

Monitoring and Control of Multiple EtherNet/IP™ Control Groups

EtherNet/IP networks for I/O, Drive, and other control components are being used in an increasing number of process control installations worldwide. This technology allows devices made by different vendors to communicate using standard Ethernet infrastructure using the ODVA Common Industrial Protocol (CIP). These process networks can be monitored and controlled using a variety of switch based topologies. The network configuration used will dictate how well the network will function, its flexibility and the ability to connect to field devices when the PLC or Process Controller is not running.

Typical Multiple EtherNet/IP Controller Installation

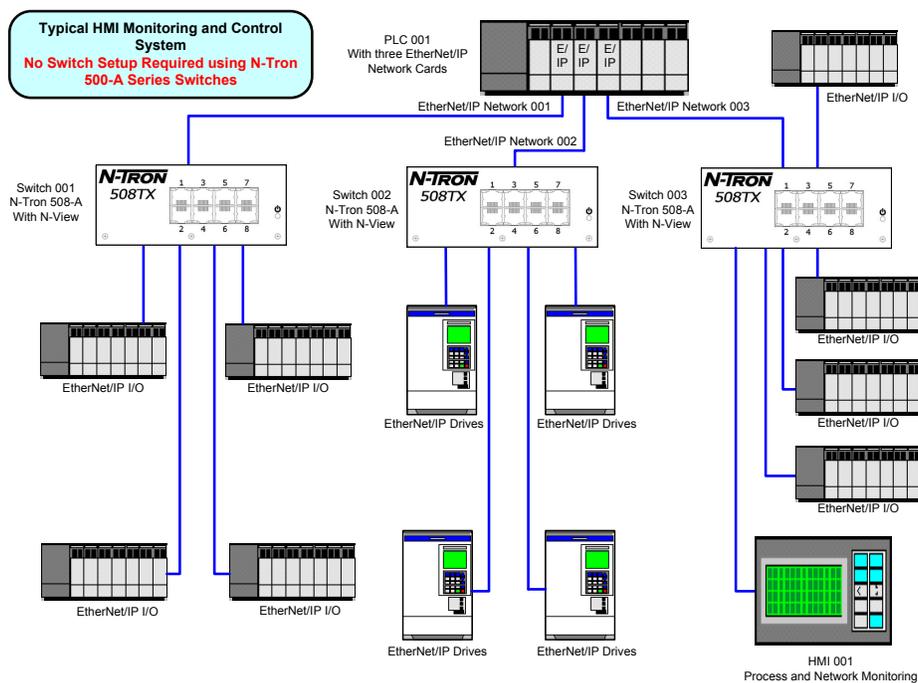


Figure 1

Figure 1 is a typical EtherNet/IP topology with field devices split between three EtherNet/IP controllers in a single PLC. This topology breaks the control scheme into three separate networks that can communicate with each other through the backplane of the PLC. A PLC that has been stopped intentionally or halted by a failure, will force maintenance personnel to connect to each individual network to view connected field devices. This limits the ability of the system to use all of the

troubleshooting options available in the switches and I/O and will complicate startup, and data acquisition.

Control engineers will frequently build multiple EtherNet/IP networks for several reasons:

1. System Bandwidth (better system performance).
2. EtherNet/IP Group Multicast Isolation (one control group per network).
3. Use of the PLC Backplane as a network router to separate control levels (I/O Control, HMI Supervision and enterprise communications).
4. One switch networks can cause a single point of failure (if commercial switches with 25K to 50K Hour MTBF are used this is a problem).
5. The PLC controls several processes or locations and there is a network for each.

These Networks can be combined into a single network with the ability to communicate directly to all devices on the network during a PLC outage. This can be done while addressing the concerns listed above if the proper network switch is used. N-Tron's 500-A Series switches are ideal for these applications and can be used to combine all EtherNet/IP Control groups into one switch (Figure 2) or over several switches located in different control areas (Figure 3).

