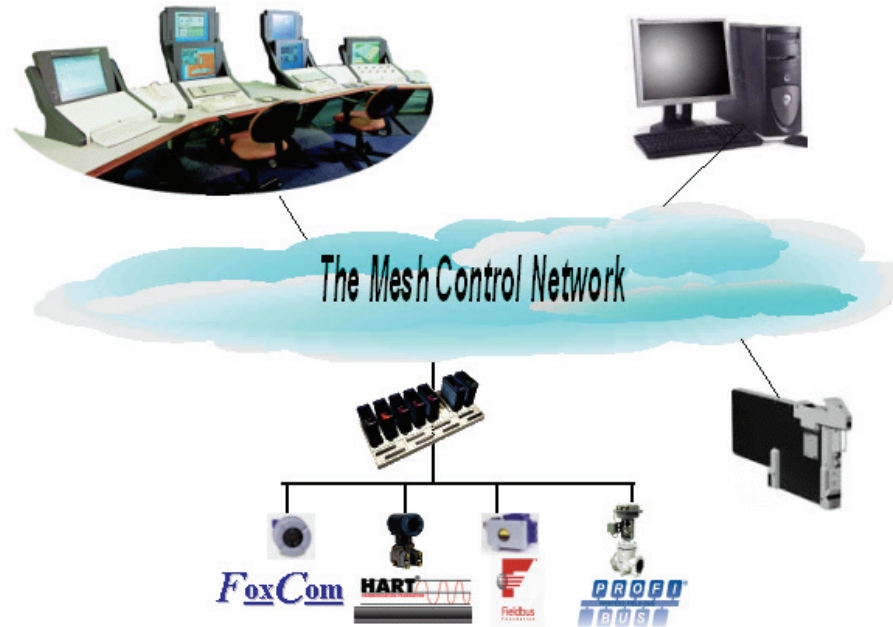


The MESH Control Network Architecture



The MESH control network is a switched Ethernet network based on IEEE 802.3u (Fast Ethernet) and IEEE 802.3z (gigabit Ethernet) standards.

FEATURES

The MESH control network offers:

- ▶ System scalability by interconnecting Ethernet switches with 8-ports or more for connecting stations in a linear, ring, star, inverted tree or modified tree network topology
- ▶ Ethernet switches connected in a MESH configuration; up to 1920 I/A Series® stations
- ▶ Support for Fast Ethernet (100 Mbps) and Gigabit (uplink only) Ethernet (1000 Mbps)
- ▶ Modular uplinks to high-speed backbones using 1 Gb 1000Base-T, 1000Base-SX, 1000Base-LX/LH 1000Base-LX, 1000Base-BX and 1000Base-ZX standards
- ▶ Software in every station to manage redundant Ethernet ports in response to network faults
- ▶ Rapid Spanning Tree Protocol (RSTP) which manages redundant paths, prevents loops, and provides high speed convergence time for a network
- ▶ High speed response to network and station faults to provide a highly reliable redundant network

- ▶ Network management and configuration via local port or Web access for various switches
- ▶ Network configuration for Virtual Local Area Networks (VLANs), separating the MESH Network into multiple segments. A total of six VLANs can be configured. VLANs configured for non-I/A Series communication can only be configured for TCP and UDP protocol use.
- ▶ With the I-series switch, migration of The MESH control network into industrial environments with temperatures ranging from -40°C to 60°C (-40°F to 140°F) and into hazardous locations rated for ISA12.12.01 Class I, Div. 2 A-D55022B Class A
- ▶ Full duplex operation based on the IEEE 802.3 standards
- ▶ System Management software for monitoring the health of The MESH control network and managing equipment in the system.

OVERVIEW

The MESH control network consists of a number of Ethernet switches connected in one of two MESH configurations - Standard and Security Enhanced.

Both configurations of The MESH control network allow very high availability by providing redundant data paths and eliminating single points of failure. The MESH control network is designed to provide multiple communication paths between any two devices or stations connected to the network. This network architecture reduces network complexity, cost, and maintenance requirements.

The flexibility of the architecture allows you to design a network configuration that fits the needs of the control system. Configurations can be as simple as a workstation and controller connected with a single switch, or as complex as a multi-switch, fully meshed Ethernet network, communicating at speeds up to 1 gigabit per second.

The MESH control network architecture integrates powerful control stations and workstations in a 100 Mb/1 Gb Ethernet network. These control stations, workstations and networks comprise scalable systems for process monitoring, process control and integration with industrial information management.

High speed, coupled with redundancy and peer-to-peer characteristics, provides high performance and availability. Redundant station interfaces to Ethernet switches further ensure secure communications between the stations.

