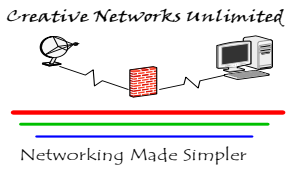

Industrial Ethernet Switches

ITEC495 V1WW

Assignment 1-3-5 Whitepaper

Developed for

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2. Abstract

This Whitepaper provides information and a detailed look into an industrial network infrastructure backbone environment using Industrial Ethernet Switches and why they are a good choice for ABC Utility Company. It describes the specifications and features of the switches and expresses the design capabilities to operate in hazardous and harsh environments, as well as provide the organization with a reliable, redundant, and rugged industrial backbone.

3. Introduction

To understand why industrial Ethernet switches are an important network component to install when building a backbone infrastructure for an electric utility environment, it helps to know the important aspects of the environment and what the backbone needs to accomplish. "Industrial networks are different than the traditional office PC networks because the equipment includes specialized automation systems such as PLCs, robots, process controllers, and power monitoring systems" (Ismat, n.a.). The industrial network is designed for factory automation, process control applications and provides real-time behavior. Note: figure 1 in the Appendix, which displays a complete Industrial network system. The network backbone is part of the network infrastructure that connects to other switches or routers, by fiber optic or Ethernet cables, and provides a high speed path to transfer network traffic and exchange information. Each switch becomes an entrance point or exit point for all messages, making this a very valuable network component for an organizations traffic flow. "A network and its backbone are based on the needs of the business, can be easily maintained, is fault tolerant, generally support lots of bandwidth for all current users (and future users), and have the ability to be expanded" (Toolbox, 2005). In an industrial network system,

large amounts of data need to be transmitted across the network without any interruption in the network communications.

Important elements required in an industrial environment backbone which the network system must address are; to contain effective high speed communication while reducing noise characteristics, provide high availability and deliver the performance under rough conditions, shock, vibration and temperature fluctuations between - 40° C up to + 85° C. A redundant network backbone needs to be built in order to with stand these conditions and sturdy reliable Industrial Ethernet switches can communicate under these types of industrial settings. The specifications of these Industrial switches provides true enterprise-class networking capabilities, exceeding the equipment connected, such as PLC's, Ethernet I/O, HMI's, etc.

4. Problem Analysis

The current problem with Creative Networks Unlimited client, ABC Utility Company, is their existing network infrastructure backbone is not easily maintained, is out-dated, has reached its bandwidth limit and can not be expanded for future use. ABC's network backbone is critical to all the plants processing functionality. Their current network backbone contains 10 Base T technology connecting unmanaged hubs and forming a Token Ring style protocol and peer to peer communication. The interconnection to the plant process equipment, (PLC) Programmable Logic Controllers, is through a serial proprietary interface which has exceeded network length limits, is very susceptible to EFI noise and has reached its bandwidth limit. The unmanaged hubs in the backbone are experiencing collisions as well as loosing data and bottle necking, causing severe network communication problems.

Early plant-floor Ethernet networks often attempted to tie plant-floor equipment into the same Ethernet hubs that were handling front-office workstations. A hub is simply a multi-

port broadcast device. It takes whatever comes in any port and broadcasts it out all the other ports. Even if two hubs are interconnected, you basically end up with one big collision domain, with all traffic shared. As network nodes are added or traffic increases, every node in the collision domain has a greater chance of slowing communication or having a collision. (Network Hubs vs. Switches, n.a.)

The hub shares the total bandwidth among all users, plus it makes no traffic direction decisions so they offer no network protection. The hub does not verify the packets integrity nor does it inspect the quality of the traffic. Many users who are sending large files have to wait on each computer to take its turn before sending data, causing response time delays. This was a great concept in the 70's when data could not be transmitted at the high speeds available today, which makes this half-duplex system a very inefficient way for traffic to flow.

5. Potential Solutions

The project has been approved for ABC Utility Company to change their network infrastructure to an Ethernet network. The backbone of the system will include a fiber optic ring to form as the central hub for a star topology while a network component is needed for transmitting the data around the ring. Below are a few potential solutions available when considering which type of industrial switching equipment will benefit ABC's backbone.

1. Industrial Ethernet Hubs
2. Industrial Ethernet Bridges
3. Industrial Ethernet Switches (managed or unmanaged)

Each component has its own special features in aiding network traffic and all devices connect one or more computers to other computers, network devices, or to other networks. "Each has two or more

connectors called ports into which you plug in the cables to make the connection" (Kioskea, 2009). The main difference in these devices is their intelligence and what happens inside the device.

6. Criteria

There are literally hundreds of different components available and by different vendors which are beyond the scope of this paper, which is why comparing these different Ethernet components and how they transmit data across a backbone will suffice which communication device is best for ABC. Each of these network devices are designed to operate in industrial plant floor environments which are harsh with a lot of electrical interference.

6.1 Industrial Ethernet Hubs

"A hub operates by gathering signals from individual network devices, optionally amplifying the signals, and then sending them onto all other connected devices regardless of the MAC address" (Network Primer, 1999). It does not filter or redirect the data and it does not examine any signal contents. If two devices try to communicate within the same area of the network, congestion and collisions can occur and performance can be degraded. Performance can be improved by adding other routers, switches or bridges to the network. Most hubs operate at OSI level 1, the physical layer, by investigating incoming or outgoing signals for information.

