Industrial Video Monitoring Networks

Modern Industrial Video Monitoring Systems use digital technology to send images over an Internet Protocol (IP) network. These systems are used to monitor remote sites such as electrical substations, oil and gas rigs and refineries, wind and solar renewable generation facilities. An IP network is commonly used for Internet connections and corporate LANs making it a very common, easy to use and deploy technology. Use of IP technology allows video systems to be connected to existing corporate networks and to be managed by existing personnel and policies minimizing installation costs and training. IP networking techniques allow the video system to be secured and segregated from the Internet and from the corporate LAN but still connected to the control center and the SCADA network. As an example, video systems from several substations can be accessed for viewing from the control center, connected to the energy SCADA system and connected to a remote archive server, all over an IP network.

Video Monitoring on Industrial Process Networks

IP networks are commonly deployed in substations and other industrial applications to connect Intelligent Electronic Devices, (IEDs), Remote Terminal Units, (RTUs), and other protection and control equipment to each other and to the SCADA system. Substation automation networks are industrial, process based networks that run critical applications to keep substation equipment and the power system protected and running safely. Process based communications is machine to machine so uninterrupted and timely delivery of data is critical to keep processes running correctly. Process based networks must therefore be kept isolated from the Internet and other corporate traffic to ensure that the data flow is secure and free of losses. In an IP network, technologies such as Virtual Private Networks, (VPNs), subnets and firewalls are used to keep the substation network isolated from the rest of the corporate LAN.

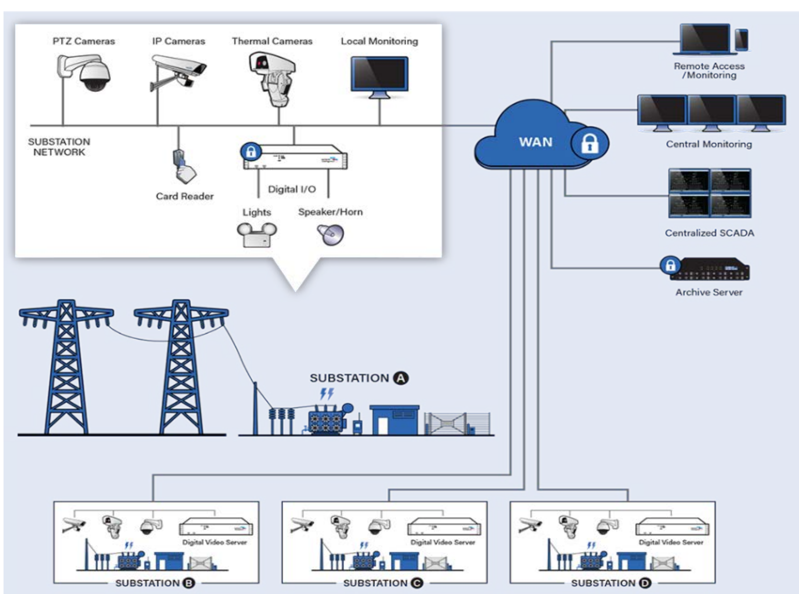

Figure 1. Decentralized architecture with a DVS at each remote location.

The video monitoring system is connected on the substation network so it can communicate with the SCADA system at the control center with alarms, messages, visual and thermal information of the operating conditions at the substation. The information can be fed into the control system for automated responses or for operators to make decisions and take actions. Since the substation network requires access privileges, the video and SCADA systems are not accessible to personnel without proper authorization.

Decentralized Architecture – Processing at the Network Edge

Most SCADA communication is optimized and requires only a low bandwidth connection to communicate between the remote substation and the control center. Remote video systems are often expected to communicate to the control center over the same low bandwidth connection and therefore the video system architecture must be designed to operate within these limitations. Centrally located, enterprise video systems do not have this restriction since they can be located on a high speed local area network. Decentralized systems as shown in figure 1, have a Digital Video Server (DVS) at each location that does the processing of analytics and video storage at the network edge reducing the data that flows over the network.

IP video cameras have three separate video streams that are dedicated for viewing, storage and analytics. Each video stream consumes network bandwidth, a single camera can consume 2Mbps or more depending on the resolution, frame rate and compression. If a site has several cameras and there are several sites the amount of data can overwhelm a wide are network connection.

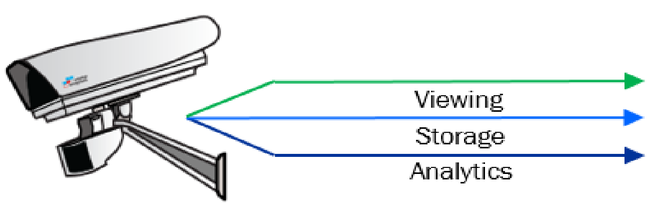

Figure 2. – Data streams from typical video camera

A decentralized system conserves network resources used by these three data streams in the following ways:

1) Analytics – the DVS processes the analytics data stream locally to automatically detect events at the remote site. The events can correspond to monitoring transformers and other assets or motion detection from intrusions. If an event is detected, the DVS will send an alarm and a video snapshot of the event to a client at the operations center. Network bandwidth is only consumed to sent the alarm message and the snapshot.

2) Storage – customers generally want to record the video data for some period of time in case something happens at the site and an event needs to be reviewed. In a decentralized system the DVS records the video at the remote site so it does not require network bandwidth.

3) Video for viewing – because the analytics can be programmed to automatically detect events at the remote site it greatly reduces the need for viewing live video. The live video stream is only opened between the remote site and control center if live viewing is required.