SWITCHED ETHERNET CHARACTERISTICS

Standard Fast Ethernet switches and fiber optic/copper cabling provide versatile, low-cost solutions for building Ethernet networks using industry standard protocols. The 8-port or larger managed Ethernet switches used in The MESH control network allow connection of multiple control stations, workstations and other Ethernet switches.

SECURITY ENHANCED CONFIGURATION FEATURES

The Security Enhanced Configuration provides additional features beyond those of the Standard Configuration. The Security Enhanced Configuration of The MESH control network offers improvements in network security, Loop Detection and many additional features not offered in the Standard Configuration. Refer to "Additional Features of the Security Enhanced Configuration" on page 14 for more details.

The Security Enhanced Configuration deploys specific network topologies and switch configurations that allow for advanced network loop detection in the event of an RSTP and/or data loop (storm) failure. This advanced network loop detection minimizes the potential for a single point of failure that will degrade communications between devices in the network.

Deploying the advanced network loop detection is accomplished by carefully designing the network and correctly deploying the Loop Detection Policy (LDP) algorithms required for the network design, and by following the network configuration requirements provided in *The MESH Control Network Architecture Guide* (B0700AZ) and *The MESH Control Network Operation and Switch Installation and Configuration Guide* (B0700CA).

NETWORK TOPOLOGIES

The Standard, and Security Enhanced Configurations of The MESH control network are available. These switches are listed in *The MESH Control Network Operation and Switch Installation and Configuration Guide* (B0700CA).

The Security Enhanced version takes advantage of features available in higher-end Ethernet equipment to provide additional security features.

There are several basic MESH control network topologies supported by the I/A Series system in each of the Standard and Security Enhanced Configurations. These are:

- ▶ Standard Configuration
 - Linear
 - Ring
 - Star
 - Inverted tree
 - Modified inverted tree

- ▶ Security Enhanced Configuration

- Linear
- Star
- Inverted tree
- Modified inverted tree

Each topology listed has unique features and the one chosen for a particular control network depends on the specific requirements of the site or installation. The following diagrams provide examples of the different topologies as well as recommendations on where they might be used.

NOTE

All graphics of switches and media converters in this Product Specification Sheet are intended as generic illustrations of networking concepts and do not necessarily reflect the currently offered products. For the current product line of switches, refer to *The MESH Control Network Ethernet Equipment* (PSS 21H-7C3 B4).

Linear Configuration

The linear configuration is appropriate for a small, two switch network, as shown in Figure 1. In this example a failure of any one component in the network does not affect the operation of the remaining components due to switch redundancy.

Large chassis switches with hundreds of ports can be used in a linear configuration to create a large control system.

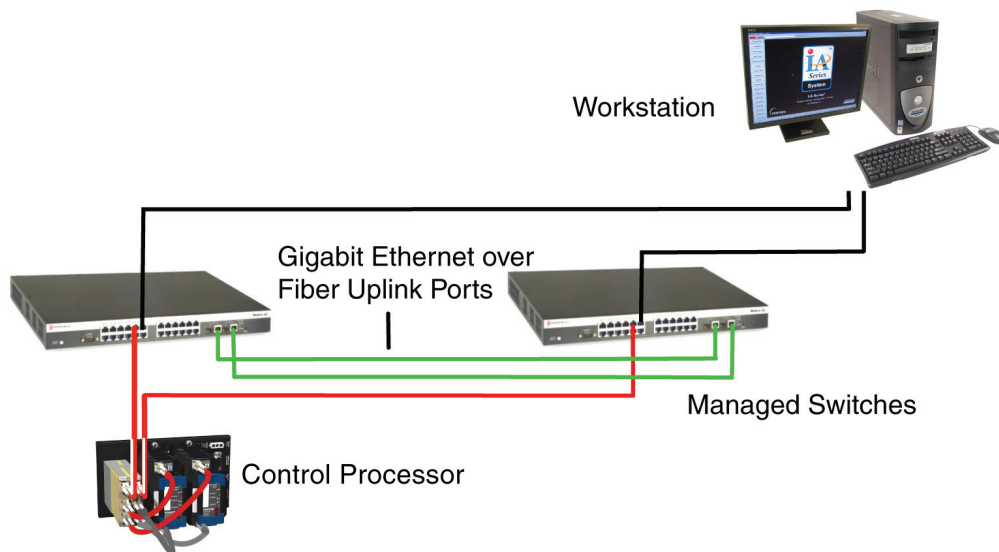


Figure 1. Linear Topology

Ring Topology

This topology is suited for networks containing three to seven switches. As shown in Figure 2, each switch has connections to the two adjacent switches. The primary and the backup root switch must be connected. In the event of a failed switch, the ring is broken and the network assumes the characteristics of the linear topology shown in Figure 1.

