

Differences Between Industrial Ethernet Fiber Optic Backbone, Ring, and Star Topologies

Fiber Optic Backbones

Fiber Optic backbones have been used effectively in industrial Ethernet systems requiring high-speed communications with excellent noise characteristics. Since the fiber optic cable is impervious to electric and magnetic fields, all conventional electrically generated cross talk and interference is eliminated.

In the event that great distances (over 100m) separate nodes, fiber optic backbones can realize very cost effective Ethernet systems. A diagram of an N-TRON fiber optic backbone implementation is shown in Figure 1.

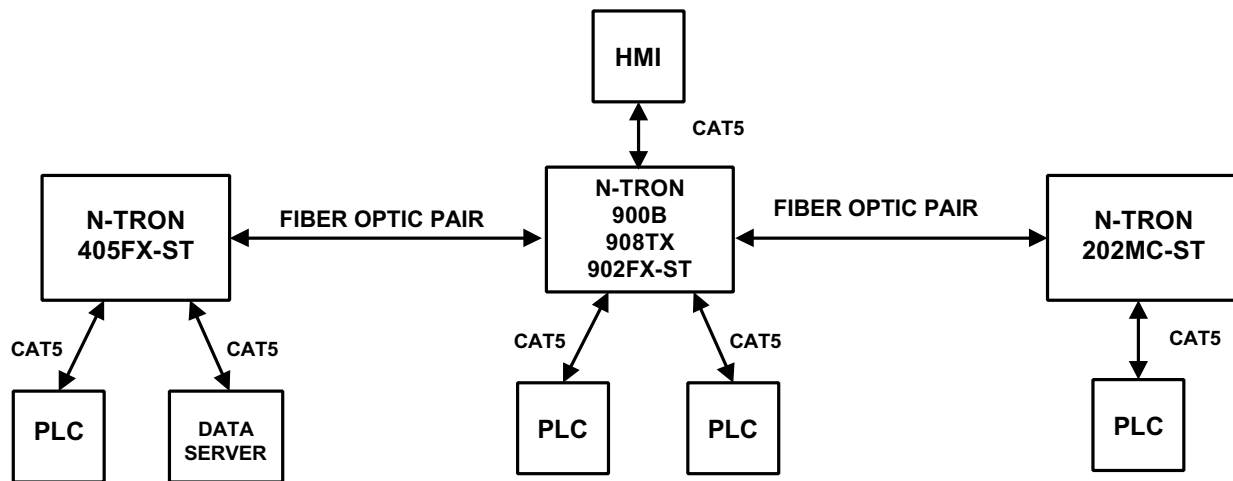


Figure 1.

