

The Transmission of Video Images for Transportation Management Systems

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Introduction

Video cameras play an important role in providing administrators of modern Transportation Management Systems with real-time information. Unlike other types of detectors and sensors—which only provide digital data—cameras provide real-time images of traffic situations, giving administrators a valuable tool for analyzing complicated traffic patterns and making snap decisions.

A typical Transportation Management System requires installing many video cameras. For example, it is now commonplace to see cameras located at regular intervals along the roadside when traveling on the highway. However, the problem faced by system administrators is that most of the cameras could be located up to several miles from the Central Traffic Control Center. In fact, for this kind of video application, large systems with numerous cameras and “distributed” camera locations make the installation and management of video transmission more difficult and complicated than for other types of devices. It is fair to say that video transmission is the most important issue related to making large, distributed video camera systems a part of a Transportation Management System.

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About MOXA

The MOXA Group manufactures one of the world’s leading brands of device networking solutions. Products include serial boards, USB-to-serial Hubs, media converters, device servers, terminal servers, Modbus gateways, industrial switches, and Ethernet-to-fiber converters. Our products are key components of many networking applications, including industrial automation, manufacturing, POS, and medical treatment facilities.

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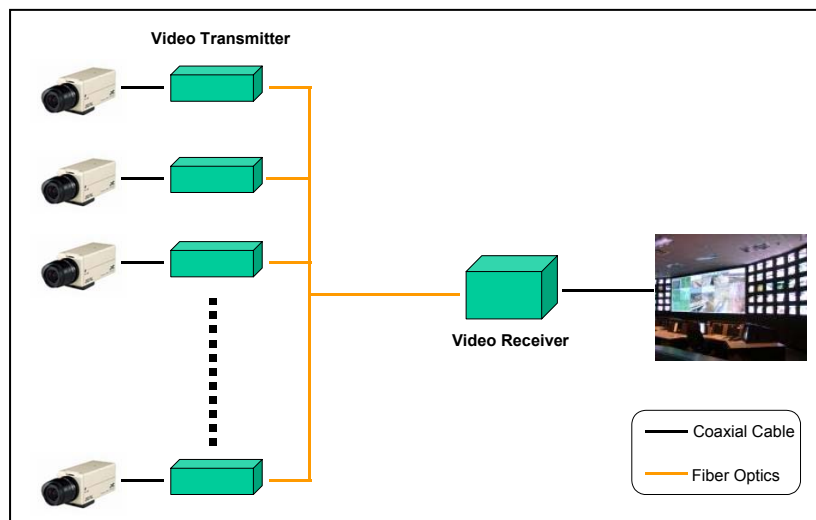


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Two kinds of video transmission solution are used for most Traffic Monitor & Control systems. One is the traditional “CCTV system,” which uses optical fiber to extend the transmission distance of video signals. The other is “Video over IP system,” which uses an IP network to transmit video signals.

Using Video over Fiber Transmission for CCTV Systems

Coaxial cable is the most common media for transmitting analog video signals for traditional CCTV systems. However, due to signal attenuation, the video transmission distance is limited, and some equipment, such as signal boosters and multiplexers, need to be added at the nodes to guarantee the successful transmission of signals over long distances. For this reason, and since the cameras are installed outdoors, coaxial cable is not a good media for video transmission for traffic systems. Fiber optics, which is good for signal transmission due to less attenuation, is the number one choice for media used to transmit video for transportation systems.



When building a video over fiber system, two major pieces of equipment are required for setting up video transmission.

Video Transmitter—A video transmitter is an electrical to optical converter at the camera end of the link. The unit converts the analog video signal from the camera into a light signal that varies in proportion to the camera output signal. The light signal is generated by an LED (Light Emitting Diode)

or laser transmitter, which is designed to couple a maximum of the generated light into an optical fiber.

Video Receiver—A video receiver is an optical to electrical converter at the monitor end of the link. The unit converts the optical signal from the optical fiber into an analog electrical signal that is compatible with the monitor's input requirements. The light to electrical conversion is carried out by a semiconductor detector, which is called a photodiode or avalanche photodiode. Subsequent electronic circuitry regenerates the output signal. Products from the top manufacturers compensate for optical fiber losses and transmitter output intensity variation with time and temperature by providing automatic gain control to give a standard video signal output format as generated at the camera output.