There is a limit of seven (7) switches between any two devices on the network, a limit imposed by the I/A Series system

Figure 2 illustrates a network composed of six managed switches configured in a ring. A network in this configuration is able to maintain its integrity during the failure of:

- ▶ a cable to a CP270 or workstation
- ▶ interconnecting cables within the network
- ▶ a switch within the network

The ring topology cannot be configured with the Security Enhanced Configuration. When designing Security Enhanced Configurations, use one of its four supported topologies.

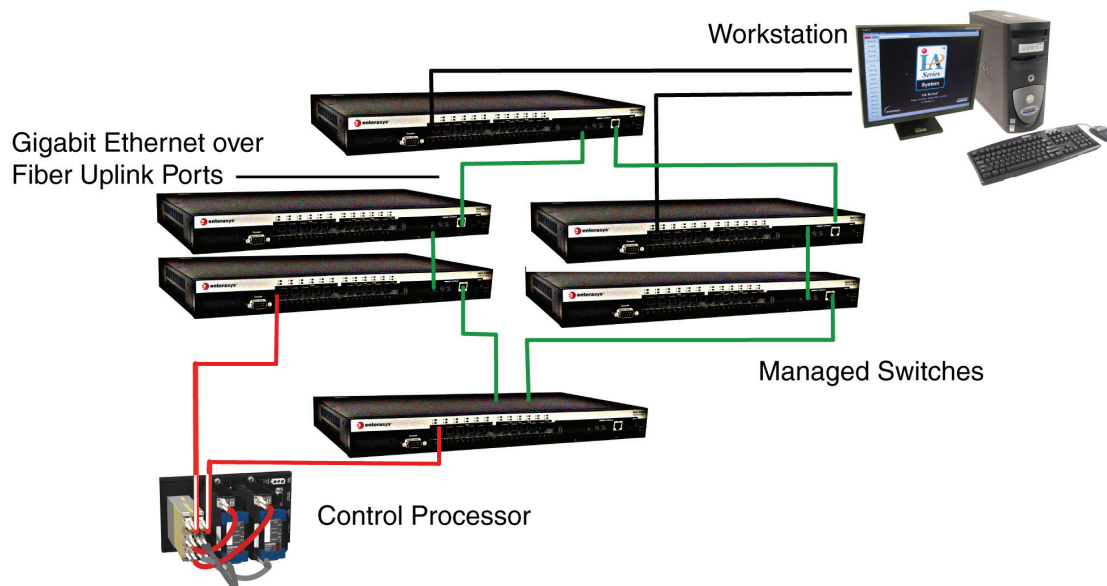


Figure 2. Ring Topology

Star Topology

The star topology is the preferred topology for all medium and large sized networks. In a star topology, the switches at the outside edge of the network have connections to each of the two root switches. The root switches are connected to each other and to the edge switches.

Redundant data paths allow the network to continue to operate if any one component fails.

Figure 3 illustrates a star network containing ten edge switches and two root switches. In a Standard

Configuration star topology, the switch can support up to 190 edge switches using 1 Gb uplinks, depending on the switch blade type configuration. In a Security Enhanced Configuration star topology, up to 190 edge switches can be connected to the Chassis switches using 1 Gb uplinks. (Refer to *The MESH Control Network Architecture Guide* (B0700AZ) for the number of switch types allowed in a network.) An inverted tree topology can be considered if there are a larger number of edge switches required (up to 500 total switches).

