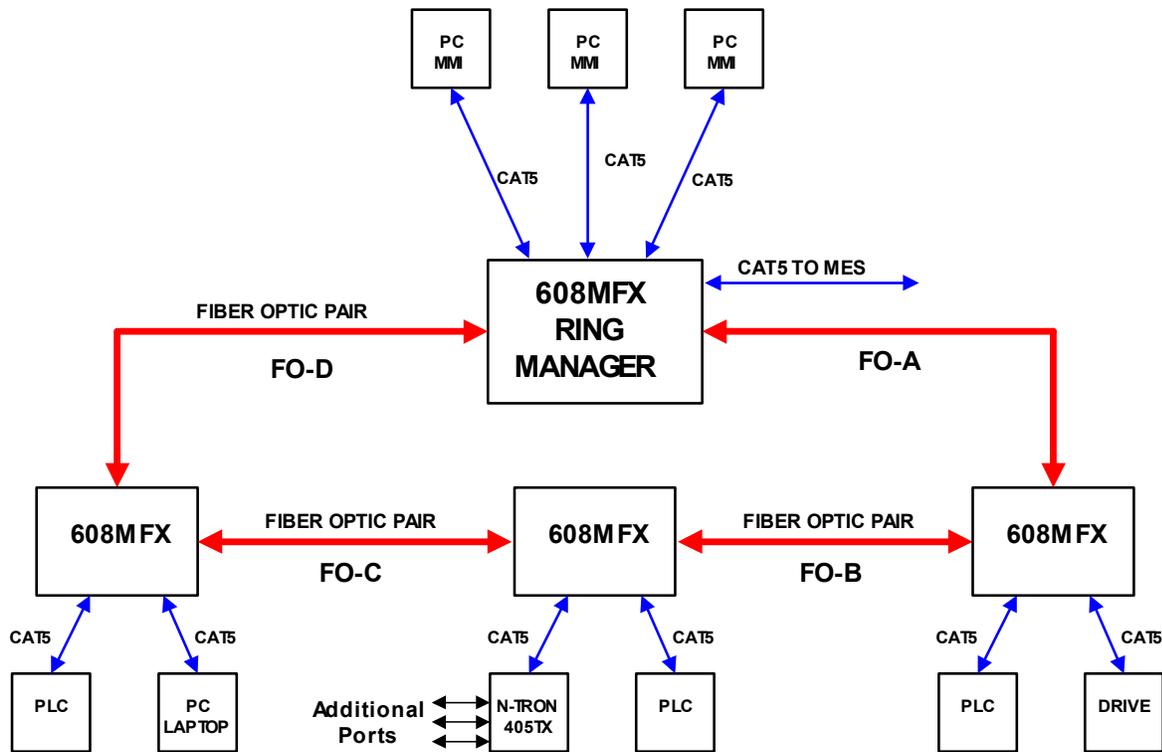


## Ring Redundancy Schemes

### Basic Media Redundancy using Proprietary Ring Healing Technology

The following topology can be used for basic media redundancy using N-TRON 600 Series Managed Switches:



