UNIVERSITAT ROVIRA I VIRGILI

Report on Video Surveillance Hardware Platforms

Hatem A. Rashwan, Antoni Martínez Ballesté and Domènec Puig

Department of Computer Engineering and Mathematics

Content

Introduction

The aim of this report is to overview the main platforms that might allow us to implement a privacy-aware video surveillance system. To that end, we have analyzed three approaches:

- AXIS surveillance systems: AXIS is a Swedish company that is a one of the leaders in network video for physical security and video surveillance. It was established in 1984. AXIS Company develops and sells many of technology, such as network camera, video encoders/decoders, and video management software. It was the first manufacturer that products a network camera, so-called AXIS NETEYE-200 in 1996. Its products of IP cameras usually contain an embedded mini-processor with a flash memory.
- CISCO surveillance systems: Cisco is an American multinational cooperation established in 1984. It is one of the best companies in network technology, and it designs and sells network equipments for the most world countries. Cisco products many types of IP video cameras, video encoders, routers, virtual switches matrix and video management software. It has many contributions in data and network security solutions.
- Finally, we have also considered the implementation using the tiny computer Raspberry Pi. Raspberry Pi is a single board computer designed in UK by Raspberry Pi Foundation. The Raspberry Pi is a small computer that contains a 700 MHZ microcontroller, originally a ship with 256 or 512MB as RAM, and SD card for booting and long storage. It provides Linux based Debian operating system, also supports Python, BASIC and C languages. It is used as a HD video player, in addition to use for games.

Note: the pictures and tables in this report have been extracted from the manufactures' websites:

- http://www.axis.com/solutions/index.htm
- http://www.cisco.com/en/US/products/ps10818/index.html
- http://www.raspberrypi-tutorials.co.uk/

AXIS Surveillance Systems

In this first part of the report, we address Axis surveillance systems. We will give a brief summary for the system architecture, components and system software tools of different available systems.

AXIS is not only a one of the best companies in network video, but also it is the partner of choice in network video systems. AXIS offers a full variety of network video solutions for surveillance applications in a wide field of industry segments under open technology standards with enabling the easy integration and scalability.

Network video provides users, particularly in the security surveillance systems, with many advantages over traditional analog closed-circuit television (CCTV) systems. These network video, often called IP-based video surveillance or IP-Surveillance as it is applied in the security industry, uses a wired or wireless IP network as the backbone for transporting digital video, audio, as well as other data over the network infrastructures. A network video system allows video to be monitored and recorded from anywhere and anytime on the network, whether it is, for instance, on a local area network (LAN) or a wide area network (WAN) such as the Internet.

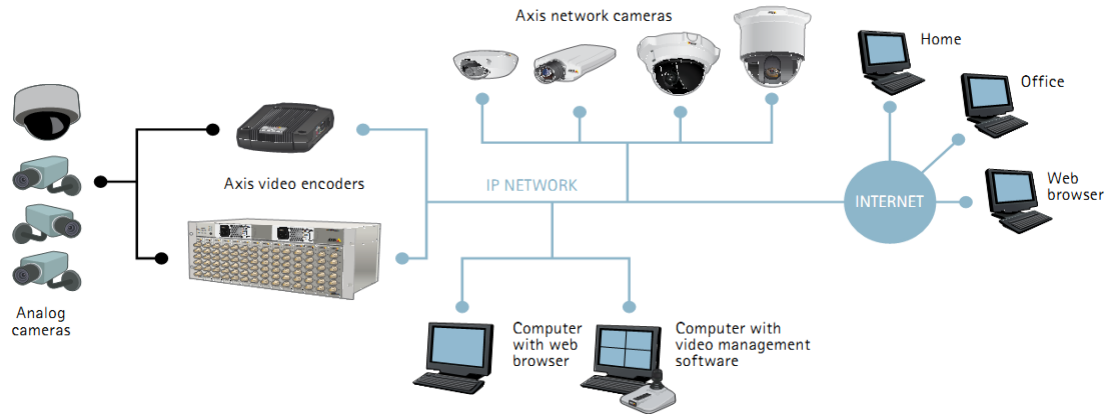


Figure (1): AXIS network video system.

AXIS network video systems consist of many of different components, such as network cameras, video encoders and video management software. These three equipments are the main components of an IP-Surveillance solution. The other components including the network, storage, servers, PoE (Power over Ethernet), midspans and active splitters are all standard IT equipments, as shown in figure (1). The digital, network video surveillance system designed by AXIS provides a host of benefits and advanced functionalities, such as remote accessibility, high image quality, event management and intelligent video capabilities, easy integration possibilities and better scalability, flexibility and cost-effectiveness.

In addition, AXIS network cameras and video encoders have built-in features such as video motion detection, audio detection alarm, active tampering alarm, and alarm and event management functionalities. The network cameras and video encoders frequently analyze the input frames to detect an event and to automatically respond to an event with actions such as video recording and sending alarm notifications.

Network cameras

With AXIS, there is a wide range of network cameras to meet a variety of requirements. A network camera or IP camera can be described as a camera and microcontroller combined in one unit. The main components of a network camera include a lens, an image sensor, one or more processors, and memory. The embedded processors are used for video compression, video analysis and networking functionalities (FTP, HTTP or e-mail). In addition, the memory is used for storing the network camera's firmware and for local recording of video streams. The captured images can be streamed as Motion JPEG, MPEG-4 or H.264 video. Most network cameras also offer input/output (I/O) ports that enable connections to external devices such as sensors and relays. Other built-in features are supported, such as audio capabilities, support for PoE, as well as advanced security and network management features.

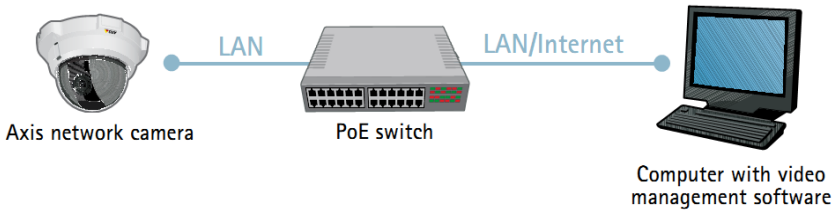


Figure (2): A network camera connects directly to the network.

AXIS IP cameras, used whether for indoor or outdoor scenes, can be further categorized into fixed, fixed dome, PTZ (Pan, Zoom and Tilt), and PTZ dome network cameras.

Fixed network camera: it is a camera that has a fixed field of view (normal/telephoto/wide-angle) once it is mounted. This type of camera represents the best choice in applications where it is advantageous to make the camera very visible. A fixed camera usually enables its lens to be changed, see figure (3.a).

Fixed dome network camera: it essentially involves a fixed camera that is pre-installed in small dome housing. The camera can be directed to point in any direction, in the same time it is hard to see in which direction the camera is pointing. The camera is also tamper resistant. However, it rarely comes with an exchangeable lens, and even if it is exchangeable, the choice of lenses is limited by the space inside the dome housing. In order to avoid this problem, variable focal lens cameras is often used to adjust the camera's field of view. Figure (3.b) shows some examples of AXIS fixed dome cameras.

PTZ cameras and PTZ dome cameras: A PTZ camera or a PTZ dome camera can manually or automatically pan, tilt and zoom in and out of an area or object. All PTZ commands are sent over the surveillance network cables. Some of the features can be integrated in a PTZ camera or a PTZ dome camera, such as electronic image stabilization (EIS) that helps reduce the affects of vibration in a video and reduce the file size of the compressed image. In addition, once the preset positions have been set in the camera, it is very quick for the operator to go from one position to the

next. Furthermore, these cameras have two important features, auto flip that helps it to instantly flip the camera head 180 degrees and continue to pan beyond its zero point, and auto tracking that helps the camera to automatically detect a moving person or vehicle and follow it within the camera's area of coverage. Figure (3.c) and (3.d) show some models of PTZ and PTZ dome AXIS cameras, respectively.

(a) Fixed network cameras wireless and megapixel versions.

(b) Fixed dome network cameras. From left to right: AXIS 209FD and AXIS 216FD (also available in ruggedized and megapixel versions), AXIS P3301 and AXIS 225FD.

(c) PTZ network cameras. From left to right: AXIS 212 PTZ-V (non-mechanical), AXIS 213 PTZ, AXIS 214 PTZ and AXIS 215 PTZ.

(d) PTZ dome network cameras. From left to right: AXIS 231D+, AXIS 232D+, AXIS 233D.

Figure (3): AXIS network camera.

Furthermore, all types of AXIS network cameras: fixed, fixed dome, PTZ, and PTZ dome can offer day and night functionality that are used in outdoor installations or in indoor environments with poor lighting. As light diminishes below a certain level, the camera can automatically switch to night mode to make use of infrared (IR) light to deliver high-quality, black and white images.

In addition, megapixel network cameras, available in AXIS' fixed cameras and fixed dome cameras, incorporate a megapixel image sensor to deliver images with one million or more pixels. Recently, Megapixel cameras are normally less light sensitive than a non-megapixel network camera. In turn, megapixel cameras generate higher-resolution video streams demanding a higher network bandwidth and a bigger storage space for recordings. Therefore, they use this can be the H.264 video compression standard to avoid this issue.

In order to select the suitable network camera from the different cameras available, that depends on multi things, such as, the surveillance goal, area of coverage, indoor or outdoor environment, overt or covert surveillance, image quality, image resolution, type of video compression, event management and intelligent video and open interface and application software.

Video encoders

Video encoders, video servers, play a significant role in the IP surveillance systems installation where many analog cameras are to be maintained. A video encoder connects to an analog video camera via a coaxial cable and converts analog video signals into digital video streams that are then sent over a wired or wireless IP-based net-work (e.g., LAN, WLAN or Internet) to view and record the digital video. By using video encoders, video cameras of all types can be remotely accessed and controlled over an IP network, as well as they offer event management and intelligent video functionalities. In addition, video encoder provides scalability and ease of integration with other security systems. Figure (4) shows some models of AXIS video encoders.

(a) 1 channel AXIS Video encoder Q7401.

