels with progressive scan. Consequently, this creates a frame resolution of 2,073,600 (1920x1080) pixels. The frame rate can vary and is specified after the letter p, for example: 1080p30 or 1080p50.

Other HDTV formats are 1080i and 720p. The aspect ratio is the same for all three: 16:9. 1080i shows 1920x1080 lines with interlaced scanning, while 720p displays 1280x720 (921,600) pixels with progressive scanning.

#### **6. Benefits of HDTV in video surveillance**

Working with progressive scan, network cameras with HDTV performance deliver true color representation and clear images even if the object is moving fast. This makes it a highly attractive solution for surveillance operations where greater image detail is required, such as at retail stores, airports, passport controls, casinos and highways.

This quality development has been long sought after, but it could not be realized until the video compression techniques were efficient enough. The H.264 standard is an open, licensed standard that can reduce the size of a digital video file – without compromising image quality – by more than 80% compared with the Motion JPEG format and by as much as 50% compared with MPEG-4 Part 2. Because of the flexibility combined with its economy of bandwidth and storage, H.264 is expected to be more widely adopted than previous compression standards.

There is no doubt that H.264 was a necessary prerequisite for introducing HDTV in video surveillance. The efficient compression simultaneously enables high resolution, high frame rates and 16:9 aspect ratio.

HDTVs are based on square pixels, similar to computer screens, so HDTV video from network video products can be shown on either HDTV screens or standard computer monitors. However, with progressive scan HDTV video, no conversion or deinterlacing technique needs to be applied when the video is to be processed by a computer or displayed on a computer screen.

## 7. Conclusion

The image quality improvements brought by high-definition TV has been well received and generates great demand in the consumer market. Consequently, a similar trend can already be seen in the traditional video surveillance market. HDTV-compliant network cameras deliver a resolution, color representation, 16:9 aspect ratio and frame rate that are in accordance with international standards, making them an appealing solution in surveillance situations that require high quality images.

### Benefits of HDTV

- > International standard
- > Superior image quality
- > Minimum 25/30 frame rate capacity
- > High resolution
- > Color fidelity
- > 16:9 aspect ratio



## About Axis Communications

Axis is an IT company offering network video solutions for professional installations. The company is the global market leader in network video, driving the ongoing shift from analog to digital video surveillance. Axis products and solutions focus on security surveillance and remote monitoring, and are based on innovative, open technology platforms.

Axis is a Swedish-based company, operating worldwide with offices in more than 20 countries and cooperating with partners in more than 70 countries. Founded in 1984, Axis is listed on the NASDAQ OMX Stockholm under the ticker AXIS. For more information about Axis, please visit our website at [www.axis.com](http://www.axis.com).