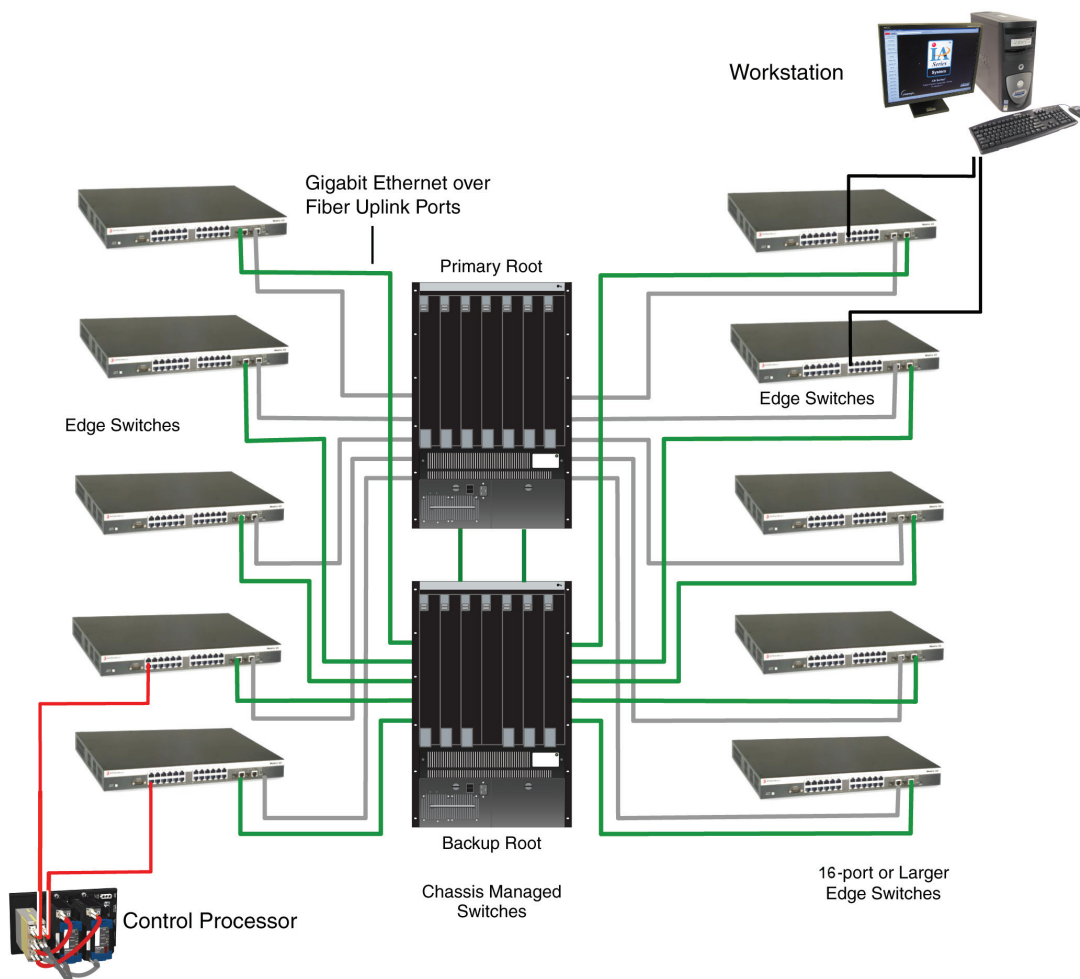


Figure 3. Star Topology

Inverted Tree Topology

The inverted tree topology is suited for very large networks with specific physical constraints. In this topology the switches are arranged in tiers, with the root switches in the top tier and up to three tiers below them. The root switches have redundant connections between them, and the other switches each have a connection to two of the switches in the tier above them. An inverted tree network topology is illustrated in Figure 4 on page 8.

When deployed in a Security Enhanced Configuration, all switches within the network must be switch types that support Loop Detection (LDP).

The switches available to each Configuration are listed in *The MESH Control Network Operation and Switch Installation and Configuration Guide* (B0700CA).

There can be no more than four-tiers of switches (including the root) in order to comply with the I/A Series system requirement limiting the number of switches between devices to seven.

