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Leveraging the Industrial Internet of Things (IOT) to Optimize Renewable Energy

Creating More Efficient and Connected Wind Turbines

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Leveraging the Industrial Internet of Things (IIOT) to Optimize Renewable Energy

Overview

The Industrial Internet of things (IIoT) has been made possible in part by the mass transition of industrial grade equipment utilizing an Ethernet data medium as a main link to networking infrastructures. Along with rapidly expanding availability and affordability of the Internet through access links such as Ethernet, fiber optics, wireless and LTE, even the most remote locations have internet connectivity options.

The Industrial Internet of things represents the ability to access information and data from critical machines, sensors, and controllers connected to the Internet. The resulting systems and individual devices that comprise it can collect, exchange, monitor, analyze, and act on information to intelligently make changes to the systems or devices with little to no human intervention.

Today, more and more devices are being connected to the Internet of Things, and therefore, our world is finding itself in a time where we can interact with and control everything from light switches in our home to wind turbines in large, remote wind farms.

However, unlike light switches, failures that occur in remote locations such as wind farm systems result in interrupted wind power generation which leads to decreased productivity and increased costs. With constant fluctuating energy prices, profit margins can be very thin making it extremely critical to ensure optimal energy production, efficiency and uptime.

Why Industrial Networking?

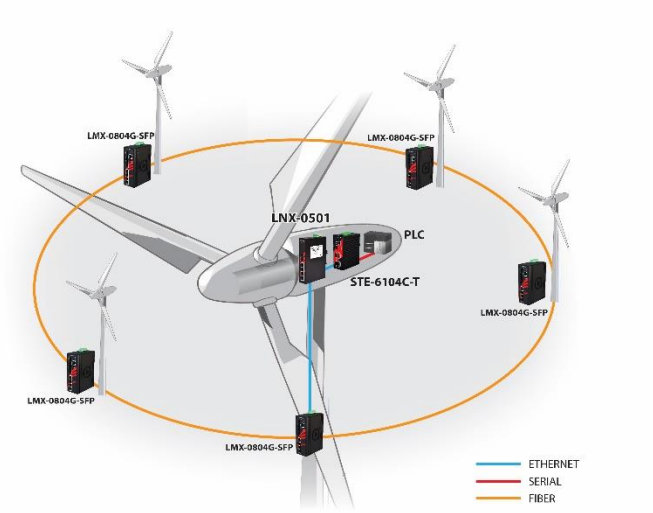
Industrial networking equipment can bridge the gap between a wind farm, control center, and remote access sites making IIoT possible. The need for regular on-site inspection and preventative maintenance to sustain long-term returns is critical. The ability to monitor and analyze data on a daily, monthly and even yearly basis at a wind farm can provide a more in-depth look at individual turbine performance. Based on this data, an optimized maintenance strategy can be utilized to prioritize turbines that have been experiencing abnormal performance losses and minimize downtime.

An industrial-grade network infrastructure offers wind farm operators many benefits, including improved operational management, access to real-time data, network security features and automatic system warnings. These features are designed to provide real time data, control, and secure access from remote monitored locations.

Because wind farms are typically situated in extremely remote, outdoor environments, reliability of equipment is critical. Industrial-grade networking solutions are also designed for extremely rugged environments and support long mean time before failure rates, typically greater than 100,000 hours. All controls and Ethernet equipment must be able to tolerate extreme temperatures, lightning strikes, and potential electrical interference from high power turbines.

Redundancy

Keeping the network up and running at all times is imperative to wind farm operations. For networks containing multiple end devices, in our case wind turbines, industrial managed Ethernet switches with built-in fiber ports allows for a ring redundancy architecture which prevents the loss of control and data to the wind farm despite any link failure. Multiple fiber ports available on the switch in the control cabinet at the base of the wind turbine provides at least two connections to the redundant ring, plus one or more additional fiber ports to run fiber to the nacelle to connect sensors and other devices, proactively safeguarding against failure while assuring network uptime. If a switch fails, a cable is cut, a connector disconnects, or any other type of disruption occurs, the system can automatically route data around the problem using the redundant path.



Network administrators can choose between multiple ring topology standards that is the best fit for their application. For example, a wind farm might decide on implementing a Rapid Spanning Tree Protocol (RSTP) ring because they would like to utilize a mesh network topology. The RSTP is very resilient, capable of operating throughout multiple points of failure but has a network recovery time of approximately thirty seconds. If thirty seconds of network outage with no energy production or data collection is a major issue a wind farm might choose to implement Ethernet Ring Protection Switching (ERPS). By utilizing a ERPS ring in a managed industrial Ethernet switch it is possible to achieve recovery times of under 50 milliseconds if a link failure occurs. The downside is that a ERPS ring is only capable of having a single point of failure.