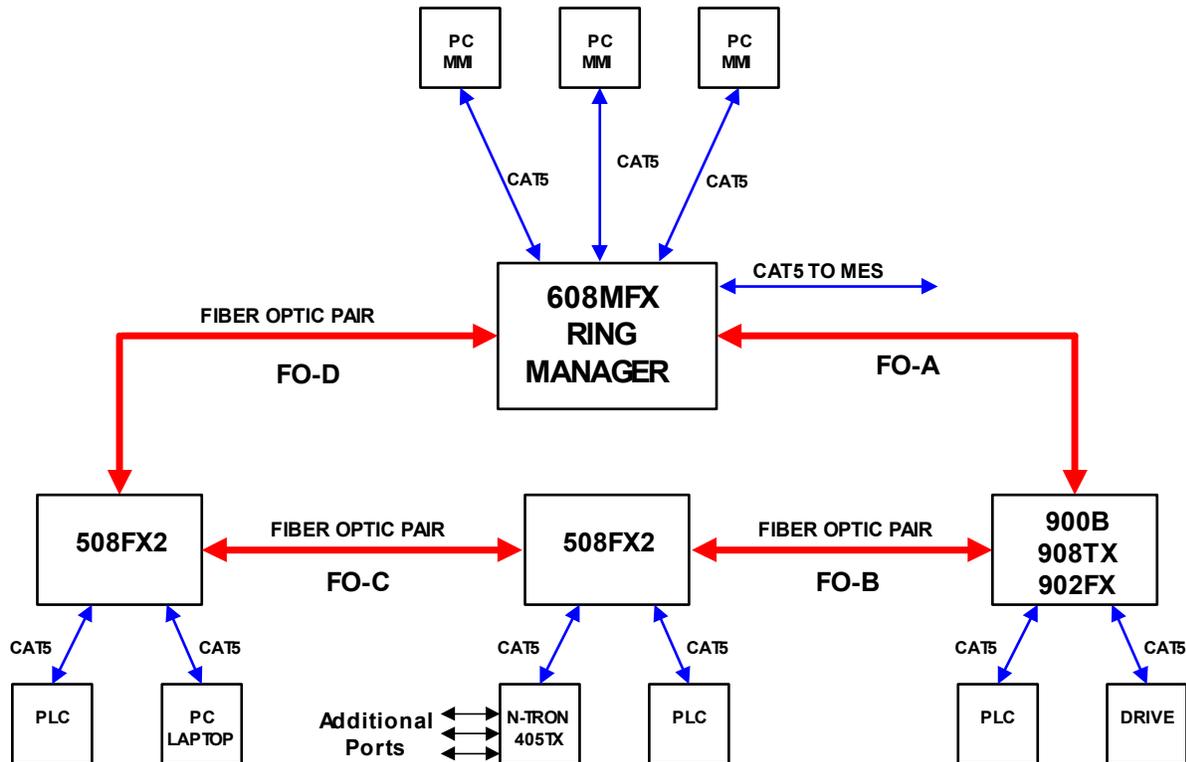
**608MFX RING TOPOLOGY**  
**Figure 1**

### Theory of Operation:

Only one unit serves as Ring Manager. The Ring Manager sends out a health check packet periodically over segment FO-A. The packet has a high QoS (802.1p) level, so it will not be delayed due to traffic. If the packet is received over segment FO-D within 50ms, the ring is intact. Any other information that comes in FO-D is discarded to break the loop. If the Ring Manager does not receive the packet within 50ms, it times out, declares a fault and closes its fault contact, flushes its ARL table (Address Resolution Table) and sends out a broadcast packet for each node switch to also flush their ARL, and becomes a standard switch, and starts processing data over the FO-D link. Therefore the Ring will self heal by each switch re-learning the available path. The system will reset and be ready to relearn addresses within 300ms. The actual re-learning time will depend on the polling update rate of the HMI software.

## Media Redundancy Scheme Using Proprietary Ring Healing Technology and Hybrid Switch

The following topology can be used for basic media redundancy using a combination of N-TRON 600 Series Managed Switches and different N-TRON switch families:



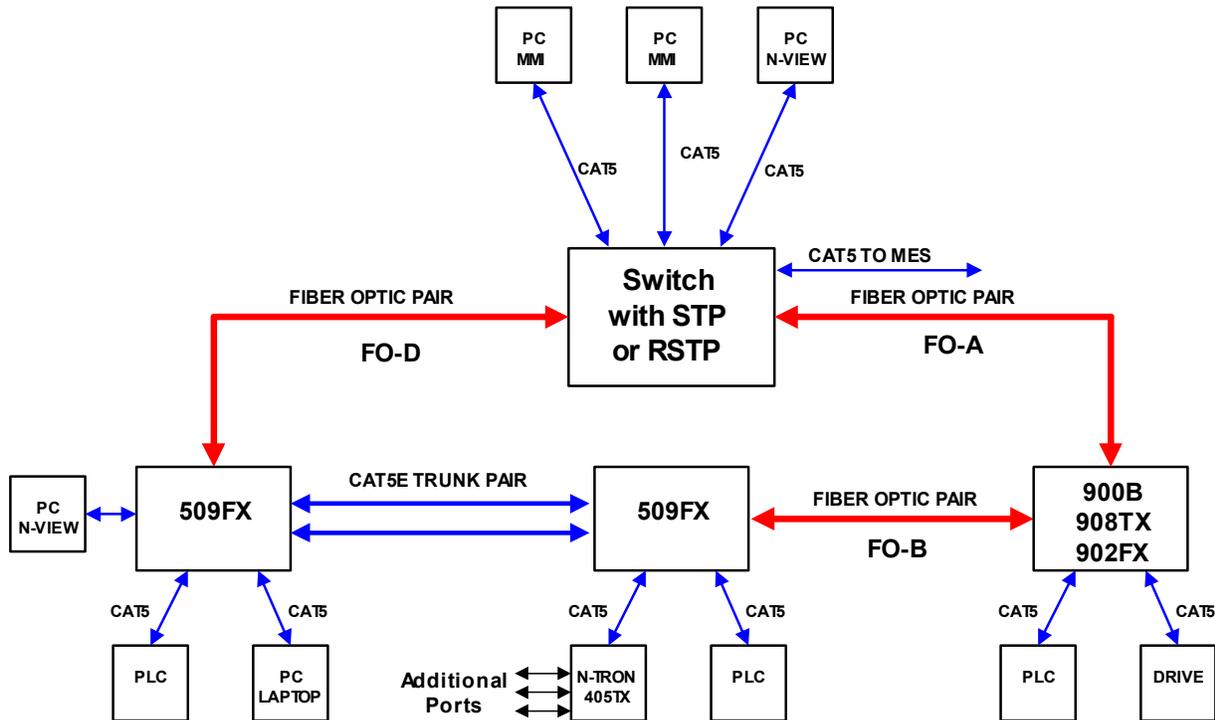
**608MFX HYBRID RING TOPOLOGY**  
**Figure 2**

### Theory of Operation:

The Ring Manager behaves the same as before. Only one unit serves as Ring Manager. The Ring Manager sends out a health check packet periodically over segment FO-A. The packet may be delayed due to ring traffic unless all switches support QoS. If the packet is received over segment FO-D within 50ms, the ring is intact. If the Ring Manager does not receive the packet within 50ms, it times out, declares a fault and closes its fault contact, flushes its ARL table, and become a standard switch, and start processing data over the FO-D link. The unmanaged switches will ignore the ARL flush message. Therefore the Ring Manager will self heal by each switch re-learning the available path. The node switches will reset and be ready to relearn addresses after the nodes switches aging time expires (set to 20 sec for 900B and programmable for 500 Series products). **Note1:** the aging time can be overridden by generating some multicast peer-to-peer traffic between nodes that will force a re-learning at the node switch level once the topology has changed due to a ring fault. Using this peer-to-peer traffic, the remapping time can be tuned to that peer-to-peer update rate. **Note2:** The system fault recovery time is best when the HMI polling software is connected to the Ring Manager.

## Basic Media Redundancy using Non- Proprietary 802.1d or 802.1w Ring Healing Technology

The following topology can be used for basic media redundancy using a Managed Switch that supports either 802.1d (Spanning Tree Protocol) or 802.1w (Rapid Spanning Tree Protocol):