The decentralized system process the video data at the network edge in the substation and only sends the data over the wide area network as required. The edge processing send alarms to system operators when their attention is required. In case of a network failure the video system remain operational, analytics continue to run and video is stored on the DVS at the substation.

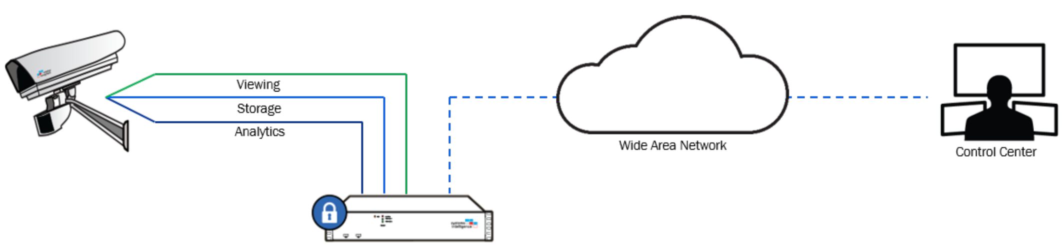

Figure 3. – Decentralized system processes and stores video data at the network edge to reduce bandwidth and increase reliability.

If there are no network or bandwidth limitations the video systems can be configured in a centralized architecture. In this scenario, the video streams from all the cameras are sent over the wide area network and are processed at the control center.

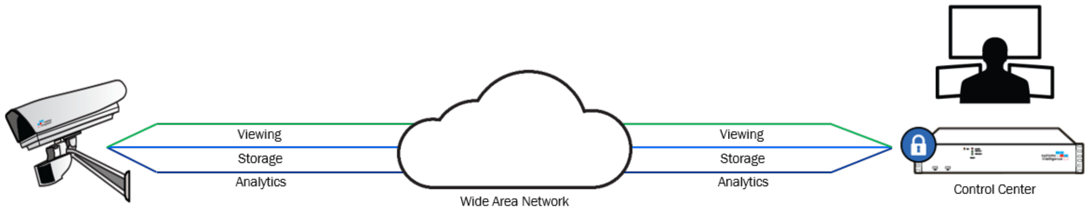

Figure 4. – Centralized system processes and stores video data at the control center.

A typical monitoring system is connected on the substation LAN with all the cameras connected to the DVS. The DVS processes and stores the video data locally and sends alarms to the control center when an event is detected. Each device on the substation LAN including all cameras and DVS require an IP address to communicate to each other and to the video clients and the SCADA system.

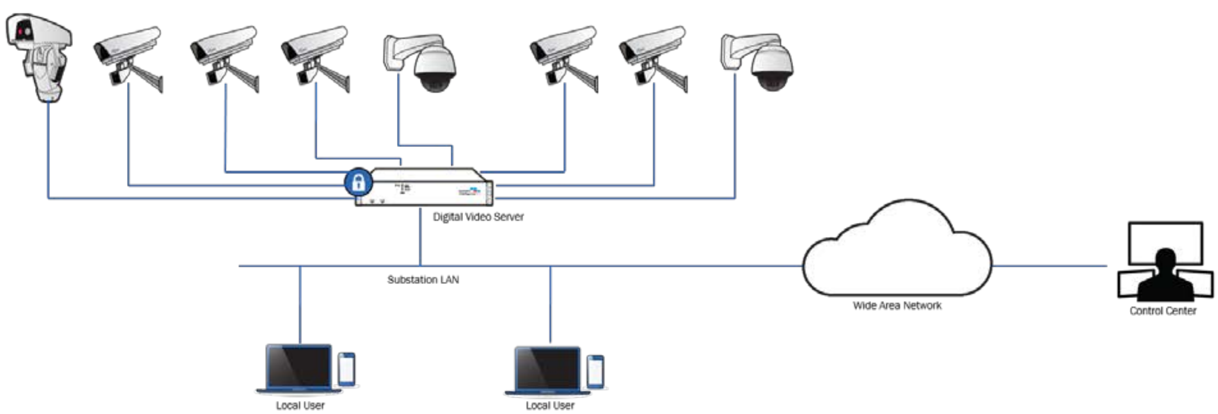

Figure 5. – Each device on the substation LAN requires an IP address to communicate locally and to the control center.

Industrial Video Physical Network Layer

IP networks can be carried over many types of physical media including copper and fiber Ethernet cabling and wireless. Inside a substation, it is generally recommended to use fiber optic cabling to connect devices for two main reasons:

1) Avoid electromagnetic interference – EMI exposure is high in substations due to presence of high voltage lines, switching, lightning etc. EMI can be induced into copper Ethernet cables causing loss and corruption of data. Fiber optic cables are immune to the effects of EMI.

2) Avoid Short Circuit Induced Currents: Short circuits in the switchyard inject currents into the grounding grid of the substation. These short currents break the balance of the potential distribution causing a transient current flowing through the shielding sheath of the copper communication cables all the way to rack where the server or communication equipment are in the control house. This can cause damage to other equipment in the rack and is a safety hazard for anyone working in the control house. Fiber optic cables don't have this problem.

3) Cable length limitation – the maximum length for copper Ethernet cable 100 meters. This will be a limiting factor in most substation installations. Fiber optic cables can run several kilometers in distance with any losses making it more suitable to outdoor environments.

Summary

Industrial video monitoring systems in substations use the same IP technology as the Internet and Enterprise networks to reduce costs and promote interoperability. Industrial LANs are process based networks that have additional requirements over enterprise networks to increase reliability and security. These networks use the features of IP networking to make them more secure, reliable and immune to the effects of substation environments.

For more information about Industrial Grade Video Monitoring Solutions for Substations please contact: Sales@SystemsWithIntelligence.com