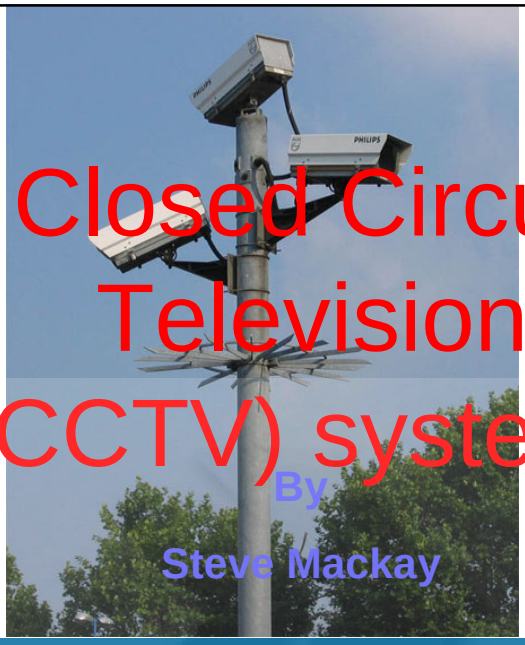

Closed Circuit Television (CCTV) systems

By

Steve Mackay

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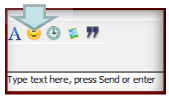
RH

Welcome to this webinar

There are at least 3 ways to interact with your presenter today.

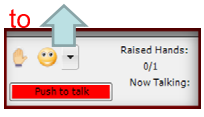
1. Use the ***Text*** tab, near bottom left of your screen. Type the message in the space next to the "Send" button, then enter or click Send. (Ensure "All" is selected in the drop-down menu under the typing area)

2. Use the ***Emoticons*** selection in the text window – choose an emoticon then click send or enter.



3. ***Talk!*** Click the **Push To Talk** button. The button will change to yellow when you are queued, then green to show that your microphone is live.

Remember to click it again when you have spoken



This 45 minute session will commence shortly

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Objectives

- Quick Overview
- Terms used
- Challenges and opportunities

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INTRODUCTION

Closed Circuit TV (CCTV) is a system in which the circuit is closed and all the elements are directly connected. This is unlike broadcast television where any receiver that is correctly tuned can pick up the signal from the airwaves. Directly connected in this context includes systems linked by microwave, infrared beams, etc.

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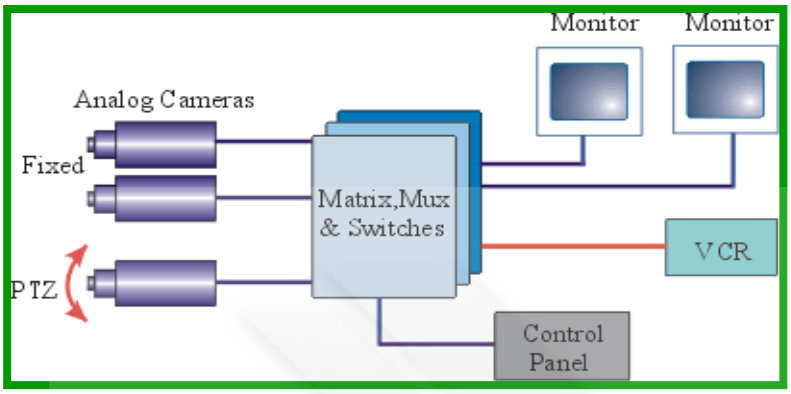
Evolution of CCTV

CCTV systems originated in the 1950s. Low-resolution black and white cameras were connected by coaxial cable to basic monitors. Solid-state cameras, VCRs, switches and multiplexers were introduced during 1980s.

Architecture of Analog CCTV

- Analog cameras
- Coax cable infrastructure to connect cameras to centralized control room
- Hardware multiplexers used to combine multiple video streams into a single display
- Control panels used to move PTZ cameras and divert video to monitors
- Hardware matrix and switches to divert video to appropriate monitors and VCRs
- VCR for recording
- Monitors to display video

Schematic Diagram of Analog CCTV System



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Limitations of Analog Systems

- Installations were complex and costly;
- Long process to find and review an event;
- Recording and reviewing of taped events at the same time is not possible;
- Limited Motion detection ability;
- Monitoring had to be in close proximity to cameras;
- No remote viewing capabilities;
- Very limited ability to integrate with wider applications;
- Complex archiving process;
- Systems required large space.

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Disadvantages of Analog Systems

- Frequent replacement of filled Videotapes;
- Tape degradation due to multiple re-recordings;
- Systems were unable to record and playback at the same time;
- The system had multiple points of failure.

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Digital CCTV

In the 1990's digital video recorders (DVRs) were introduced which allowed video to be recorded in higher resolutions than VCRs and eliminated videotapes.

DVR are of two forms:

- appliance based DVRs
- PC-based DVRs.

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Digital CCTV Architecture

- Video signals from analog cameras are connected to video capture cards inside the DVR appliance or PC.
- The capture cards take the analog signal and digitize it.
- These digitized images are then compressed by a mathematical algorithm and stored on a hard disk or multiple hard disks.

