



Facts

- To date, more wind turbines are installed in the state of Texas (US) than any other single region in the world. More than 400 are currently in use.
- According to Bloomberg New Energy Finance, new global investment in clean energy reached \$243 billion in 2010. Overall investment in wind gained 31% to reach \$96 billion. Of the total, 38% was accounted for either by China or by large European offshore wind farms.
- Honduras has announced that its first wind park is expected to come online in 2012.

Controlling and Monitoring Wind Farms with Redundant Ethernet Communications

Wind turbine manufacturers have embraced the use of Ethernet to monitor and control wind farms worldwide. N-TRON® specializes in developing and manufacturing products for the wind energy market so a significant number of these installations use the company's switches in fields. They are used to control, monitor and optimize the operation of the wind turbine installations from a central control room. N-TRON switches feature extreme specifications and can be used in the harshest environments:

- Up to -40° to 85° centigrade operation
- 200g shock
- 50g vibration
- 15 kV ESD overvoltage protection

Many wind turbine fields are in very remote areas. Component failures require an expensive site visit by maintenance personnel. This service call, combined with operational downtime, adds up to significant costs associated with a failure. Designed for high reliability (2 million hours MTBF), N-TRON switches have become a valued part of the control schemes used by many wind turbine suppliers and integrators. Reliability of the control system will also depend on the topology used to interconnect the wind turbine towers.

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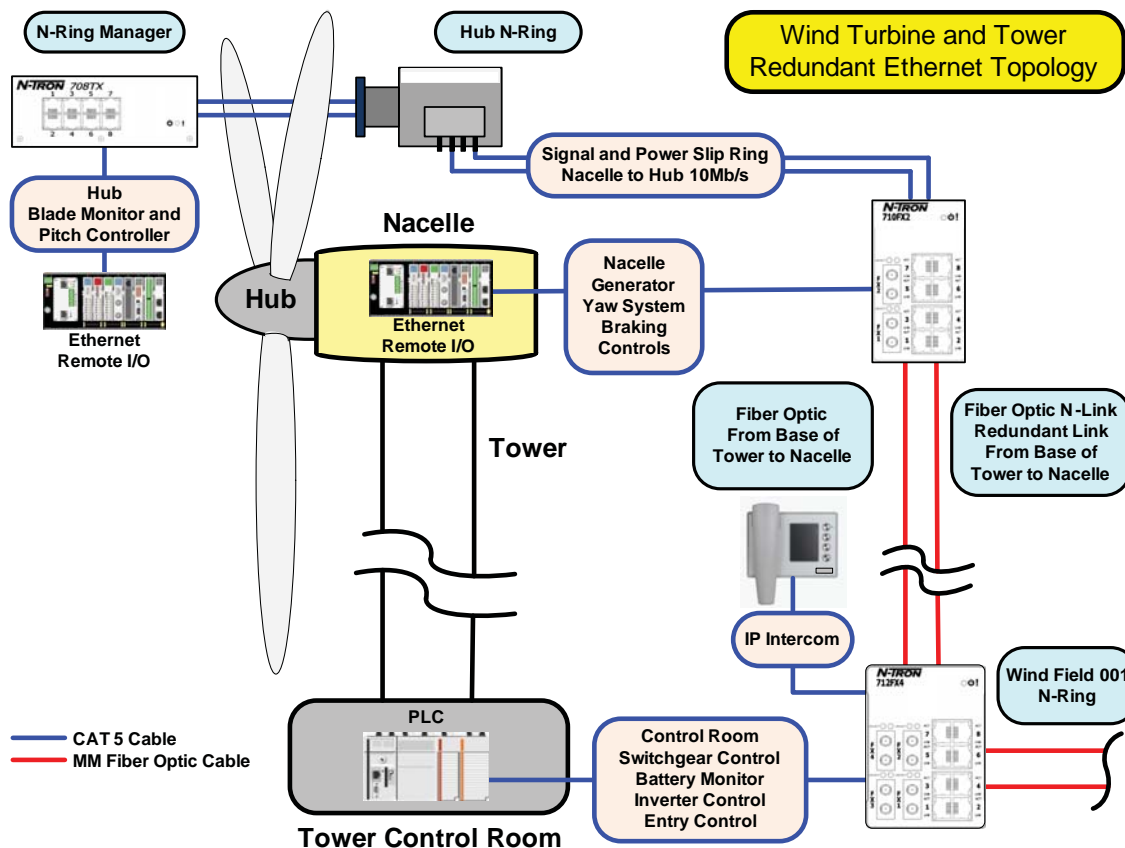
Wind Turbine Topology

