RNA-1845: A Sensible Approach to Industrial Ethernet Disruption

Raven Technology Group introduces the RNA 1845 Industrial Ethernet device which helps to mitigate the disruption caused by the inevitable transition of the industrial world to Ethernet-based bus technology. By drawing parallels to adjacent industries such as telecommunications, and exploring real world market trends in the deployment of Ethernet-based devices, this document makes the case for the need of a hardware/software based solution that bridges the gap between legacy and next generation.

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As Yogi Berra was fond of stating "It's Déjà vu all over again!" Today, the industrial world finds itself in nearly the same position as experienced by the telecom industry in the mid to late '90s. The challenge for the telecom world then was how to leverage its huge existing copper infrastructure in order to satisfy the rapidly expanding demand for high speed broadband access. The need for high quality video on demand was emerging, but required broadband size data pipes to make it a viable option for users. Replacing the existing copper infrastructure was expensive and cost prohibitive. The development of xDSL technology allowed for broadband speeds over copper lines, thus bridging the gap between the copper infrastructure and newer broadband/IP infrastructure technologies. The demand for higher speed and greater volumes drove service providers to create new and innovative technologies that could be deployed over their existing copper and cable systems resulting in minimum service disruptions and significantly lower cost.

Some resisted the technological changes, but those unwilling to embrace the new emerging standards were soon replaced by those who could offer next generation services and technologies. This is true of the industrial world today.

The proprietary industrial protocols and buses currently in use (e.g. Data Highway, Profibus, Modbus Plus, etc.) mirror the old standards and copper infrastructure of the telecom world a decade ago. IP and web-based technologies are revolutionizing the industrial world as they did in the telecom industry a decade ago. Few can deny that there is an increasing need for industrial products capable of supporting and utilizing web and IP applications. Like the telecom industry, the industrial world must innovate and create solutions that will allow it to utilize its existing infrastructure; replacing existing systems would be cost prohibitive and time consuming.

Technological advances as well as market demands for greater data acquisition and analysis are forcing the industrial world to change in much the same way as the telecom industry was forced to do so a decade ago. Increased efficiencies, higher bandwidth and throughput, greater and faster data acquisition and information analysis, coupled with lower costs are driving the industry to change. Older industrial bus and infrastructure standards and protocols exist and are admittedly robust; however, just as in the telecom industry, there are significant limitations that place barriers to achieving current and future market demands.

Leading industrial manufacturers have been working together for over a decade in an attempt to create a single industry standard that is open, easy to implement, fast, and scalable. Unfortunately, as they worked toward creating an acceptable industry standard they were often implementing a proprietary version, unique to their product line. This has resulted in not one standard but a plethora of competing, proprietary architectures resulting in market confusion and little or no progress toward meeting emerging market demands. During this time—commonly known as the Bus Wars—the standard used by virtually the entire non-industrial world, Ethernet has quietly and steadily made inroads into the industrial world and has arguably become 'the' standard.

At this point we are no longer talking about a new and emerging technology; we are speaking of well-established technology, one that is the universal standard the industrial world has been attempting to create for many years. We believe that industry adoption of Industrial Ethernet will occur at a very rapid rate for the foreseeable future and that those who choose to ignore it and maintain the status quo will meet a similar fate as those who made the same decision in the telecom industry.

According to a new ARC Advisory Group study, "Industrial Ethernet Infrastructure Worldwide Outlook," industrialized Ethernet products will grow over the next 5 years to represent a nearly $1 Billion market. This same market was reported at $124 Million in 2004[i]. The ARC Advisory Group continues to predict the proliferation of Ethernet in the industrial space stating, "Ethernet is gaining traction as the preferred factory network protocol because of its cost and performance benefits, hardware availability and ease of implementation. The worldwide market for industrial Ethernet is expected to grow at a compounded annual growth rate (CAGR) of 51.4 percent over the next five years. The market totaled 840,000 units in 2004 and is forecasted to total just over 6.7 million units in 2009[ii]." The modern bus, the bus for the new millennium of control and monitoring is here, and is currently being deployed and implemented. Industrial Ethernet has become the de facto standard for industrial buses and communication.

Industrial equipment manufacturers, recognizing the enormous market opportunity for industrial Ethernet, have begun producing industrial-grade infrastructure products including hardened switches, PoE (Power over Ethernet) switches and mid-points, Ethernet radios, and field devices capable of Ethernet communication. PLC manufacturers have added Ethernet capability to their product lines, offering Ethernet modules, conversion modules for proprietary protocols, and web-enabled processors that allow internet access and availability. Adoption of these technologies has been slow, primarily because of the reluctance of the industrial community toward early adoption and the high cost to replace existing systems. Despite this reluctance, vendors have been successful in creating the supporting infrastructure and have eliminated or reduced much of the deployment difficulties that typically occur with new technologies. This has and does make the decision to implement an Ethernet-based solution nearly impossible to ignore. The reduced cost and enhanced data efficiencies obtained by utilizing a universally accepted standard bus along with the flexibility and scalability offered by an industrial Ethernet architecture make for a compelling business case.