Generally speaking, video transmitters and receivers are used to extend the transmission distance of CCTV systems. This kind of video transmission solution is for peak to peak use, which means that video over fiber transmission only occurs when the transmitter and receiver are used at the same time.

Video over IP Transmission Systems

Due to the fast-growing development of digital video compression and IP network technologies, video over IP transmission is becoming the most common type of video camera system. This is especially true for "Distributed" and "Large" video camera systems, which can save on cable layout and cost by making use of existing IP networks to transmit video signals. Since IP networks are everywhere, modern Transportation Management Systems are much more likely to include IP transmission of video images as part of the overall solution.

Of prime importance is the trend of integrating Transportation Management Systems into large management systems in Traffic Control Centers in order to centralize monitoring and control. These kinds of systems are commonly referred to as "Intelligent Transportation Systems (ITS)" or "Advanced

Transportation Management Systems (ATMS).” Administrators in Traffic Control Centers can benefit from ITS/ATMS by getting real time traffic information, running traffic analyses, and generating responses in real-time. According to many research reports, a good ITS/ATMS can improve the efficiency of transportation systems by a factor of 30% to 50%, which means a lot of traffic time can be saved, and the number of traffic accidents can be reduced. For these reasons, many governments around the world have elevated ITS/ATMS to a position of high importance when updating their transportation development plans.

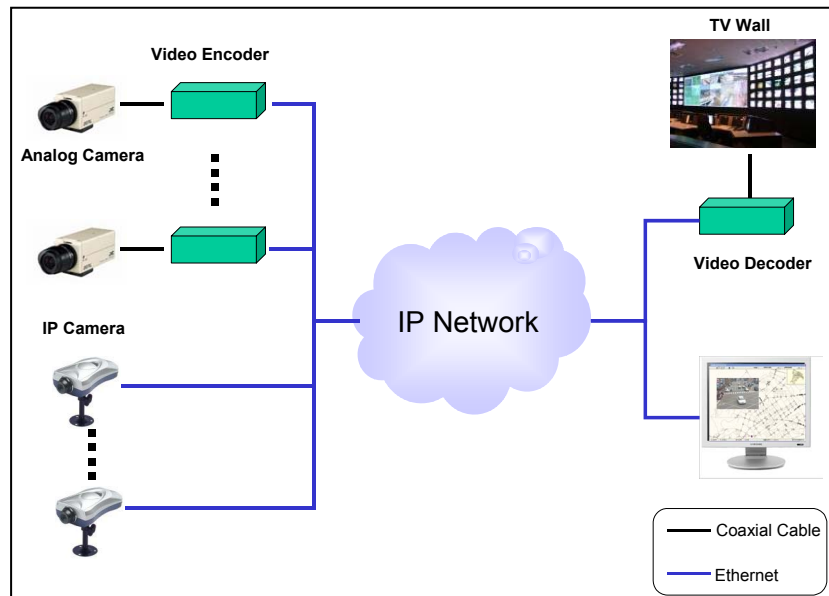
When creating an ITS/ATMS, it is important to start off with a good network infrastructure to which all of the subsystems can be linked. For obvious reasons, IP networks are the most suitable type of network since they can support the transmission of all kinds of data. For this reason alone, you can get an idea of why ITS/ATMS designers are scrambling to find the best video over IP servers for transmitting video signals.

What is Video over IP?

The video over IP concept is extremely simple: Video images generated by traditional analog cameras are converted into a digital format, and then transmitted over an IP network. However, due to the fact that digital video data is very complicated, a bandwidth on the order of several hundred times what would otherwise be required must be available. This means that to avoid clogging up the network with continuous bursts of data, the digital video data must be compressed first before sending it over the IP network. Starting in the 1980s, several video compression algorithms were developed, resulting in making video over IP transmission a realizable target. The most well-known video compression algorithms are MJPEG (developed by Joint Photographic Experts Group, which was founded in the mid-1980s) and MPEG (developed by Motion Picture Experts Group, which was founded in the late 1980s). For more details about video compression algorithms, many relevant

documents and articles can be found on the IEEE and ITU websites.