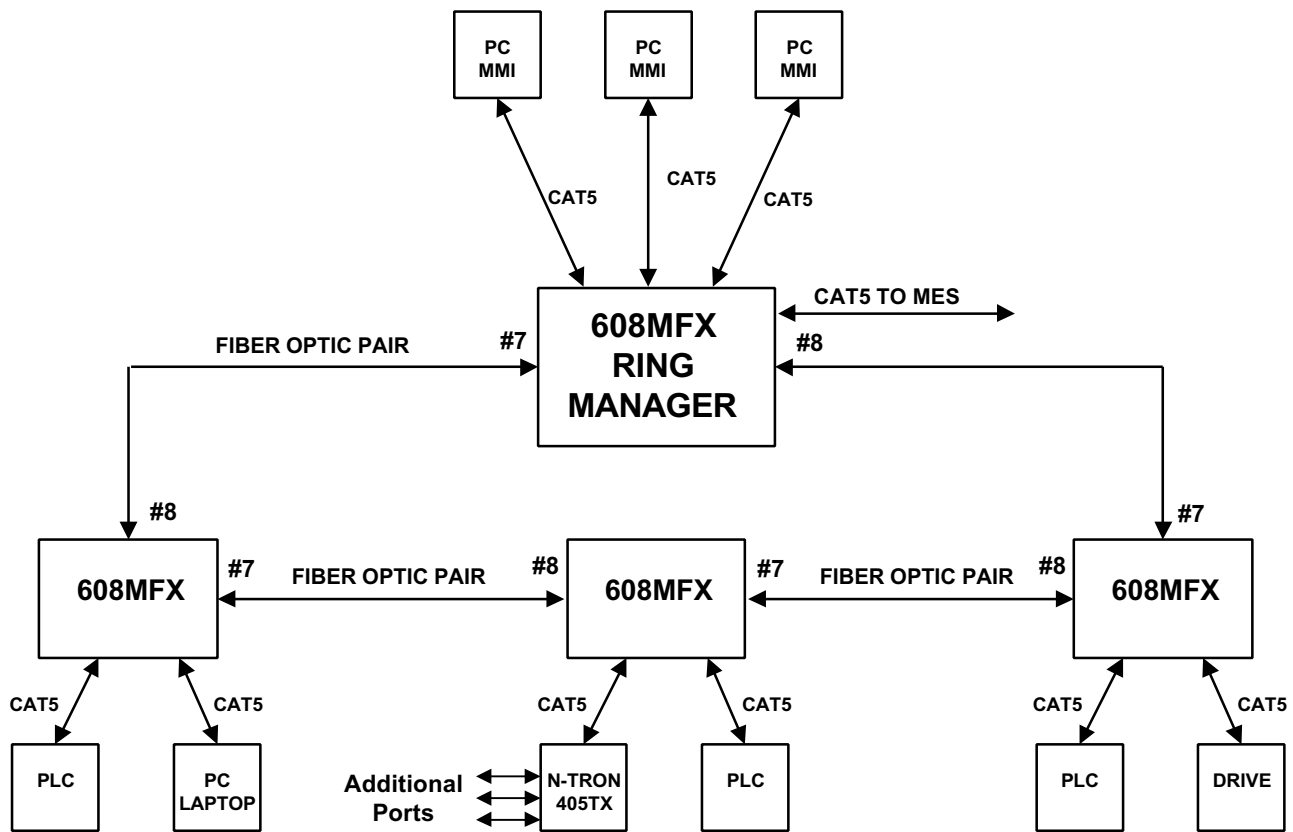
However, the classic fiber-optic backbone has several limitations:

- A single fiber media failure divides the network into segments that cannot communicate.
- A single switch failure divides the network into segments that cannot communicate.
- Many single points of failure can render a control system inoperable.
- All network traffic is funneled down into the 100Mb/s fiber-optic backbone. Devices must compete for this party line resource.

Industrial Ethernet Ring Topology

To remove the limitation of media failure, Ethernet switches have been used effectively in ring topology installations where long fiber distances and low bandwidth were requirements. When the switches are to be located so far apart that it becomes cost prohibitive to make a “home run” for each switch, ring topology offers a definite cost saving alternative.

In addition, industrial ring topology offers media redundancy. In the event that the fiber link is broken, the redundancy manager heals the ring by re-directing traffic. For industrial applications, the traditional spanning tree algorithm is much too slow to use in control and high-speed data acquisition applications. This has led to the development of the “higher speed” protocols now being used by prominent leaders in the industrial network arena. Healing speeds of less than 300ms are achievable. A diagram of an N-TRON Fiber-Optic ring implementation is shown in Figure 2.



608MFX RING TOPOLOGY
Figure 2

The Industrial Ring Topology still has several shortcomings:

- Many single points of failure can still render the control system inoperable.
- A failed switch can render a control system inoperable.
- The network becomes inoperable with the failure of the redundancy manager.
- Implementation requires costly managed switches.
- Utilizes proprietary high speed healing algorithms that are not 802.3 compliant. Users cannot use products from different vendors in the ring due to compatibility issues.
- All network traffic is funneled down into the 100Mb/s fiber ring.
- All traffic must flow on the ring, thus hard limiting the bandwidth of the installation to 100Mb/s.