With industrial-grade Ethernet infrastructure more widely deployed, PLC and instrumentation manufacturers are actively producing new products that utilize Ethernet's capabilities. While deploying the latest technology may be an easy decision for new installations, existing plants will remain resistant because it will require the replacement of existing field equipment, spares and inventories, as well as new tools. In addition, it will require valuable hours to replace equipment, cause interruptions in process operations, and require extensive personnel retraining, all at significant cost, both in time and money.

While the future may be less than 15 months away (according to the ARC Advisory Group) for new installations, existing facilities simply cannot afford to make the leap as quickly. While they may desire and need the benefits and efficiencies the new technology will bring, replacing their existing infrastructure is simply not a viable option.

But what if it they didn't have to replace their equipment and field devices? What if there was a solution, a technology that could bridge the gap, allowing an existing facility to leverage their current investments in equipment, spares, tools, and knowledgebase. What if this technology would allow them to reap the benefits of the latest innovations in networking and IP tools, and provide cost effective solutions that did not require existing units to be removed or replaced? Raven Technology Group believes that it has technology today in the RNA-1845, which provides existing facilities with a means of upgrading their existing plants more cost effectively, faster, and without disruption of process or knowledgebase.

So the technology exists. Let's examine reasons why an existing facility would move to implement this technology. The short answer is efficiency in data collecting, monitoring and access; all of which equate to costs savings for the end user. In the '80s plants gained efficiency by implementing industry changing technology: the programmable logic controller (PLC). It provided an interface for field devices into a common processor that was capable of making

decisions on input signals based on programmed logic. This information was soon ported to the man-machine-interfaces (MMI), soon to be politically changed to human-machine-interfaces, or HMI packages. The efficiencies in the '90s was the HMI and its ability to display PLC provided field data, while providing the efficient capability of human input for control and monitoring of their facility. This technology evolved quickly providing the capabilities of comprehensive graphing and data archiving, as well as statistical process control and data modeling. Now that the plants had extensive control and monitoring capabilities, both local and remote, manufacturers and technology reached a point of efficiency saturation with PLC and HMI systems.

And so the next wave of efficiency appeared in the form of highly flexible access to data. In the late '90s companies like Lighthammer and IndX Software, now a Siemens company, created IP rich applications that allowed anyone with a browser the ability to gather data and even choose how to display that data. This was the first real portal into the industrial plant. It was the first time we saw technology unifying disparate systems, in this case data, into a common viewing format. This advance allowed more data to be displayed in more places, and better decisions to be made. Plant floor data and Enterprise Information Systems (EIS) information now shared space on one screen. The plant supervisor and the CFO now shared time on the portal watching data and KPIs (Key Performance Indicators) change in real time. And so began the new efficiency for the 21st Century; access to more data. And this led to, as it did in each evolution of efficiency, cost savings for the customer. Decisions to move a production line off site due to mechanical failures, distribution problems, or better utilization of corporate resources were all capable of being made with real-time data and statistics by better informed people on any Internet browser-capable device.

Industrial instrumentation and PLC manufacturers are scrambling to get to market first with Ethernet and IP technologies. The recent Rockwell-Cisco partnership highlights this race. Companies such as Honeywell and Emerson have announced new product rollouts including Emerson's SmartWireless mesh networking devices. Garretcom, Ruggedcom, GE Multilin, Woodhead, Phoenix Contact and others offer a plethora of industrial-rated switches and PoE devices. More PLCs are now web-enabled and have Ethernet and IP technology offerings. HMIs are now inherently capable of being viewed and implemented in remote sites due to these technologies. So all the pieces of the control and monitoring puzzle exist and are now available.

