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White Paper

Best Practices for Networking Automation Computers

Written by: Mike Berryman, Advantech Corporation, Industrial Automation Group

Automation computers can be anywhere, and do very many things. Modern automation computers are connected to networks that may be connected to other networks throughout the plant, and via TCP/IP to the entire world.

This is far different from the early days of automation. Those systems and even many systems today, were “islands of automation” in the plant. The operation of the controller was fundamental. There was little or no need to connect the controller to the rest of the control systems on the plant floor. What data was being collected was collected manually, using the operator-and-clipboard method.

Now, an automation computer is almost always a network node on a network that connects the operation of the entire plant, and connects the plant floor to the enterprise.

The network that connects those automation computers is sometimes more important to the operation of the plant than the individual automation computers it connects, and even the enterprise systems it interfaces with.

How can this be?

Aren’t the programs in the automation computers critical to plant performance? Aren’t they critical to the manufacturing process?

Well, yes, but because of the fact that control of plant processes is significantly distributed, whether you are operating a conventional process plant DCS or using a set of automation computers as networked controllers in a discrete automation plant, it is the performance of the network that is the critical path to optimal performance of the entire plant.

Following the "Yellow Brick" Ethernet Road…

Throughout the 1990s, the path toward true plant interconnectivity appeared to wander around a lot. There were lots of false starts and dead ends before Ethernet finally became the global standard for networking in the enterprise. Finally, it became the global standard for networking on the plant floor as well. Industrial Ethernet is robust, deterministic, flexible and resilient enough to perform in the harshest of environments, including the plant floor.

Getting there hasn't been easy. In fact, it has been like the journey down the Yellow Brick Road. An Ethernet network that works just fine in an office environment is almost certainly not robust enough for the plant floor. The plant floor has hazards that simply do not exist in an office, like electrical and electronic noise, power surges, power failures, and the like. When we begin to look at the Ethernet environment that is recommended for the factory floor, one thing is certain. "We're not in Kansas anymore!"

The only way back to Kansas is to get the network done right. For that you need a guide. You got an Ethernet "Wizard of Oz?" If not, you better get one…

Ethernet to the North and to the South

In most plants, there are actually multiple Ethernet networks. There are the device networks on the plant floor. They connect sensors and fieldbus networks and devices to controllers and connect controllers to area controllers and control systems. There are the area-wide networks that group together device level networks and pass data up to higher level networks and computers, and pass data and instructions down to the device level networks.

These networks need to be deterministic, and capable of handling high traffic loading. Most of them require not just a typical Ethernet router, but an Ethernet Switch, and in many cases, multiple Managed Ethernet Switches to interconnect the controls networks and connect the Control Network to the MES/ERP/Plant enterprise network.

Plant Ethernet systems don't just carry information to and from the device networks either. Often, plants now have VoIP communications networks that also run on Ethernet, and many plants have video inspection and surveillance systems that are also running on the same or co-existent Ethernet networks that the device networks run on.

Sometimes, an automation computer being used as an HMI or a controller is also being used as a router between networks.

A network consists of several parts. There are, of course, the automation computers that make up the nodes that we usually think of: the devices and controllers. There are also the automation computers that make up the routers, switches and servers that route the data and keep the network running. Finally, there is the cable, or media, that the network runs on.

Redundant Networks or Redundant Paths?

Industrial networks need robust architectures. Typically, several LAN switches are connected together in a ring, and the Ethernet devices connect to the ring. Standard Ethernet rings are not a fully redundant topology, and are less robust than is required on the plant floor, in either discrete or process industries.

A fully redundant ring topology protocol is usually available from the switch vendor, such as the dual X-Ring topology from Advantech that provides users with an easy way to establish a redundant Ethernet network with ultra high-speed recovery time less than 10 ms.

Thus, there are two ports, two cables, and duplicated LAN switches with duplicate IP addresses for each Ethernet switch in a truly redundant system. The switch protocols make sure that all the devices on the ring use the same application layer protocol and LAN redundancy mechanisms. This redundant ring topology prevents a single network break from impeding the network path, while permitting “best x of y” voting for synchronization.

Even though the ports, cables and switches are duplicated, this provides the application with certain simplicity, since the redundancy is essentially transparent to the user of the network.

Gigabit or Bust!

The proliferation of high bandwidth applications in the plant environment has caused a major migration from standard Ethernet (10/100) to Gigabit Ethernet. Gigabit Ethernet, once only used for major trunks or rings, is becoming the standard for network speed. Some of these high bandwidth applications include VoIP communications, wireless backhauls, high bandwidth surveillance video, and machine vision applications.

VoIP communications carried on the plant network mean that operators and other plant floor personnel do not need to carry a plethora of communications devices (cell phone, PDA, walkie-talkie, etc.) and can carry a single phone or PDA device which handles all their communications needs. The burgeoning market for wireless devices in the plant and on the shop floor has already required increased bandwidth from the wireless gateway to the control systems (the backhaul). More and more, plants are concentrating their security systems into the same networks that carry plant data and the VoIP communications network. This, too, is requiring Gigabit Ethernet. AIDC applications like automatic barcode readers and active or passive RFID readers have also increased the required bandwidth on the plant floor. Finally, advanced sortation and control algorithms have been developed for machine vision systems that make them even more useful in many applications than they have already been.

All of these applications have made it necessary for the typical Ethernet switch to be capable of gigabit speeds, as well as robust redundancy.

Legacy Networks / Device Integration

Notwithstanding the huge gains and the standardization of most of the plant networks on Ethernet since the 1990s, there are still many devices on the plant floor that are not directly able to use Ethernet for communications. Many are serial devices, using RS-232, RS-422, or RS-485 communications. Others use proprietary communications networks, like Modbus, or Profibus or Foundation Fieldbus. Some Modbus devices can connect to an Ethernet LAN using Modbus/TCP protocol. Others need a Modbus-to-Ethernet Gateway.

Serial devices are ubiquitous, as well. They, too, require gateways to be able to connect to an Ethernet LAN. These devices can be field mounted, for ease in connection to a single device like a barcode scanner or an analyzer, or they can be part of the network architecture and mounted in rack or panel configurations. Having the ability to convert serial data to be carried on Ethernet networks to serial data servers in PCs mounted remotely makes it possible to utilize many of the existing assets in a plant network. Profibus and Foundation Fieldbus networks require gateways,

as well, except for FF HSE, which is an Ethernet protocol specifically for Foundation Fieldbus devices, and Profinet, which performs the same function for Profibus devices and network nodes.

As wireless networking grows in popularity, wireless network gateways are also being required to connect the wireless sensor networks to the infrastructure.

So what should an “industrial strength” automation computer that is being used as an Ethernet network appliance look like?

They can have many different physical shapes and construction. They can be designed for mounting in the field, such as Advantech’s EKI serial device servers. They can be designed for rack or panel mounting such as Advantech’s UNO embedded automation computers. They can be designed for mounting in Ethernet ring structures, such as Advantech’s EKI Ethernet switches.

They need to have industrially-hardened circuit boards. They need to have wider-than-commercial operating temperature specifications. They need to have industrial mounting that prevents damage from shock and vibration. In other words, they need to be as robust and the plant floor devices they are networking.

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