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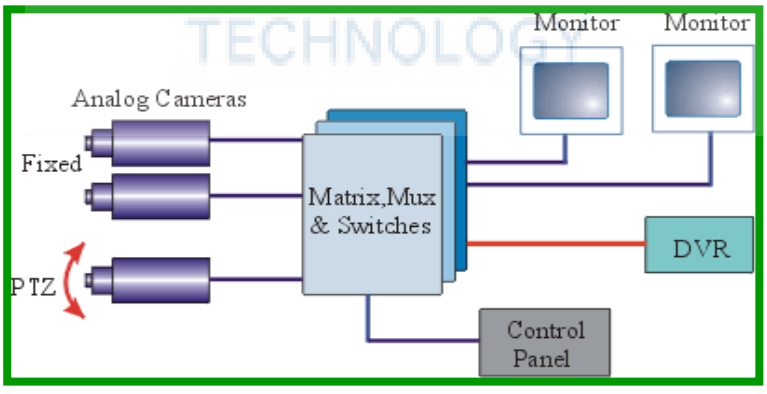
Digital CCTV System



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Digital CCTV Functions

- The user can monitor live cameras, review stored video data, save images and video clips to disk through DVR software and connect remotely to the main unit via the network.
- DVR allows users to playback video without interrupting current recordings

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Limitations of Digital Systems

- Small and fixed hard drive space and inability to expand the video storage
- Use of coaxial cable for each camera in the system
- Supports small number of cameras, 4-16.
- Requirement of expensive hardware multiplexers, switches and matrix;
- Not suitable for organizations operating in open environments.

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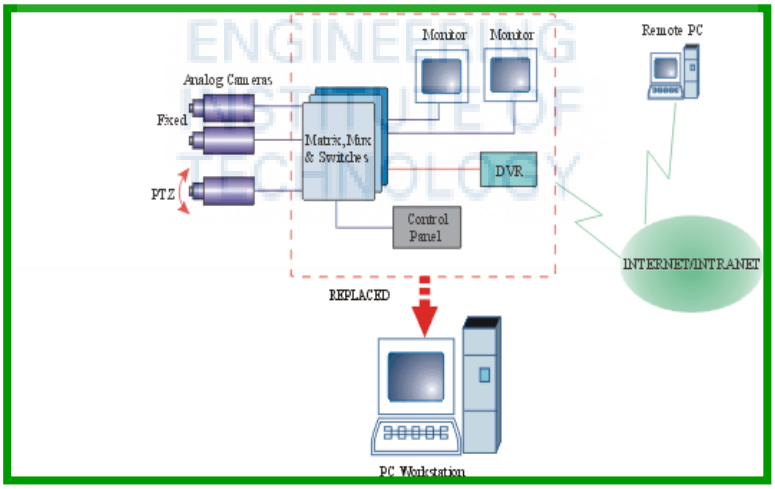
Network based CCTV systems

Network based CCTV systems are 100% digital which allows full control and management of CCTV cameras and surveillance over the LAN, WAN and Internet.

It eliminates the hardware and cabling associated with analog based CCTV by using a PC workstation and the application software.



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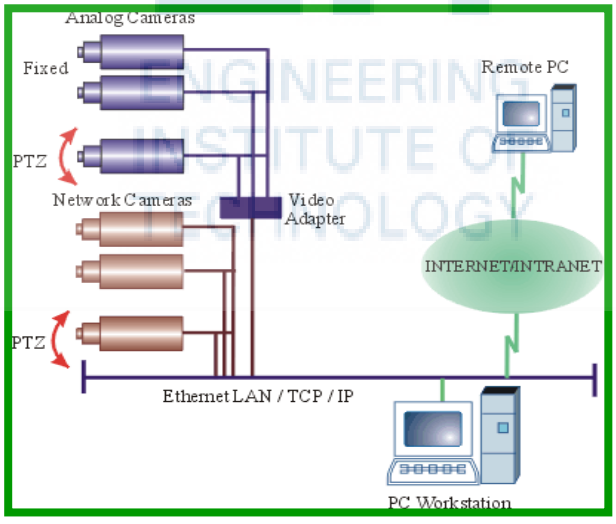
Network based system enables complete management and control of cameras via the network and/or Internet. Fixed and wireless IP network cameras can be positioned at any point on the network using the existing Ethernet cabling infrastructure and/or wireless access points.



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The system provides full integration with analog cameras for easy migration to a digital network-based system using video adapters.
The user can remotely access the system via the Internet from any location, using a standard Internet browser.

Every camera has a camera server and there is a Video Relay Server for connection to a communications network. Each camera is allocated a separate IP address.

Videos are transmitted as a sequence of JPEG images over the communications network from each camera server to a Video Relay Server and are relayed to viewing devices (generally using HTTP).

Control commands are transmitted using TCP/IP protocol.

Control commands are communicated to the designated devices through the Video Relay Server.

Recorded images are stored on one or more disk drives on the Video Relay Server, or on other computers linked to the communications network.

Scalable System - adding cameras and Video Relay Servers.

The Video Relay Server provides system administration functions, which can be performed from either local or remote locations.