A Single Network with Multiple EtherNet/IP Network Controllers

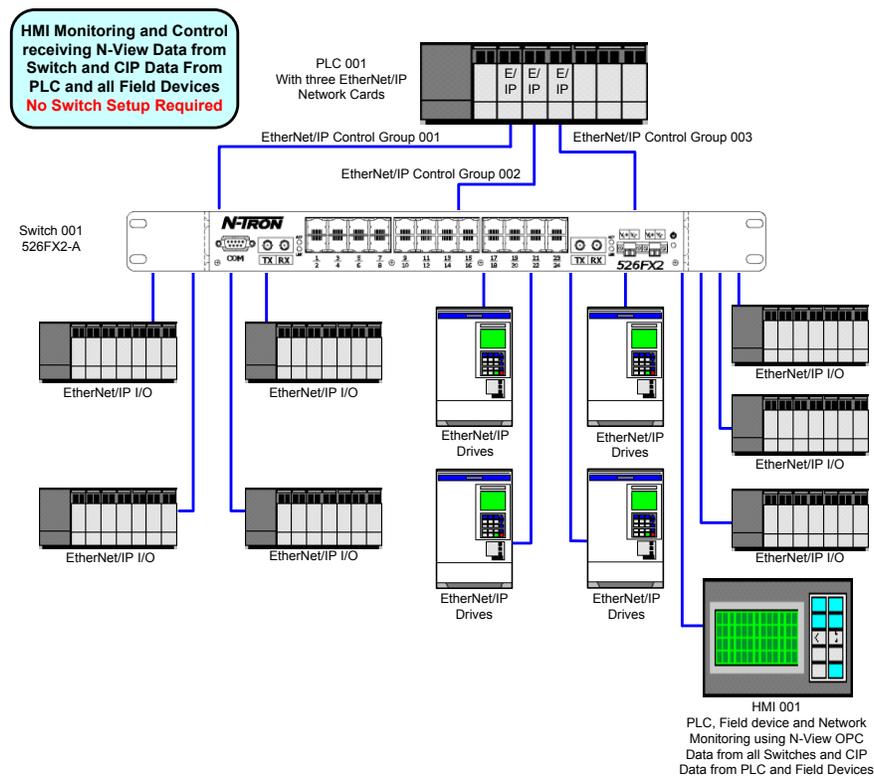


Figure 2

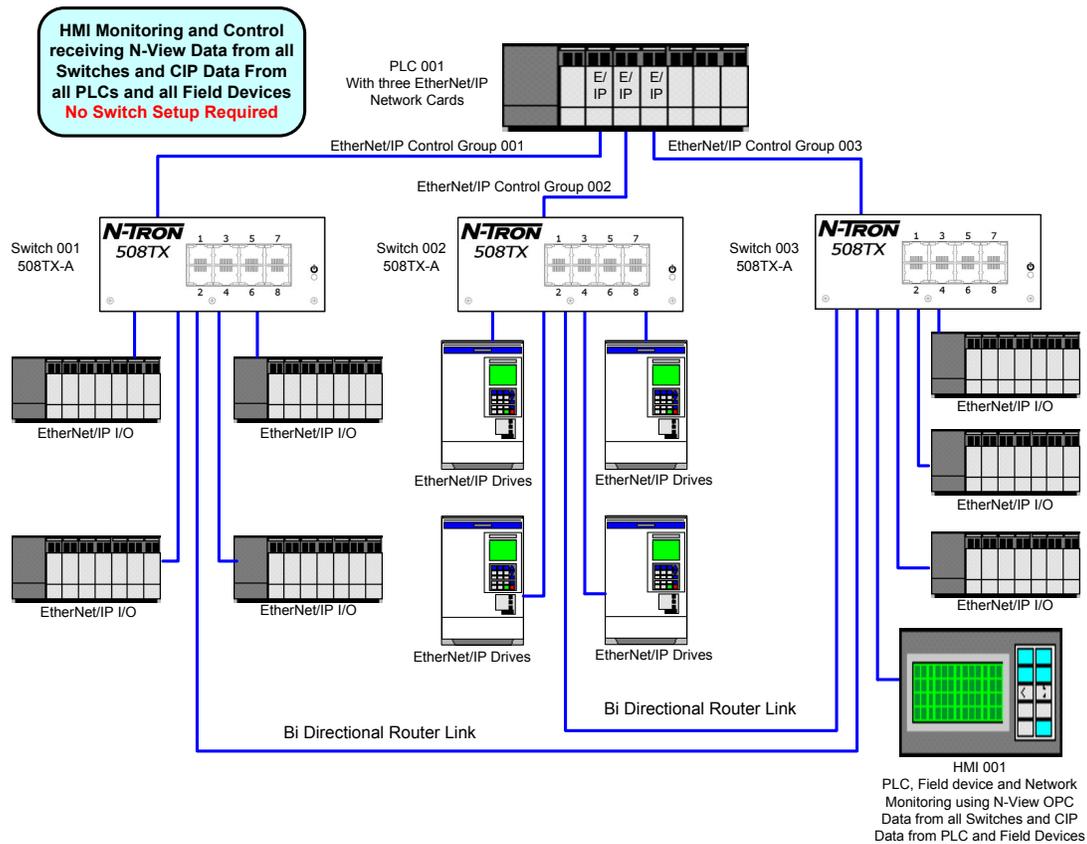


Figure 3

The N-Tron 508TX-A Process Control Switch configures itself automatically in a multi controller, EtherNet/IP environment. The N-Tron Switches will detect other managed N-Tron Switches in a network and each switch will set itself to handle the EtherNet/IP Traffic in the most efficient manner. In Figure 3 there are three 508TX-A (-A = Advanced Function) Ethernet Switches which require no setup by the user. The 500-A Series requires no IP address and will automatically perform the following EtherNet/IP setup:

1. Internet Group Management Protocol (IGMP Snooping) is enabled to allow each switch to route EtherNet/IP Multicast Packets efficiently through the switch.
2. In networks using more than one switch, the switches vote and elect one switch to create IGMP Queries periodically. These queries will cause each IGMP Group Multicast consumer (each EtherNet/IP Controller on the PLC) to send an IGMP Group Join signal to each connected switch. Each Switch will log the EtherNet/IP group number transmitted by each controller. This Group number is stored along with the port number of the receiving port. Anytime an IGMP Group Multicast with this Group Number is detected entering the switch from field devices it will be routed to the proper consumer port.

3. Each switch will detect the presence of another N-Tron switch connected to any of its ports and automatically establish Bi-Directional Router Port communication on these ports. The Bi-Directional Router Ports will forward all IGMP Commands (IGMP Group Join, and Group Leave Commands) and IGMP Multicasts to the other switches in the network so that these switches will know how to route IGMP Multicasts across the network if necessary. IGMP Commands are not forwarded to other switches unless the switch that receives these commands has established Bi-Directional Router Ports. If these ports are not setup properly the Group Multicasts from the field devices will be broadcast out all ports of the switches that have not received the Group Join routing information. This will cause devices that are sensitive to high traffic volumes (half duplex equipment, wireless products and RS232/485 to Ethernet converters) to stop communicating properly and will cause general network congestion.