(b) 4 channel AXIS Video encoder 243Q Blade.

(c) 6 channel AXIS Video encoder Q7406 Blade.

(d) 4 channel AXIS Video encoder M7014

(e) 16 channel AXIS Video encoder P7210.

(e) AXIS Video decoder P7701

Figure (4): AXIS standalone video encoders with audio, I/O (input/output) connectors for controlling external devices.

AXIS video encoders offer many of the same functions that are available in network cameras. Some of the main components of a video encoder include:

- Analog video input for connecting an analog camera using a coaxial cable.
- Processor for running the video encoder's operating system, networking and security functionalities, for encoding analog video using various compression formats and for video analysis. They offer 30 frames per second (fps) with NTSC-based analog cameras or 25 fps with PAL-based analog cameras in the highest resolution for every video channel.
- Memory for storing the network firmware and for local recording of video stream sequences.
- Ethernet port sending and receiving data and PoE port for powering the unit and the attached camera.
- Serial port (RS-232/422/485) for controlling the pan/tilt/zoom functionality of an analog PTZ camera, figure (5).

- Input/output connectors for connecting external devices such as sensors and relays.
- Audio in for connecting a microphone or line-in equipment and audio out for connecting to speakers.

One of the main benefits of AXIS video encoders is the ability to provide event management and intelligent video functionalities such as motion detection, audio detection and active tampering alarm, as well as input ports for external sensors. Once an event is detected, the system can automatically respond with actions.

Figure (5): An analog PTZ dome camera can be controlled via the video encoder's serial port (e.g., RS-485), making it possible to remotely control it over an IP network.

Video decoder

A video decoder decodes digital video and audio coming from a video encoder or a network camera into analog signals, which can then be used by analog monitors, such as regular TV sets, and video switches. Moreover, another common application for video decoders is to use them in an analog-to-digital-to-analog conversion for transporting video over long distances, see figure (6). A video decoder has the ability to decode and display video from many cameras sequentially; by decoding and showing video from one camera to another.

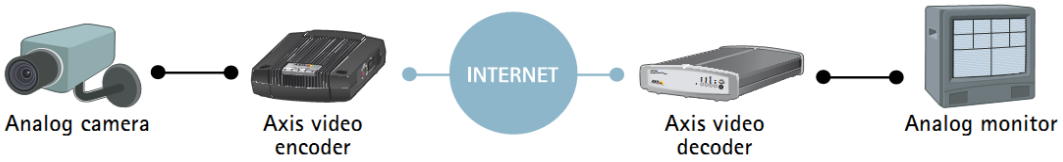


Figure (6): An encoder and decoder can be used to transport video over long distances, from an analog camera to an analog monitor.

Video resolutions

The different resolutions that AXIS networks video can provide include NTSC, PAL, VGA, megapixel and HDTV:

- NTSC (National Television System Committee) and PAL (Phase Alternating Line) resolutions are analog video standards. Current PTZ or PTZ dome network cameras and video encoders also provide NTSC and PAL resolutions as shown in figure (7).

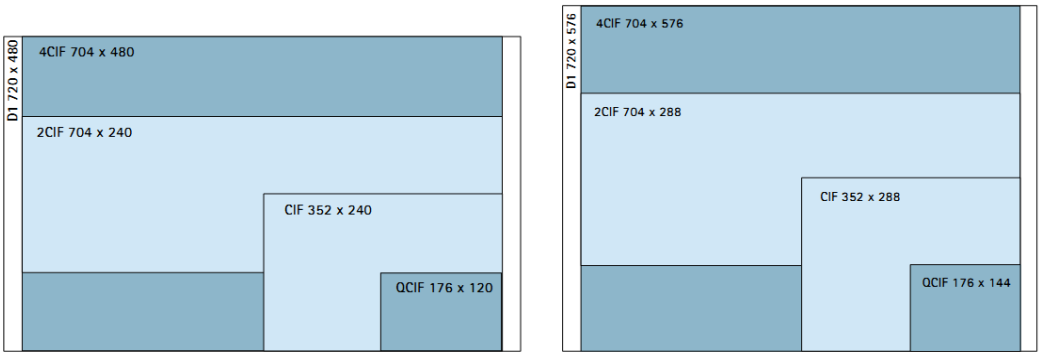


Figure (7): At left, different NTSC image resolutions. At right, different PAL image resolutions.

- VGA resolutions: with 100% digital systems based on network cameras, resolutions that are derived from the computer industry and that are standardized worldwide can be provided, allowing for better flexibility. Table (1) shows different resolutions for VGA standards.

Display format	Pixels
QVGA (SIF)	320x240
VGA	640x480
SVGA	800x600
XSVGA	1024x768
4x VGA	1280x960

Tablel (1): VGA resolutions.

- Megapixel resolutions: A network camera that offers megapixel resolution uses a megapixel sensor to deliver an image that contains one million or more pixels as shown in table (2). The more pixels a sensor has, the greater the potential it has for capturing finer details and for producing a higher quality image.

Display format	No. of megapixels	Pixels
SXGA	1.3 megapixels	1280x1024
SXGA+ (EXGA)	1.4 megapixels	1400x1050
UXGA	1.9 megapixels	1600x1200
WUXGA	2.3 megapixels	1920x1200
QXGA	3.1 megapixels	2048x1536
WQXGA	4.1 megapixels	2560x1600
QSXGA	5.2 megapixels	2560x2048

Table (2): Megapixel resolutions.

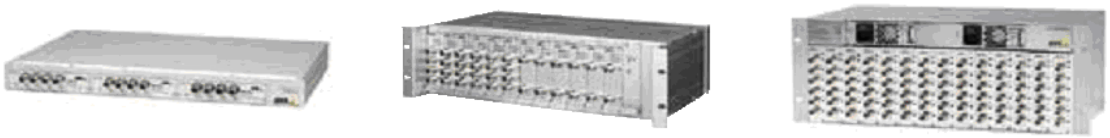
- High-definition television (HDTV) resolutions: HDTV provides up to five times higher resolution than standard analog TV. HDTV also has better color fidelity and a 16:9 format. (HDTV 720P) defines a resolution of 1280x720 pixels with high color fidelity in a 16:9 format at 25/30 fps or at 50/60 fps depending on the country. In turn, (HDTV 1080) defines a resolution of 1920x1080 pixels with high color fidelity in a 16:9 format, using either interlaced or progressive scanning at 25/30 fps and 50/60 fps.

Video compression

AXIS uses three different video compression standards: Motion JPEG, MPEG-4 Part 2 (or simply referred to as MPEG-4) and H.264. H.264 is the latest and most efficient video compression standard. The main disadvantage of Motion JPEG is that it makes no use of any video compression techniques to reduce the data size, since it is a series of still, complete images. The result is that it has a relatively high bit rate or low compression ratio for the delivered quality compared with video compression standards such as MPEG-4 and H.264. Since there is no dependency between the frames in Motion JPEG, a Motion JPEG video is robust, meaning that if one frame is dropped during transmission, the rest of the video will not be affected. Motion JPEG is an unlicensed standard. It has broad compatibility and is popular in applications where individual frames in a video sequence are required for analysis, and where lower frame rates, typically 5 frames per second or lower, are used. Motion JPEG may also be needed for applications that require integration with systems that support only Motion JPEG.

Racks for Enterprise Installations

The racks are designed for improved serviceability and quick replacement of units, AXIS 291 1U Video Server Rack, AXIS Video Server Rack and AXIS Q7900 Rack hold up to 3, 12 or 14 video encoder blades respectively, see figure (8). They are interchangeable and hot-swappable, thus there is no need to power down of the system, when installing or changing blades. AXIS video encoder racks combine high reliability and functionality with flexible and professional installation, and provide higher density of video channels compared with standalone solutions. AXIS video encoder racks are specially designed for applications involving a large number of cameras, both existing and new ones. They are also designed for applications that cover large physical surveillance areas such as prisons, airports, large buildings, university campuses, subways and railway stations.



(a) AXIS 2911U Server Rack. (b) AXIS Video Server Rack. (c) AXIS Q7900 Rack.

Figure (8): AXIS video servers racks.

Video management software

AXIS offers IP-Surveillance software solutions as a complement to the company's network cameras and video encoders. AXIS offers three types of management software.

AXIS Camera Companion (ACC): AXIS Camera Companion is the video surveillance solution used for small areas, such as small retail, offices and hotels. ACC consists of 1 to 16 standard AXIS cameras, SD cards, software clients for PC and Smartphone, and standard network equipment. With AXIS Camera Companion, all video is recorded

on SD cards in the cameras without needing to digital video encoders. Furthermore, ACC offers HDTV quality for reliable identification of people and incidents with easily exporting video clips. The ACC user can view surveilled video from anywhere by using Internet access with support for apps for iPhone, iPad and Android. Technical specifications of ACC show in details in figure (9).