System Functionality

The CCTV System shall provide for the following functionality:

- Viewing and Management
- Local and Remote Viewing and Management
- Communications Flexibility
- Integration with Third Party Programs
- Support Multiple Vendor Products
- Panoramas

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- Point and Click Navigation
- Pre-Set Camera Views
- Touring
- Snapshots
- Storage and Retrieval
- Multiple Viewer Access
- Bandwidth Manager
- Password Protection

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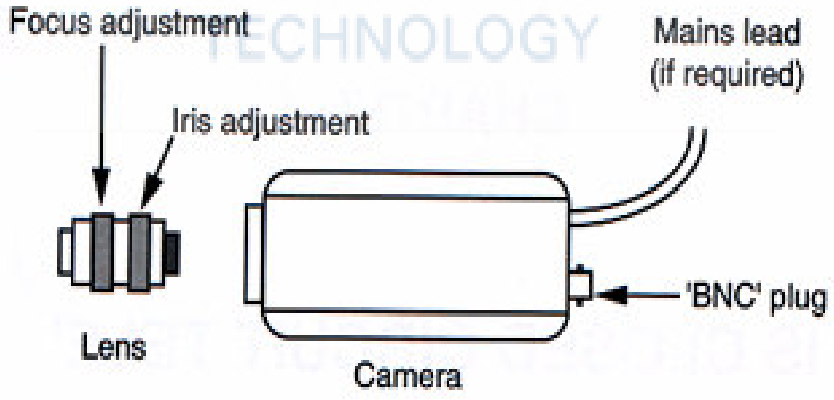
Cameras

Cameras convert the visible scene captured by a lens into an electric signal and transmit that signal to a monitor for viewing.
Older cameras are analog devices but newer and more advanced cameras are IP addressable, and connect to a web server to provide motion JPEG images.

Camera and Lens



Several considerations are to be taken into account when choosing the proper camera/lens for any video system:

- The purpose of the video system i.e. detection, assessment, identification, etc.
- The overall sensitivity of the camera needed based upon the actual application.
- The amount and varying levels of light available at the scene
- The environment in which the camera will operate (indoors/outdoors)
- Cost
- Field of view

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Performance of a camera depends on the reflected light at the scene and the quality of the imager.

Cameras fitted with automatic iris control ensure consistent quality. The opening and closing of iris depends on the available light i.e. it will allow greater amount of light into the camera during night and lowest on bright day.

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Cameras are available with different size of the imager which are generally termed as "**format**" of "Focal Length" and expressed as 1/2, 1/3, or 1/4 inches. The longer the focal length the narrower the field of view (noticeable with an adjustable zoom lens on a personal camera)

Lens format should match up to the camera format.

The Lens

Reflected light is collected from a scene and focuses a clear, sharp image on the camera's imager. The more light that passes through a lens, the better the quality of the picture.

Lens directly affects the size, shape, and sharpness of the image to be displayed on the imager. Distance from the scene, focal length, desired field of view, lighting and format affect the size and clarity of the image on the camera's imager.

Camera lenses are of two types –

Fixed focal and **Varifocal** (Zoom).

Focal length is the distance from the optical center of the lens to a focal point near the back of the lens.

Zoom lenses have variable focal length where as fixed focal lenses have fixed focal length and are expressed in millimeters.

The **Field of View** (FOV) is the actual picture size (height and width) produced by a specific lens and can be changed by using a different lens (wide angle, telephoto, etc.) to increase or decrease the field of view.

Fixed focal length lenses are available with wide, medium and narrow field of view.

Wide-angle lenses have a short focal length and telephoto lenses a long focal length.

A lens with a "normal" focal length (Ex: 8.0mm on a 1/3" camera) produces a picture that approximates the field of view produced by the human eye.

A Zoom lens, an adjustable assembly of lens elements, is used for both wide scenes and close-up views.

It changes the focal length from wide angle to telephoto while maintaining the focus on the imager. The field of view also can be changed between narrow, medium and wide-angles- all in one lens.

F-Stop

The light gathering ability of a lens depends on the relationship between the aperture (lens opening) and the focal length of that lens and this relationship is termed as "F- Stop". It is generally expressed by "f" and printed on the lens.

The F-Stop number is equal to (focal length of the lens)/(maximum diameter of aperture).

Monochrome and Colour Cameras

Monochrome cameras require lower level of lighting compared to colour cameras. In colour systems a viewer can distinguish different colour images where as in black-white systems all images are black/white and gray (different shades).

Monochrome cameras are very useful for very low light situations. Cost of camera depends on its ability to capture good quality images in low light situations.

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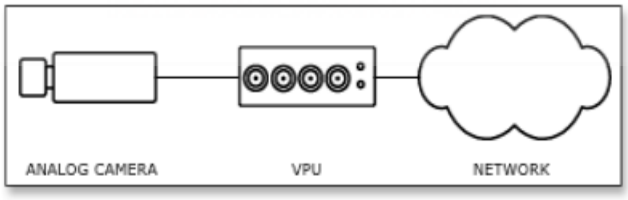
A **Video Processor Unit** allows standard analog cameras to be connected to digital networks. They are generally available in 4-camera and 1-camera options.



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Digital Camera

The shutter on a camera keeps light from entering the camera except at the desired time. Some digital cameras don't use shutters, but combining digital technology with a mechanical shutter tends to yields higher-quality images.
Digital cameras have mechanical openings to adjust the iris size.

Functionality

Instead of film, digital cameras have an image sensor built with a single overall sensitivity to light, equivalent to ASA 100-speed film in most cameras.

The camera's built-in computer can enhance images by removing the blur and thus effectively raising (or lowering) the light recorded in the image sensor, which is made up of thousands of picture elements (pixels) to turn light energy into digital information.

By combining information about hue and intensity, the camera assigns a specific colour to each pixel.

