Because of connectivity, scalability, bandwidth utilization efficiency and significant cost advantages, Ethernet is rapidly being deployed as the de facto technology of choice across a wide spectrum of railroad applications. The migration to Ethernet from legacy TDM-based SONET/SDH systems is gaining momentum, and a new breed of industrial grade Ethernet backbone switch is required to accommodate the specific needs of the railroad industry.

TC Comm’s Industrial Gigabit Ethernet Modular Switch, the JumboSwitch®, offers a unique blend of popular Ethernet and legacy interfaces to provide an integrated, cost-effective and ruggedized set of solutions specifically tailored for the railroad industry. This application note describes some of the key applications of the JumboSwitch for railroads and how it accommodates Positive Train Control (PTC).

**JumboSwitch Benefits & Features:**

- Compatible with all popular Ethernet/IP devices, traffic controllers, video encoders and emergency phones
- Supports IGMP, VLAN and extensive security features
- Centralized Management System (TCView®) including remote software downloads and live operating temperature and power consumption for each interface card
- Dynamic bandwidth allocation enables 100’s of live video streams
- Industrial Hardened (exceeds NEMA TS-2)
- Self-Healing topology, including RSTP, with fault recovery of less than 38 msec.
- Long reach optics over single mode fiber extends the distance between JumboSwitch nodes to over 100Km
- Real Time Serial Server for legacy traffic controllers

**JumboSwitch Interfaces:**

- Ethernet (802.1Q, 802.1P, 802.1ag)
- DCS/SCADA
- Teleprotection
- Serial interfaces (RS-232, RS-422/RS-485)
- Integrated PABX
- T1/E1 over Ethernet
- Ethernet over PDH (T1/E1, T3/E3, STS-1/STS-3 Clear Channel)
- 600 Ω analog
- G.703/64k
- Dry Contact
Light Rail

Subways, trollies and other forms of urban transportation vehicles are all examples of “Light Rail” transportation. The JumboSwitch Gigabit Multi-Service Modular Ethernet Switch is ideal for light rail applications.

In light rail and metro rail systems, reliable communications for Network Operation Centers-to-Station (NOC) and Station-to-Station applications are critical to help ensure passenger safety and convenience. The JumboSwitch can be deployed in wayside cabinets as a reliable communications backbone for applications such as public address systems, ticket vending machines, video surveillance and security systems. The JumboSwitch also natively supports delay-sensitive, mission critical control and signaling applications normally served by separate TDM-based products.

Figure 1 illustrates a typical JumboSwitch-based communication network for commuter rail. Interfaces and applications include:

1. RS-232 – Serial Communications with Ticket Vending Machines (TVMs)
2. 10/100/1000 – Ethernet Communications with IP Cameras and other IP-Based Products
3. FXO/FXS – Telephone Connections for Emergency Assistance and connectivity to the PSTN
4. 2/4-Wire E&M – 600 Ω Audio communications with Public Address Paging System and Radio Communications between the Network Operation Centers and Stations

Heavy Rail

A heavy rail system has the capacity to handle a heavy volume of traffic compared to a “light rail” system. In addition to supporting all of the applications outlined in the previous section under light rail, the JumboSwitch offers unique solutions for the heavy rail industry as well. The most significant trend for heavy rail systems is the migration to Positive Train Control (PTC) as mandated by the Rail Safety Improvement Act of 2008 (RSIA). Required to be completed by 2015 for all North American Class I railroads, PTC essentially allows trains to receive information about its location and where it is allowed to safely travel, also known as “movement authorities.” On-board equipment enforces a train’s movement authority and prevents unsafe movements.

Figure 1: Typical train station application using JumboSwitch in a rail-side cabinet.
In implementing PTC, the final communication between the base stations and the train is provided by wireless radio systems; however, the back office must communicate with base stations via a highly reliable backbone network. The mission critical nature of this backbone makes high reliability and survivability of the selected platform absolutely essential. The JumboSwitch Industrial Gigabit Ethernet platform supports a unique blend of features to offer the reliability of SONET/SDH with the plug-and-play simplicity of Ethernet:

- Smart hot-swappable modular architecture to minimize down time
- Long haul fiber optics – to accommodate inter-base station communication
- Recovery in less than 38ms – for mission critical reliability
- Multi-Service – Unique hybrid, single-box solution offers seamless integration and significant savings in Opex and Capex.
- Industrial hardened (Exceeds NEMA TS-2)
- Centralized Management System (TCView) including remote software downloads and live operating temperature for each interface card
- Investment Protection with 10GigE Migration

**Case Study: Commuter Train in Southern California**

The network design for this train control application called for ruggedized platforms, the highest degree of availability and full compatibility and interoperability with existing IT routers. Another key requirement for this project was to utilize the existing fiber optic cabling infrastructure to minimize additional costs.

As illustrated in Figure 2, the backbone communications networks use diverse paths to achieve 99.999% reliability. Furthermore, redundant links to each switch are provided by a combination of ring and mesh topologies on the JumboSwitch and offer added “last-mile” reliability for end node connectivity such as CP and PTC equipment.

Backhaul connectivity to the back office is provided by two separate redundant technologies, including SONET and MPLS, to achieve ultimate project reliability.

![Figure 2: Typical JumboSwitch Back Office Backbone Application](image-url)
JumboSwitch Overview
The JumboSwitch is a modular Gigabit Industrial Ethernet Switch for Backbone, Edge and Access applications. It is designed to maintain the reliability and survivability of SONET/SDH (less than 38 msec recovery) and still offer the plug-and-play simplicity of Ethernet.

The JumboSwitch offers four cost-efficient chassis options that can hold from 1 to 7 interface cards. For example, a 4U chassis with 7 interface cards could be located in a Traffic Operations Center. The economical 2S unit, with 2 cards, could be located in various traffic control cabinets that are connected to the network.

The JumboSwitch product family meets all pertinent industry specific standards for environmental, security and performance requirements including NEMA TS-2 and NERC CIP. Future JumboSwitch family products will continue to be compliant with both existing and emerging industry standards and requirements, including developing Ethernet standards.

TCView (Advanced Management System)
TCView provides the comprehensive management tools needed to simplify the configuration, administration, monitoring, troubleshooting and servicing of JumboSwitch networks and other TC Communications networking devices.

Designed with FCAPS (Fault, Configuration, Asset, Performance, Security) in mind, TCView enhances network administration by simplifying both repetitive and one-time tasks, such as reconfiguring switches and gateways, monitoring network performance and isolating faults.

Key Features:
- Remote software/firmware download capability
- Extensive Asset Management capabilities including ongoing collection of system part/serial numbers and version numbers/upgrade dates for precise inventory management
- Remote monitoring for “live” operating temperatures and power consumption of each interface card
- Remote monitoring for “live” TX/RX power for critical fiber links

These features can be especially critical for industrial applications. For example, TCView’s precise power consumption and temperature sensing capabilities can be used to create real time preventive maintenance parameters (e.g. identify any degradations) for Transportation network IEDs being used in extremely hot or cold environments.

About TC Communications
Founded in 1992, TC Communications specializes in Industrial Ethernet, Voice and Data products for Transportation, SCADA and Utility communications networks. Products include all types of Ethernet Switches, Media Converters, Modems, Multiplexers, Mode Converters and Telephone Extenders.