“Networking Survival Guide: A Plan for Drive Manufacturers & Integrators”

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It's Not The Good Old Days

In the old days – three to five years ago – networking was a nice addition to your drive. You could tell your customer that about this neat "other" feature. Except for innovative and new Profibus and DeviceNet systems most drives were configured, controlled and monitored pretty much the way they always were. Configuration was done over a serial link or for low end applications from the front panel. If you had a serial connection, the end user or integrator had to have a copy of the serial configuration tool. It had to be the right rev and it had better be for your version of windows which seemed to change on a regular basis. Drives were controlled using I/O lines from the PLC and monitoring a drive meant opening the drive cabinet and watching the front panel.

Drives That Don't Communicate On Ethernet Won't Sell

Over the last five years the proliferation of networking standards has really coalesced around Profibus, DeviceNet and now Ethernet. Ethernet is no longer an option for advanced, complicated Industrial Devices like Drives – ETHERNET IS A REQUIREMENT. Ethernet is the fastest growing segment of Industrial Networking for one reason – The Market (Your Customers) Loves Ethernet. Ethernet is quickly going to dominate Industrial Networking, especially for devices like drive systems. Here's why:

1. Control Engineers want to monitor drives from their desks, from their laptops, from their handheld PDAs – no one wants to walk across the plant to check on a drive parameter or check for error conditions.
2. Prices on 32-bit sophisticated microprocessors with built-in Ethernet are dropping like a stone. Ethernet connectivity will be a given on the majority of new development projects.
3. Customers love Ethernet. They love the fact that they don't need training, that they understand the hardware and that they already buy those components today. The bad news is that they think it's cheap and easy to use.
4. Programmable Controllers will likely only support sensor bus networks, DeviceNet, Profibus and all the rest, with add-on cards. Ethernet will likely be supported right out of the main processor. Ethernet will be the lower cost PLC hardware option.
5. Web Browsers are very important – for good reasons. They're how Control Engineers can avoid walking out to the floor to monitor equipment. With cell phone, PDA and other non-

traditional browsers, manufacturing systems can be monitored and problems diagnosed from the office, a conference room, a home or a hotel room anywhere in the world.

6. Customers hate custom configuration tools and special network interfaces. DeviceNet, Profibus and the rest all require a dedicated hardware interface to get on the network. With an Ethernet Web Browser devices can be configured more easily and the tool is always available.
7. Ethernet devices can include all their documentation right online in the web browser.
8. Customers and end users always prefer more speed over less, probably because it is one thing that is very easy to compare. Given a choice between using a 10/100 Mbaud Ethernet network and a sensor network Ethernet has a leg up right away.
9. Leading companies like GM are standardizing on Ethernet solutions for certain class devices like robots and welders. This will only grow in the future.

Industrial Ethernet is not a future networking technology. It is very popular and a standard in automotive, semiconductor, material handling and many other parts of the automation business. In fact, Ethernet capability is a prerequisite for participation in many new automation projects. This paper is about getting that capability.

Quite frankly, today it is a mistake to ***not*** support Ethernet.

Important Questions You Must Ask Yourself First

Once you decide that your products must support Ethernet, the big question becomes “how can I get it done and get it done quickly”?

Do you have excess Engineering resources to commit to the project? Can your existing opportunities and customers for Ethernet be put off until next year? Is your engineering staff intimately familiar with the specification? Are you prepared to work to discover all the nuances of the specifications that are a given in any complicated software project?

If you’re having difficulty with any of these issues, then this paper was written for you. It details the technical information you need to know and gives you practical steps for adding Ethernet to your existing product in the next 30 Days.

“What is Industrial Ethernet?”

The term “Industrial Ethernet” generally refers to the industrial application layer protocol that PLCs use to communicate with industrial devices over Ethernet. These systems use all the traditional Ethernet hardware just like in your office LAN. They also use the same high level internet protocols, UDP, TCP and IP, for sending messages from one node to another. What’s different about Industrial Ethernet is the application layer protocols that are used to structure the task of configuring, accessing and controlling industrial automation devices. These protocols are specific to industrial automation devices.

What are the main Industrial Ethernet Application Layer Protocols?

Three are three primary Ethernet Application layer protocols that should be considered for any drive system.

MODBUS TCP

Quick Summary: Modbus/TCP is the easiest to use, easiest to understand of all the high-level industrial application layer protocols for industrial automation applications. Modbus TCP combines two extremely popular technologies, TCP/IP and the flat network view of Modbus RTU, to form a simple yet very functional worldwide standard for industrial data networking. Built on top of TCP/IP protocol, Modbus TCP is compatible with all standard Ethernet hardware and software. Using the flat file structure of Modbus RTU as the network interface gives Modbus TCP a much less complicated method of representing device data than EtherNet/IP or PROFInet. TCP/IP, the Modbus RTU command set and the flat network representation make Modbus TCP an easily understood and not difficult to implement Ethernet protocol.

