N-Tron Corporation

Creating Reliable Ethernet Topologies for Wind and Solar Energy
Growth of the Industrial Ethernet Market

Source: ARC Advisory Group
Ethernet Energy System Control Applications

• Gas Turbine
• Steam Turbine
  • Convectional
  • Nuclear
  • Solar
• Hydro Turbine
• Wind Turbine
• Solar Array
International Organization for Standardization (ISO)

Open Systems Interconnection (OSI) Reference Model

- **Layer 7**: Application
  - Application Software
- **Layer 6**: Presentation
  - Application Data Presentation
- **Layer 5**: Session
  - Application communications
- **Layer 4**: Transport
  - Error Recovery Mechanisms and Flow Control
- **Layer 3**: Network
  - Station to Station Communication Different Networks
- **Layer 2**: Data Link
  - Station to Station Communication Same Network
- **Layer 1**: Physical
  - Electrical and Mechanical Specifications
APPLICATION SOFTWARE (PLC/DRIVE/CONTROLLER/OIT)

APPLICATION PROTOCOLS
ETHERNET/IP, MODBUS/TCP, PROFINET

USER DATAGRAM PROTOCOL (UDP)

TRANSMISSION CONTROL PROTOCOL (TCP)

INTERNET PROTOCOL (IP)

ETHERNET DRIVER

HARDWARE ETHERNET INTERFACE

NETWORK SWITCH

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Media Access Control
MAC Address

48 BITS

00 07 AF 00 06 12

24 BITS

MANUFACTURER’S ID or ORGANIZATIONALLY UNIQUE IDENTIFIER (OUI)
N-TRON

24 BITS

UNIQUE DEVICE ID
LAYER 2
IEEE 802.3 ETHERNET
FRAME OR PACKET

- **PREAMBLE**: 0 or 1
- **DESTINATION MAC ADDRESS OR GROUP ADDRESS**: 0 = UNICAST, 1 = MULTICAST OR BROADCAST
- **SOURCE MAC ADDRESS**
- **VID TYPE**: PROTOCOL TYPE OR LENGTH OF DATA
- **QOS**: CYCLICAL REDUNDANCY CHECK CALCULATION RESULTS
- **PAD DATA**: LAYER 3 DATA (Example TCP/IP, MODBUS/IP, ETHERNET/IP)
- **CRC**
- **IEEE 802.3Q VLAN ID NUMBER VID 1 to 511**
- **IEEE 802.3P QUALITY OF SERVICE PRIORITY 1 TO 7**
- **64 TO 1522 BYTES**

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## Ethernet Packet Types

### Ethernet Unicast

<table>
<thead>
<tr>
<th>Preamble</th>
<th>0</th>
<th>Destination MAC Address</th>
<th>Source MAC Address</th>
<th>TCP/IP</th>
<th>CRC</th>
</tr>
</thead>
</table>

### Ethernet Group Multicast

<table>
<thead>
<tr>
<th>Preamble</th>
<th>1</th>
<th>Group Number</th>
<th>Source MAC Address</th>
<th>UDP/IP</th>
<th>CRC</th>
</tr>
</thead>
</table>

### Ethernet Broadcast Multicast

<table>
<thead>
<tr>
<th>Preamble</th>
<th>1</th>
<th>All 1’s</th>
<th>Source MAC Address</th>
<th>UDP/IP</th>
<th>CRC</th>
</tr>
</thead>
</table>
Ethernet Collision and Network Domains

Network Domain

Switching Hubs (Switches)
Port and Switch Bandwidth (Hub vs Switches)
Switch Packet Processing
  MAC Address Mapping (MAC Address Table)
  CRC Check
  Store and Forward or Cut Through
  MAC Aging
MAC Memory
SWITCH CPU

<table>
<thead>
<tr>
<th>PORT</th>
<th>MAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port 1</td>
<td>47</td>
</tr>
<tr>
<td>Port 2</td>
<td>62</td>
</tr>
<tr>
<td>Port 3</td>
<td>84</td>
</tr>
<tr>
<td>Port 4</td>
<td>72</td>
</tr>
</tbody>
</table>

IEEE 802.3 NETWORK DOMAIN

DESTINATION MAC ADDRESS

SOURCE MAC ADDRESS

Preamble 111...1

62 LAYER 3 DATA CRC
UNICAST TRAFFIC
TWO SWITCHES
LINKED WITH
AUTO PORT
CONFIGURATION
(MDIX)

CPU Backplane High Speed Packet Switching

Port 1  32  
Port 2  10  
Port 3  14  
Port 4  47,62,84

PORT  MAC
SWITCH CPU

Preamble 0: 47  32  LAYER 3 DATA CRC
Preamble 0: 32  10  LAYER 3 DATA CRC
Preamble 0: 14  62  LAYER 3 DATA CRC

