WHITE PAPER

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PHOENIX CONTACT
INSPIRING INNOVATIONS

Ethernet switches 101

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INSIDE:

Introduction

Ethernet has been making its mark on the networking world for years because of its abundance of benefits. It serves as a universal communication technology used worldwide, from homes to industrial networks to data centers. Ethernet has played a crucial role in the evolution of device communication and the Industrial Internet of Things (IIOT), empowering the world of data collection, transmission, and analysis to reach the magnitude that it is at today.

In the industrial world, Ethernet is used across a variety of applications as a standard for device communication. Ethernet is the fundamental platform for many widely known industrial protocols such as EtherNet/IP, PROFINET, and Modbus TCP. These protocols utilize the Ethernet platform to perform a multitude of industrial tasks that are often critical to industrial applications. In some networks, hundreds of Ethernet devices work together to ensure that a system is running correctly. This is where Ethernet switches come into play.

Ethernet switches are devices implemented into a network to connect multiple devices and allow them to communicate with each other. They also prioritize the flow of data between devices to minimize latency and data collisions while improving network efficiency. However, Ethernet switches come in many different sizes and variations. Today's Ethernet switches feature increased functionality such as network security, diagnostics, redundancy mechanisms, and much more. Through the use of Ethernet switches, anyone can feel confident in their network's reliability.

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Ethernet basics and industrial protocols

Ethernet technology allows communication between devices over a single network or multiple networks. For these devices to communicate effectively, every Ethernet device follows a standardized set of rules that permits communication with other Ethernet devices in a reliable, clear way. With this standardization, many different types of Ethernet devices can be added to a network seamlessly.

Ethernet sets the foundation for many industrial networks. Industrial protocols then build upon this foundation, resulting in greater control, reliability, and management of an industrial system. These protocols ensure proper communication between the many devices on an industrial network. It is extremely important that the system operates efficiently and without downtime, and industrial protocols play a large part in that. There are many different industrial protocols that independently excel at performing certain tasks; however, some of the more common protocols are Modbus, PROFIBUS, and EtherNet/IP.

Ethernet has developed significantly over the years and can be transported in a variety of methods. Typically, data is transmitted in the form of copper cables with RJ45 connectors. When many people see an RJ45 cable, they often connect it with Ethernet. In homes, it's the most common way to connect to the Internet.

However, Ethernet can also be transported over fiber-optic cable. This is common in industry for situations that require a long run of a communication line. For example, fiber-optic cables are run across the floor of the ocean to connect the Internet between continents. Ethernet standards and technologies are updated often, and the transmission speed has increased significantly over the past decade. The newest Ethernet devices can transmit at speeds of up to a gigabit and beyond.

Ethernet topologies and redundancy

Ethernet topologies ensure the efficiency and reliability of an industrial Ethernet network. An Ethernet topology is the orientation and wiring of the devices within an Ethernet network. These topologies typically give devices multiple paths to communicate with other devices. The design of a network topology is crucial when trying to design a redundant network. A few examples include a star topology, ring topology, and mesh topology (Figures 1-3).

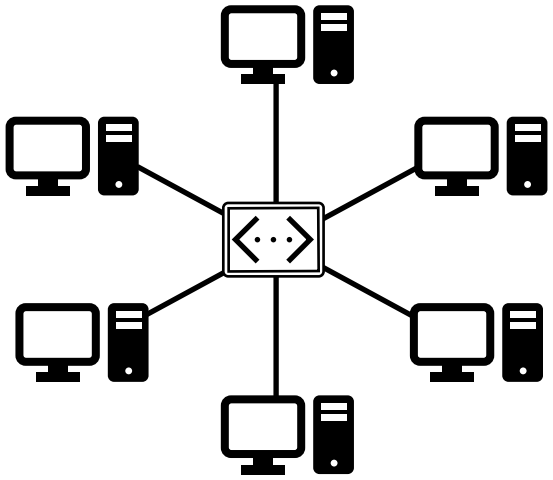

Figure 1: A star topology is very common when using unmanaged switches to connect multiple devices together on the same network.

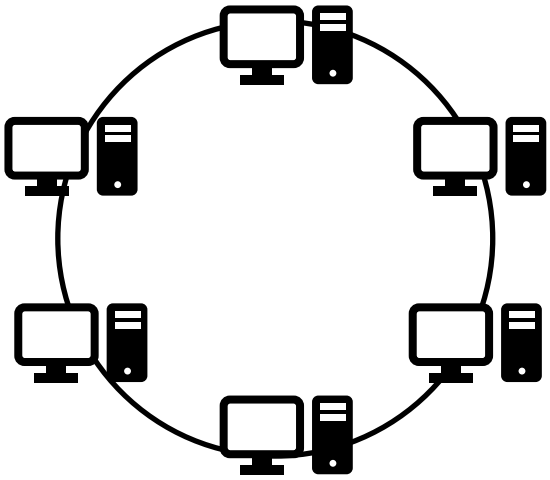

Figure 2: A ring topology is the foundation of many redundant systems, which are common in industrial networks.