Figure 1 shows the topology for a single wind turbine tower. Wind turbine control schemes vary. No matter which topology is implemented, redundant Ethernet connections between each area of the wind turbine installation will increase the reliability of the system no matter how the control is distributed. In Figure 1, N-TRON's N-Ring™ and N-Link™ protocols are used to provide a high-speed, redundant ring topology between each switch in the wind turbine network. The switches choose one path and block the other in the redundant links. If the connection being used is interrupted or fails for any reason, these switches will heal the ring by rerouting the Ethernet communications through the alternate connection within 30ms.

Using fiber cables instead of CAT5 copper cables between the control room equipment and the nacelle will provide optical isolation between the two control areas. This will minimize the potential for damage to the network switches and connected field devices during lightning events.

Each switch in this configuration can also transmit port assigned IP addresses to the field devices connected to these ports. Any time a field device is replaced for any reason the replacement will receive the same address. This feature ensures that the new device will receive the correct IP address for the SCADA control scheme. In order to take advantage of this feature, the field devices must be setup as DHCP clients.

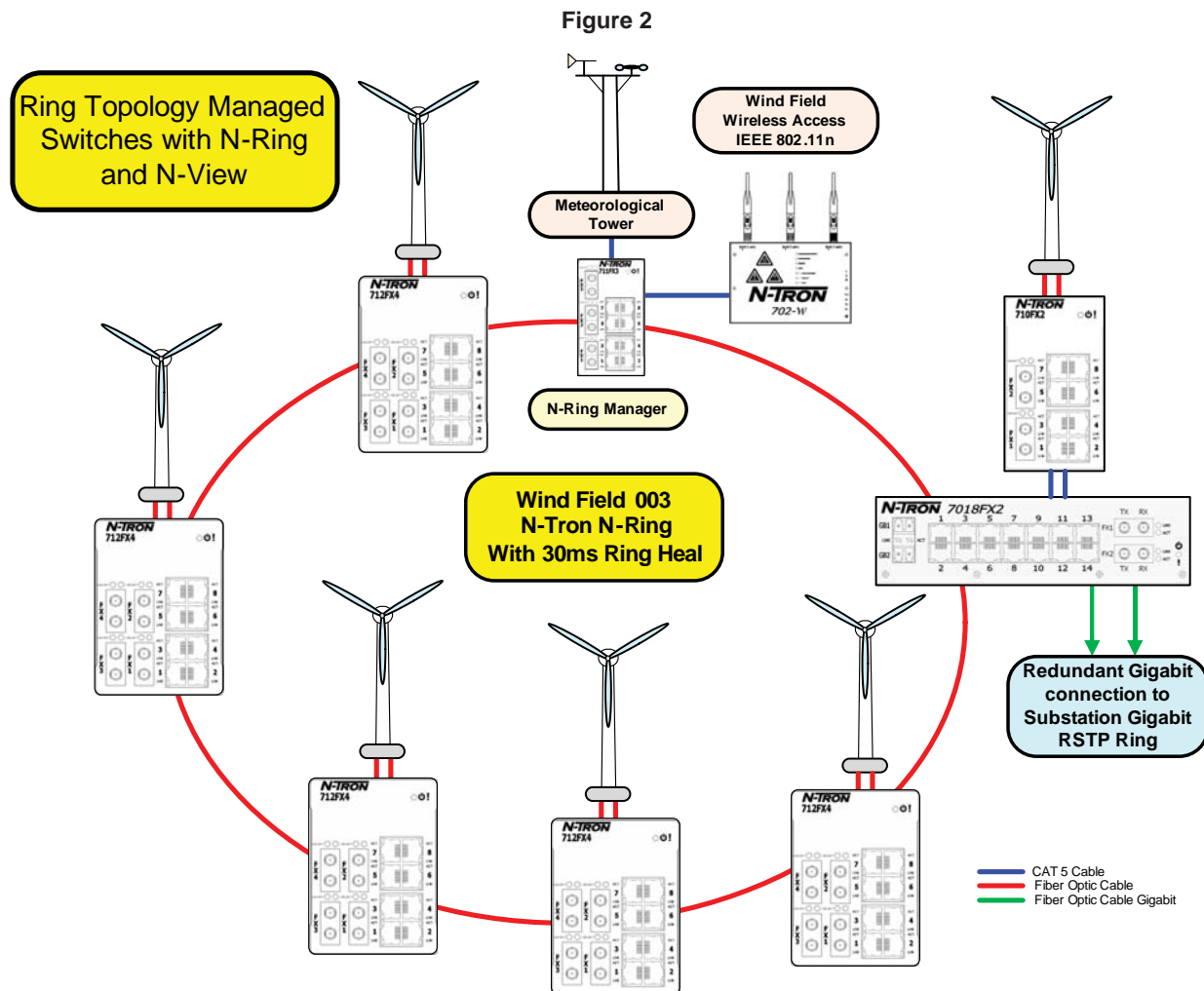
Figure 1



Wind Field Topology

Figure 2 shows an N-Ring high-speed self-healing ring topology. This configuration can be used to provide redundant fiber optic rings between the control rooms of each tower in the wind field. N-Ring will monitor and reroute Ethernet communications in the event of a break in the fiber optic cable within 30ms. The N-Ring manager can be monitored from anywhere in the network to determine where the break is located for quick repair (see Figure 3).