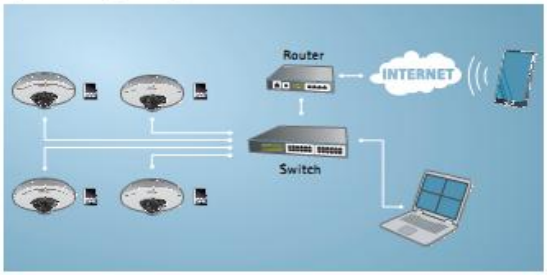
Technical Specifications – AXIS Camera Companion

General	
PC client	Download from: www.axis.com/companion
Mobile access	Apps for Android devices, iPhone and iPad (Available from third-party vendor)
Number of channels	1 to 16 cameras
Compatible products	Axis network cameras and encoders with firmware 5.40 or later
Language	English, UK English, Arabic, Brazilian Portuguese, Czech, Dutch, Finnish, French, German, Italian, Japanese, Korean, Polish, Russian, Simplified Chinese, Traditional Chinese, Slovak, Spanish, Swedish and Turkish
Video	
Video compression	H.264 (MPEG-4 Part 10/AVC)
Resolutions	Supports all camera resolutions
Frame rate	Supports all camera frame rates
Audio	One-way audio streaming, AAC audio compression
Storage	
Storage media	SD card, speed class 4 or higher recommended, refer to camera/encoder documentation for specification Storage option: Network-Attached Storage (NAS)
Storage capacity	With AXIS Camera Companion default settings: more than a month of video with 64 GB SD card Configurable retention recording, duration can be limited per camera to conform to local legal requirements

More information is available at www.axis.com

System	
Minimum client computer requirements	OS: Windows XP SP3 (Windows 7 recommended), CPU: Intel Atom 1.6 GHz (Intel i5 recommended), RAM: 1 GB (2 GB recommended), Graphics card: 256 MB onboard video memory recommended. Always use the latest graphics card driver
Recommended network	100 Megabit
Required equipment	Power over Ethernet switch, Ethernet cables, PC, SD cards and/or NAS. For remote and/or wireless access a router with UPnP is also required.
Security	Multiple user access levels with password protection
Live view	
Camera live view	Live view of up to 16 cameras 1, 4, 9 and 16-split views and full screen, Axis Corridor Format, camera sequence
PTZ	Control of PTZ cameras using mouse or joystick
Playback	
Search for recordings	Search for recordings based on camera, date and time. Timeline visualization
Playback	Playback speed: up to 8x or frame by frame
Export	Single images in JPEG or video sequences in ASF Installation-free standalone player included, Digital signature on exported recordings
Recording control	
Motion detection	Advanced camera-based motion detection for low bandwidth utilization
Continuous and scheduled recording	Schedule per camera allows continuous recording or customization of weekday and weekend recordings

System setup example



Installation example: retail shop

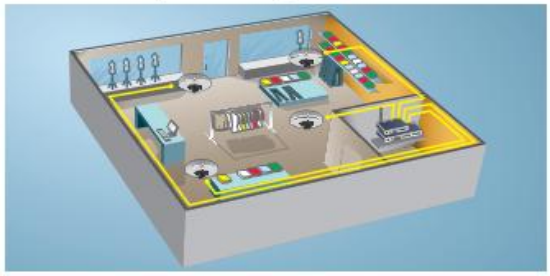


Figure (9): Technical specifications of ACC and examples for system setup and installation.

AXIS Camera Station (ACS): AXIS Camera Station is a comprehensive monitoring, recording system and events management. ACS offers easy installation and setup with automatic camera discovery and powerful event configuration wizard, as well as efficient management of cameras in the system. A high quality video and audio from up to 100 cameras with different video compression is viewed and recorded. It also supports H.264 video compression that enables optimization of bandwidth and storage efficiency. Figure (10) shows technical specifications of ACS.

Technical specifications – AXIS Camera Station

Camera	
Models	Compatible with Axis network video products running firmware 4.30 or higher
Number of channels	Up to 100
Video	
Video compression	H.264 (MPEG-4 Part 10/AVC) MPEG-4 Part 2 Motion JPEG
Resolutions	Supports connected Axis video product resolutions
Recording frame rate	3000 fps or more on recommended hardware
Audio	
Audio streaming	One-way audio
Audio compression	AAC G.711 G.726
Recording server	
Security	Multiple user access levels with password protection using local or Windows domain users (Active directory)
Installation and setup	Automatic camera discovery Efficient camera management Powerful event configuration wizard
Recording storage	Unlimited recording database, limited only by disk space Record directly to local and network disks Duration can be limited per camera to conform to local legal requirements Fail-over recording in cameras Locking of prioritized recordings
Client	AXIS Camera Station Client (for Windows) included for local and remote viewing, playback and administration
Live view	
Camera live view	Flexible live view configuration of up to 100 cameras, Axis' Corridor Format™ , multiple monitors Hot-spot, camera/view sequence, site maps, web page
PTZ	Control of PTZ and dome cameras using mouse or joystick Area zoom, Digital PTZ Programmable hot-keys
Image enhancement	Improved live and recorded video quality in challenging conditions such as snow and fog
Playback	
Search for recordings	Search for recordings based on camera, date and time Timeline visualization, smart search, bookmarks
Playback	Playback speed: up to 64x or frame by frame Graphical timeline for quick overview of events
Synchronized playback	Playback of video and audio from up to 25 cameras simultaneously
Export	Manual and scheduled export Single images in JPEG format or video sequences in ASF format Digital signature on exported recordings Standalone player

Triggers & Events	
Event recording	Events triggered by video motion detection, Active Tampering Alarm, AXIS Cross Line Detection, external inputs, manual trigger, system triggers and device event triggers
Scheduled recording	Schedule per camera allows customization of weekday and weekend recordings
Motion detection	Advanced camera-based motion detection for low bandwidth utilization
Input/output control	Advanced control of cameras' digital inputs/outputs
Alarm notification	Visual indication, audible alert, traybar notification, switch to camera/view, go to PTZ preset, email, alarm procedure, acknowledgement of alarms
Logs	Alarm, event and audit logs
System	
Minimum system requirements	Windows 7 Professional, Vista Business, XP Professional (server and/or client), 2008 Server R2, 2008 Server, 2003 Server (server only, 64 bit OS recommended for larger systems) Always use the latest service packs Microsoft .NET runtime environment (included in installation package)
Minimum computer requirements – client	CPU: Intel P4 or higher, 2 GHz (Intel Core i7 recommended for larger systems) RAM: 1 GB (4 GB recommended for larger systems) Graphics card with full DirectX 9.0 hardware acceleration and onboard video memory of 256 MB or more Important! Use latest graphics card driver and DirectX runtime
Minimum computer requirements – server	CPU: Intel P4 or higher, 2 GHz (Intel Xeon recommended for larger systems) 1 GB RAM (8 GB recommended for larger systems)
Recommended network	100 Megabit network (Gigabit network recommended for larger systems)
Recommended hard disk configuration	At 30 fps in VGA: up to 15 cameras/hard disk
General	
Languages	English, French, Italian, German, Spanish, Polish, Russian, Korean, Japanese, Chinese, Swedish, Danish, Turkish, Arabic and Persian
Licenses	AXIS Camera Station base licenses for 4 or 10 cameras/channels to be used on one single dedicated PC/server Additional licenses in +1, +5 or +20 up to 100 cameras/channels One year support license included in initial base license Future support and upgrades require a yearly support license 30-day demo can be upgraded to licensed version
License registration	Register automatically over the Internet or manually at www.axis.com within a five day grace period
Included accessories	Installation Guide CD with software and User's Manual

More information is available at www.axis.com

Figure (10): Technical specifications of ACS.

AXIS Video Hosted video (AVHS): AVHS is a full surveillance system solution that allows customers using a video hosting solution to view an area and access the system from anywhere and anytime using an Internet connection. The solution supports up to 10 cameras per site in single or multiple locations (retailers) such as convenience stores, gas stations, banking, and small offices and gives businesses the ability to better manage view and respond. The hosted video access service provider will manage system maintenance, as well as storage of recorded data. Encoders compatible with AVHS can easily be connected to the system in order to add the benefits of a trouble-free hosted video solution. Furthermore, in order to enhance system functionality, the solution can be completed with a Network Attached Storage (NAS) for redundant storage of high frame rate, high resolution video in HDTV or megapixel resolution.

Recommended equipment

- Computer with Internet connection
- Minimum browser requirement - Latest releases of IE, Firefox, Safari and Chrome
- Axis network cameras and encoders compatible with AVHS
- Iomega StorCenter Series (optional)
- Axis Video Service Provider

Axis network product selection

	Resolution	PoE support	Light conditions	Application range	Accessories
 Fixed network cameras	SVGA to HDTV 1080p/5MP	Most models	Day/Night*	Indoor Outdoor	Full line available
 Fixed dome network cameras	SVGA to HDTV 1080/3MP	All models	Day/Night*	Indoor Outdoor	Full line available
 PTZ dome network cameras	SVGA to HDTV 1080p	All models	Day/Night*	Indoor Outdoor	Full line available
 Video encoders	CIF to D1	Most models	n/a	n/a	Blade chassis

For a full list of products compatible with AVHS refer to www.axis.com/hosting.
*P and Q-line models.

Iomega product selection

Product	Capacity	Interface	Key features
StorCenter ix Series 	2-12 TB	10/100/1000 Ethernet Port	EMC LifeLine; GbE connectivity; RAID 1,5 or 10 (JBOD also available); Supports up to three (3) USB printers; UPnP and DLNA certified; VMware, Windows, and XenServer Certified; Three (3) USB ports; up to 4 SATA II Hard Disk Drives (1TB, 2TB, or 3TB)
StorCenter px Series 	0-18 TB	Ethernet Port	EMC LifeLine; Dual GbE connectivity; Solid State Drives (optional); RAID 1, 10, 5 or 6 with hot spare; automatic RAID rebuild and hot swap; RAID 0 and JBOD mode; Diskless Configuration; Device to Device Data Replication; VMware, XenServer, Windows Certified; Three (3) USB ports; SATA II Interface

Figure (11): Required equipments for AVHS.

AXIS network and applications

AXIS surveillance system works with more than 800 Application Development Partners globally to ensure tightly integrated software solutions, video motion detection, cross line detection, people counter, and object tracking, for your AXIS video product. For instance, AXIS video motion detection 2.1 is an easy-to-configure application installable on AXIS network cameras and encoders as shown figure (12). The application detects moving objects within a predefined area of interest, making it possible to automatic ally trigger an action.

Technical Specification – AXIS Video Motion Detection 2.1

Compatible products	
Models	All Axis cameras and video encoders with firmware 5.40 or later and support for AXIS Camera Application Platform Complete list at www.axis.com
Setup and configuration	
Setup	Web interface camera/video encoder
Configuration	Web interface camera/video encoder*
Application settings	
Settings	One area of interest (20 point polygon), one exclude area, (20 point polygon), visual confirmation to verify setup
Scenarios	
Typical applications	General low-traffic areas such as corridors, parking lots and unattended shop areas
Limitations	Weather conditions such as heavy rain or snow may affect detection accuracy

* Requires Windows and Internet Explorer

System integration	
Camera	Integrates with camera event management system to enable event streaming to Video Management Software and camera actions such as I/O control, notification, edge storage, etc.
Application Programming Interface	Open API for software integration, including the ONVIF specification available at www.onvif.org, as well as VAPIX® from Axis Communications, specifications available at www.axis.com
General	
Language	English

More information is available at www.axis.com

Figure (12): Technical specification of AXIS Video Motion Detection.