Dual Redundant Fiber Optic Rings

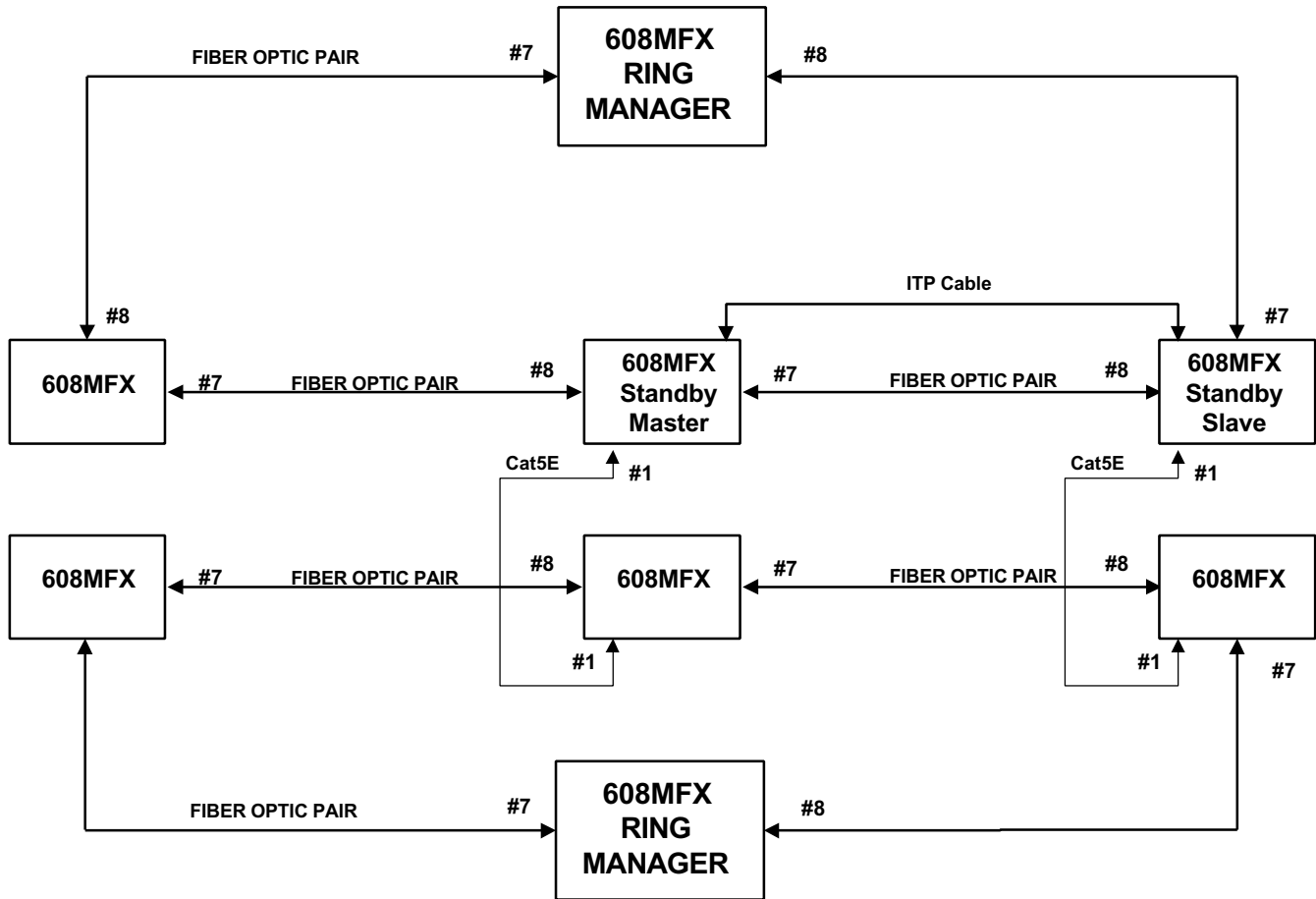
To build a fault tolerant network (no single point of failure) requires two rings. The redundancy manager is operating with a standby master and standby slave to shadow its operation and step in and direct traffic in the event of a redundancy manager failure.