What has been missing or has been in short supply are devices that can bridge the gap, providing Ethernet connectivity and enhanced capabilities to existing field devices. The RNA-1845 from Raven Technology Group is easily attached to an existing field device. It converts the analog signal to a digital value and transmits that value over standard Ethernet to either a PLC or a HMI workstation. It is industrial-rated, powered by either PoE or an external 24vDC source, and is designed to mount directly to any transmitter, analyzer, or field device. It can provide loop power to the attached field device, gather, monitor, and log data, has onboard diagnostics, document storage, and is HART master capable. The RNA-1845 provides a "virtual upgrade" of any existing field device. It enables the device, provides direct access to device data without disrupting the process or requiring device replacement. Spares, maintenance and repair tools and personnel knowledge remain unchanged. The RNA-1845 is protocol independent, it can be attached to any manufacturers' field device and can put literally thousands of devices onto one Ethernet network providing values to PLCs, DCS systems, HMI systems, or browser based interfaces. Raven Technology Group claims that the software technology used is extremely robust having been utilized in a commercial application to the tune of nearly a couple hundred thousand devices.

Many current events and questions surround the transition to newer technologies. With the latest passing by the HART Communication Foundation of WirelessHART, many argue that Ethernet enabled IO or field devices aren't needed. While it is true that HART dominates the world of field devices and instrumentation, a recent editorial from the pages of Control Engineering notes that, "For all of the HART-enabled instruments installed, fewer than one in

five use the diagnostics functions and secondary variables.[iii]" Chuck Lanham, of Raven Technology Group asks, "So what's left of HART but the network; wired or wireless?" Lanham, VP and CIO of Raven Technology Group, oversees Network Architecture and Operations.

Lanham explains that the RNA-1845 transparently replaces existing proprietary industrial bus networks such as a HART network with an standard Ethernet network while providing the HART diagnostics and secondary variables should the user want to use them. In addition, the Ethernet network is significantly faster and offers far greater scalability than HART or other existing bus networks. If the user doesn't have HART in the field, or utilizes HART among other deployed buses, WirelessHART is only partially effective as a solution; if at all. With the use of the RNA-1845, the user can benefit from their HART-enabled field devices as well as benefit from those that aren't HART-enabled. The RNA-1845 can unify these disparate devices and allow all of them to happily co-exist on one bus; an Ethernet bus. Raven Technology Group promotes the RNA's ability to virtually upgrade existing devices as a real and tangible solution to implementing cost saving upgrades and achieving the benefits of increased efficiencies in data collection and dissemination.

It is easy to justify deployment of RNA-1845 technology, especially with the increasing availability of Ethernet and IP solutions. Some of the deployment opportunities include age-induced field device replacement requirements, increases in I/O beyond existing PLC/PLC cabinet capacities, the cost of additional analog I/O into existing PLC infrastructures, built-in limits on number of devices on device bus networks, slow network speed and data throughput, and the ability to monitor, manage, and maintain deployed field devices from a central office, remote locations or any internet browser-capable mobile device. When you consider plant expansions and complete or partial system upgrades, the RNA-1845 really shines. And while it provides compelling benefits in low or single unit quantities, deployment of the RNA-1845 in very large quantities becomes even more compelling because of the unique architectural benefits it employs.

It is important to note that the RNA-1845 design has been specifically tailored to easily connect to field devices rather than mounted in an enclosure located in some centralized location. Thus each device becomes an IP addressable device that can be incorporated into a subnet that contains literally thousands of devices. Configuration and maintenance information can be monitored and adjusted remotely through the attached RNA-1845 assuming the device is HART-enabled.

Traditional bus network architectures are limited by the number of nodes that can be supported. Large plant installations must therefore deploy numerous networks of field devices; each network requiring a connection to an IO module on the PLC. Deploying the RNA-1845 in either new or existing plants adds nearly endless opportunities to increase data acquisition and monitoring capabilities to existing PLC systems without requiring additional IO modules. A single Ethernet port can support a virtually unlimited number of field devices. At the same time, simultaneous access to data from multiple sources can easily be achieved without additional programming or changes to existing HMI/SCADA systems. Data values are logged and stored at each field device location and can be retrieved and archived if desired.

Figure 1 illustrates a small network with four remote storage tanks with level transmitters mounted to each tank. Each level transmitter has a RNA-1845 mounted directly to it and standard Ethernet Cat-5e cables are run from each RNA-1845 to either a PoE-enabled Switch or a midspan device that connects the devices to the network while providing power to cabled RNA-1845 devices. Each RNA-1845 provides 24VDC loop power to the attached transmitter; no additional wiring for data or power is required.

Network connectivity from the remote switch or midspan to the central control office can be accomplished through any number of media including Cat-5e cable, Fiber-optic cable, or wireless radio. At the central control office the incoming network connection can be a standard switch, hub, or Ethernet module. Note that the incoming data values coming from the remote field devices can be simultaneously accessed from multiple locations. Specialized or proprietary network interface cards (NIC) are not required to provide connectivity between the field device and a enterprise network or standalone workstation.

