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The Future of Industrial Networking and Connectivity

Manufacturing and process control systems demand the efficient and reliable transmission of information from measurement and control devices on the plant floor all the way up to applications across the manufacturing enterprise. As worldwide competition, government regulations, and consumer expectations continue to rise, companies must look for more cost effective and efficient means to automate and control their production facilities.

TODAY'S MARKET

In the production facilities of today, discrete and 4-20 mA analog devices are individually wired from the device in the field or factory to a central controller. Point-to-point wiring is the de-facto standard today. It is important to note that traditional point-to-point wiring is very limited in the information it transmits or receives from the field. Only the process variable is communicated without any diagnostic or health information. Other solutions are proprietary all-digital communication technologies. The problem with this solution is that end-users are locked into buying all their equipment from one supplier.

Industrial Networks	*Type of fieldbus*
ASI	Sensorbus
WorldFIP	Fieldbus
CANOpen	Devicebus
ControlNet	Control
DeviceNet	Devicebus
Ethernet	Enterprise
FOUNDATION Fieldbus	Fieldbus
Interbus-S	Sensorbus
LonWorks	Devicebus
Profibus DP	Devicebus
Profibus PA	Fieldbus

Table 1. Existing fieldbus technology.

FIELDBUS TECHNOLOGY

There are many different types of industrial networking or "fieldbus" technology on the market today. (see table 1). The basic idea behind this development is to offer the market an industry standard method of connecting devices together so they can exchange information, both process variables and diagnostic information, back to a controller or application. However, as stated previously, there are many different types of fieldbus technologies. When looking at the fieldbus market, you'll see a very fragmented market with many different players battling over which industry standard is the preferred solution.

Types of fieldbuses: (see table 1)

Sensorbus - Lowest level network, generally for connecting simple low cost sensors, such as on/off switches. Transmits very small amounts of data and requires very little processing in the sensor.

Devicebus - Largest general network category that provides communication services for smart devices that can perform multiple functions and communicate process and diagnostics information.

Fieldbus - Generally a "step up" from a Devicebus. Supports transmission of larger amounts of data, but generally running at slower communication speeds and requiring more processor power in the device. Some Fieldbus technologies also support the distribution of control functions directly in the device.

Control - Targeted primarily at peer-to-peer communication between higher-level control devices, such as PLCs or DCS controllers.

Enterprise - Traditionally the backbone network for the company where business is shared. Predominantly TCP/IP on Ethernet.

SIMPLIFYING THE NETWORK HIERARCHY

Ethernet has come a long way from being viewed as only an information tool for office and business applications. As industrial networks gain in popularity, Ethernet is being used more and more as a solution for high-speed communication backbone applications between PCs or workstations and the industrial network. As a hardware technology, Ethernet addresses nearly all the requirements of the specialized industrial buses, with the added advantages of widespread usage and lower costs due to high volumes. There will always be applications, however, that require some specialized connectivity. For example, hazardous areas require explosion proof devices and wiring, common wire for signal and power, opto-isolation, etc... In these cases, specialized fieldbus networks will be used at the device level and a "gateway" converter will

