Should Encoders Be Integrated Into Dome Cameras for ITS Applications

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Background

There has been a major shift in the communications philosophy of ITS systems design in the past few years. The introduction of lower priced, multicast video encoders, utilizing standards based compression techniques, has sparked a revolution in what have been traditionally point-to-point and analog multiplexed systems. Even SONET and ATM systems are being replaced with IP systems, as newer technology has introduced the desired redundancy of these systems. Hardened Ethernet switches with fiber optic interfaces, and the advent of Gigabit Ethernet backbones, have furthered this reality. The vast majority of new ITS system designs have incorporated, in some manner, Video over IP (Ethernet).

Ethernet has been around for a long time, and there are multitudes of personnel well-versed in its deployment and use, including operation and maintenance. The days of proprietary protocols and specialized equipment setup, requiring custom training, have been replaced with much simpler plug-and-play concepts of standardized Ethernet devices. Cameras and PTZ (pan-tilt-zoom) receivers now communicate via Ethernet, and are viewable and accessible by virtually anyone on a given network (subject to network access controls and priorities), and no longer saturate the network with unicast video streams.

The ITS industry has appeared to standardize on MPEG2 (Elementary and/or Transport Streams) as the de facto standard, although there are systems deployed using MJPEG, H.263, and proprietary protocols, and MPEG4 has become popular where bandwidth is limited. H.264 is just now coming onto the scene. The field encoders used within this environment are typically external to the camera, and are hardened to meet the extreme conditions of roadside environments.

Other industries, such as security, gaming and casinos, are also adopting the Video over IP topology. These environments typically provide much less extreme physical circumstances (typically indoors), are usually more proximal (equipment is located within a more confined overall area), and lend themselves much more to encoders built into the cameras and/or Power over Ethernet (POE). Additionally, the primary purpose of these cameras is for recording, and NVR's on the network can directly access the video streams. Virtually all of these systems incorporate recording as the head end system.

With the advertising blitz common today, many ITS and IT personnel are drawn to the attractiveness of encoders built into the camera. These cameras are typically referred to as web-cams, IP cameras, or such. They appear in every security related trade journal and are found at virtually every local computer and camera store, gaining high visibility. These are not true digital cameras, but are the same analog camera with an encoder chip built into the unit. The question is: do these devices really fit the ITS market?

Viewpoint

While IP or web-based cameras (from this point forward referred to as IP cameras) have their place in different industries, they do not truly fit into the general ITS system design. They may work in some applications, but there are limitations that need to be understood before deciding on such a deployment. Most CCTV manufacturers implement proprietary protocol encoders into their camera offerings, but this is primarily to target non-ITS markets and to meet the never-ending specifications game (whether or not a feature is needed - if it is specified somewhere, it must be offered).

Field Locations

The most attractive feature of web-cams/IP cams is that they are an all-in-one package. There is simplicity of not having a separate camera, encoder, multiple power supplies and more cabling. No local cabinet is required. However, this simplicity does not necessarily fit the ITS model.

Cat5e/Cat6

A standard dome camera has power (24VAC – 2 wires), RS-422/RS-485 data communications (2 twisted pairs) and video coaxial cable connections. An IP camera has power (24VAC -2 wires) and Ethernet connection (Cat5E or Cat6), or simply Cat5e/Cat6 using POE. One may think that this reduction in cabling is a cost benefit, but it most likely is not, as Cat5e and Cat6 are quite expensive.

Cat5e/Cat6 cabling has a maximum distance of 300ft. It is not uncommon for the local ITS CCTV control cabinet to be located in excess of this distance. RS-422 has a maximum distance of 2000ft. and RS-485 has a maximum distance of 4000ft. Coaxial cable has varying distances, with the most commonly used RG-59 rated to 800ft, and RG-6 rated to 2000ft. Use of standard transmission means for data and video allows flexibility in design consideration for local cabinet location, without encountering distance limitations faced by Ethernet.

Additionally, coaxial cable and two twisted pair shielded cabling is relatively inexpensive, as compared to Cat5e and especially Cat6 cabling.

Field Hardware

Most CCTV field locations have a local CCTV cabinet at the base of the pole or within 3000ft. of the pole. In IP systems, hardened Ethernet switches are deployed to interconnect the various ITS components – cameras, detection

devices, 2070's, etc. These switches are typically interconnected to a GigaBit or Ethernet backbone via fiber optic connections, due to the distance (1/4 mile or more) between locations. Since a field cabinet already exists with hardened equipment, there are plenty of existing facilities for additional field equipment (encoders), power supplies**,** lightning protection, ease of access to equipment and proximal interconnection to an Ethernet switch.