4. A switch, or router connected to an EtherNet/IP Network may have no use for the EtherNet/IP Multicasts being sent to it over the established Bi-Directional router ports; in other words it may have no IGMP Consumer for the group in question. If these IGMP multicasts are sent to a network device over a Bi-Directional router port and this device has no consumers for the group address, it will broadcast these packets out all ports. N-Tron Switches with registered IGMP Groups will prevent these Group multicasts from being forwarded to ports with no IGMP Consumer for that group by using an automatic port filtering feature (R-Filter), which prevents these multicasts from being transmitted out of a Bi-Directional router port that has not received an incoming IGMP Group Join for this group. R-Filter will also prevent these packets from flooding routers with unwanted traffic.

Once the switches auto configure the network, the EtherNet/IP controllers will communicate to their assigned field devices as they did in Figure 1. No unwanted traffic will be introduced into the control groups because each switch will route the EtherNet/IP Multicasts only to the individual Controller that requires the data. Communication between control groups is now possible without using the PLC backplane. This means that programming, setup and trouble shooting on the entire control scheme can be accomplished by connecting to any switch in the network. The HMI can directly monitor and control all CIP devices on the network and will be able to monitor the N-View OPC operational data from each 508TX-A Switch in the control network. This flexibility is not possible when separate networks are used. The N-Tron N-View Ethernet heartbeats generated by each switch are multicasts and will not be transferred over the PLC backplane. Creating a single control network will allow data from all switches to be monitored from anywhere in the control network.