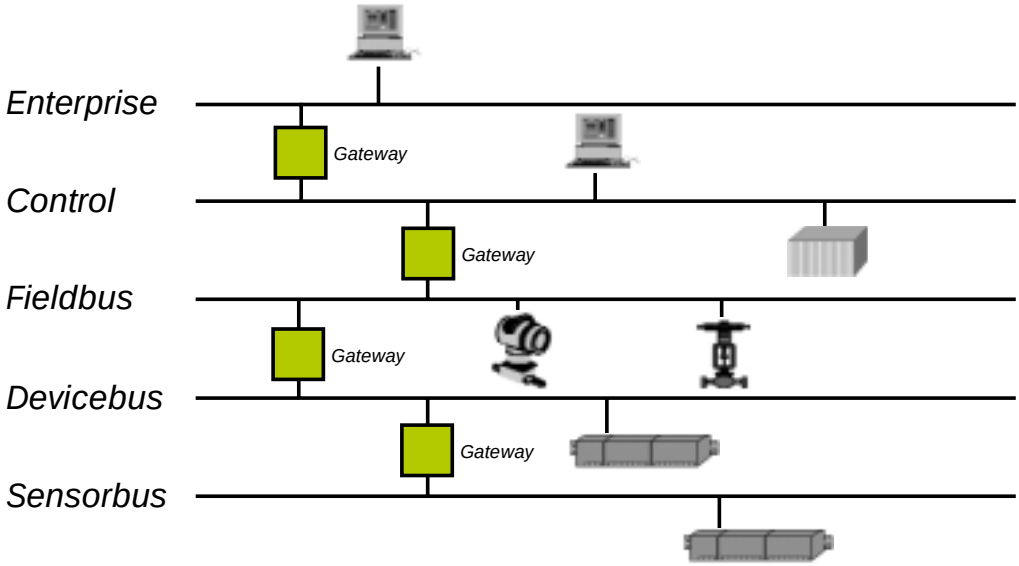

Figure 1. Today's Industrial Bus Hierarchy.

be used to connect these special sub-networks into the larger Ethernet network. Having a single network technology from the enterprise to the sensor level gateway will greatly simplify systems architecture, design, installation, and maintenance. Figure 2 gives an illustration of this simplified network hierarchy.

Benefits of using Ethernet

There are many compelling reasons for the use of Ethernet as the common communication backbone from the enterprise to the sensor level gateway. Some of those benefits are:

De facto Standard - Ethernet traditionally has been used as the business information backbone and is the de facto network installed in many companies today. Many corporations that use Ethernet for business systems can leverage their existing infrastructure for both business and manufacturing automation systems.

Most PCs ship with Ethernet support - Ethernet is built onto the motherboard of many PCs and the cost is very reasonable. Windows NT and Windows 9x come with built-in support for many Ethernet boards and TCP/IP.

Ethernet is low cost - Ethernet products are commercially produced in very high volumes, which results in lower component costs. Using system components that are commercially available off-the-shelf means that complete systems can be commissioned and installed very cost-effectively compared to low volume industrial networks where most components are specific to the network.

Challenges with using Ethernet

Initially, there were many critics that questioned whether Ethernet could operate practically as a suitable communication backbone to an industrial network. However, through time, many of these issues, listed below, have been addressed:

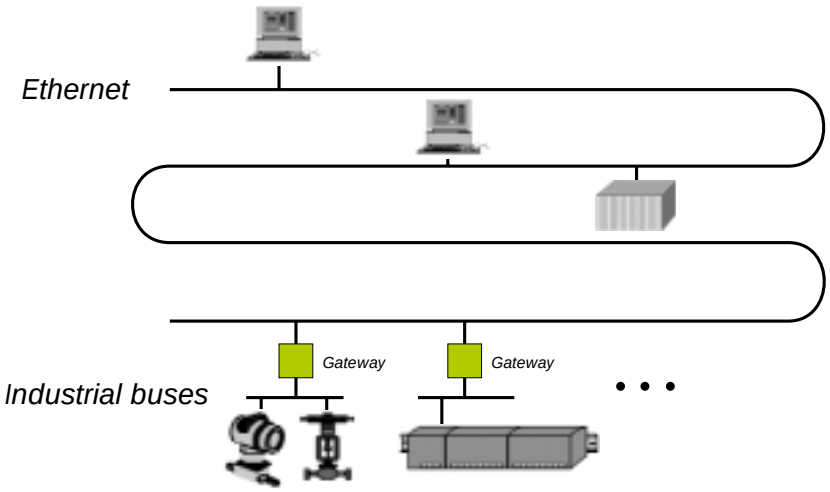

Figure 2. Simplified Network Hierarchy using Ethernet.