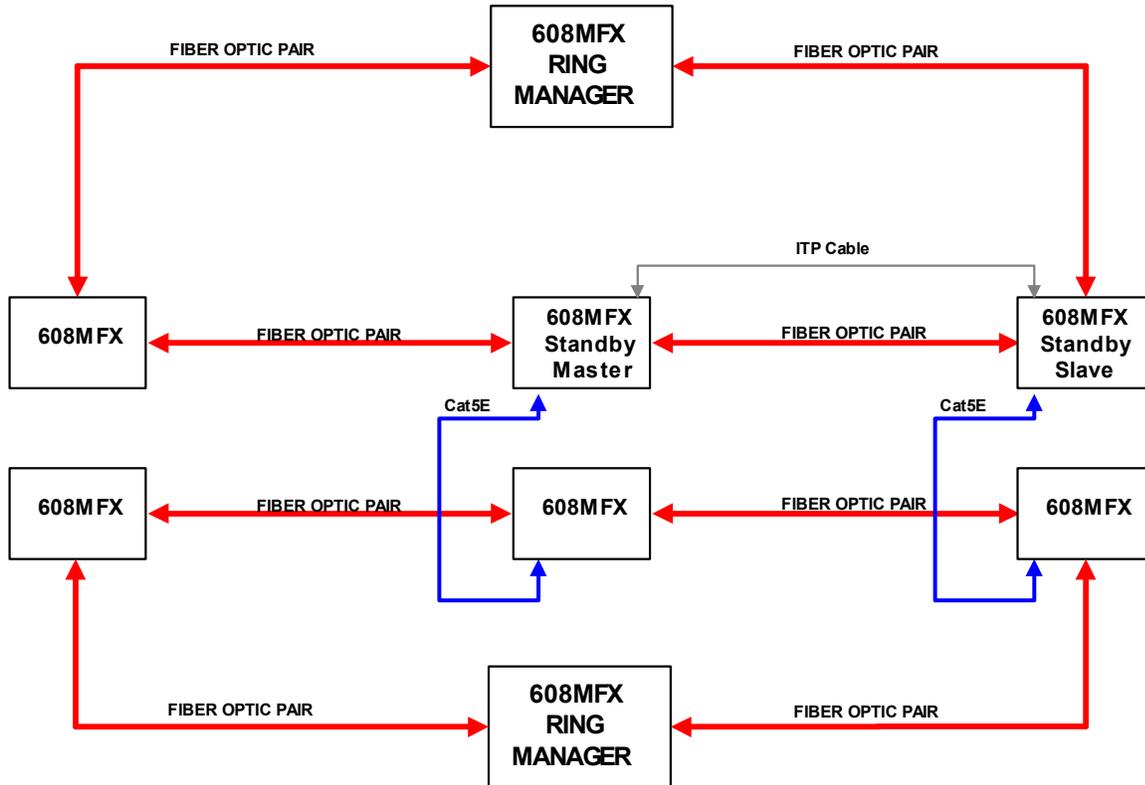
**RING TOPOLOGY WITH SPANNING TREE,  
N-VIEW, and TRUNKING**  
Figure 3

### Theory of Operation:

The switch running the spanning tree protocol becomes the ring manager. Duplicate ARL entries are eliminated by the spanning tree protocol. Optimum paths are also discovered using the spanning tree algorithm, and the system creates a preferred mapping. Duplicate broadcast and multicast packets are deleted by the switch running the spanning tree algorithm. If a fault occurs, the system remaps after the aging time of the spanning tree protocol (typically 1-2 minutes for 802.1d and 1-2 seconds for 802.1w). As before, the node switches will reset and be ready to relearn addresses after the nodes switches aging time expires (set to 20 sec for 900B and programmable for 500 series products). Also as before, the aging time can be overridden by generating some multicast peer-to-peer traffic between nodes that will force a re-learning at the node switch level once the topology has changed due to a ring fault. **Note1:** The use of Trunking in figure 3 allows for link aggregation (increased bandwidth stacking between switches) and media redundancy (automatic failover and recovery). This feature is available with any N-Tron 500 Series product when purchased with the -A extension. **Note2:** Shown in figure 3 are several PC's with the N-VIEW OPC software package displaying switch and port information in real time. N-View is available for all N-Tron products when purchased with the -A or -N option and with the purchase of the N-View OPC Server Software (provided keyless on a site license basis).

## Fault Tolerant Redundancy using Proprietary Ring Healing Technology

The following topology can be used for fault tolerant redundancy (no single point of failure), using N-TRON 608MFX Series Managed Switches:



**608MFX Network Segment Redundancy**  
**Figure 4**

### Theory of Operation:

These are two loops operating independently, identical to figure 1. In each ring, only one unit serves as Ring Manager. In addition, two nodes switches have been added (standby master and standby slave). This is to provide a fault tolerant path between rings (i.e. if standby master fails, standby slave provides an alternate path between loops). **Note:** to build a fault tolerant topology, all node clients (i.e. PLC's, PC's, etc.) must have redundant Ethernet controllers with unique MAC addresses and IP addresses. Failover times will depend on the system software and its time out failover provisions, but this topology allows for the system HMI software to selectively choose paths. Each ring will detect media and switch faults as previously described.

A variation to this fault tolerant scheme would be to eliminate the standby master and slave units and redundant loop connections and build two completely isolated ring networks (i.e. two rings similar to figure 1 or figure 2). The implications of this approach would be for the HMI software and PLCs to use either one network or the other (no selective coupling). Using this simpler approach, the unique MAC and IP addresses are no longer required, and hybrid unmanaged switches could be used in the independent loops as well.