This also requires that dual Ethernet ports be installed in the PC's, and PLC's to fully utilize the fault tolerance features (still higher costs). This topology is shown implemented with N-TRON Products in Figure 3.

Drawbacks of the Redundant Ring Topology include:

- Cost
- Performance (still limited to 100Mbit Fiber-Optic Loop)

The 100Mbit limitation can become quite severe when users start considering the addition of security cameras and vision systems to their control networks.



**608MFX Network Segment Redundancy
Figure 3**

Star Topology

Star topology networks have been used effectively in data acquisition and control systems. Because the MTBF of a high quality industrial switch is in excess of 2M hours, the likelihood of a switch failure, or media failure is indeed remote. All N-TRON switches offer dual power supply inputs to eliminate the possibility of a single power supply failure bringing the network down.

Star topology also allows for the utilization of lower cost layer 2 switches and an order of magnitude speed improvement over Ring Topology. N-TRON 900 Series switches utilize a 2.6Gb/s backplane that is over 260 times faster than the 100Mb/s Ring.

Star topology can easily be implemented with fiber or copper, or a combination of both. The network is also simpler to maintain and troubleshoot, and it is far more open and adheres to 802.3 standards (thus allowing plug and play multi-vendor interoperability). This topology is shown implemented with N-TRON products in Figure 4.

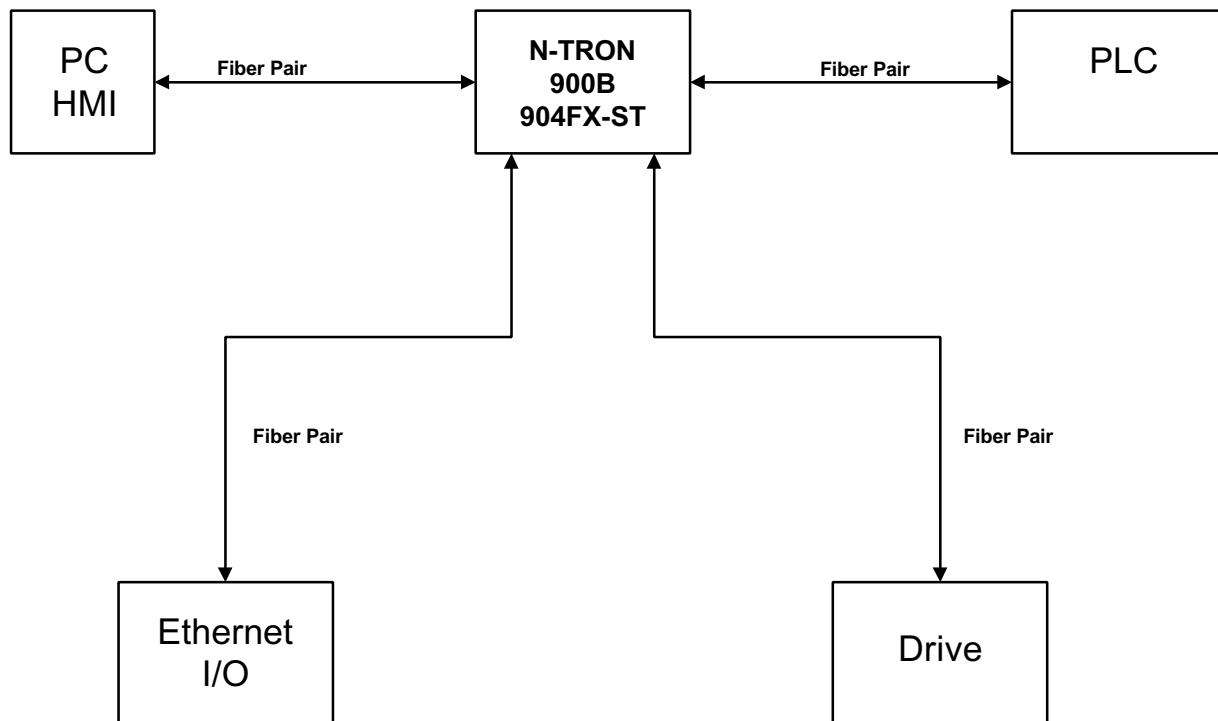


Figure 4.