CPU Backplane High Speed Packet Switching

Port 1  TX
Port 2  TX
Port 3  TX
Port 4  TX

TX  RX
MAC # 32
PLC-001

TX  RX
MAC # 10
PC-001

TX  RX
MAC # 14
PLC-002

TX  RX
MAC # 47
PLC-003

TX  RX
MAC # 62
HMI-001

TX  RX
MAC # 84
RAD-001

TX  RX

HMI-001

RAD-001

PLC-003

PLC-001

PC-001

PLC-002

CPU Backplane High Speed Packet Switching

Port 1  RX
Port 2  RX
Port 3  RX
Port 4  RX

RX  TX

TX  RX

TX  RX

TX  RX

TX  RX

TX  RX

TX  RX

TX  RX

Switch CPU

Port 1  47  
Port 2  62  
Port 3  84  
Port 4  32, 10, 14

PORT  MAC

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THE INDUSTRIAL NETWORK COMPANY
Ethernet Unmanaged Topologies

Star
Tree
Daisy Chain
Redundant Star
Redundant Daisy Chain
N-TRON 500 SERIES IN STAR NETWORK DOMAIN

- ETHERNET/IP AC DRIVE
- PLC ETHERNET/IP
- ETHERNET/IP I/O RACK
- ETHERNET/IP REMOTE
- TEMPERATURE CONTROLLER
- PLC ETHERNET/IP
- INDUSTRIAL PC HMI & N-VIEW SOFTWARE
N-TRON 500 SERIES IN DAISY CHAIN NETWORK DOMAIN
Using Ethernet for Process Control Applications

Hardened Components
- ESD & RF Protection
- High G Force Construction
- High Temperature Range Performance
- High MTBF Performance (Last Man Standing)

OPC Reporting
- OPC vs SNMP
- OPC Heart Beat
  - Managed and Unmanaged Switches

N-View OPC Setup and Monitoring
HMI OPC Ready
<table>
<thead>
<tr>
<th>Specifications</th>
<th>Typical Commercial Switch with Fan Cooling</th>
<th>Typical Industrial Switch and Field Devices</th>
<th>N-Tron Critical Control Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTBF Hours</td>
<td>25K</td>
<td>200K</td>
<td>1-2M</td>
</tr>
<tr>
<td>Vibration</td>
<td>0G to 1G</td>
<td>5G</td>
<td>50G</td>
</tr>
<tr>
<td>ESD Protection</td>
<td>2KV</td>
<td>4KV to 6KV</td>
<td>16KV</td>
</tr>
<tr>
<td>RF Rejection</td>
<td>3 Volts/Meter</td>
<td>3 Volts/Meter</td>
<td>15 Volts/Meter</td>
</tr>
<tr>
<td>Operation Temp</td>
<td>0° to 45°</td>
<td>-20° to 60°</td>
<td>-40° to 70°</td>
</tr>
</tbody>
</table>
N-View OPC Monitoring
N-View OPC can be used with most leading Supervisory Control & Data Acquisition (SCADA) systems:

- RSVIEW 32
- WinCC
- Wonderware
- Citect
- Intellution
- Cimplicity
- Iconics

N-View OPC Software

OPC (Object Linking & Embedding for Process Control)
Each switch that is not shown in the right side list must be mapped to a switch model in the box below.

To Change the switch alias select the switch in the right side list type in the new alias name in the box below and press '>>'.

To delete a switch highlight it and press '<<'.
Adapter: Intel® Pro/100 VE Network Connection

Switch: STA # 023

To Change the switch alias select the switch in the right side list type in the new alias name in the box below and press ‘>>’ Button.