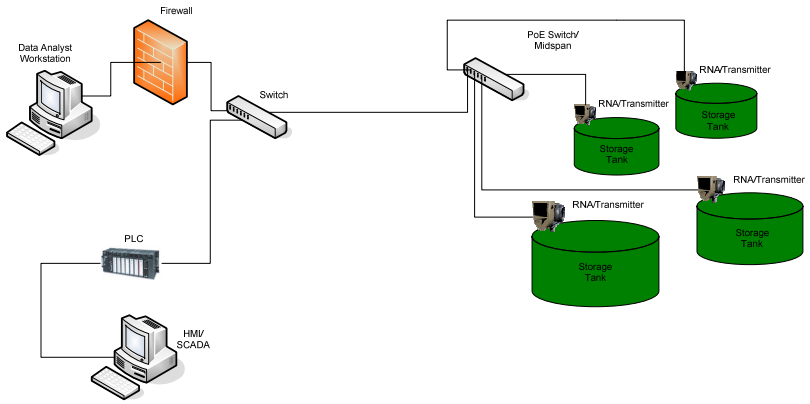

FIGURE 1. SMALL REMOTE SYSTEM ARCHITECTURE

While the size of the network in Figure 1 is for illustrative purposes very small, there is virtually no practical limit to the number of devices that can be placed on a properly designed subnet. Remote PoE switches/midspans are available with a wide range of ports and each can be connected to intermediate switches in order to provide large network capabilities as shown in Figure 2.

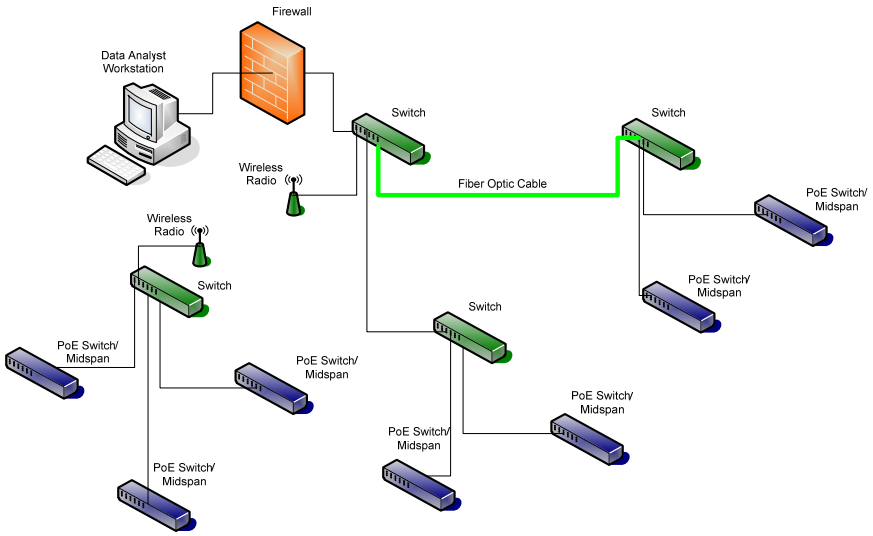

FIGURE 2. FLEXIBLE NETWORK ARCHITECTURE

Traditional bus networks such as HART are limited to the number of nodes that can be physically attached to a network. While repeaters or similar devices can be inserted into the network to allow for more devices, the overall physical size of the network remains limited. By configuring and deploying multiple networks throughout the plant, the user can achieve required device densities, but at the cost of adding additional IO modules to the PLC.

Customers that choose to use Ethernet can configure a network that will support literally thousands of devices and required a single IO port on the PLC or network. Distance between nodes becomes irrelevant or certainly much less of a limitation since subnets can be connected utilizing a wide array of available media such as Fiber Optic cable, wireless radio, or even satellite.

In summary, we have observed that:

1. the growth of telecom industry exploded when they deployed Ethernet technologies and offered users flexibility, ease of use, and cost efficiencies,
2. the same trends are already happening in the industrial space to the tune of an emerging Billion dollar market, and
3. industrial Ethernet infrastructure currently exists and has and is being deployed.

The technology to bridge the gap between the capabilities of legacy systems and the latest advanced technological systems exists today. Bridging this gap provides users the opportunity to obtain the benefits of current technology without the necessity of replacing their entire systems prior to planned obsolescence or replacement.

[i] Marketing & Public Relations Portal: Products, New, Articles, Events & Resources ARC says International Ethernet Market will hit $955 Million by 2011 – Automation.com September 20, 2007
[ii] ARC Advisory Group. - Industrial Control Design, July 24, 2007
[iii] Editorial: WirelessHART moves into its next stage. Should it? - Control Engineering, September 20, 2007