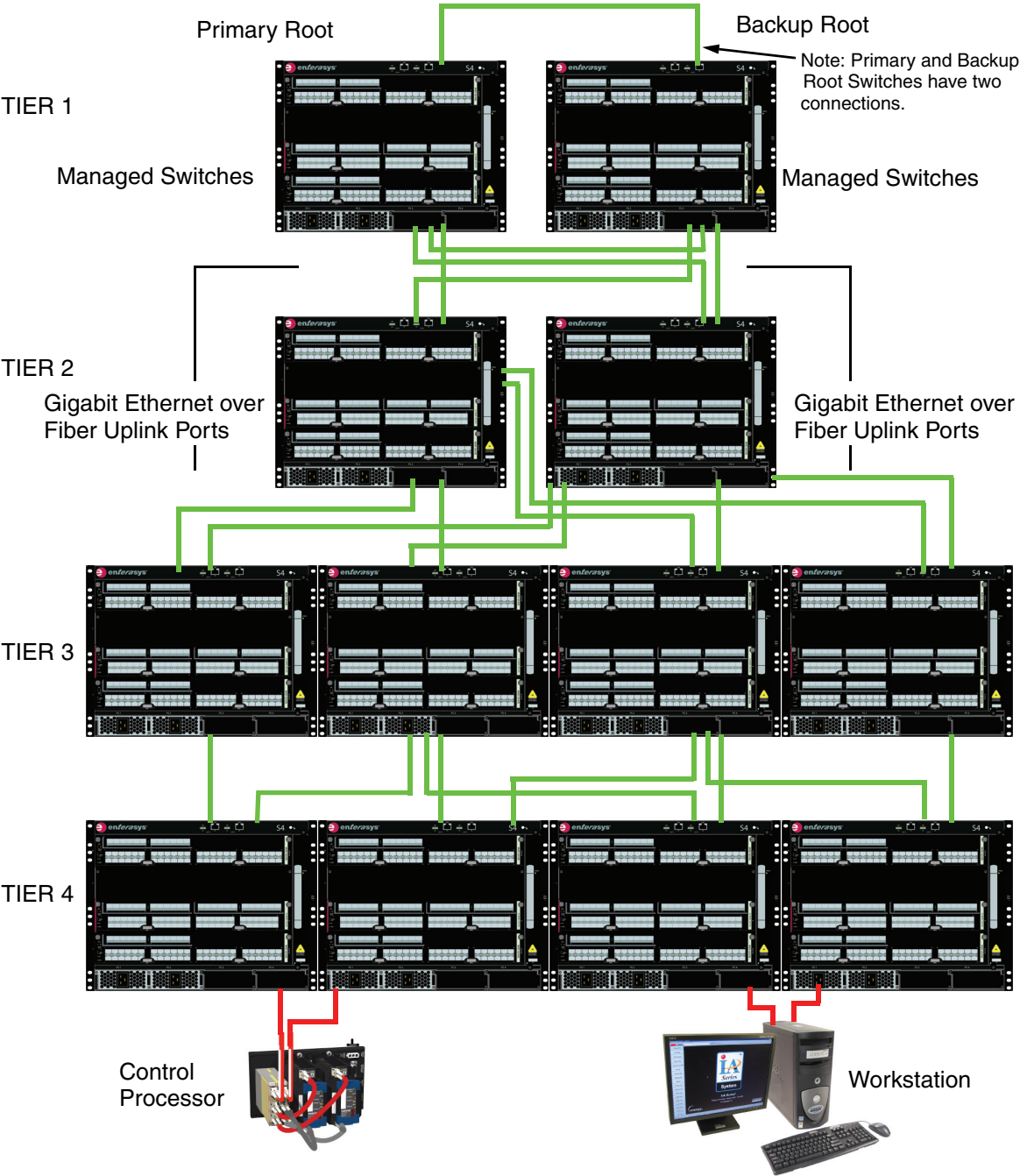


Figure 4. Inverted Tree Topology

Modified Inverted Tree Topology

The modified inverted tree topology is suited for very large enhanced networks with specific physical constraints and requirements. The modified inverted tree topology allows for standard qualified (lower cost) switches to be utilized at the outer edge, which allows for larger networks to be deployed at a lower cost. In this topology, the switches are arranged in tiers, with the root switches in the top tier with up to three tiers below them. The root switches (tier 1) are the only switches in the network that have connections between switches on the same tier; all other switches have two connections to switches in the tiers above them. All outer edge switches are interfaced to the network on different tiers (e.g., tier 3 and tier 4). By doing this, all end devices with redundant connections interface to the network on different tiers. A modified inverted tree network topology is illustrated in Figure 5.

There can be no more than four-tiers of switches (including the root) in order to comply with the I/A Series system requirement limiting the number of switches between devices to seven.