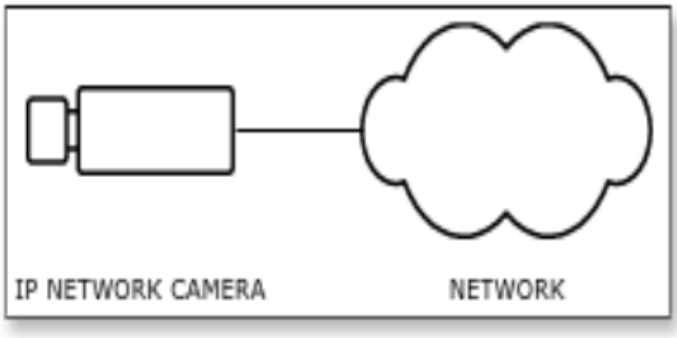
A digital camera records light electrically. This "information" then becomes an image.

A microchip inside the camera converts the digital reading from each individual sensor and combines it with information from the surrounding pixels.

A colour is assigned to a particular pixel.

Thousands or millions of pixels are combined into a single computer file, which can then be downloaded.

Digital cameras can be connected directly onto a digital network.



Both of these camera solutions can be delivered over fixed line or wireless networks, which means they can be deployed in remote or mobile CCTV camera systems.

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PTZ Camera

CCTV cameras can be fixed or have pan, tilt and zoom ((PTZ)) capability.

Fixed cameras are mounted on a fixed bracket and cannot move in response to operator commands.

PTZ cameras are motor driven and can pan left and right, tilt up and down and zoom in and out for close-up or wide-angle viewing.

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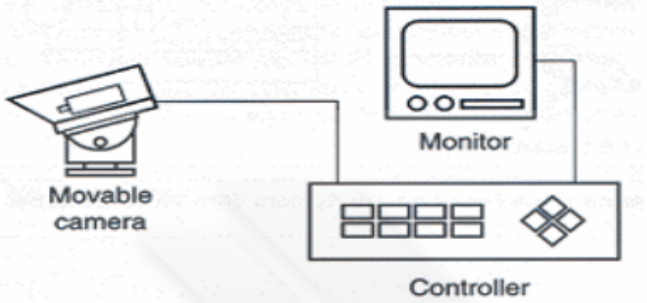
PTZ cameras allow the operator to follow a moving object without moving from camera to camera, and potentially missing something important.



Dome Camera

Many PTZ cameras today are disguised in dark colored Plexiglas housings called domes and are particularly popular wherever aesthetics are valued.

It is virtually impossible for suspects to determine where the camera is pointed.

It provides much lower system expense.

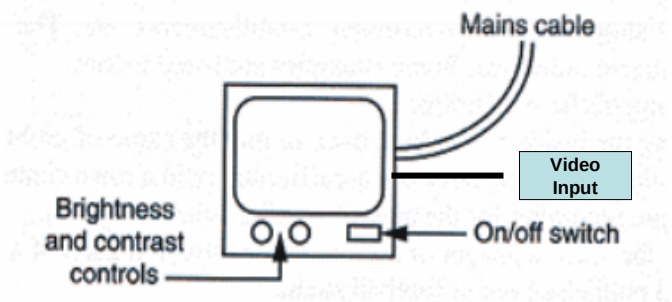
Monitor

The picture created by the camera needs to be reproduced at the control position.

A CCTV monitor is virtually the same as a television receiver except that it does not have the tuning circuits.

Monitors can be either colour or mono with 9", 14", 15", 17" and 21" displays. Sizes vary and most come with metal casings.

Most systems use both dedicated monitors and switchable monitors. A dedicated monitor displays the video from only one camera. A switchable, monitor enables operators to "call or switch" different cameras to the monitor.



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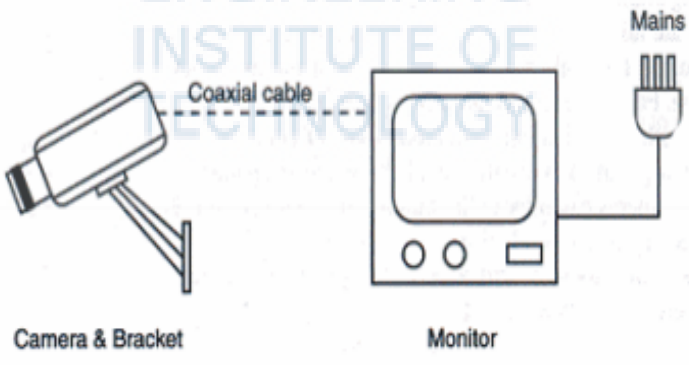
SIMPLE CCTV SYSTEMS

The simplest system is a camera connected directly to a monitor by a coaxial cable, with the power for the camera being provided from the monitor. This is known as a line powered camera.



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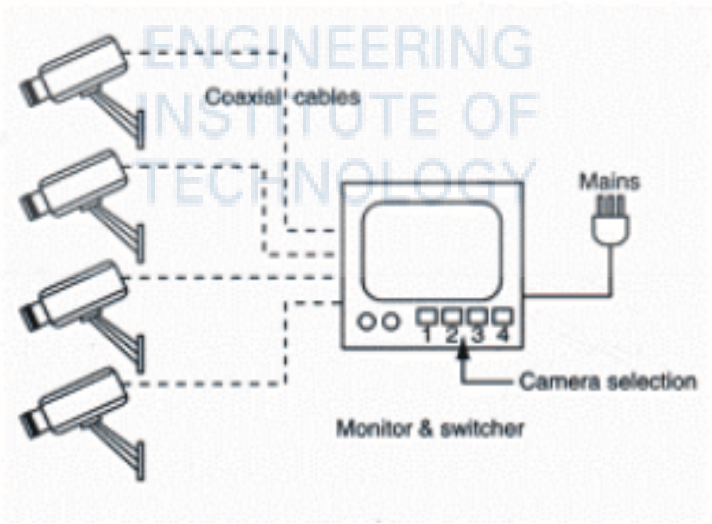
The output from four cameras may be incorporated into one monitor and set to sequence automatically through the cameras or any camera may be held selectively.