A Single Network with Multiple EtherNet/IP PLCs

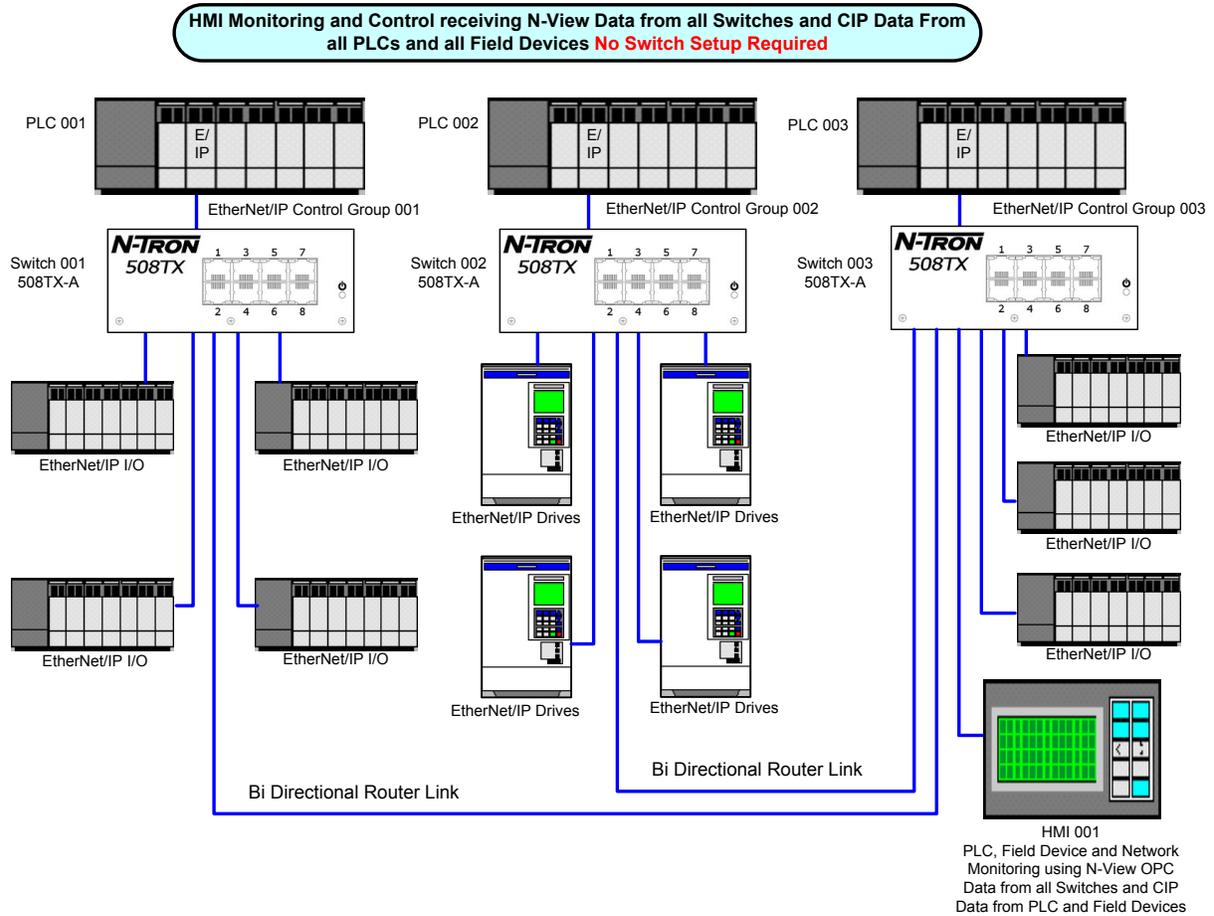


Figure 4

EtherNet/IP Control Schemes using multiple PLCs (see Figure 4) can be configured to use one network to improve access to all PLCs, CIP field devices and switches from any switch port on the network. The N-Tron 500-A Series Switches will automatically isolate the EtherNet/IP multicasts from each control group and provide N-View OPC diagnostics from all switches.