N-View™ OPC server software can be used to monitor 40 parameters on every port of each switch using the SCADA software to control the wind field (see Figure 4) or with the standalone N-View monitoring software provided with each switch.



A wireless access point with security (e.g. WPA2), located in each wind field provides maintenance personnel with access to the control network without physically connecting to the network or entering a controlled area. Area IP cameras can be used for security and IP intercoms can provide communication throughout the wind farm.

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N-Ring OK!!					
N-Ring Status View					
Switch is an N-Ring Manager.					
Switch No	MAC Address	IP Address	Subnet Mask	Name	Ports
RM	00:07:af:ff:f6:e0	192.168.1.136	255.255.255.0	N-TRON Switch	A2 A1
1	00:07:af:ff:f6:40	192.168.1.131	255.255.255.0	N-TRON Switch	A1 A2
2	00:07:af:ff:f6:60	192.168.1.132	255.255.255.0	N-TRON Switch	A2 A1
3	00:07:af:ff:f6:80	192.168.1.133	255.255.255.0	N-TRON Switch	A1 A2
4	00:07:af:ff:f6:a0	192.168.1.134	255.255.255.0		
5	00:07:af:ff:f6:c0	192.168.1.135	255.255.255.0		

Figure 3: N-Ring Manager Ring Status via Web Browser

N-Ring Fault!!					
N-Ring Status View					
Switch is an N-Ring Manager.					
Switch No	MAC Address	IP Address	Subnet Mask	Name	Ports
RM	00:07:af:ff:f6:e0	192.168.1.136	255.255.255.0	N-TRON Switch	A2 A1
1	00:07:af:ff:f6:40	192.168.1.131	255.255.255.0	N-TRON Switch	A1 A2
2	00:07:af:ff:f6:60	192.168.1.132	255.255.255.0	N-TRON Switch	A2 A1
3	00:07:af:ff:f6:80	192.168.1.133	255.255.255.0	N-TRON Switch	A1 A2
4	00:07:af:ff:f6:a0	192.168.1.134	255.255.255.0	N-TRON Switch	A2 A1
5	00:07:af:ff:f6:c0	192.168.1.135	255.255.255.0	N-TRON Switch	A1 A2