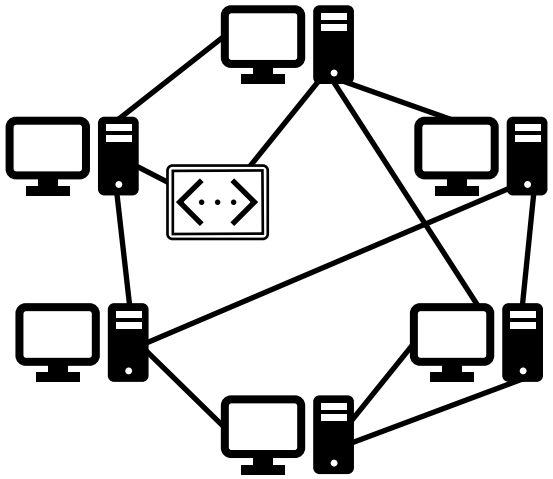

Figure 3: Mesh topologies are also very common. They are robust and help ensure the uptime of the network because there are multiple connections to each device.

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These topologies become very important when looking to design a robust, redundant network. Redundancy, in its most basic form, allows the network to stay online even if it has a failure. This makes the network more reliable and ensures network availability.

As mentioned earlier, ring topologies are the foundation of many redundant systems. Ring topologies are an easy way to provide multiple paths for traffic to flow in a network. If there is a line break or a device goes down, there is still a way for all the working devices to communicate with each other.

This is different from a star network. If the connection between the device and the hub or switch is interrupted in a star network, that device will lose connection until the connection issue is resolved.

Minimizing possible downtime in automated processes is critical today, so redundancy is crucial in industrial networks.

Switches

An Ethernet switch is a piece of networking hardware that connects devices on a network. It works as a centralized connection point for any wired network devices to communicate with other devices. It also manages the flow of data between these devices. A switch can connect things like computers, Wi-Fi access points, power over Ethernet, and IoT devices so they can communicate with other devices on the network.

When two or more devices on a shared network attempt to send data simultaneously, this can result in a "packet collision" or the possible loss of transmitted data. Ethernet switches can prevent these packet collisions and improve the efficiency of the network. The switch does this by learning the media access control (MAC) address, which is comparable to your home address in the Ethernet world. Nobody else in the world has your address, and the same goes for the MAC address of a network device. The switch learns these addresses, so that when one device is trying to send data packets to another, the switch can direct those packets to the correct device, rather than broadcasting that packet to all of the devices connected to it. This increases the network efficiency and limits the amount of unnecessary traffic on the network.

Network switches are an easy way to add a multitude of devices to a network and are a staple in the world of Ethernet.

Unmanaged switches

Unmanaged switches are simple and could be considered the "terminal block" of the Ethernet world. They don't require any configuration. You can simply plug devices in to have them communicate. Unmanaged switches can have RJ45 ports, fiber ports, or a combination of the two, depending on the user's needs. They can be used everywhere for connecting devices on a shared network.

Unmanaged switches are the easiest way to connect Ethernet devices on the same network, and they are typically used for smaller networks. Industrial unmanaged switches typically come with a lot of variabilities in terms of the number of ports they have, their environmental rating, and the flexibility of connections (RJ45 and fiber).

Managed switches

Managed switches have all of the functionality of an unmanaged switch, but they are configurable, so they have plenty of advanced features, like diagnostics and port mirroring. As the name implies, "port mirroring" mirrors packets to a second port, so that those packets can be monitored, possibly by a network-monitoring software or IT department. It's like providing a carbon copy of every packet so that it can be properly monitored.

They can also provide network statistics, so you can see what kind of traffic is flowing through the switch. This allows the admins to decrease possible downtime of a system. In the long term, this can result in cost savings, especially in a system where failure is detrimental.

Managed switches can also handle a variety of redundancy protocols and topologies. Some topologies will require a managed switch to manage the connections between devices on the network to prevent broadcast storms. Managed switches also come with security features to keep unwanted devices out of your network. You can disable and enable ports, as well as set a password on the switch to prevent unauthorized access.

There are tons of reasons why a network would need a managed switch, but the diagnostics, security, and redundancy make them especially suitable for large and complex systems.

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Conclusion

Ethernet technology allows communication between devices on the same network. Ethernet switches are pieces of hardware that serve as a central place for communication. Switches manage the flow of data to prevent packet collisions and improve the efficiency of the network.

There are two types of Ethernet switches: unmanaged and managed. Unmanaged switches are simple as they require no configuration, while managed switches have abundant advanced features with their configuration options. When designing and implementing an industrial network, understanding the differences between managed and unmanaged switches will help ensure an efficient and reliable network.

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Phoenix Contact is a global market leader based in Germany. Phoenix Contact produces future-oriented components, systems, and solutions for electrical controls, networking, and automation. With a worldwide network reaching across more than 100 countries with over 20,300 employees, Phoenix Contact maintains close relationships with its customers, which are essential for shared success. The company's wide variety of products makes it easy for engineers to implement the latest technology in various applications and industries. Phoenix Contact focuses on the fields of energy, infrastructure, process, and factory automation.

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