Video over IP transmission can be achieved in many different ways, but currently, the best solution is to use an IP camera together with a video server (essentially an Encoder/Decoder).



IP Camera—This is simply a camera with built-in video compression capability to digitize analog video signals directly and transmit them via an Ethernet port.

Video Server—Since many analog cameras are still in use, the Video Server is the best solution available to transform an analog video camera into a digital video signal, compress the images, and then transmit the image through an Ethernet port. In general, Video Servers include two kinds of product: Video Encoder and Video Decoder. A video encoder transforms the analog video image into a compressed digital video format. A video decoder transforms the compressed digital video data back into an analog video image.

In fact, an IP camera can be viewed as an analog video camera with a built-in video encoder function. However, due to the fact that so many types of video camera are available, with some

designed especially for critical applications, it is more convenient for system integrators to use a video sever as the video over IP solution. All in all, the video server plus video camera solution is more versatile than just using an IP camera.

Which Solution is Better? Both the video over fiber and video over IP solutions have their merits, so it probably doesn't make sense to ask "which solution is better?" What does make sense is to look for the most optimal of the two solutions. System integrators for Transportation Management Systems should consider the following issues when choosing which video transmission solution they should use.

Functionality—The most important issue to consider about video camera systems for Transportation Management Systems is the reason for collecting the video images. For example, in ITS/ATMS, real-time video images are required not only for recording traffic situations, but also for analyzing video images when making accident reports, for vehicle detection, for taking snapshots of license plates, etc. A digital video image can help the system achieve these kinds of intelligent functions. So, video over IP is appropriate for ITS/ATMS. If the system only requires the real-time monitoring of video images, then video over Fiber or video over IP are both suitable.

Transmission media—For video over IP solutions, an existing IP network can be used for video transmission. System integrators can use copper or fiber to build a LAN solution, or an xDSL connection for Internet access; WLANs can also be used as the network transmission media. However, only fiber optics can be used for video over Fiber transmission.

System Architecture—A video over IP transmission solution needs an IP network architecture, which means that effort must be expended building the network infrastructure and system maintenance resources, such as switches, routers, and servers. However, it is a must for ITS/ATMS. Comparatively, a video over fiber system is simpler since it can inherit all of the

equipment of a CCTV system if it is already installed in the Traffic Control Center.

Accessibility—We all know that IP network systems have good accessibility and flexibility. By using a video over IP transmission solution, any client can easily acquire video images via an IP network. On the other hand, a video over fiber solution has limited accessibility.

Future-proven—Everything related to IP networks is already well-tested and proven. We believe that more and more information and equipment will be integrated into Transportation Management Systems in the future to gain the benefit of centralization, interoperation, and intelligence. From this point of view, video over IP solutions are obviously more suitable for future trends than video over Fiber solutions.

Rugged, Reliable Video Transmission Solution

Except for choosing optical video transmission solutions, another critical issue that system integrators must pay attention to is reliability. Since for transportation systems most of the video cameras are located in an outdoor environment, the equipments used must have a rugged enough design. The consequence of not using rugged equipment is that in the long run, you will end up paying more for maintenance. For example, NEMA TS2, which is a standard in the United States for defining devices or equipment used in transportation systems, specifies rules for environmental criteria, such as temperature, surge, shock, and vibration. The video transmission products that are used should meet these requirements if they will be used on the roadside. The bottom line is that system integrators should be very cautious when choosing video transmission solutions and products.

MOXA Industrial Video over IP Solutions

For more than 18 years, we at MOXA have provided system integrators with a wide range of industrial networking solutions, including RS-232/422/485 to serial servers, industrial Ethernet switches, and media converters. Many of Moxa's products are designed for use in harsh industrial

environments, which means that reliability and a rugged design are an intrinsic quality of the products. Moxa's video over IP solutions are no exception. We believe that Moxa's video over IP solutions are well suited for Transportation Management Systems.

In addition, accompanied with other industrial communication product lines, we can provide the completed data and video over IP solution for overall Transportation Management Systems, which means that system integrators can enjoy "one-stop shopping" at MOXA.