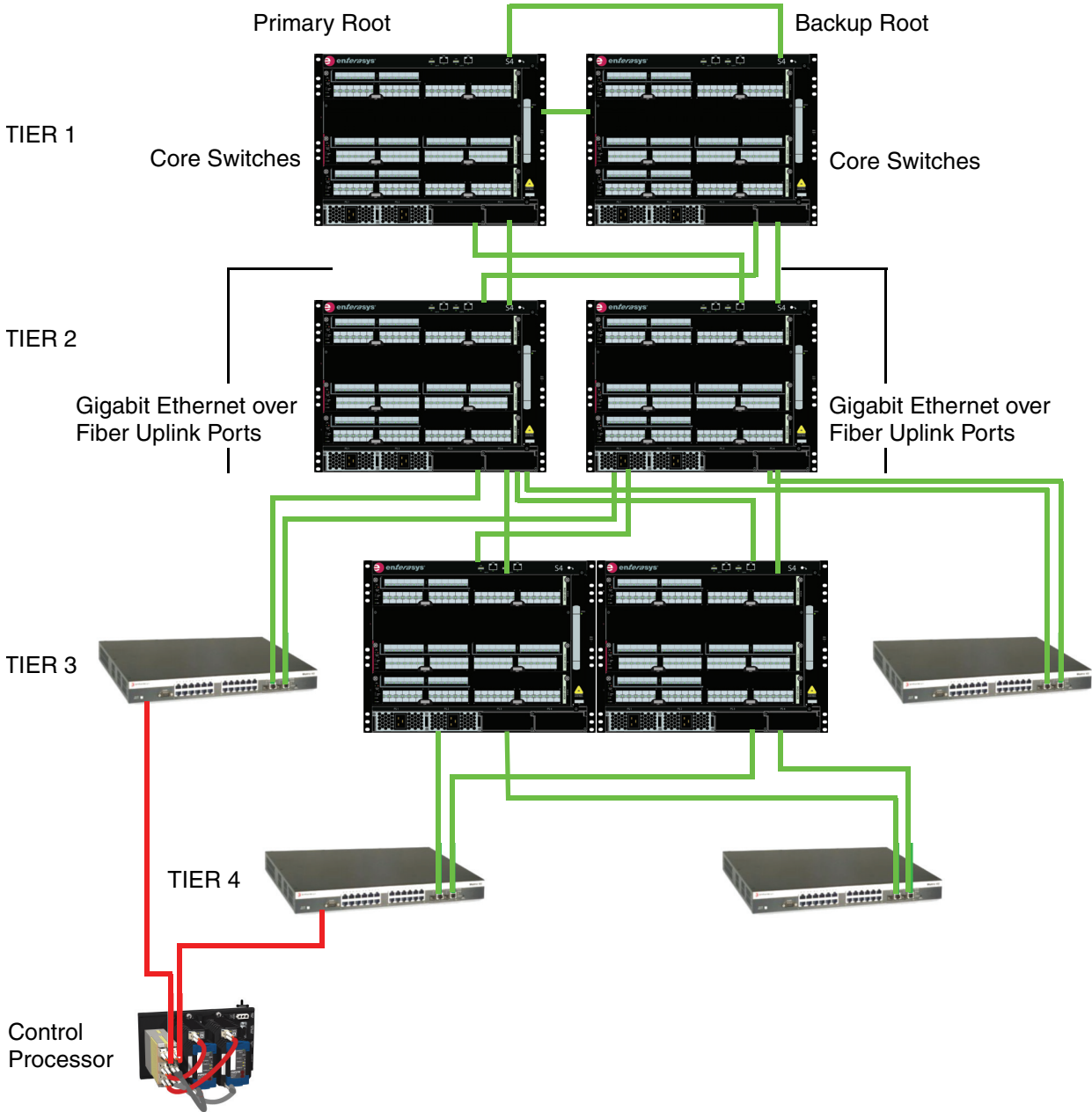


Figure 5. Modified Inverted Tree Topology

THE MESH CONTROL NETWORK CONFIGURATION EXAMPLE

The MESH control network utilizes Fast Ethernet switches which are configured to form a highly robust redundant network. Figure 6 shows an example with several I/A Series stations connected redundantly to The MESH control network.

Workstations are also redundantly connected to the Fast Ethernet switches.

The Field Control Processor 270 (FCP270) is a single or fault-tolerant control processor that mounts on a baseplate and provides a communication interface between the FBMs and The MESH control network. The FCP270 connects to The MESH control network via standard fiber optic 100 Mbps Fast Ethernet.

The Z-Module Control Processor 270 (ZCP270) is a single or fault-tolerant control processor that mounts in a 1x8 or 2x8 mounting structure. The ZCP270 connects to The MESH control network via fiber optic cables. The Fieldbus Communications Module (FCM100Et or FCM100E) provides interface between the ZCP270 and the FBMs. The FCM100Et and FCM100E are available as a single or redundant modules.

Fieldbus Modules (FBMs) serve as an interface between the field devices and the I/A Series control station. They perform necessary data conversion, providing full support for analog measurement, discrete sensing, analog or discrete control and digital communication.