DRV # 007

Ports:

- PLC  # 001
- DRV  # 001
- DRV  # 002
- DRV  # 003
- DRV  # 004
- DRV  # 005
- DRV  # 006
- HMI  # 001
- HMI  # 002
- PLC  # 002

PORT 11
PORT 12
PORT 13
PORT 14
PORT 15
PORT 16

Select the port then check the box. Hidden port will not be visible in the item list of the N-Tron OPC Server.
### Switch Details

**Switch:** STA # 023  
**IP Address:** 192.168.1.61  
**N-Ring Version:** 1  
**N-Ring Member:** No  
**N-Ring Manager:** Yes  
**N-Ring State:** Ok

<table>
<thead>
<tr>
<th>Ports</th>
<th>Links</th>
<th>Speed</th>
<th>Duplex</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC # 001</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>DRV # 001</td>
<td>DOWN</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>DRV # 002</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>DRV # 003</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>DRV # 004</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>DRV # 005</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>DRV # 006</td>
<td>DOWN</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>HMI # 001</td>
<td>UP</td>
<td>10</td>
<td>HALF</td>
</tr>
<tr>
<td>HMI # 002</td>
<td>UP</td>
<td>10</td>
<td>HALF</td>
</tr>
<tr>
<td>PLC # 002</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>I/O # 001</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>I/O # 002</td>
<td>DOWN</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>DRV # 007</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>DRV # 008</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>I/O #003</td>
<td>UP</td>
<td>100</td>
<td>FULL</td>
</tr>
<tr>
<td>CAM # 003</td>
<td>UP</td>
<td>10</td>
<td>HALF</td>
</tr>
</tbody>
</table>
### Port Counters

Switch: STA # 023  
IP Address: 192.168.1.61  
Port: CAM # 003  
Speed: 100  
Duplex: Full  
Link: Up  
Enable: Yes  
N-Ring Version: 1  
N-Ring Manager: Yes  
N-Ring Member: No  
N-Ring State: Ok

<table>
<thead>
<tr>
<th>Usage</th>
<th>0</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.34%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tx Octets: 4052024  
Rx Octets: 39844501556

| Tx Dropped Packets: 0 | Rx Dropped Packets: 0 |
| Tx Broadcast Packets: 568 | Rx Broadcast Packets: 0 |
| Tx Multicast Packets: 14346 | Rx Multicast Packets: 9 |
| Tx Unicast Packets: 2992 | Rx Unicast Packets: 17890849 |
| Tx Collisions: 0 | Rx Undersize Packets: 0 |
| Tx Single Collision: 0 | Rx Oversize Packets: 0 |
| Tx Muliple Collision: 0 | Rx Jabbers: 0 |
| Tx Deferred: 0 | Rx Alignment Errors: 0 |
| Tx Late Collision: 0 | Rx Good Octets: 3984501780 |
| Tx Excessive: 0 | Rx SA Changes: 0 |
| Tx Frame In Disc: 0 | Rx FCS Errors: 0 |
| Tx Pause Packets: 0 | Rx Pause Packets: 0 |
| 64 Packets: 264937 | Rx Fragments: 0 |
| 65 to 127 Packets: 2545888 | RX Excessive Disc Size: 101606610 |
| 128 to 255 Packets: 10160661 | Rx Symbol Errors: 0 |
| 256 to 511 Packets: 1442929 | 1024 to 1522 Packets: 0 |
| 512 to 1023 Packets: 3740131 | |

Select the port from the list below:

| PLC: # 001 |
| DRV: # 001 |
| DRV: # 002 |
| DRV: # 003 |
| DRV: # 004 |
| DRV: # 005 |
| DRV: # 006 |
| HMI: # 001 |
| HMI: # 002 |
| PLC: # 002 |
| I/O: # 001 |
| I/O: # 002 |
| DRV: # 007 |
| DRV: # 008 |
| I/O: # 003 |

CAM #: 003
N-Tron 405FX-N Switch 05, Area 32, Status

Switch Status = Online
Switch Last Updated = 3 Sec

Port 1
Area 0032
PLC 0032-001

- Speed = 100
- Duplex = Full
- Status = Up

Bandwidth = 78 Percent

Port 2
Area 0032
I/O 0032-001

- Speed = 100
- Duplex = Full
- Status = Up

Bandwidth = 70 Percent

Port 3
Area 0032
HMI 0032-001

- Speed = 10
- Duplex = Full
- Status = Up

Bandwidth = 40 Percent

Port 4
Area 0032
DRV 0032-002

- Speed = 10
- Duplex = Half
- Status = Up

Bandwidth = 55 Percent

Up Link
Area 0032
DCS 0001-001

- Speed = 100
- Duplex = Full
- Status = Up

Bandwidth = 32 Percent
### Switch Variables

<table>
<thead>
<tr>
<th>Port</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Alias</td>
<td>Port1</td>
<td>Port2</td>
<td>Port3</td>
<td>Port4</td>
</tr>
<tr>
<td>Port Duplex</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Port Link Status</td>
<td>Up</td>
<td>Up</td>
<td>Up</td>
<td>Up</td>
</tr>
<tr>
<td>Port Pld</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Port Speed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Port Usage</td>
<td>0.63</td>
<td>0.63</td>
<td>0.14</td>
<td>0.14</td>
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<tr>
<td>Port Enable/Disable</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</table>