A microphone may be built into the camera to carry sound

A speaker in the monitor only puts out the sound of the selected camera.



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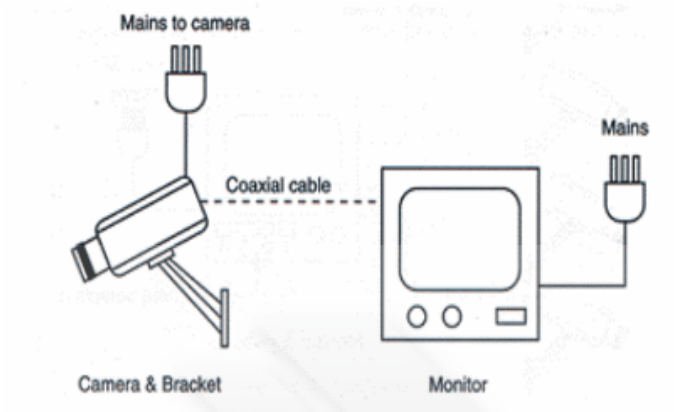
The microphone, being in the camera, tends to pick up sound close to it and not in the area at which it was aimed.

There may be a noticeable pause between pictures when switching because the camera may be powered down when not selected and it may take time for the tube to heat up again.

This type of system is cheap and simple to install.

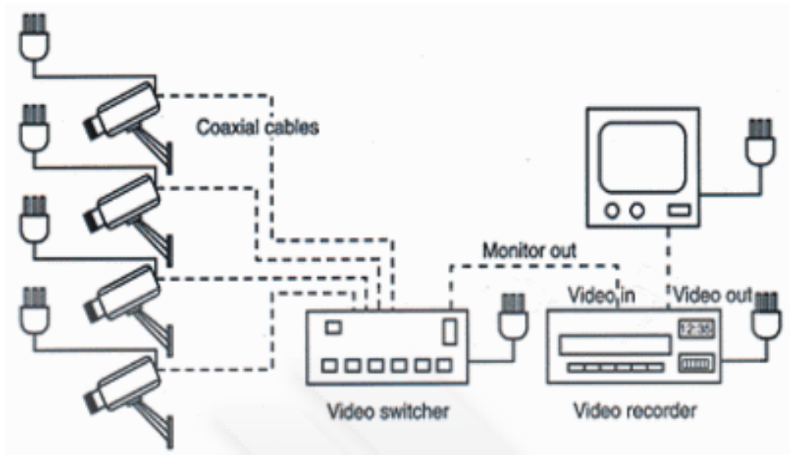
Mains Powered CCTV Systems

CCTV installation where the camera is mains powered, as is the monitor. A coaxial cable carries the video signal from the camera to the monitor. This arrangement allows more flexibility in designing complex systems. A video switcher must be included when more than one camera is required. Using this switcher, any camera may be selected to be held on the screen or it can be set to sequence in turn through all the cameras. Usually the time that each camera is shown may be adjusted by a control knob.



Systems With Video Recording

Additionally a video recorder may be included in the basic system. The pictures shown during playback will be recorded in the same sequence in which the switcher was set up.
Some analog video recorders can record up to 16 cameras simultaneously through a switcher/multiplexer. The more cameras used the lower the frame rate per camera from the recorded images.



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If installation requires the control of remote PTZ cameras then each camera will require two sets of transmitter (TX) and receiver (RX) pairs.
One TX/RX pair is required to send video back to the control point, and one TX/RX pair is required to send control data to the camera.
PTZ control systems can be set up as either point-to-point (where each receiver receives commands from a separate transmitter) or as point-to-multipoint (where multiple receivers receive commands from a single transmitter).

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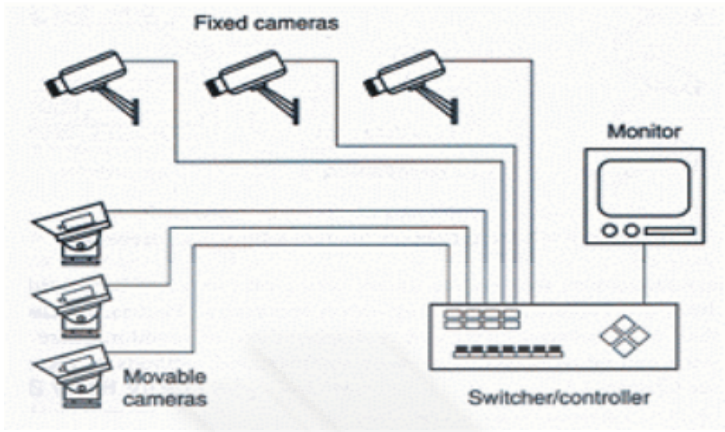

Video Matrix Switcher

A Switcher is required when a CCTV system contains more than one camera.