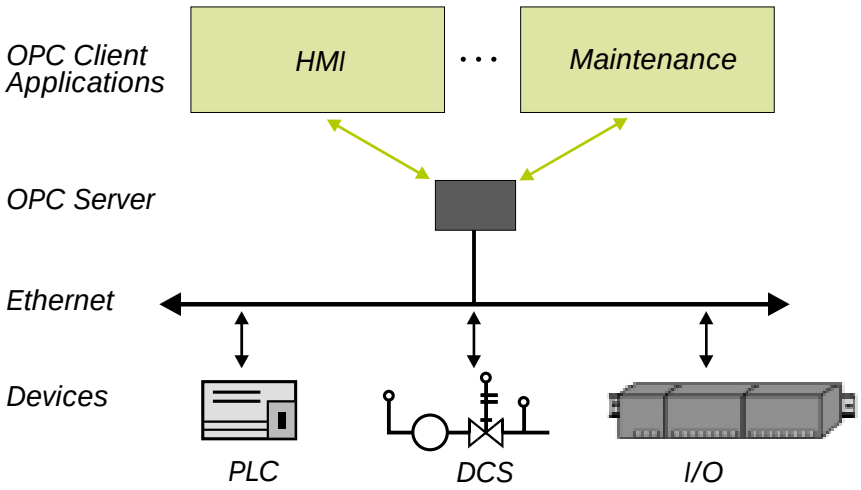

Figure 3. Simplified network hierarchy using OPC.

Ethernet is nondeterministic - Ethernet technology is based on collision detection and avoidance that slows down the response of the network as traffic increases. However, the statistical probability of delays can be lowered when setting up an Ethernet system. To accomplish this, Ethernet traffic must be kept significantly below its theoretical limits to avoid collisions. Most Ethernet installations today are based on 10 Mb/s Ethernet technology. However, faster Ethernet networks based on the newer 100 Mb/s, and in the future 1Gb/s, are quickly becoming the de-facto standard in new installations. Faster Ethernet networks do not eliminate collisions, but they increase the probability that data will be delivered in a predetermined time and greatly reduces the probability of data packet collision.

Data collisions effect bandwidth - All traffic on Ethernet is seen at every node, thus increasing the probability for collisions and making the performance of any one networked application dependant on the network usage of all the other applications. While this is true, you can segment Ethernet networks into separate "collision domains" using techniques such as switched Ethernet. By using dedicated subnets, you can remove your industrial network applications from the collision domain of other network traffic, improving determinism by eliminating extraneous traffic from critical applications.

Lack of industrial-grade components - Because Ethernet is mostly used in office environments, some people are worried that components are not appropriate for industrial applications. While the highest volumes of Ethernet devices are for office applications, the growing use of Ethernet in industrial applications has created a market for industrial components.

THE ROLE OF OPC

At the highest level, users want to be able to easily exchange information between a variety of networks, devices, and systems without resorting to expensive custom software development. OLE for Process Control (OPC) is an industry standard interface for sharing real-time data, alarms, and historical data with the components of a system or network. Any OPC client software, like National Instruments' LabVIEW, BridgeVIEW and Lookout, would be able to communicate with your OPC servers by way of this standard interface. Using OPC in your system architecture means you'll have one driver for each device and all applications use the same driver. Ethernet will provide the common method of connection so devices will be able to communicate with PCs or workstations directly through OPC. Figure 3 illustrates a simplified network hierarchy using OPC.

TOMORROW'S MARKET

In summary, today's world of multiple competing fieldbuses and user confusion will become much simpler in the future. Ethernet will be the universal backbone from the enterprise to the sensors. There will still be a role for specialized industrial buses, and standard bridges will allow users to connect these buses into the Ethernet network. While there will likely never be a single universally-accepted fieldbus standard, users will see a very large degree of interoperability due to the use of industry-standard TCP/IP communication and OPC connectivity ■

Chris LeBlanc is Industrial Communications Product Manager and joined National Instruments in 1994. His responsibilities include leading the worldwide positioning and promotion of the company's industrial communications products - CAN, DeviceNet, FOUNDATION Fieldbus, PROFIBUS, and serial (RS-232/RS-485). LeBlanc received a B.S. in electrical engineering from Lamar University in Beaumont, Texas.