Variables Port 1 - 4

### N-Ring Details

<table>
<thead>
<tr>
<th>Port</th>
<th>Port 5</th>
<th>Port 6</th>
<th>Port 7</th>
<th>Port 8</th>
</tr>
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<tbody>
<tr>
<td>Port Alias</td>
<td>Port5</td>
<td>Port6</td>
<td>Port7</td>
<td>Port8</td>
</tr>
<tr>
<td>Port Duplex</td>
<td>Full</td>
<td>N/A</td>
<td>Full</td>
<td>N/A</td>
</tr>
<tr>
<td>Port Link Status</td>
<td>Up</td>
<td>Down</td>
<td>Up</td>
<td>Down</td>
</tr>
<tr>
<td>Port Pld</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Port Speed</td>
<td>100</td>
<td>N/A</td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td>Port Usage</td>
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<td>Port Enable/Disable</td>
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<td>1</td>
<td>1</td>
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</table>

Variables Port 5 - 8

### Additional Ports

<table>
<thead>
<tr>
<th>Port</th>
<th>Port 9</th>
<th>Port 10</th>
<th>Port 11</th>
<th>Port 12</th>
</tr>
</thead>
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<tr>
<td>Port Alias</td>
<td>Port9</td>
<td>Port10</td>
<td>Port11</td>
<td>Port12</td>
</tr>
<tr>
<td>Port Duplex</td>
<td>Full</td>
<td>Full</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Port Link Status</td>
<td>Up</td>
<td>Up</td>
<td>Up</td>
<td>Down</td>
</tr>
<tr>
<td>Port Pld</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Port Speed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>N/A</td>
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<tr>
<td>Port Usage</td>
<td>0.27</td>
<td>0.00</td>
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</table>

Variables Port 9 - 12

<table>
<thead>
<tr>
<th>Port</th>
<th>Port 13</th>
<th>Port 14</th>
<th>Port 15</th>
<th>Port 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Alias</td>
<td>Port13</td>
<td>Port14</td>
<td>Port15</td>
<td>Port16</td>
</tr>
<tr>
<td>Port Duplex</td>
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<td>N/A</td>
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<td>N/A</td>
</tr>
<tr>
<td>Port Link Status</td>
<td>Down</td>
<td>Down</td>
<td>Up</td>
<td>Down</td>
</tr>
<tr>
<td>Port Pld</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Port Speed</td>
<td>N/A</td>
<td>N/A</td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td>Port Usage</td>
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<td>Port Enable/Disable</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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</table>

Variables Port 13 - 16
### Ports 1 - 4 Status Variables

<table>
<thead>
<tr>
<th>Port Alias</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Duplex</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Port Link Status</td>
<td>Up</td>
<td>Up</td>
<td>Up</td>
<td>Up</td>
</tr>
<tr>
<td>Port Speed</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Port Usage</td>
<td>0.03</td>
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<td>Port Enable/Disable</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Ports 1 - 4 Traffic Variables

<table>
<thead>
<tr>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 Packets</td>
<td>954886</td>
<td>2013</td>
<td>1071983</td>
</tr>
<tr>
<td>65 - 127 Packets</td>
<td>635281827</td>
<td>5078912</td>
<td>423624549</td>
</tr>
<tr>
<td>128 - 255 Packets</td>
<td>137983652</td>
<td>1271849</td>
<td>335223264</td>
</tr>
<tr>
<td>256 - 511 Packets</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>512 - 1023 Packets</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1024 - 1522 Packets</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rx Ocets</td>
<td>1075104790</td>
<td>995874603</td>
<td>2097764742</td>
</tr>
<tr>
<td>Rx Good Ocets</td>
<td>1075104790</td>
<td>995874603</td>
<td>3007764742</td>
</tr>
<tr>
<td>Rx Broadcast Packets</td>
<td>26696</td>
<td>12</td>
<td>22505</td>
</tr>
<tr>
<td>Rx Multicast Packets</td>
<td>252448708</td>
<td>0</td>
<td>3648577118</td>
</tr>
<tr>
<td>Rx Unicast Packets</td>
<td>521724561</td>
<td>6969279</td>
<td>425410383</td>
</tr>
<tr>
<td>Rx Pause Packets</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tx Ocets</td>
<td>1144135070</td>
<td>2603744244</td>
<td>1167196678</td>
</tr>
<tr>
<td>Tx Collisions</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tx Multiple Collision</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tx Single Collision</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tx Broadcast Packets</td>
<td>178842</td>
<td>204067</td>
<td>183234</td>
</tr>
<tr>
<td>Tx Multicast Packets</td>
<td>1061399137</td>
<td>7539002</td>
<td>781388804</td>
</tr>
<tr>
<td>Tx Unicast Packets</td>
<td>567824279</td>
<td>8005931</td>
<td>423012149</td>
</tr>
<tr>
<td>Tx Pause Packets</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Key Managed Switch Protocols