Notes:

- *AXIS encoders/decoders does not support MPEG-2 video compression, they just support Motion JPEG, MPEG-4 and H.264.*
- *AXIS presents open API software for the application wanted to merge within the installed surveillance system. However, it is not certain if AXIS offers an open platform for encoder or decoder firmware for updating.*
- *AXIS is with cooperation with IPS Company: IPS has been working in the last generation of IP based software solutions for video analytics. Therefore, there are a lot of applications for AXIS network cameras designed by IPS, such as IPS motion detection, IPS privacy protection and so on.*
- *All the pictures used in this report have been extracted from the manufactures' websites http://www.axis.com, with no commercial aim.*

CISCO Surveillance Systems

In this second part, we concern with CISCO surveillance systems. We will give a brief summary for the system architecture, components and system software tools of different available systems.

Cisco offers network video surveillance systems for monitoring, recording, and managing video. Cisco video surveillance systems can be compatible with different CCTV systems, including matrix switches, keyboard controllers, and displays to enable new digital recording capabilities. A Cisco platform solution allows the customers to remain unchanged and provides an easy transportation path to a Cisco Virtual Matrix Switch solution, where the IP network provides a dynamic transport of video streams.

A typical analog Cisco video surveillance system includes many components as shown in Figure (7). In the system shown, video streams are monitored concurrently by using a matrix switch as an aggregation device. This approach collects video streams from different network cameras to be switched to analog CCTV monitors by using special-purpose controls. Analog cameras, either fixed or pan-tilt-zoom (PTZ), are typically connected to the matrix switch by using coaxial cables for video transmission and serial cables to control and command PTZ cameras.

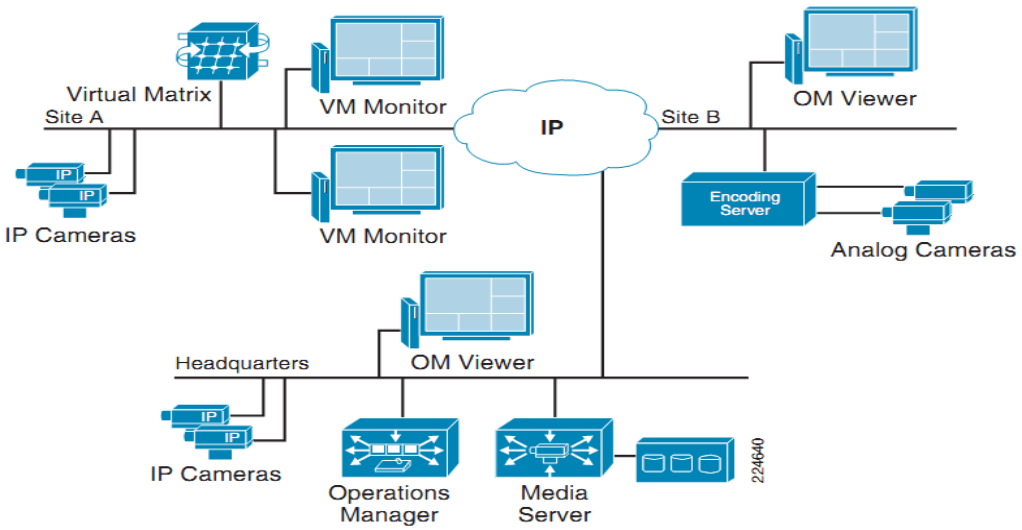


Figure (13): Typical Analog Video Surveillance System.

The Cisco IP-based video surveillance solution consists of five majors components:

- IP Cameras: these cameras are used to captures video for monitored area. The analog cameras attached to encoders, analog gateway network modules for sharing and routing the services on surveillance network.
- Video management software: Cisco systems offer the Cisco Video Surveillance Manager (VSM) suite of software that runs on one or more standalone, Linux-

based servers or on a Cisco Integrated Services Router (ISR) to manage and store the video captured.

- Media Servers (video encoders): Cisco Physical Security Multi Services Platforms are servers for network digital recording and playback.
- Media Storage: the data center architecture and the Cisco video surveillance storage system or with off-the-shelf iSCSI servers address the archiving and storing of video feeds.
- Video Surveillance Network: this component is the enterprise network (WANs or MANs)—the Media Ready Network that is the main responsible to access and transmit video data on surveillance network.

Network cameras

Cisco products Cisco Video Surveillance IP Cameras that are generating images with high-definition resolutions, offering efficient network utilization with the highest-quality video with input/output ports, microphones, speakers, and access control systems. Moreover, Cisco IP camera provides an ideal platform for integration and operation as an independent device or as part of a Cisco Video Surveillance network. Some models of Cisco 2000 and 4000 Series IP cameras are shown in figure (14) and (15). The Cisco Video Surveillance IP Camera offers a variety of benefits, such as:

- The camera streams crisp and clear 1080p (1920 x 1080) (2.1 MP) video at 30 frames per second while maintaining surprisingly low network bandwidth. For fast motion applications, the camera can be set to stream 720p (1280 x 720) video at 60 frames per second.
- The camera captures each frame at its entire resolution using a progressive scan, which allows for better detail for video of moving objects, such as faces and license plates on automobiles.
- The camera can stream H.264 and MJPEG video simultaneously.
- Day/night operation is that the camera provides true day/night functionality, and includes an IR filter that automatically switches to night mode in low-light scenes to use in indoor and outdoor scenes.
- The camera supports Power over Ethernet (PoE).
- The camera can be installed with a fixed mount or with an optional external pan/tilt mount and motorized zoom lens.
- The camera provides hardware-based Advanced Encryption Standard (AES), as well as the camera supports IP Multicast for managing bandwidth.
- The camera can alarm for activity and notify users or other applications when it detects abnormal activity that exceeds a predefined sensitivity and threshold. The camera also provides two digital inputs and two digital outputs that can be used to initiate specific actions when an alarm is detected.
- The camera supports the medianet interface that is used in Cisco switches that recognize the camera as a video endpoint, which then uses SmartPort Macros to set the right network parameters for the video stream on the network.
- The 4500 IP camera provides and supports real-time, edge-based video analytics capabilities.

Selecting the proper camera from a wide variety of cameras offered from Cisco for a specific system also is important to meet specific deployment requirements. The system often needs many requirements, such as cameras with PTZ functionality, day/night capabilities, vandal-resistance, weather-proofing, and many other features. Serial PTZ data can be transmitted either in a point-to-point fashion or by using a multidrop bus, which cameras can be configured with unique system dome IDs and can be daisy-chained by using the same set of electrical wires.

In order to transmit video signals from analog cameras, different media can be used. Coaxial cable is one of the most common cable types, but twisted pair and fiber optic cable have also become popular.