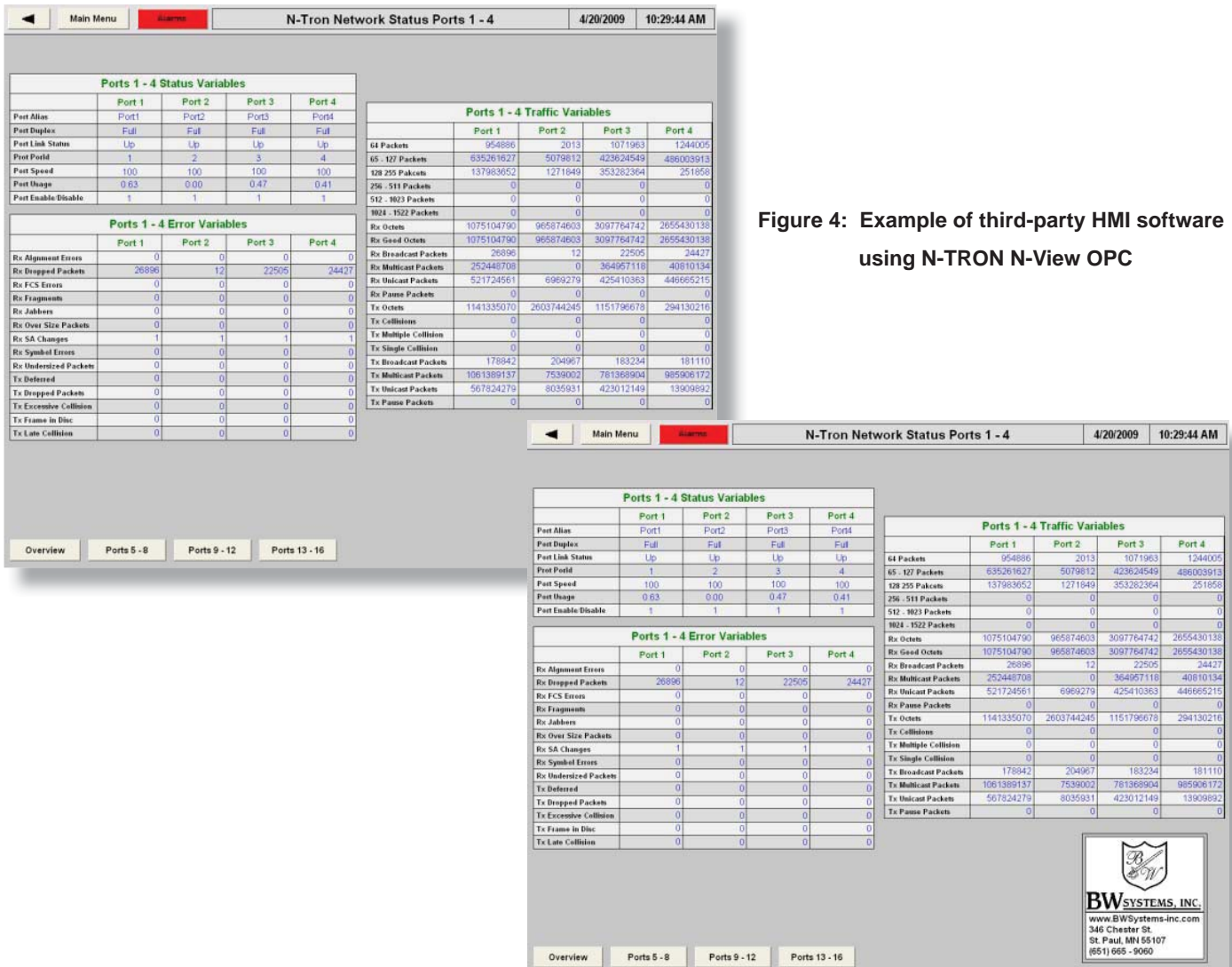


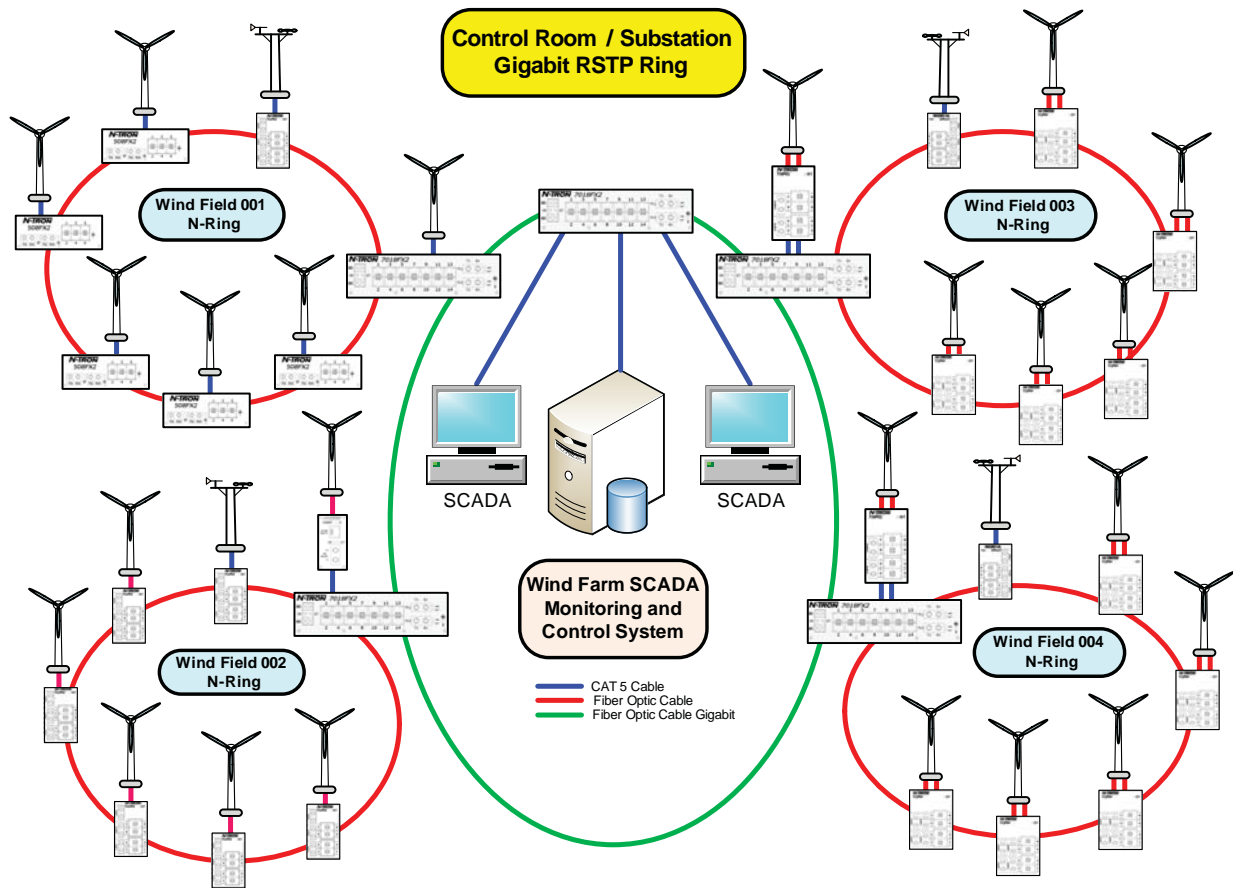
Figure 4: Example of third-party HMI software using N-TRON N-View OPC

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Wind Farm Topology

Wind fields can be connected to a central wind farm control room SCADA system in order to monitor and control all wind turbines from one location.

Figure 5



A gigabit Rapid Spanning Tree (RSTP) Ring is used to provide redundant communications between all connected wind fields and the central control SCADA system (see Figure 5). The gigabit bandwidth provided by this topology can handle data transfer to and from the wind fields including IP camera monitoring and Voice over IP communication.

Larger wind farms may require more IP addresses than the 254 available in one sub-network. These installations may need to segment the wind fields into separate networks using Virtual Local Area Networks (VLANs) so that IP addresses can be reused in each field of the wind farm. The N-TRON VLAN function will allow each port of a switch to be set to a separate VLAN ID. The switches on the main control room ring can be setup to segment the topology of the wind farm into separate VLANs allowing the use of duplicate IP addresses in each VLAN.

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Did you know?

N-TRON® is recognized around the world for developing and manufacturing high-quality ruggedized products for Industrial Ethernet automation. The company's network solutions are the benchmark for quality and reliability, providing exceptional performance for mission-critical data acquisition and control applications. N-TRON offers a complete line of affordable unmanaged and managed Ethernet switches, media converters, Power over Ethernet (PoE), and wireless access devices for industrial environments.

Quality of Service (QoS) is available on all N-TRON fully managed and 500-A Series switches. QoS allows the prioritization of important data over less critical data. Examples of this process include Voice over IP and Video over IP packet prioritization. These applications require QoS to deliver voice or video without gaps in delivery caused by packet buffering delays through the network. Other data, including messages regarding critical turbine conditions, may also be configured to use QoS.

Control schemes using EtherNet/IP™ can be used with minimal switch configuration. N-TRON switches will automatically manage the group multicast messages created by the EtherNet/IP control systems used in many wind farms.

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