- Internet Group Management Protocol (IGMP)
- Quality of Service (QoS)
- Virtual Local Area Network (VLAN)
- Dynamic Host Configuration Protocol (DHCP)
- Rapid Spanning Tree (RSTP)
- High Speed Ring Manager (N-Ring)
Ethernet Managed Topologies

- Spanning Tree (IEEE)
- Rapid Spanning Tree (IEEE)
- Proprietary High Speed Ring
- Multi Ring
RSTP Ring Topology

[Diagram of a ring topology network with HMI, Managed Ethernet Switch, PLC, SCADA, and Server connections.]
RSTP Mesh Topology
N-Ring Topology
# N-Ring VS RSTP

<table>
<thead>
<tr>
<th>Ring Management Comparison</th>
<th>N-Ring</th>
<th>RSTP</th>
<th>STP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring Break Detect Time</td>
<td>~30 ms</td>
<td>~1-3sec</td>
<td>&gt;30 sec</td>
</tr>
<tr>
<td>Ring Heal Time</td>
<td>~10 ms</td>
<td>~1-3sec</td>
<td>&gt;30 sec</td>
</tr>
<tr>
<td>Fault Reporting</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Proprietary</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sufficient for Automated Control</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
# N-Ring Status Monitoring

## N-Ring Status View

Switch is an N-Ring Manager.

<table>
<thead>
<tr>
<th>Switch No</th>
<th>MAC Address</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Name</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM</td>
<td>00:07:af:ff:6e0</td>
<td>192.168.1.136</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A2</td>
</tr>
<tr>
<td>1</td>
<td>00:07:af:ff:640</td>
<td>192.168.1.131</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A1</td>
</tr>
<tr>
<td>2</td>
<td>00:07:af:ff:660</td>
<td>192.168.1.132</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A2</td>
</tr>
<tr>
<td>3</td>
<td>00:07:af:ff:680</td>
<td>192.168.1.133</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A1</td>
</tr>
<tr>
<td>4</td>
<td>00:07:af:ff:6a0</td>
<td>192.168.1.134</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A2</td>
</tr>
<tr>
<td>5</td>
<td>00:07:af:ff:6c0</td>
<td>192.168.1.135</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A1</td>
</tr>
</tbody>
</table>
# N-Ring Status Monitoring

## N-Ring Fault!!

### N-Ring Status View

Switch is an N-Ring Manager.

<table>
<thead>
<tr>
<th>Switch No</th>
<th>MAC Address</th>
<th>IP Address</th>
<th>Subnet Mask</th>
<th>Name</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM</td>
<td>00:07:af:ff:f6:e0</td>
<td>192.168.1.136</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A2</td>
</tr>
<tr>
<td>1</td>
<td>00:07:af:ff:f6:40</td>
<td>192.168.1.131</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A1</td>
</tr>
<tr>
<td>2</td>
<td>00:07:af:ff:f6:60</td>
<td>192.168.1.132</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A2</td>
</tr>
<tr>
<td>3</td>
<td>00:07:af:ff:f6:80</td>
<td>192.168.1.133</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A1</td>
</tr>
<tr>
<td>4</td>
<td>00:07:af:ff:f6:a0</td>
<td>192.168.1.134</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A2</td>
</tr>
<tr>
<td>5</td>
<td>00:07:af:ff:f6:c0</td>
<td>192.168.1.135</td>
<td>255.255.255.0</td>
<td>N-TRON Switch</td>
<td>A1</td>
</tr>
</tbody>
</table>
N-Linked Rings

N-RING A

N-Ring Manager
N-Link Master
Control Link
Partner Link
Primary Link
Standby Link
N-Link Slave

N-RING B

N-Ring Manager
N-Link Master
Control Link
Partner Link
Primary Link
Standby Link
N-Link Slave