Cisco IP Camera Model	Cisco 2500W (CIVS-IPC-2500W)	Cisco 2600 (CIVS-IPC-2600)	Cisco 2611 (CIVS-IPC-2611)	Cisco 2621 (CIVS-IPC-2621V)	Cisco 2630 (CIVS-IPC-2630V)
Product Photo					
Camera Characterstics					
Image sensor	1/3 inch progressive scan CMOS	1/3 inch progressive scan CMOS	1/3 inch progressive scan CMOS	1/3 inch progressive scan CMOS	1/3 inch progressive scan CMOS
Power Input	12 VDC	12 VDC PoE (802.3af) @ 48V/0.3A	12 VDC or 24 VAC, isolated external power PoE (802.3af) @ 48V/0.3A	12 VDC or 24 VAC, isolated external power PoE (802.3af) @ 48V/0.3A	24 VAC, isolated external power supply
Power Consumption	11 W (max)	11 W (max)	11 W (max)	11 W (max)	
Lens	Fujinon / Tamron 3-8 / 3-11 / 5-50 mm (Varifocal)	Fujinon / Tamron 3-8 / 3-11 / 5-50 mm (Varifocal)	3.3mm - 12mm Horizontal: 24°-90° Vertical: 18°-64° Remote focus and zoom	3.3mm - 12mm Horizontal: 24°-90° Vertical: 18°-64° Remote focus and zoom	3.3mm - 12mm Horizontal: 24°-90° Vertical: 18°-64° Remote focus and zoom
Day and Night	Automatic and manual control	Automatic and manual control	Automatic and manual control		
Wide Dynamic Range	Yes 102 dBtypical/120 dB maximum	Yes 102 dBtypical/120 dB maximum	Yes 102 dBtypical/120 dB maximum	Yes 102 dBtypical/120 dB maximum	Yes 102 dBtypical/120 dB maximum
Minimum Illumination/Light Sensitivity	Color mode: F1.4 @ 0.65 lux Black and white mode: F1.4 @ 0.08 lux	Color mode: F1.4 @ 0.65 lux Black and white mode: F1.4 @ 0.08 lux	Color mode: F1.4 @ 0.65 lux Black and white mode: F1.4 @ 0.08 lux	Color mode: F1.4 @ 0.65 lux Black and white mode: F1.4 @ 0.08 lux	Color mode: F1.4 @ 0.65 lux Black and white mode: F1.4 @ 0.08 lux
Features and Architecture					
Video Compression	MPEG-4 Motion JPEG	H.264 MPEG-4 Motion JPEG	H.264 MPEG-4 Motion JPEG	H.264 MPEG-4 Motion JPEG	H.264 MPEG-4 Motion JPEG
Supported Video Resolutions (data sheets contain secondary stream frame rates)	720 x 480 (D1) 704 x 480 (4Cif) 352 x 288 (Cif)	720 x 480 (D1) 704 x 480 (4Cif) 352 x 288 (Cif)	720 x 480 (D1) 704 x 480 (4Cif) 352 x 288 (Cif)	720 x 480 (D1) 704 x 480 (4Cif) 352 x 288 (Cif))	720 x 480 (D1) 704 x 480 (4Cif) 352 x 288 (Cif)
Maximum Frames per Second (NTSC / PAL) (data sheets contain secondary stream frame rates)	30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)	30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)	30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)	30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)	30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)
Primary Stream	MPEG-4	H.264, MPEG-4	H.264, MPEG-4	H.264, MPEG-4	H.264, MPEG-4
Secondary Stream (data sheets contain frame rates)	MPEG-4, MJPEG	H.264, MPEG-4, MJPEG	H.264, MPEG-4, MJPEG	H.264, MPEG-4, MJPEG	H.264, MPEG-4, MJPEG
Camera Angle Adjustments			Pan: 340° Tilt: 160° Rotation: 200° Zoom 3.6X	Pan: 340° Tilt: 160° Rotation: 200° Zoom 3.5X	Pan: 340° Tilt: 160° Rotation: 200° Zoom 3.5X
Audio Support (but not when used with Cisco Video Surveillance manager)	Bidirectional; full duplex or half duplex Built in microphone and speaker out	Bidirectional; full duplex or half duplex Built in microphone and speaker out	Bidirectional; full duplex or half duplex (with optional accessory)	Bidirectional; full duplex or half duplex (with optional accessory)	Bidirectional; full duplex or half duplex (with optional accessory)
Audio Compression (but not when used with Cisco Video Surveillance manager)	G.711 A-Law, G.711 U-Law, G.726	G.711 A-Law, G.711 U-Law, G.726	G.711 A-Law, G.711 U-Law, G.726, AAC	G.711 A-Law, G.711 U-Law, G.726	G.711 A-Law, G.711 U-Law, G.726
Alarm Inputs and Outputs (but not when used with Cisco Video Surveillance manager)	2 alarm inputs, 2 alarm outputs, logical level programmable	2 alarm inputs, 2 alarm outputs, logical level programmable	2 alarm inputs, 2 alarm outputs, logical level programmable	2 alarm inputs, 2 alarm outputs, logical level programmable	2 alarm inputs, 2 alarm outputs, logical level programmable
Video Analytics	Motion detection	Motion detection	Motion detection	Motion detection	Motion detection
Network Support					
Security*	Multi-level Passwords IP filtering HTTPS encryption IEEE 802.1X	Multi-level Passwords IP filtering HTTPS encryption IEEE 802.1X	Multi-level Passwords IP filtering HTTPS encryption IEEE 802.1X	Multi-level Passwords IP filtering HTTPS encryption IEEE 802.1X	Multi-level Passwords IP filtering HTTPS encryption IEEE 802.1X
Network*	Wired, wireless 802.11 b,g , IP , Qos	Wired , IP , Qos	Wired , IP , Qos	Wired , IP , Qos	Wired , IP , Qos
Operating Temperature	32° to 122° F (0° to 50°C)	32° to 122° F (0° to 50°C)	32° to 113° F (0° to 45°C)	32° to 122° F (0° to 50°C)	–22° to131° F (–30° to 55°C)
IP66 Rated	Third party enclosure	Third party enclosure	No	Yes (with optional accessory)	Yes (with optional accessory)
Lenses and Accessories					
Cisco IP Camera Tamron 3–8 mm Varifocal Lens	CIVS-IPC-VT38	CIVS-IPC-VT38	CIVS-IPC-VT38	CIVS-IPC-VT38	CIVS-IPC-VT38
Cisco IP Camera Tamron 3–11 mm Varifocal Lens	CIVS-IPC-VT31	CIVS-IPC-VT31	CIVS-IPC-VT31	CIVS-IPC-VT31	CIVS-IPC-VT31
Cisco IP Camera Tamron 5–50 mm Varifocal Lens	CIVS-IPC-VT55	CIVS-IPC-VT55	CIVS-IPC-VT55	CIVS-IPC-VT55	CIVS-IPC-VT55
Cisco IP Camera Fujinon 3–8 mm Varifocal Lens	CIVS-IPC-VF38	CIVS-IPC-VF38	CIVS-IPC-VF38	CIVS-IPC-VF38	CIVS-IPC-VF38
Cisco IP Camera Fujinon 3–11 mm Varifocal Lens	CIVS-IPC-VF31	CIVS-IPC-VF31	CIVS-IPC-VF31	CIVS-IPC-VF31	CIVS-IPC-VF31
Cisco IP Camera Fujinon 5–50 mm Varifocal Lens	CIVS-IPC-VF55	CIVS-IPC-VF55	CIVS-IPC-VF55	CIVS-IPC-VF55	CIVS-IPC-VF55

Figure (14): Models of Cisco 2000 series IP cameras and their specifications.

	Cisco 4300 (CIVS-IPC-4300)	Cisco 4500 (CIVS-IPC-4500)	Cisco 5000 (CIVS-IPC-5010/11)	Cisco 2911 (CIVS-IPC-2911/2916)	Cisco 2930 (CIVS-IPC-2930/2935)
Product Photo					
Camera Characteristics					
Image sensor	1/3 inch progressive scan CMOS	1/3 inch progressive scan CMOS	1/3 inch progressive scan CMOS	1/4 inch Sony EXview HAD	1/4 inch Sony EXview HAD
Power Input	12 VDC or 24 VAC PoE (802.3af) @ 48V/0.3A	12 VDC or 24 VAC PoE (802.3af) @ 48W/0.3A	24 VAC, isolated external power PoE (802.3af)	18 to 32 VAC; 24 VAC nominal 22 to 27 VDC; 24 VDC nominal	18 to 32 VAC; 24 VAC nominal 22 to 27 VDC; 24 VDC nominal
Power Consumption	11 W (max)	11.5 W (max)	6 W (max)	24 VAC 23 VA nominal (without heater) 73 VA nominal (with heater) 24 VDC 0.7A nominal (without heater) 3A nominal (with heater)	24 VAC 23 VA nominal (without heater) 73 VA nominal (with heater) 24 VDC 0.7A nominal (without heater) 3A nominal (with heater)
Lens	Fujinon / Tamron 2.8-12 / 3-8 / 5-50 / 15-50 mm (Varifocal)	Fujinon / Tamron 2.8-12 / 3-8 / 5-50 / 15-50 mm (Varifocal)	Horizontal: 5°-109° Vertical: 4°-89°	55.8° at 3.4 mm wide zoom 2.3° at 91.8 mm telephoto zoom f/1.4 (focal length, 3.4 ~ 91.8 mm)	55.8° at 3.4 mm wide zoom 1.7° at 119 mm telephoto zoom f/1.4 (focal length, 3.4 ~ 119 mm)
Day and Night	Automatic and manual control	Automatic and manual control	Automatic	Automatic	Automatic
Wide Dynamic Range	No	No	Yes 60 dB	Yes	Yes
Minimum Illumination / Light Sensitivity	Color mode: F1.4 @ 0.4 lux Black and white mode: F1.4 @ 0.2 lux	Color mode: F1.4 @ 0.4 lux Black and white mode: F1.4 @ 0.2 lux	Color mode: F1.2 @ 0.12 lux Black and white mode: F1.2 @ 0.03 lux	0.55 lux at 1/60 sec (color) 0.018 lux at 1/2 sec (color) 0.00018 lux at 1/2 sec (B-W) 0.45 lux at 1/50 sec (color) 0.015 lux at 1/1.5 sec (color) 0.00015 lux at 1/1.5 sec (B-W)	0.55 lux at 1/60 sec (color) 0.018 lux at 1/2 sec (color) 0.00018 lux at 1/2 sec (B-W) 0.45 lux at 1/50 sec (color) 0.015 lux at 1/1.5 sec (color) 0.00015 lux at 1/1.5 sec (B-W)
Features and Architecture					
Video Compression	H.264 Motion JPEG	H.264 Motion JPEG	H.264 MPEG-4 Motion JPEG	H.264 MPEG-4 Motion JPEG	H.264 MPEG-4 Motion JPEG
Supported Video Resolutions (data sheets contain secondary stream frame rates)	1920 x 1080 (1080p) (2 MP) 1280 x 720 (60 fps at 720p) 720 x 480/576 fps (D1) 704 x 480/576 (4CIF) 352 x 240/288 (CIF)	1920 x 1080 (1080p) (2 MP) 1280 x 720 (60 fps at 720p) 720 x 480/576 fps (D1) 704 x 480/576 (4CIF) 352 x 240/288 (CIF)	1920 x 1080 @ 30 ips (2MP) 1600 x 1200 @ 20 ips 1280 x 1024 @ 20 ips 1280 x 960 @ 20 ips 1280 x 720 @ 30 ips 800 x 600 @ 30 ips 680 x 480 @ 30 ips 320 x 240 @ 30 ips	704 x 480 352 x 240 704 x 576	704 x 480 352 x 240 704 x 576
Maximum Frames per Second (NTSC / PAL) (data sheets contain secondary stream frame rates)	30 fps (1080p) 60 fps (720p) 30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)	30 fps (1080p) 60 fps (720p) 30/25 fps (D1) 30/25 fps (4CIF) 30/25 fps (CIF)		Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6, 5, 4, 3, 2, 1 (dependent upon coding, resolution, and stream configuration)	Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6, 5, 4, 3, 2, 1 (dependent upon coding, resolution, and stream configuration)
Primary Stream	H.264	H.264	H.264, MJPEG	H.264, MJPEG	H.264, MJPEG
Secondary Stream (data sheets contain frame rates)	MJPEG	MJPEG	H.264, MJPEG	H.264, MJPEG	H.264, MJPEG
Camera Angle Adjustments			Pan: 368° Tilt: 160° Rotation: 355°	Pan: 360° continuous rotation Tilt: Unobstructed +2° to –92° Zoom: 27X optical, 12X digital	Pan: 360° continuous rotation Tilt: Unobstructed +2° to –92° Zoom: 35X optical, 12X digital
Audio Support (but not when used with Cisco Video Surveillance manager)	Two-way, Half duplex, Built in microphone and speaker out	Two-way, Half duplex, Built in microphone and speaker out	No	Bidirectional; full duplex or half duplex	Bidirectional; full duplex or half duplex
Audio Compression (but not when used with Cisco Video Surveillance manager)	AAC (encoding only), G.711 A-Law, G.711 U-Law	AAC (encoding only), G.711 A-Law, G.711 U-Law	N/A	G.711 PCM 8-bit, 8 KHz mono at 64 kbit/s	G.711 PCM 8-bit, 8 KHz mono at 64 kbit/s
Alarm Inputs and Outputs (but not when used with Cisco Video Surveillance manager)	2 alarm inputs, 2 alarm outputs, logical level programmable	2 alarm inputs, 2 alarm outputs, logical level programmable	10 VDC max, 5 mA max / 0 to 15 VDC max, 75 mA max	2 alarm inputs, 7 auxiliary inputs	2 alarm inputs, 7 auxiliary inputs
Video Analytics	Motion detection	Motion detection DSP processor for video analytics	Motion detection	Motion detection	Motion detection
Network Support					
Security*	Multi-level passwords IP filtering HTTPS encryption IEEE 802.1X	Multi-level passwords IP filtering HTTPS encryption IEEE 802.1X	Multi-level Passwords IP filtering HTTPS encryption	Multi-level passwords HTTPS encryption	Multi-level passwords HTTPS encryption
Network*	Wired, IP, Qos	Wired, IP, Qos	Wired, IP	Wired, IP	Wired, IP, Qos
Operating Temperature	32° to 122° F (0° to 50°C)	32° to 122° F (0° to 50°C)	32° to 122° F (0° to 50°C)	32° to 122° F (0° to 50°C)	140°F (60°C) absolute maximum; 122°F (50°C) -sustained maximum –60°F(–51°C) Absolute minimum; prevents icing at sustained minimum of –50°F (–45°C); de-ices 0.1 inch (2.5 mm) within 3 hours after power-up
IP66 Rated	Third party enclosure	Third party enclosure	No	No	Yes