In the flat network representation carried over from Modbus RTU, devices on the Modbus TCP network are represented as a set of up to 64K words and up to 64K bits (known as coils). Commands, identical to Modbus RTU commands, are issued from a Client device to read or write the data words or bits of a server device. Modbus TCP is rapidly ground in applications that formerly used Modbus RTU, Modbus Plus and other serial communications protocols.

Unlike other application layer protocols, Modbus TCP communications are stateless. Each Client – Server transaction is totally independent of every other transaction.

Advantages: Ease of implementation. Small code size. Easily understood object model. Small, very efficient set of commands.

Disadvantages: No capability to abstract data. Little to no standards for device representation (called profiles in other application layers). An identical device from two different manufacturers will use completely different representations on the network.

More Information: www.rtaautomation.com/modbustcp

ETHERNET/IP

Quick Summary: Ethernet/IP, promoted by the ODVA (Open DeviceNet Vendor Association), is much more sophisticated protocol than Modbus TCP. EtherNet/IP classifies EtherNet/IP nodes as predefined device types with specific behaviors. The set of device types and the EIP application layer protocol is based on the Control and Information Protocol (CIP) layer used in both DeviceNet™ and ControlNet™. Building on these widely used protocol suites the CIP-based protocols provides a seamless integrated system from the sensor-actuator network to the controller and enterprise networks.

Ethernet/IP uses all the transport and control protocols used in traditional Ethernet including the Transport Control Protocol (TCP), the Internet Protocol (IP) and the media access and signaling technologies found in off-the-shelf Ethernet interface cards. Structuring EtherNet/IP on these standard PC technologies allows EtherNet/IP to work transparently with all the standard off-the-shelf Ethernet devices found in today's marketplace. It also means that EIP can be easily supported on standard PCs and all their derivatives. Even more importantly, basing EIP on a standard technology platform ensures that EIP will move forward as the base technologies evolve in the future.

Advantages: EtherNet/IP devices are easily integrated into the Rockwell Automation Logix family architecture.

Disadvantages: EtherNet/IP is complex to implement. One estimate is that it is four to five times more complicated than DeviceNet.

More Information: www.rtaautomation.com/ethernetip

PROFINET

Quick Summary: PROFInet is really three different networking technologies; PROFInet CBA, PROFInet IO and PROFInet IRT. PROFInet CBA is a component model version of PROFInet. In CBA, PROFInet devices are Microsoft COM (Component Object Model) servers that represent device data using COM objects. These COM objects use standard COM Coclass (COM Class) classes, Interface pointers and member functions. Data is transported between a COM client and server at 10msec intervals. The solid infrastructure of COM, its data abstraction mechanisms and the ability to easily build distributed applications are incorporated into PROFInet CBA.

PROFInet IO is the I/O version. It is much more like Profibus than like PROFInet CBA. Like Profibus, data is organized and transported over the network as I/O data. Data can be moved from server to client (PLC) at 1msec type speeds.

PROFInet IRT is the isochronous version of PROFInet. This version is for coordinating high-speed motion control and is capable of response times in the 250nsec range.

Advantages: PROFInet builds on the world-class and highly popular Profibus standard.

Disadvantages: PROFInet is not easily ported to other architectures.

More Information: www.rtaautomation.com/profinet

How to implement an Ethernet Application Layer Quickly & Effectively

Once you've made a decision to add Ethernet connectivity to your drive system you have a number of ways to proceed. The choices vary in time-to-market, supportability, your internal resource requirements and long term cost.

1. Use an off-the-shelf Serial Gateway

An off-the-shelf serial gateway is the least economical approach with the fastest time-to-market. To implement a serial gateway your product and the gateway must both support a common serial communication protocol such as Modbus or some proprietary serial protocol. Data from your product will transfer to the gateway at serial baud rates (1200-19200).

Other than time-to-market (typically a week or two), there are few real advantages to this approach and many negatives. Gateways require an additional footprint, they can be costly, they rarely

support messaging characteristics needed for you data, and the gateway vendor name appears on the screens of network configuration tools.

Most importantly, your data is represented as generic data. The characteristics of your device are lost to the network. This option is only attractive if you expect very low volume requests for Ethernet connectivity.

2. Add-on Daughter Boards

An add-on daughter board is another fast time-to-market method of adding Ethernet to your product. An Add-on PCB plugs into your device internally (usually TTL-level communications) and acts as a serial gateway with less cost and sometimes more benefits.