Using Port VLAN Routing to Isolate Control Networks

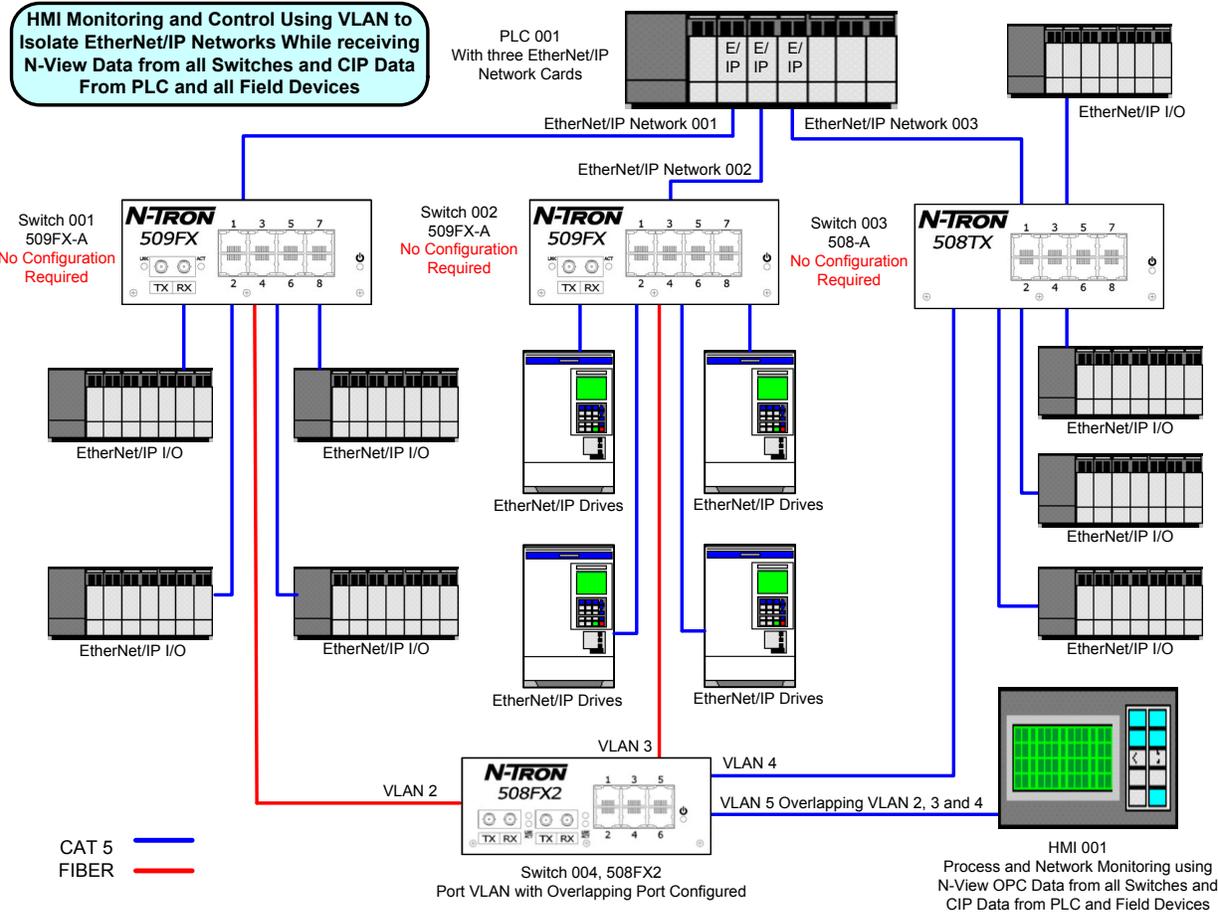


Figure 5

N-Tron 500-A Series switches can be used to form separate VLAN Networks isolating each EtherNet/IP Control Group. Although this is not necessary to control EtherNet/IP Multicast traffic on an N-Tron Network, as it is for many other switch manufacturers, this may be desirable for security reasons to isolate the plant floor from the HMI Network or the enterprise network. The N-Tron Overlapping Port VLAN feature allows VLAN Routing on a selected port enabling this port to communicate across a multiple Port VLANs configuration with no external router necessary (see Figure 5). N-Tron switches can be configured with multiple Overlapping VLAN ports if more than one uplink port is required. Connected end devices do not need to be VLAN capable.

N-View OPC and CIP Data from all control devices and switches will be transported across the Overlapping VLAN ports for monitoring, control and troubleshooting purposes.