Figure (15): Models of Cisco 4000 series IP cameras and their specifications.

Cisco Video Surveillance Manager

Cisco Video Surveillance Media Server, as shown in figure (16), is the core component of the Cisco Video Surveillance Manager and performs the following networked video surveillance system functions:

- Collecting and routing of video from a wide range of cameras and encoders over an IP surveillance network.
- Providing secure local, remote, and redundant video archive capabilities.
- Classifying events for review and archival purposes.
- Managing both Live distribution and historical recording bandwidth.

By using the advanced capabilities of IP networks, Cisco Video Surveillance Media Server software allows applications, users, cameras, and storage to be added over time. As a result, the software provides unparalleled video surveillance system flexibility and scalability to support:

- Deploying of thousands of cameras instead of small systems.
- Hundreds of simultaneous users accessing live and recorded video.
- Standard video codec such as Motion JPEG, MPEG-4, and H.264 in a single Media server.
- Storage management using events, clipping, record-on-motion, and loop-based archival options.
- Integration with other security and IT applications using open API streaming.
- Easy maintenance with good efficiency based on fault-tolerant storage.

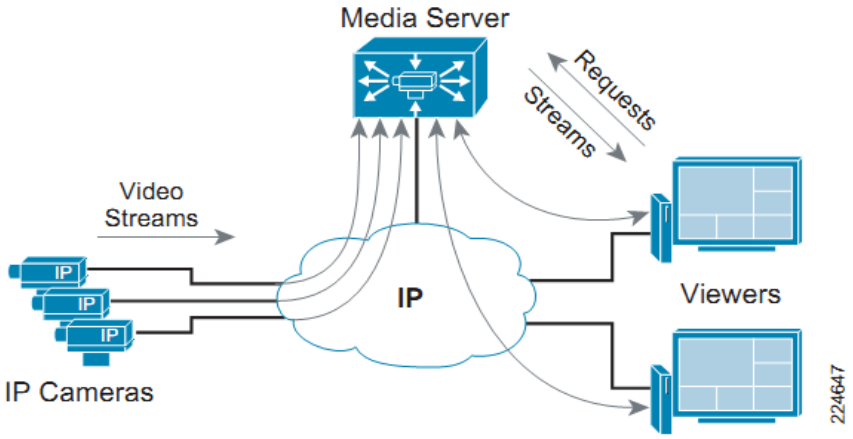


Figure (16): Media Server.

Cisco Video Surveillance Media Server is fully compatible with other Cisco Video Surveillance Manager applications that virtual matrix switching, display controllers. Media Server and other Cisco Video Surveillance software applications run on Linux-operating systems. As a result of Linux based servers, new features and different requirements can be added to the investment to support a diverse range of deployment scenarios. In addition, the use of standards-based architecture provides the flexibility to use a broad range of devices, resolutions, video codecs, viewing platforms, and network topologies.

The next table lists the minimum system requirements for server and client hardware for Cisco Video Surveillance Media Server.

Product Name	Part Number
Cisco Physical Security Multiservice Platform; 1-RU	CPS-MSP-1RU-K9
Cisco Physical Security Multiservice Platform; 2-RU	CPS-MSP-2RU-K9
Cisco Multiservice Platform for Video Surveillance; 1-RU	CIVS-MSP-1RU
Cisco Multiservice Platform for Video Surveillance; 2-RU	CIVS-MSP-2RU
Cisco Multiservice Platform for Video Surveillance; 4-RU	CIVS-MSP-4RU

Table (3): Supported Platforms for Cisco Video Surveillance Operations Manager.

Video Storage

Cisco video surveillance system provides multiple options to store video and audio files at storage units. Direct attached or SAN storage may augment the internal storage of the Media Server. The video surveillance storage system can store video in loops, instantaneously archives, or event clips generated with alarm systems providing for redundant and remote long-term archival.

With MJPEG, it is difficult to provide fixed frame sizes. Because, the frame size of each image captured plays a key role in estimating the storage and transmission requirements. Since, each frame with MJPEG is unique and varies depending on the image complexity. A lower image with low complexity will generate smaller frame sizes, which require less bandwidth and storage capacity.

The following formula is used to calculate the bandwidth requirements for MJPEG streams:

MJPEG storage = Average Frame size x Frame rate x duration

Rather than standalone images, MPEG-4 / H.264 streams take into account video frames and the size of a given video frame varies widely between I-frames and predictive (p-) frames. MPEG-4 is generally more efficient than Motion JPEG and requires less bandwidth and storage capacity when using higher frame rates. In turn, typically, H.264 is more efficient than MPEG-4 and requires less bandwidth and storage than it.

The following formula is used to calculate the bandwidth requirements for MPEG-4 streams:

MPEG4 storage = Bit rate (kbps) x duration.

The target bit rate is configured on the used camera.

Several settings play a role in providing the proper image quality and frame rate, when setting a new IP camera. For MJPEG video streams, the resolution and quality of each frame may be set. In turn, for MPEG-4 and H.264 videos streams, the resolution, bit rate, and quality may be configured. The bit rate setting specifies the

amount of bandwidth required for the MPEG-4 / H.264 video stream. Higher values generate more video data every second, translating into accurate video, however it translates into larger archive file sizes.

Cisco Video Surveillance Storage System benefits include:

- Storage Area Network (SAN), Network-Attached Storage (NAS), and DB2 administration server (DAS) configurations.
- Internal storage up to 24 TB (on the Media Server).
- SAN arrays that support up to 42 TB per array, 420 TB per rack.
- Redundant archives.
- Redundant array of independent disks (RAID) 0/1/5 configuration.
- Optional clustering for failover protection.
- Online access to video at more than 100 times faster than tape.
- Redundant power supplies and RAID controllers.

Video management software

Cisco Video Surveillance Manager (VSM) suite is used as video management software. This software runs on one or more standalone, Linux-based servers or on a Cisco Integrated Services Router (ISR) Series Video Management and Storage System network module as shown in Figure (17). In order to build developed video surveillance networks that meet the exact requirements such as operations managers and systems integrators, the Cisco Video Surveillance Manager (VSM) is used. The software suite allows high scalable and flexible video systems easily managed, monitored. In addition, it permits to view and record video anywhere, anytime using an internet access. Moreover, using highly reliable Linux operating system allows often upgrading and updating system components.

Authorized network users can view and control live video from IP or encoder-connected analog cameras or retrieve recorded video from system storage. Cisco Video Surveillance technology effectively protects customers' investments using various fault-tolerant recording options. Systems can be increased by changing or adding standards-based cameras, servers, storage, technologies, and users as needed. Furthermore, Cisco video surveillance convergence with network equipments can optimize bandwidth and storage utilization with the capability of exact network. In turn, the investments of the system can be unlocked by integrating and synchronizing video with other networked applications.

Cisco Video Surveillance Operations Manager

In order to quickly configure and effectively manage complex video applications generated with Cisco surveillance systems, Cisco Video Surveillance Operations Manager is used for meeting various needs of administrators and operators such as, configuration, management, displaying, and controlling video generated with an IP network. A single Operations Manager can manage large number network components, such as Media Servers, Virtual Matrixes, cameras, and users.