It switches from one camera to another so we can see multiple cameras from one monitor, and record all of those cameras on one recorder.

Switcher reduces the cost of duplication of equipment i.e. monitors, recorders etc.

Video Matrix Switcher should be fully compatible with both simple fixed lens cameras, and complex pan-tilt -zoom cameras.

The matrix system should have a flexible architecture that is scalable from fewer than 100 inputs and outputs, to a system with more than 1000 inputs and 1000 outputs.

The matrix should be capable of switching any video input to any video output(s).

Multiplexers

Multiplexer allows to display live camera pictures while full-field recording all cameras and may also play back any single camera or all connected cameras for detailed event analysis.
Playback images can be displayed in variety of multiple-picture screen formats while recording.
Multiple-picture screen formats will not be "live". All recorded images must be played back through the multiplexer. -

Video Coding

The Moving Picture Experts Group (MPEG) is a working group under ISO/IEC in charge of the development of international standards for compression, decompression, processing and coded representation of moving pictures, audio and their combination.

MPEG's Production

MPEG-1: A standard for storage and retrieval of moving pictures and associated audio on storage media

MPEG-2: A standard for digital television

MPEG-4: A standard for multimedia applications

MPEG-7: A content representation standard for information search

MPEG-1

Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s.

The standard is divided into 5 Parts:

- System standards
- Video Standard
- Audio Standard
- Testing Standard
- Software implementation

MPEG-2

MPEG-2; Generic coding of moving pictures and associated audio information. MPEG-2 is a standard currently in 9 parts.

The first three parts of MPEG-2 have reached International Standard status; other parts are at different levels of completion. One has been withdrawn.

MPEG-4

The most important goal of both MPEG-1/2 was to make the storage and transmission of digital AV material more efficient, by compressing the data.

They deal with 'frame-based video' and audio.

Interaction with the content is limited to the video frame level, with its associated audio.

The new MPEG-4 standard goes beyond these goals by specifying a description of digital AV scenes in the form of 'AV objects' that have certain relations in space and time.

Applications

Internet Multimedia
Interactive Video Games
Interpersonal Communications
(Videoconferencing, Videophone etc.)
Interactive Storage Media (optical disks, etc.)
Multimedia Mailing
Networked Database Services (via ATM, etc.)
Remote Emergency Systems
Remote Video Surveillance
Wireless Multimedia & Broadcasting Applications

MJPEG

The motion JPEG (M-JPEG) codec is a highly integrated virtual-component solution for leading-edge image compression and decompression applications.

Aimed at a broad range of high-performance/low-cost consumer and professional imaging applications requiring baseline JPEG- or M-JPEG-compliant still-image compression/decompression in real time.

Supports the encoding/decoding of full-color image datastreams up to 36 megasamples per sec. This highly integrated design operates in standalone mode with no host, embedded processor, or central processing unit (CPU) control required. It offers a unique range of advanced image coding features including bit-rate control and user-programmable tables for quantization and Huffman coding.

H.261 Video Coding

H.261 is a video coding standard published by the ITU (International Telecom Union) in 1990.

It was designed for datarates which are multiples of 64Kbit/s, and is sometimes called p x 64Kbit/s (p is in the range 1-30).

These datarates suit ISDN lines, for which this video codec was designed for.

The coding algorithm is a hybrid of inter-picture prediction, transform coding, and motion compensation.

The datarate of the coding algorithm was designed to set in between 40 Kbits/s and 2 Mbits/s.

The inter-picture prediction removes temporal redundancy.

The transform coding removes the spatial redundancy.

Motion vectors are used to help the codec compensate for motion.

Variable length coding is used to remove any further redundancy in the transmitted bitstream.

H.263 Video Coding

H.263 is a provisional ITU-T standard designed for low bit-rate communication.

Half pixel precision is used for motion compensation whereas H.261 used full pixel precision and a loop filter.

CCTV Transmission Media

All CCTV systems require connections from the camera to the monitor and other equipment. These usually are in the form of coaxial cable or fiber optic cable. Video signals can also be transmitted by wireless methods .

Three distinct types of media: Copper, Air and Glass.

Copper serves as an excellent conductor for electricity and is therefore well suited to the transmission of electrical data with high fidelity.

Since Air is not bounded to a physical medium, it stands out as a media access methodology.

Infrared

Infrared provides an effective solution for temporary LANs and for difficult installation situations.

Infrared is slower with compared to fibre optics & cable; its speed ranges from 300kbps to 4Mbps and is limited to line of sight.

Fibre Optics

Fibre optics allows the transmission of light that represent data values by the absence and transmission of light. It is expensive but very fast.
Installations need care and require specialized skill. Fibre optics systems are immune to electro-magnetic radiation.

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Unshielded Twisted Pair (UTP)

UTP cables consist of two insulated copper wires with 1 or more twisted pairs and able to transmit at 1-100Mbps. It is low in cost and relatively easy to install. It suffers from high attenuation and electro-magnetic interference.

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Shielded Twisted Pair (STP)

STP-cables consist of pairs of copper conductors twisted around each other inside a metal or foil shield. It supports higher speed than non-shielded cables and can transmit at 1-155Mbps. It is more expensive than UTP, but provides additional resistance to interference from electrostatic radiation, and also resistance to signal capture as a security measure.