Fiber Optic Support

Wind turbines are equipped with a control cabinet containing a PLC, inverter power source, HMI and I/O devices at the base of each tower. At the top of the tower or the nacelle, there are several sensors to detect wind speed, wind direction, and shaft rotation speed. Sensors that collect real-time data from turbines must be quickly analyzed and turned into actionable insights to continually assess acceleration, temperature, and vibration. To optimize power generation, each wind turbine must adjust its settings/behavior, based on data it receives from the system.

Sending and receiving data to and from all of the various sensors and pieces of equipment that are located in the nacelle is very important. The communication path from the top of the wind turbine to the base has some of the greatest communication challenges to overcome. Sometimes it is possible to utilize shielded Ethernet cables to provide the data link from the cabinet at the base of the wind turbine to all of the equipment in the nacelle. Ethernet cables are able to provide communication links for about 330 feet, well within the range of most wind turbine heights. A fiber optic link, however, does not only overcome possible distance limitations, but can also offer EMI immunity. Due to the power generated by the turbine, there is considerable electromagnetic interference present inside the wind tower. This can negatively impact communication and corrupt data or cause the loss of data if Ethernet cables are used exclusively. Fiber optic cables are also able to mitigate damage caused by lightning strikes to the wind turbine and prevent the lightning strike effects from propagating to other pieces of equipment.

Advanced Management

The sheer size of wind farms and their remote locations pose challenges. If issues do arise the detection and recovery time is much longer for networks that implement unmanaged network equipment. By utilizing industrial grade managed switches there are quite a few additional software features that can be implemented through the web interface of the switch to improve data flow, performance, network traffic and maximize system uptime. Some of the more commonly implemented features include IGMP snooping, Quality of Service (QoS), VLAN's, network redundancy and system warnings.

The IGMP snooping feature monitors traffic on the network creating and maintain a map of what pathways use multicast traffic streams. Some common pieces of equipment that send out multicast traffic are security cameras and PLCs. By learning where network traffic goes the switch is able to filter the multicast traffic and only send it to locations that require it, rather than sending it all over the network, thus greatly reducing bandwidth consumption.

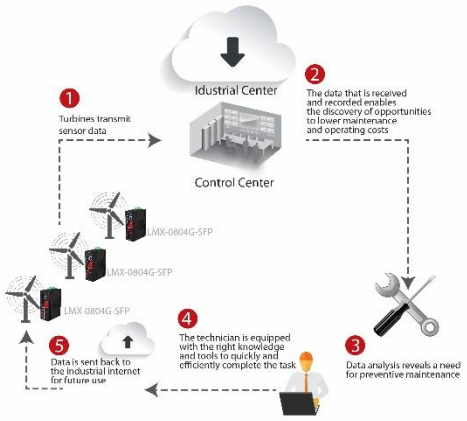
Virtual LANs (VLAN's) allow the network to be segmented through software to create seemingly isolated smaller networks. For example management overview, control data and security surveillance monitoring can all be put onto separate VLAN's and provided to the appropriate parties. This prevents someone in the surveillance monitoring department from

accessing the control section of the network. VLANs have the added benefits of reducing the amount of bandwidth being consumed. More importantly if a security threat or denial of service attack effects one VLAN, the threat will not spread to other VLANs on the network.

Quality of Service (QoS) allows traffic to be prioritized, so that if network congestion occurs higher priority traffic takes precedence. Managed switches also allow users to implement warnings and email alerts for various events so operators can be alerted remotely and respond faster to network issues.

IIoT Wind Farm Connectivity

The Internet of Things has been a growing topic since its introduction in 1999. Industrial grade networking equipment provides a high degree of reliability and control pertinent to smart energy management systems and offers a variety of solutions to the unique networking challenges that wind farms present. Not only is industrial networking equipment designed for rugged environments found in many wind farms, but redundancy, fiber optic support, and advanced software management features make a reliable and easily managed IIoT network possible.



About Antaira Technologies

Antaira Technologies is a leading developer and supplier that provides high-quality industrial networking and communication product solutions. Since 2005, Antaira has offered a full spectrum of product lines that feature reliable Ethernet infrastructures, extended temperature tolerance, and rugged enclosure designs. Product lines range from industrial Ethernet switches, industrial wireless devices, Ethernet media converters, and serial communication devices. Our vast professional experience allows us to deploy a wide array of products worldwide in mission-critical applications across various markets, such as, automation, transportation, security, oil & gas, power/utility, and medical.