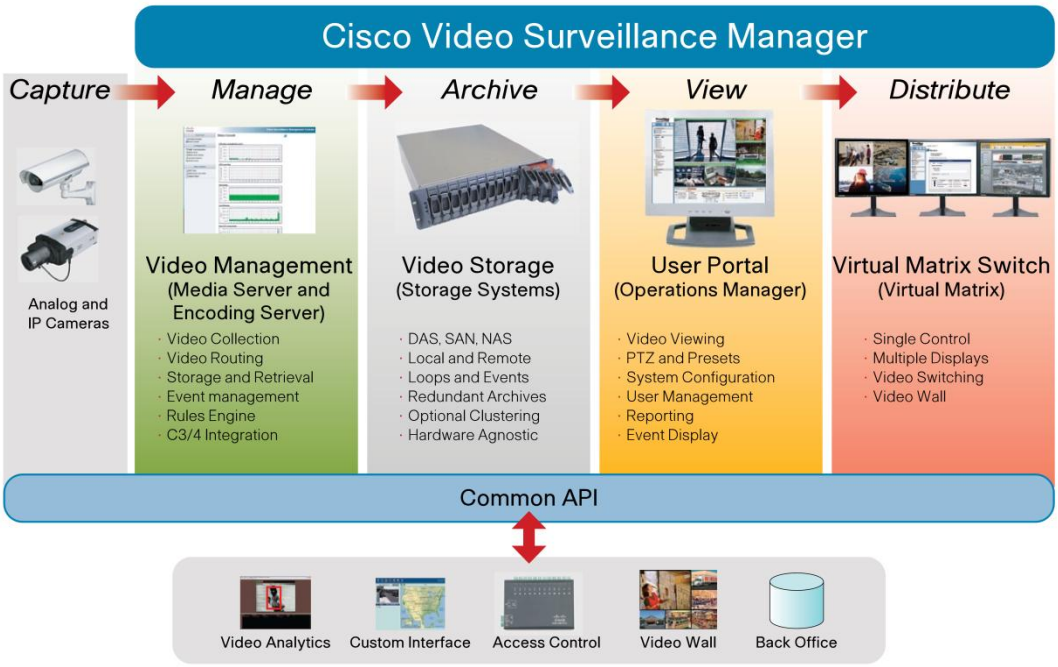


Figure (17): Cisco Video Surveillance Manager.

The Cisco Video Surveillance Operations Manager provides administrators with:

- Customizable branding and appearance
- Server, encoder, DVR and camera administration
- Scheduled and event-tagged video recording
- Record on motion capabilities
- User and role management
- Detailed activity reports and system audit
- Ability to push predefined views to any number of monitors with Cisco Video Surveillance Virtual Matrix
- Ability to schedule to operator shifts, event filters, temporary views, and more

The Cisco Video Surveillance Operations Manager provides operators with:

- Secure login
- Flexible video displays
- Views with both live and archived video
- PTZ controls and presets
- Digital zoom and instant replay
- Archive review and clipping
- "Record Now" feature while viewing live video
- Event setup and event notifications
- Ability to search video based on motion

Number of Cameras per Location

Indeed, the coverage requirements and the nature of the business effect on number of cameras at any one building or facility used for surveillance. There are some small office deployment scenarios, where only a single IP camera is needed. Although, in most cases, even a small office will require more cameras that one might initially expect. Using a small bank branch is shown in figure (as an example, consider the number and placement of cameras in figure (18).

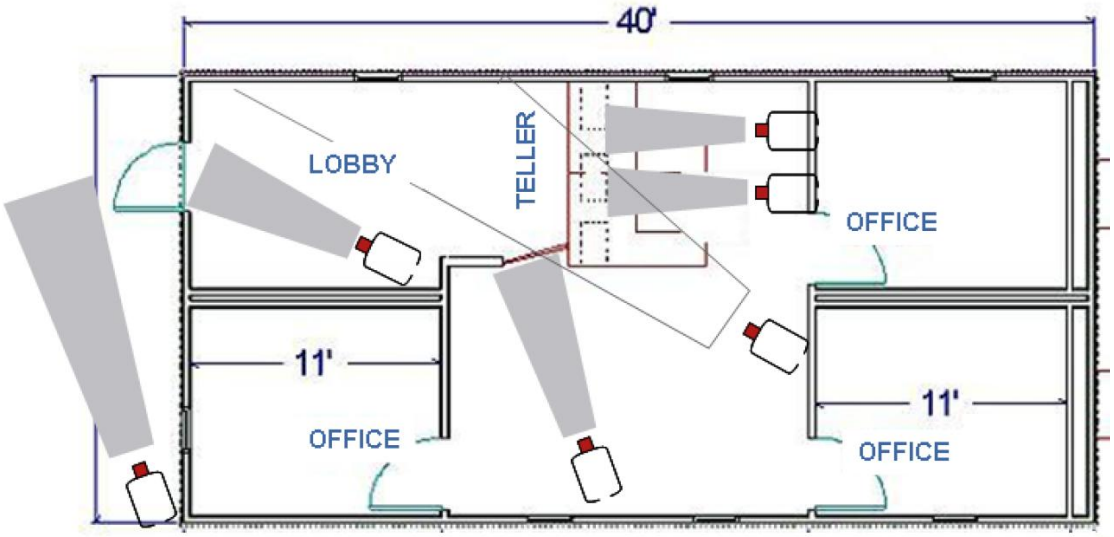


Figure (18): Camera Deployment Floor Plan.

There is a camera behind each teller station, a camera on the main entrance (both inside and outside), and two cameras in the inner office area focused on the lobby and half doorway leading into the manager office areas. Additionally, the parking lot area, side, front, and rear of the branch as well as any exterior ATM need to be covered. This small location may easily require 10 to 16 IP cameras. The Cisco Video Management and Storage System (VMSS) Network Module for the ISR router is targeted at a 16 to 32 camera deployment any may be implemented in this branch location. Larger facilities require more cameras per location. It is not uncommon for a large retail store, home center, or warehouse retailer to need 100 to 200 IP cameras per location. Public school deployments may need 80 to 100 cameras per building. Therefore, using high definition cameras instead of standard ones yields cover an area of interest with a similar number of pixels per foot.

Video Surveillance Network

A typical IP Video Surveillance distribution in an enterprise network consists of one or more campus locations needing to run Cisco Video Surveillance Media Server, Video Surveillance Operations Manager, and Video Surveillance Virtual Matrix with more the 32 video surveillance cameras. The branch locations are connected to the enterprise campus by WAN technologies, including Metro Ethernet, private line, the public Internet, or a MPLS VPN deployment. Branch offices and workers locations may view and administer the video surveillance system, as well as external organizations

connected either via the public Internet using a Web browser. Figure (19) illustrates this topology and application services are described in more detail below.

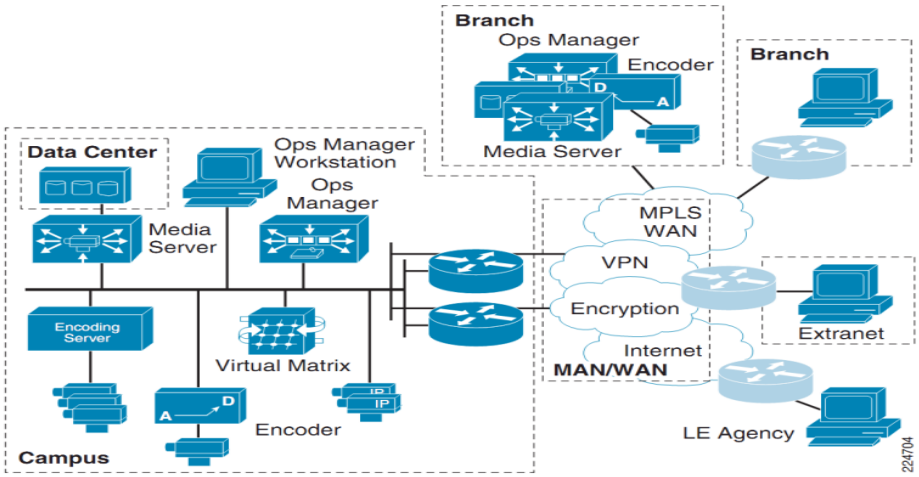


Figure (19): IP Video Surveillance Deployment Model.

The Cisco operations Manager provides a Web-based browser console to configure, manage, display, and control video generated from an IP network. This interface allows for users to manage and schedule one or more Cisco Video Surveillance Media Servers through the definition of IP and analog cameras.

Notes:

- *Cisco encoders/decoders does not support MPEG-2 video compression, they just support Motion JPEG, MPEG-4 and H.264.*
- *Cisco presents open API software for the application wanted to merge in the installed surveillance system.*
- *Cisco offers many applications of motion* detection and face and gait recognitions.
- *All the pictures used in this report have been extracted from* http://www.cisco.com/en/US/netsol/ns929/networking_solutions_sub_program_home.html *, the manufactures' websites with no commercial aim.*

Raspberry Pi

In this last part of the report, we will give a brief summary for the tiny computer Raspberry Pi including models, hardware, and software, in addition to how it can be used in a video surveillance system as a video encoder/decoder.

The Raspberry Pi is a small credit-card sized computer that plugs into your TV and a keyboard. Raspberry Pi was established in UK by Raspberry Pi foundation. It's a capable little PC which can be used for many of the things that your desktop PC does, like spreadsheets, word-processing, games and playing high definition video. Premier Farnell/Element 14 and RS components are the distributors, which sell Raspberry Pi all over the world.

Models, hardware and ports

There are different Hardware versions Raspberry Pi Boards that have been found probably from different assembly lines. Raspberry Pi has two famous models: model A and model B. Model A has 256MB RAM, one USB port and no Ethernet (network connection). Model B has 512MB RAM, 2 USB port and an Ethernet port, see figure (20).

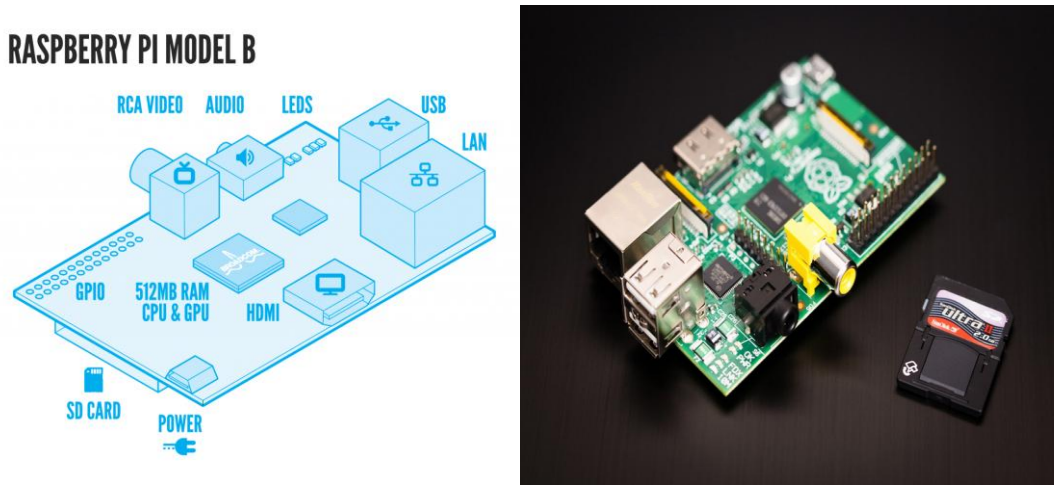


Figure (20): Raspberry pi Image courtesy of Switched On Tech Design (www.sotechdesign.com.au)

Raspberry Pi has a System On Chip (SoC) that is a Broadcom BCM2835. This broadcom contains an ARM1176JZFS, with floating point, running at 700 Mhz, and a Videocore 4 GPU. The GPU is capable of BluRay quality playback, using H.264 at 40MBits/s. It has a fast 3D core accessed using the supplied OpenGL ES2.0 and OpenVG libraries.