Co-axial Cables

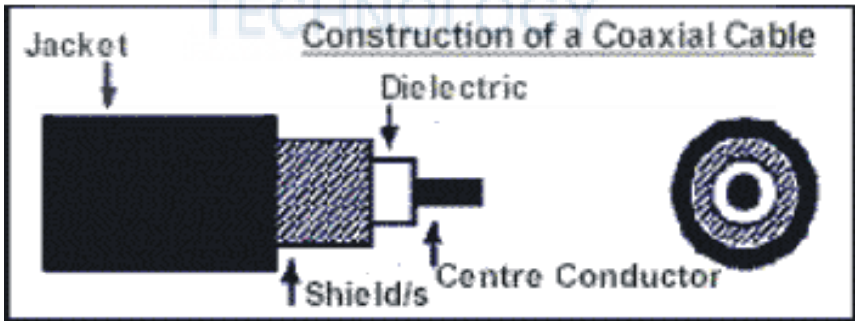
Co-axial or "coax"cables consist of two concentric conductors. It is the most commonly used cable for transmitting video signals.

The name "co-axial" refers to the common axis of the two conductors. The inner and outer conductors are separated by a non-conductive dielectric insulating material, such as plastic or foam.

A foil wrap or other conductive material is used as a second conductor, which grounds the cable. The outer conductor/shield is encased in a PVC jacket.

Coaxial cable supports a transmission rate of 1-10Mbps and is less susceptible to attenuation loss and interference than UTP or STP cabling.

It is moderately costly and difficult to install.



Most coaxial cables for video applications have a nominal impedance of 75 ohms. Their differing electrical and physical characteristics make it important to select the correct type of cable to suit the application.

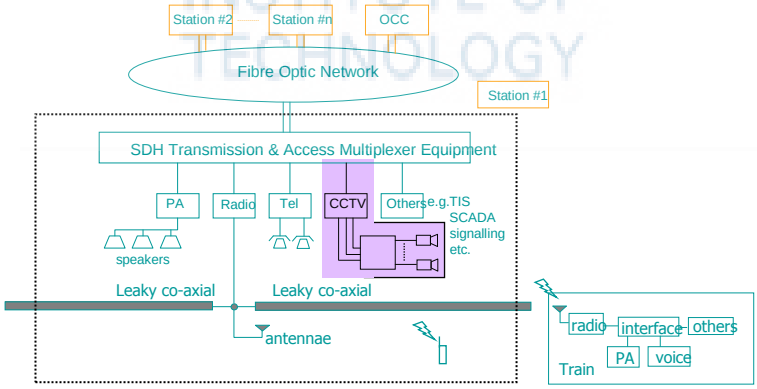
The three most commonly used coaxial cable types for video applications are RG59/U, RG6/U and RG11/U.

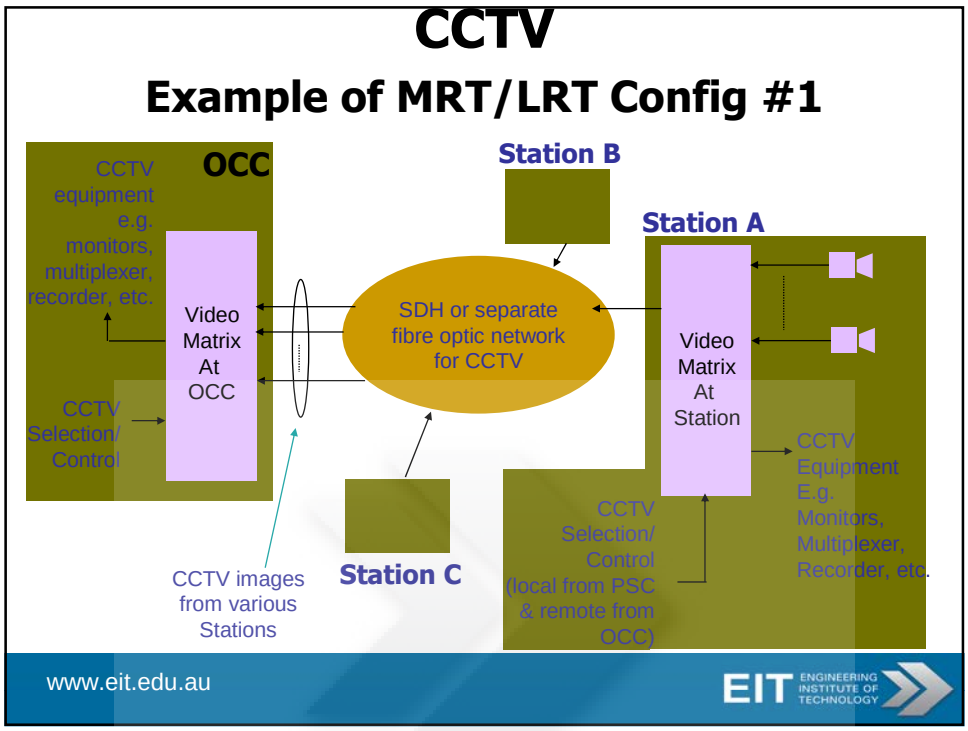
RG59/U is available with either solid copper or copper-clad-steel centre conductor. The copper-clad-steel type has high tensile strength and should be used with F-Type connectors.

RG6/U Quad-shield is a copper-clad-steel inner conductor. Single-shield, dual-shield and tri-shield versions of RG6/U are available but do not provide adequate EMI shielding.