6.2 Industrial Ethernet Bridges

A bridge connects two or more network segments, or networks of the same network, plus they can use different physical and data link protocols. Bridges examine the MAC addresses and then decide whether to forward the packet or ignore it. "Bridges can help reduce overall network traffic and are relatively simple and efficient traffic regulators, however, in most networks they have been replaced by their less expensive or more powerful cousins; hubs, switches, and routers" (Network Primer,

1999). Most bridges operate at OSI level 2, the data link layer, by examining incoming or outgoing signals for information.

6.3 Industrial Ethernet Switches (managed or unmanaged)

A switch has an additional capability as compared to a hub; it is more powerful and it can send and receive devices simultaneously and use the entire bandwidth of a network without interference. Switches examine the packets information, the sender and receiver addresses, and sends the packets only to the desired MAC address on the packet. Switches can provide pairs of communicating devices with fast connections and they are smart enough to segregate the communication and not send packets to other portions of the network. A switch also contains multiple ports as compared to bridges. Most switches operate at OSI level 3, the data link layer, by examining incoming or outgoing signal for information. Although layer 3 switches are available they are often cost prohibitive.

The differences between managed or unmanaged switches is; A managed switch gives administrators control of the network and all the traffic transferring through it, while an unmanaged switch simply allows Ethernet devices to communicate with one another. Managed switches are also much more expensive than unmanaged switches.

> Unmanaged switches use a protocol called "auto-negotiation" to agree upon certain communication parameters. One parameter they negotiate is the data rate — generally 10, 100 or 1000 MBps. Another is whether to use half-duplex or full-duplex mode. A managed switch, on the other hand, does all of this while also providing the flexibility of being able to adjust the communication parameters of each port on the switch to any setting you desire. (Pacchino, n.a.)

7. Selection and Defense

After thorough examination of each communication routing device, the selection has been chosen to include unmanaged Industrial Ethernet switches for these main reasons;

- Hubs waste transmission time and cause congestion. This puts real-time operation in jeopardy and makes determinism difficult. More hubs could be added to the backbone but this will be at a high expense, depending on how many are needed, and possibly not help the collision issues. ABC's information traffic flow is increasing and hubs were designed for less traffic.
- Bridges were designed with small networks in mind and are typically used to separate parts of the network that don't need to communicate on a regular basis, but need to be connected.
- Bridges are normally used to split a LAN into a couple of smaller network segments, whereas switches are usually used to split a large LAN into many smaller network segments.
- Bridges only have a few ports for LAN connectivity, whereas switches generally have two or more ports.
- Switches reduce the one big collision domain and break then into several separate segments, which will eliminate congestion and increase network bandwidth.
- Unmanaged switches were chosen over managed switches basically because of the difference in cost and ABC can set the switches to the parameters they need and do not need to change them for future expansion. They are more feasible for the backbone infrastructure than managed switches.
- Unmanaged switches contain several features such as redundant power inputs, extended temperature fluctuations, reduced noise vulnerability, and other hardware features that are essential to industrial networks and are more traditional for backbone connections.

8. Conclusion

Typically, messages sent across an industrial backbone environment need to be able to deliver fast performances under rough hazardous conditions and fluctuating temperatures. Ethernet is capable of resolving collisions by randomly delaying data and industrial Ethernet switches are being designed with these conditions in mind. Industrial Ethernet networks and switches are becoming a standard for many installation backbones in industrial environments. Redundancy is the surest path to system reliability and a practical solution, to provide this is by installing a ring technology using Industrial Ethernet switches.

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10. Appendix

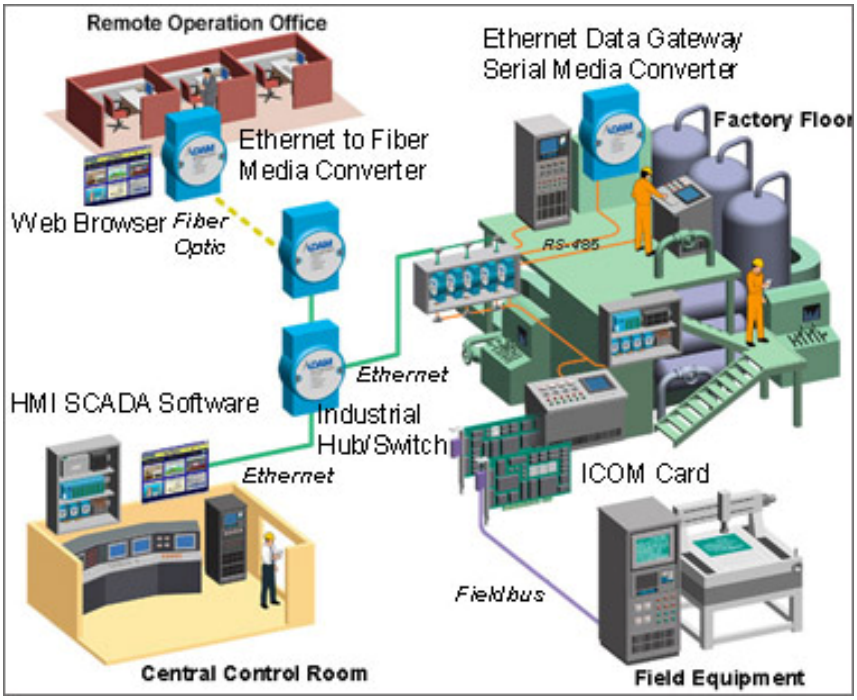

Figure 1. Industrial Network System (ntron.com, 2009)