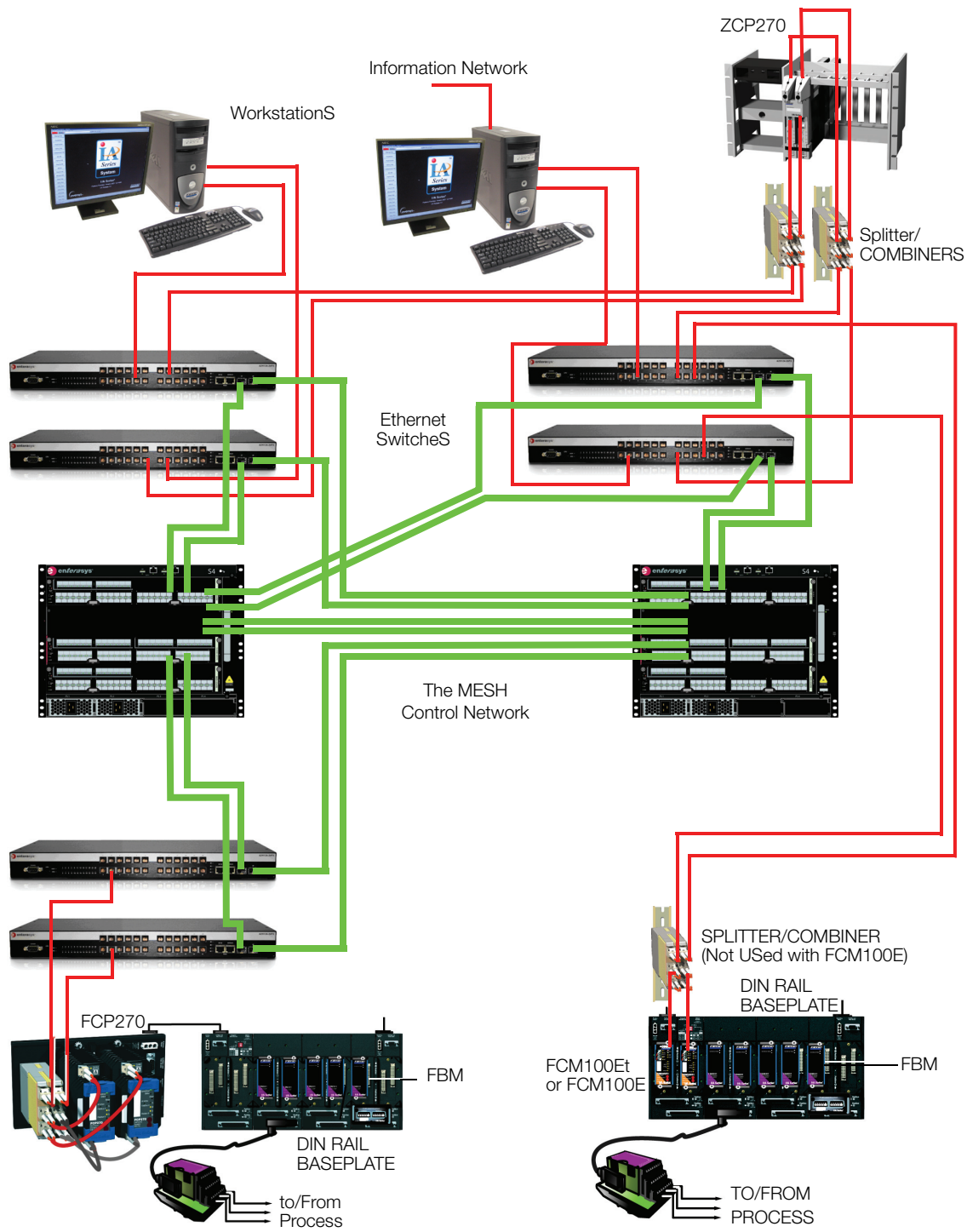


Figure 6. The MESH Control Network Example

FOR MORE INFORMATION

For additional information describing The MESH control network, refer to *The MESH Control Network Ethernet Equipment* (PSS 21H-7C3 B4). For more information on designing The MESH control network, refer to *The MESH Control Network Architecture Guide* (B0700AZ).

FUNCTIONAL SPECIFICATIONS

Number of I/A Series Stations

I/A Series stations including Ethernet switches, 1920 maximum (FCM100Et and FCM100E not included in count). Up to 500 switches.

Number of IP Addresses

10,000 maximum includes switches, controllers, workstations, ATs, FCM100Ets and FCM100Es

Standards Supported

Full duplex operation, 100Mbps copper and fiber cables, modular uplinks using 100Mb 100Base-FX and, modular uplinks using 1 Gb 1000Base-T, 1000Base-SX, 1000Base-LX/LH, 1000Base-LX and 1000Base-ZX, 1000Base-BX standards

Virtual Local Area Networks (VLANs)

Six configurable VLANs, VLAN 2 is dedicated for I/A Series communications only, VLANs 3-7 are supported with the I/A Series system when configured for use only with the TCP and UDP protocols.

When VLANs are configured, VLAN 1 is not used.

Number of Ethernet Switches Between Any Two Stations

Seven maximum

Speeds Supported

Fast Ethernet (100 Mbps) and uplink Gigabit Ethernet (1000 Mbps)

Network Failover Time

Typically a failover time of less than 1 second is achievable using fast ethernet switches qualified and supplied by Invensys and configured in accordance with I/A Series documentation.