RG11/U used to be used to connect two or more LANs. It supports 0-185m cable segments.
It features a copper-clad-steel inner conductor.

CCTV




CCTV
Example of MRT/LRT Config #1
OCC
CCTV equipment e.g. monitors, multiplexer, recorder, etc.
Video Matrix At OCC
CCTV Selection/ Control
SDH or separate fibre optic network for CCTV
Station B
Station A
Video Matrix At Station
CCTV Equipment E.g. Monitors, Multiplexer, Recorder, etc.
CCTV Selection/ Control (local from PSC & remote from OCC)
Station C
CCTV images from various Stations
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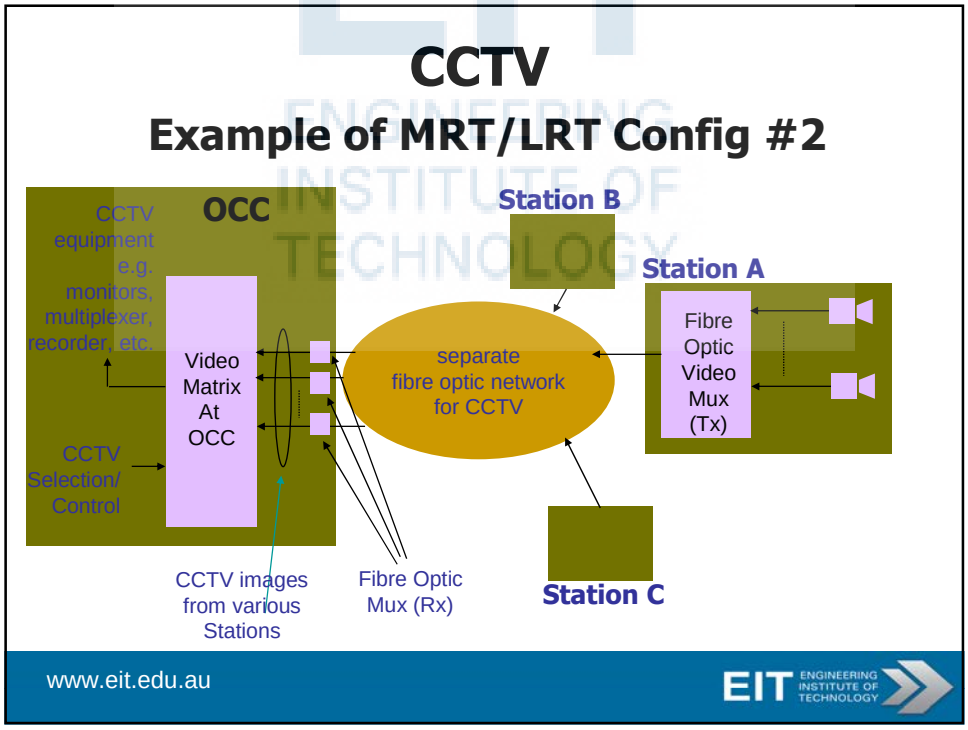
CCTV
Example of MRT/LRT Config #2
OCC
CCTV equipment e.g. monitors, multiplexer, recorder, etc.
Video Matrix At OCC
CCTV Selection/ Control
separate fibre optic network for CCTV
Station B
Station A
Fibre Optic Video Mux (Tx)
Station C
CCTV images from various Stations
Fibre Optic Mux (Rx)
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THANK YOU FOR ATTENDING

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Practical Safety Instrumentation & Emergency Shutdown Systems for Process Industries		
COUNTRY	**CITY**	**DATE**
UNITED KINGDOM	LONDON	14 & 15 Nov 2011
UNITED KINGDOM	EDINBURGH	17 & 18 Nov 201
UNITED KINGDOM	MANCHESTER	21 & 2 Nov 2011
IRELAND	DUBLIN	21 & 22 Nov 2011
Practical Tuning of Industrial Control Loops		
COUNTRY	**CITY**	**DATE**
IRELAND	DUBLIN	14 & 15 Nov 2011
SOUTH AFRICA	JOHANNESBURG	23 & 24 Feb 2012
Practical Troubleshooting and Problem Solving of PLCs and SCADA Systems		
COUNTRY	**CITY**	**DATE**
MALAYSIA	SHAH ALAM	14 & 15 Nov 2011
IRELAND	DUBLIN	16 & 17 Nov 2011

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Fundamentals of Instrumentation, Process Control, PLCs and SCADA for Plant Operators and Other Non-Instrument Personnel		
COUNTRY	**CITY**	**DATE**
AUSTRALIA	WEST PERTH	10 & 11 Nov 2011
SOUTH AFRICA	JOHANNESBURG	10 & 11 Nov 2011
AUSTRALIA	BRISBANE	14 & 15 Nov 2011
AUSTRALIA	SYDNEY	3 & 4 Nov 2011
CANADA	EDMONTON	3 & 4 Nov 2011
CANADA	HALIFAX	7 & 8 Nov 2011
AUSTRALIA	MELBOURNE	7 & 8 Nov 2011
Practical Hazardous Areas for Engineers and Technicians		
COUNTRY	**CITY**	**DATE**
MALAYSIA	SHAH ALAM	10 & 11 Nov 2011
Practical Instrumentation for Automation and Process Control		
COUNTRY	**CITY**	**DATE**
SOUTH AFRICA	JOHANNESBURG	16 & 17 Apr 2012

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