Adding CIP Switch Monitoring and Control and DHCP to Deliver Fixed IP Addresses

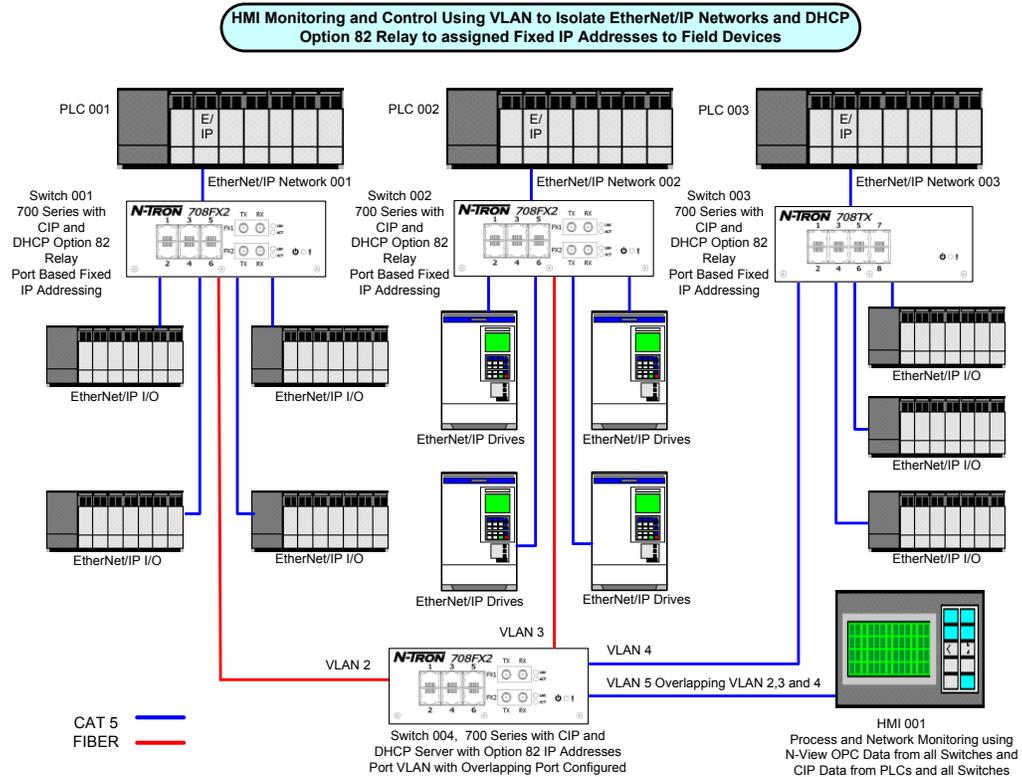


Figure 6

700 and 7000 Series switches can be used in EtherNet/IP Control networks and will provide all of the same capabilities as the 500 Series in addition to many new system options. The PLCs and HMI can monitor and control all 700 and 7000 Series* switches using ODVA's Common Industrial Protocol (CIP). All Dynamic Host Protocol (DHCP) Clients can be served IP addresses from a 700/7000 DHCP Server* either dynamically from an IP pool or with fixed IP Addresses using DHCP Option 61, or Option 82, or direct port base IP addressing.

Fixed IP Addressing is required for all EtherNet/IP Control PLCs and field devices because these devices are preprogrammed to use fixed IP addresses to communicate with each other. The IP addresses of the system's PLCs and Field Devices can be programmed into the DHCP Server. Switches in each Control network will serve these addresses port by port to the PLCs and field devices connected to the ports of the Option 82 Relay Switches (see Figure 6). PLCs or field devices that fail can be replaced and will receive the same IP Address as the original device. This will allow maintenance personnel to replace malfunctioning equipment without the necessity of loading the IP Address in the replacement equipment, eliminating the possibility of errors.

*The 7014 does not support DHCP or CIP Communication.

N-TRON® Corporation develops, manufactures and markets industrial network products for industrial, data acquisition, Ethernet I/O, and control applications. Designed to solve the most demanding communication requirements, N-TRON's rugged products are ideal for use in utility, industrial, marine, military, and other harsh environments where maximum uptime is a necessity. N-TRON's unique combination of automatic software features enable users to easily plan, install, and monitor complex network topologies.

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