Additionally, most IP cameras are not field hardened. The target market for IP cameras is security and recording, and the majority of available equipment is rated 0-60 deg. C. ITS systems are subjected to extreme environments, and equipment is typically required to be NEMA rated at -34 to +74 C (-29 to +165F).

Maintenance

Decisions are often made on an initial cost outlay basis, without careful consideration of life-cycle costs, including maintenance costs. If the camera and encoder are one single unit (or integrated), failure of either device requires access to the camera. ITS cameras are typically deployed heights of 40ft. – 70ft., and sometimes even higher. Although the increasing use of camera lowering devices somewhat offsets the detraction of having to access a camera due to an encoder failure, the overall repair/replacement time will be significantly higher in any case for an integrated unit. Integrated units will require entire replacement of the camera assembly or disassembly of the unit to replace the encoder. Additionally, technicians will require more time to troubleshoot problems as they cannot easily replace an encoder to determine if the camera or encoder is at fault.

Transmissions Standards

At the current time, most IP cameras utilize proprietary encoding optimized for recording. Many of these are touted as MPEG4, but they are non-standard variants of MPEG4, often incorporating additional wavelet or other compression techniques for optimization. They do not adopt the ITS standard of MPEG2 for high resolution, high frame rate video, nor do they interface with existing standards based products used within ITS, presenting an interoperability dilemma for an agency.

The higher end external encoders support MPEG1, MPEG2, and MPEG4, and many auto detect which stream is being transmitted for decoding. It is imperative that equipment deployed today be interoperable with equipment to be deployed in the next few years, regardless of vendor. Most of the high-end encoders are now (or are becoming) interoperable on both hardware and software decoding. Additionally, TMC wall screen manufacturers have adopted the MPEG2 and MPEG4 standards and offer internal decoders into their processors for displaying MPEG2/MPEG4 streams – a feature not available for most commercially available IP cameras due to their compression schemes.

MPG2 has been an international standard for years, most commonly found in DVD's, Digital cable television, etc. MPG4 on the other hand (Type 2), was never adopted as a standard and has been relegated to lower bandwidth solutions. H.264 (MPG4 Type 10 AVC) is the newest international standard about to hit the ITS marketplace. H.264 is

commonly found in Blu-Ray DVD, HD Digital cable, etc. Experts in the industry expect MPG4 to have one of the shortest life spans of any technology.

Multicast Support

Another issue with IP cameras deals with their video transmission. Virtually all ITS IP systems utilize multicast video, taking advantage of the ability to share the video with numerous clients without additional bandwidth requirements. In the DVR/NVR arena, unicast video is prevalent, where multiple users establish individual unicast connections at different bandwidths (which accumulate to use more bandwidth). In essence, unicast video does not work within the framework of a multicast system, thereby making the use of many IP cameras non-feasible.

Flexibility

Incorporation of the video encoder into the camera assembly limits the end user to cameras made by a specific vendor – the vendor offering the integrated package.

Use of external video encoders allows a variety of camera styles and camera manufacturers to be utilized within the same infrastructure. The recent publication of the NTCIP Standard MIB for CCTV now allows centralized control systems to function with any CCTV device that supports the standard. Interoperation between Central software and camera receivers is no longer vendor proprietary. Additionally, many CCTV manufacturers are integrating selectable protocol conversions for Pan-Tilt-Zoom control directly into their dome cameras.

Another recent introduction to ITS systems has been the integration of Homeland Security measures. ITS Systems spanning bridges and causeways have begun utilizing high-resolution, low light cameras for monitoring the bridge structures and access points from a security standpoint. These cameras are often specialized and will require the use of external communication devices.

Obsolescence:

Cameras have not changed much over the past several years. A CCD camera is still a CCD camera. Manufacturers have played specification games with presets, compasses, privacy zones, etc. – but all in all, cameras have not greatly changed (since the advent of the dome style camera). In contrary, compression technologies have changed every two or three years.

In general, the camera should outlive the encoder by several years. Encoder technology is ever changing, and a good system design will not preclude upgrading or migrating to the latest technology available. One should not have to replace the camera, or perform major hardware upgrading, to take advantage of new and compatible transmission technologies. In other words, the video image capture and the video transmission should be independent of one another.

Conclusion

While IP cameras are becoming more prevalent in other industries, and are appearing in many advertisements the public views, they do not necessarily fit the needs of a deployed ITS system. Independence of the camera and encoder allows the complete flexibility for upgrading/migrating, cost savings in maintenance and troubleshooting, freedom from proprietary protocols, and prevention from design considerations due to distance and location of equipment.