Limitations of the Star Topology include:

- No Media Redundancy
- Many single points of failure can still render the control system inoperable.

Redundant Star Topology

To build a fault tolerant star network (no single point of failure) requires dual Ethernet ports be installed in the PC's, and PLC's. Every node would have a "home run" back to dual central high-density switches. As long as the fiber distances are under 2km in distances, this topology is superior in cost performance and reliability when compared to ring.

This topology is shown implemented with N-TRON products in Figure 5.

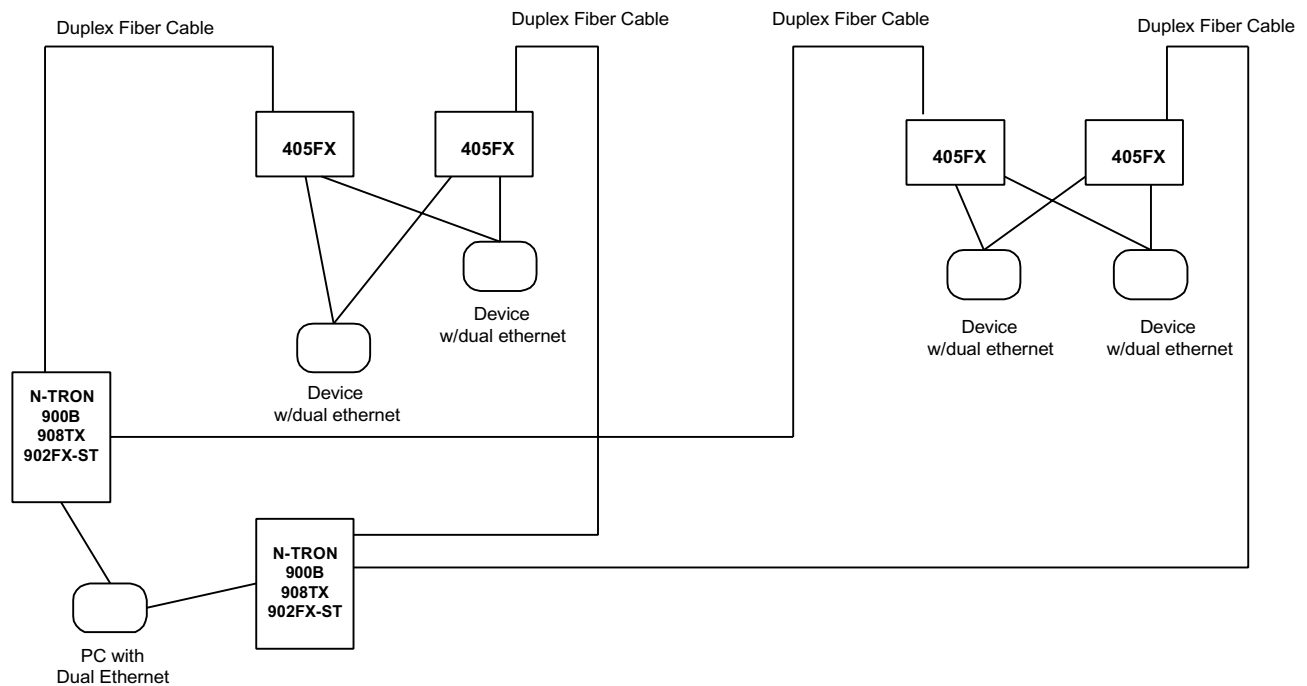


Figure 5.

In most instances, redundant star with redundant Ethernet devices can be implemented at a lower cost point than redundant ring topology. This, coupled with an order of magnitude higher bandwidth, makes it a technically superior (and more open) approach for most industrial networks. The exception is when the fiber optic runs become very long (> 2km) and the cost of the fiber (typically \$1-2 per foot) is more expensive than the switches.