N-RING C

N-Ring Manager
N-Link Master
Control Link
Partner Link
Primary Link
Standby Link
N-Link Slave

N-RING D

N-Ring Manager
N-Link Master
Control Link
Partner Link
Primary Link
Standby Link
N-Link Slave

CAT 5 Cable
Fiber Optic Cable
Multiple N-Ring

CAT 5 Cable
Fiber Optic Cable
Daisy Chained N-Rings
### IEEE 802.11 Wireless Local Area Network Standards

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Release Date</th>
<th>Operating Frequency</th>
<th>Throughput Typical</th>
<th>Data Rate Maximum</th>
<th>Modulation Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.11a</td>
<td>1999</td>
<td>5.X GHz</td>
<td>23 Mbit/s</td>
<td>54 Mbit/s</td>
<td>OFDM</td>
</tr>
<tr>
<td>802.11b</td>
<td>1999</td>
<td>2.4 GHz</td>
<td>4.3 Mbit/s</td>
<td>11 Mbit/s</td>
<td>DSSS</td>
</tr>
<tr>
<td>802.11g</td>
<td>2003</td>
<td>2.4 GHz</td>
<td>19 Mbit/s</td>
<td>54 Mbit/s</td>
<td>OFDM</td>
</tr>
<tr>
<td>802.11n Draft</td>
<td>2009</td>
<td>2.4 GHz</td>
<td>74 Mbit/s</td>
<td>300 Mbit/s</td>
<td>MIMO SDM</td>
</tr>
</tbody>
</table>

**OFDM** = Orthogonal Frequency-Division Multiplexing  
**DSSS** = Direct-Sequence Spread Spectrum Multiplexing  
**MIMO/SDM** = Multiple-Input Multiple-Output / Spatial Division Multiplexing

Note 1 - 802.11g is backward compatible with 802.11b  
Note 2 – 802.11n is backward compatible with 802.11a,b,g
N-Tron 702-W Wireless Local Area Network

Access Point SSID = Wireless001

Ac Drive

PLC

Loop Controller

Station

Temperature Controller

Station

Industrial PC

Station

Remote I/O
N-Tron 702-W WLAN Wireless Distribution System (WDS) Protocol
# N-Tron 702-W Frequency Comparison 2.4GHz or 5.0GHz

<table>
<thead>
<tr>
<th>Compare</th>
<th>2.4GHz</th>
<th>5.0GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interference</td>
<td>Many devices use these frequencies.</td>
<td>Fewer devices use these frequencies</td>
</tr>
<tr>
<td></td>
<td>Frequency spread between channels is small which leads to interference</td>
<td>Wider frequency spread between channels causes less interference</td>
</tr>
<tr>
<td>Maximum Radius Open Room, Standard Antennas, 20Mhz Bandwidth at 100 Mbps</td>
<td>~100Meters</td>
<td>~75 Meters</td>
</tr>
<tr>
<td>Maximum Radius Outdoors, Standard Antennas, 20Mhz Bandwidth at 100 Mbps</td>
<td>~400 Meters</td>
<td>~280 Meters</td>
</tr>
</tbody>
</table>
2.4 GHz Channel Allocation at 20MHz and 40 MHz Bandwidth

Channel 1

Channel 11

Channel 6

Channel 1

Channel 11

20 MHz Bandwidth

40 MHz Bandwidth

REV 090519 47
N-TRON Confidential
5.0 GHz Channel Allocation at 20MHz and 40 MHz Bandwidth
Energy Topologies
Nuclear Power Plant
Wind Turbine and Tower Ethernet Control

Hub

Nacelle

Tower

CAT 5 Cable

Fiber Optic Cable

Wind Field 001 RSTP Ring

Ethernet Remote I/O
N-Ring Topology Process Control Switches with N-View

Wind Field Wireless Access IEEE 802.11n

Meteorological Tower

Redundant Gigabit connection to Substation Gigabit RSTP Ring

N-Ring Manager

Wind Field 001 N-Tron N-Ring With 30ms Ring Heal

CAT 5 Cable
- Fiber Optic Cable
- Fiber Optic Cable Gigabit

N-TRON Confidential
Ring Topology Managed Switches with N-Ring and N-View

Wind Field 003 N-Tron N-Ring With 30ms Ring Heal

Redundant Gigabit connection to Substation Gigabit RSTP Ring

CAT 5 Cable
Fiber Optic Cable
Fiber Optic Cable Gigabit