Internal daughter boards contain all the disadvantages described previously for gateways unless the vendor is able to customize the data representation and messaging characteristics. If you product contains a spare communication port and you can get a customized implementation, this approach is great for medium volume applications (i.e. a few hundred units per year). Real Time Automation supplies daughter boards of this kind, not only for DeviceNet but also for other fieldbuses like Lonworks, Industrial Ethernet and Profibus.

3. Add-on Ethernet PCB Port

An add-on Ethernet PCB port is another fast time-to-market method of adding Ethernet to your product. This device is added to your PCB and acts as an onboard serial gateway with less cost and sometimes more benefits. This is an especially good solution if you have an 8-bit controller with a lot of custom control code that is difficult to port to a new platform. Figure 1 presents one example of this type of add-on on Ethernet port:

Figure 1 - Add On EtherNet Port From RTA

Internal Ethernet PCB ports are just like daughter cards with all the advantages and disadvantages listed previously. The product in Figure 1 supplies an Ethernet product that provides simultaneous EtherNet/IP, Modbus TCP and PROFInet IO.

4. Purchase an Ethernet Client or Server Stack for your existing processor

If you have a processor that already has an Ethernet port you can simply purchase EtherNet/IP, Modbus TCP or PROFInet source code. For a one time charge with no royalties, these stacks offer you the latest in capabilities while giving you absolute control of your development, network presentation and implementation.

The advantages to this approach are relative low cost and tightly integrated firmware. If you use a common TCP/IP stack with known application layer interfaces (like Berkley sockets) this solution can be achieved quickly.

5. Custom PCBs

Contract Engineering companies can provide you with a completely custom communications card for your application usually in 90 days or less depending on the complexity of your application.

6. Do-It-Yourself

The most costly, lengthy and risky approach is to form an internal effort to build it yourself. While this is admittedly what you'd expect to hear from a company whose business is selling custom networking hardware and software, the facts still speak for themselves.

Like all complex protocol implementations there are nuances of the Industrial Ethernet specifications that are not readily discernable. The internal resources required for internal

development are usually much more costly than using an outside resource or buying a component. The risk of missing seemingly innocuous nuances and missing a ship date is much higher than the cost of outside software or engineering.

Your best customer, the Guinea Pig

Anyone who has practiced engineering for any length of time has a healthy respect for Murphy's Law. On the subject of networking, Murphy's Law states that when you roll out a new network design, the odds are that you'll have the opportunity to demonstrate your proficiency. You'll demonstrate it onsite, in front of your biggest and most important customer as they wait impatiently for their network to return to life.

Just a few more things to think about before you take the leap

Another important consideration is testing and certification. Do you have the tools and resources to test, troubleshoot and certify your implementation? A key to selecting a vendor to get fast Ethernet connectivity is to make sure that your vendor has all the right tools and can assist you with troubleshooting, locating adequate test tools and the certifying your device.

You must consider documentation. There are standard documentation formats for Industrial Ethernet devices. Your customers will expect your products to follow these standards. To get to market quickly and meet the needs of your customers documentation issues need to be addressed early in the process.

You must consider certification. Many customers simply will not purchase products unless they have passed the conformance test for the network. It's not uncommon for products to be sent back to the lab a second or third time before they finally pass. If a company like RTA does an implementation for your product, you are guaranteed the same first time success.

You must consider Maintenance and Support. There are keys to success for any new technology. There will be inevitable corrections and revisions to the initial specifications. How you deal with these changes matters a great deal.

You must consider Factory floor DeviceNet issues: What to do when devices have duplicate ID's, what to do when supposedly "compatible" devices still won't talk to each other, how to use switches and routers on the factory floor, and how to handle device replacement are all very important factors to carefully consider.

Real Time Automation Guarantees Your Success.

Few people in the automation have the guts to guarantee anything, but Real Time Automation will guarantee that your product will be Ethernet enabled in 30 days or less, or you only pay half. For an additional rush charge, we can deliver custom Ethernet implementations in only **15 days**. We simply require that you meet some basic requirements, which means filling out a project application and sending us a sample of your product. Within 7 days we will provide you with a quotation and a guaranteed time line. If we don't deliver the goods on time, you get half your money back! You can't lose.

What to do next

Call or Email John Rinaldi, our Networking Sales Manager at (414) 453-5100 / jsr@rtaautomation.com and ask for a Project Application. John will be happy to discuss your specific requirements and deadlines, and discuss any aspect of networking that you may still be unclear about. The RTA team looks forward to serving you as you tackle one of the most important new technologies in today's automation business.

Don't let a shaky economy, protocol confusion or fear of the unknown keep you from participating in new project opportunities! Ethernet can be an important part of your product success story, too.