I/A Series Station Switchover Time

Typical, less than 1 second

Maximum, 3 seconds

Protocols Used

IEEE 802.1w Rapid Spanning Tree Protocol (RSTP),
IEEE 802.1d Spanning Tree,
IEEE 802.3 Ethernet,
IEEE 802.3u Fast Ethernet,
IEEE 802.3z Gigabit Ethernet,

Loop Protect Algorithm

The Loop Protect Algorithm (LPA) feature is supported on both the Standard and Security Enhanced Configurations for all topologies on The MESH network. LPA prevents loop formations within a network when redundant paths are utilized.

LPA requires ports to receive type 2 BPDUs (RSTP/MSTP) on point-to-point inter-switch links (ISLs) before their states are allowed to switch to the forwarding state. This function prevents a loop within the network similar to LDP on the Security Enhanced Configuration but with LPA, both upstream and downstream facing ports are protected. This feature is deployable across all switch types in the network with the exception of V-series switch (P0972WP and P0972YC). Refer to *The MESH Control Network Operation, and Switch Installation and Configuration Guide* (B0700CA) for deployment rules.

LPA operates as a per port, per MST instance feature. It should only be set on inter-switch links that support this feature. LPA functionality does not protect root level ISL bridging ports. LPA does not protect the network against spanning tree events at the root level. It is recommended that LDP still be deployed across network when requiring sub-second failover.

FUNCTIONAL SPECIFICATIONS (CONTINUED)

Additional Features of the Security Enhanced Configuration

RATE LIMITING

This function is to limit the rate of inbound or outbound traffic on the S-Series devices on a per port/priority basis. The allowable range for the rate limiting is 64 kilobytes per second minimum up to the maximum transmission rate allowable on the interface type. Rate limit is configured for a given port and list of priorities. The list of priorities can include one, some, or all of the eight 802.1p priority levels. Once configured, the rate of all traffic entering or leaving the port with the priorities configured to that port is not allowed to exceed the programmed limit. If the rate exceeds the programmed limit, frames are dropped until the rate falls below the limit.

ADVANCED PORT QOS RATE LIMITING

A port priority "Port Quality of Service (QoS) Rate Limiting" can be set on each port ranging from 0-7, with 0 being the lowest priority. As the port (VLAN) receives packet frames, the port will assign a priority according to the default priority setting on the port.

Advanced port QoS Rate Limiting utilizes the Class of Service (CoS) features, which allows you to assign mission-critical data to higher priority through the device by delaying less critical traffic during periods of congestion. The higher priority traffic through the device is serviced first before lower priority traffic.

The CoS capability of the device is implemented by a priority queueing mechanism, QoS. The CoS allows you to define eight priorities (0 through 7) and QoS allows you to define up to four transmit queues (0-3) of traffic for each network device port.

ADVANCED PORT TXQ RATE LIMITING

The Advanced Port TxQ rate limiting takes the port QoS Rate Limiting one step further by setting a bandwidth limit on to the transmit queue. Each of the four transmit queues (0-3) can be assigned a bandwidth percentage of the port ranging from 0 to 100%. The four transmit queue must total 100%.

For example, if all ports in VLAN 2 are assigned a priority of 7, and priority 7 transmit queue is set to 3, and transmit queue 3 is set to 51%, then frames received through a port on that VLAN are classified as a priority 7 with a priority queue of 3 and allocated 51% of the bandwidth. All packets with a lower priority will transmit after this packet and as the network becomes congested this packet/port/VLAN will be allotted at least 51% of the bandwidth.

PHYSICAL SPECIFICATIONS

Cable Lengths

INTERCONNECTING STATIONS OR ETHERNET SWITCHES

CAT5®

100Base-TX or 1000Base-T; 100 m (328 ft) maximum

Fiber Optic, 100Base-FX

100Base-FX

MMF, 2 km (6,560 ft) maximum

Fiber Optic, 1000Base-X

1000Base-SX

MMF, 275 m (902 ft) maximum

1000Base-LX/LH

MMF, 2 km (6,560 ft) maximum

1000Base-LX

MMF, 275 m (902 ft) maximum

SMF, 10 km (6.2 miles) maximum

1000Base-ZX

SMF, 80 km (49.6 miles) maximum

1000Base-BX

Simplex-SMF, up to 10 km (6.2 miles),

40 km (24.8 miles) and 120 km

(74.6 miles) maximum depending on the module

TOTAL CONNECTION LENGTH ALLOWED BETWEEN SWITCHES

Simplex-Single mode fiber (S-SMF)

120 km (74.6 mi) maximum

Single mode fiber (SMF)

80 km (49.6 mi) maximum

Multimode fiber (MMF)

2 km (6,560 ft) maximum