Furthermore, the GPU provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode. The GPU is capable of 1Gpixel/s, 1.5Gtexel/s or 24 GFLOPs of general purpose compute and features a bunch of texture filtering and DMA infrastructure. In addition, graphics capabilities are roughly equivalent to Xbox

1 level of performance. Overall real world performance is something like a 300MHz Pentium 2, only with much, much swankier graphics. Raspberry has a 256 MB (512 MB) as a RAM, which is physically stacked on top of the Broadcom media processor. In turn, it contains SD-card that is used for booting processing. For more details see table (4).

	Model A	Model B
System-on-a-chip (SoC):	Broadcom BCM2835 (CPU + GPU. SDRAM is a separate chip stacked on top)	
CPU:	700 MHz ARM11 ARM1176JZF-S core	
GPU:	Broadcom VideoCore IV,OpenGL ES 2.0,OpenVG 1080p30 H.264 high-profile encode/decode	
Memory (SDRAM)iB	256 MiB (planned with 128 MiB, upgraded to 256 MiB on 29 Feb 2012)	256 MiB (until 15 Oct 2012); 512 MiB (since 15 Oct 2012)
USB 2.0 ports:	1 (provided by the BCM2835)	2 (via integrated USB hub)
Video outputs:	Composite video | Composite RCA, HDMI (not at the same time)	
Audio outputs:	TRS connector | 3.5 mm jack, HDMI	
Audio inputs:	none, but a USB mic or sound-card could be added	
Onboard Storage:	Secure Digital|SD / MMC / SDIO card slot	
Onboard Network:	None	10/100 wired Ethernet RJ45
Low-level peripherals:	General Purpose Input/Output (GPIO) pins, Serial Peripheral Interface Bus (SPI), I^2C, I^2S[2], Universal asynchronous receiver/transmitter (UART)	
Real-time clock:	None	
Power ratings (provisional, from alpha board):	500 mA, (2.5 W)	700 mA, (3.5 W)
Power source:	5 V (DC) via Micro USB type B or GPIO header	
Size:	85.0 x 56.0 mm (two different boards, measured with callipers)	

Table (4): Model A and Model B Raspberry Pi specifications.

Indeed, the Raspberry Pi cards are not alterative devices of standard PCs, however they are supplementing them. The cheap prices and small sizes of Raspberry Pi cards make them more powerful than the standard PCs. In addition, the Raspberry Pi has the most ports needed to implement own personal projects and programs.

In the New versions of the firmware of Raspberry Pi, they contain the option to select between five clocks. The fastest clock is called ("turbo") that presets when the user tries to get the most performance out of the SoC without reducing the lifetime of the Pi. This process is done by monitoring the core temperature of the chip, and the CPU load, and dynamically adjusting clock speeds and the core voltage. Therefore, when CPU is lowly used, or it is getting too hot, the performance is slow down, but if the CPU has much to do, and the chip's temperature is low, performance is momentarily increased, with clock speeds up to 1 GHz, depending on the individual board, and on which of the "turbo" settings is used. The five settings are:

- "None"; 700 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvoltage,
- "Modest"; 800 MHz ARM, 250 MHz core, 400 MHz SDRAM, 0 overvoltage,
- "Medium"; 900 MHz ARM, 250 MHz core, 450 MHz SDRAM, 2 overvoltage,
- "High"; 950 MHz ARM, 250 MHz core, 450 MHz SDRAM, 6 overvoltage,
- "Turbo"; 1000 MHz ARM, 500 MHz core, 600 MHz SDRAM, 6 overvoltage.

Raspberry Pi software

The Raspberry Pi is based on Linux kernel operating systems called Raspbian that is a Debian-based free operating system. Rasbian is optimized to be compatible with the Raspberry Pi hardware, and it is the current recommended system, released in July 2012. In turn, the GPU hardware can be accessed through a firmware image loaded into the GPU at boot time from the SD-card. The firmware image is known as a binary blob, while the associated Linux drivers are closed source. Furthermore, Media, 2D and 3D applications use calls to closed source run-time libraries that in turn use calls an open source kernel driver inside the Rasbian kernel. The API of the kernel driver is specific for these closed libraries. Media applications use OpenMAX, while 3D applications use OpenGL-ES, while 2D applications use OpenVG, which both are deepened on using EGL. OpenMAX and EGL use directly the open source kernel driver as shown figure (21).

After Raspberry Pi booting, a full Linux Debian box is running, and at this point the user of Raspberry Pi can do the general computer tasks. Raspberry Pi supports python that is the official language of Raspberry Pi and in addition supports C language. Many programs can be programmed with Raspberry Pi using python and C languages, such as consol programs, games and electronic circuit programming.

Throughput of the system

In this work, the Raspberry Pi can be used instead of the standard PC as shown in figure (22). The proposed system consists of keyboard (mouse) as input devices, monitor and speakers as output devices. In addition, it contains IP camera that use for monitoring the area of interest. The Raspberry is used as video encoder/decoder and for processing stages. The process stage consists of two stages: regions of

interest (ROIs) detection and ROIs protection. ROIs detection can used to detect the regions to be concealed, such as faces, moving objects or cars plates. In turn, ROIs protection stage to use an encryption algorithm to hide the details of ROIs during video encoding. The two stages are programmed with C languages under Rasbian system. Authorized users can monitor the scenes using the output video on the system display; in turn the system administrator can use see the original video after using a secure password. Moreover, the system can handle the abnormal actions by generating an alarm using the system speakers.

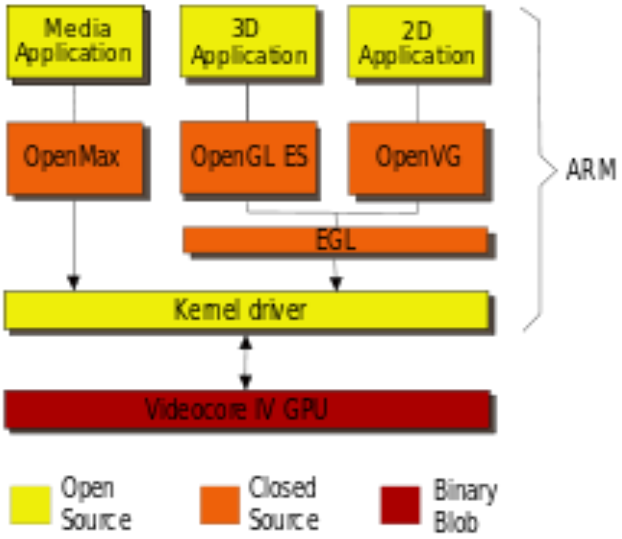


Figure (21): Visual diagram of API connections.

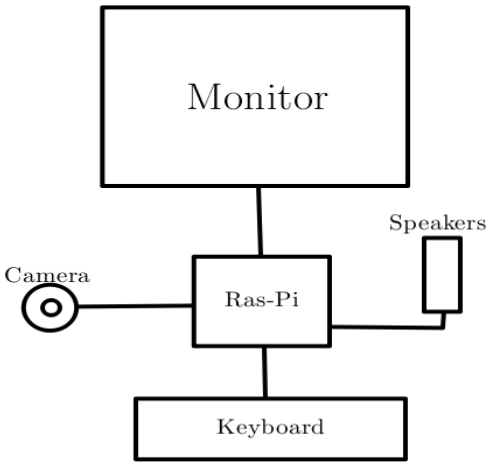


Figure (22): The proposed Raspberry Pi system, containing monitor, camera, speakers, and keyboard.

Summary

AXIS and Cisco have provided a lot of video surveillance system solutions, containing IP cameras, video encoder/decoders, video software managements and etc. Nowadays, Cisco is a one of the AXIS partners for applications developments, such as motion detection and tracking. In addition, the two companies provide a complete solution at an affordable price. Also, they offer many features in their surveillance systems such as:

- IP cameras generate high image quality with high definition resolutions.
- Event management and intelligent video capabilities.
- Easy integration possibilities and better scalability, flexibility and cost-effectiveness for exact systems
- Integrate alarms, door sensors, motion detectors, and other business and security systems into your video solution.
- View live video of the area of interest from anywhere, using an Internet-enabled PC or mobile phone.
- Receive automatic alerts, video clips, whenever motion is detected on the monitored regions after hours.
- Easily and cost effectively add new cameras, video storage, and security applications to the surveillance system.

In this project, we can suggest to buy an AXIS surveillance system, at least AXIS IP camera. AXIS systems have a simple and easy Video Software Management (VSM) that can be compatible with different cameras types not only AXIS cameras. In turn, Cisco with the video surveillance industry is based around its cameras and camera compatibility, although the amount of cameras done by Cisco is small comparing with AXIS cameras designed. Moreover, Currently Axis only has 2-5 cameras officially compatible with Cisco's VSM. Furthermore, AXIS cameras have a lot of applications such as motion detection and tracking as API open source that can be updated and modified. In addition, to my knowledge, there is no Cisco camera that has the ability to support SDKs and they have zero analytics capabilities.