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Pioneering Industrial and IP Networks

White Paper

Lantech Ethernet Switches for use with

IEC 61375 Data Networks

Version1.1
Dec 20, 2018

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IEC 61375 White Paper

A Train Communication Network (TCN) is an Ethernet-based network control system that applies to rolling stock control, detection, and diagnosis.

The international standard, IEC 61375, is defined with cooperation between members of the International Electrotechnical Commission (IEC) and the International Union of Railways (UIC).

The IEC 61375 standard's definition regarding the TCN can be divided into two parts: one is an Ethernet Train Backbone (ETB), and the other is an Ethernet Consist Network (ECN). The ETB is in charge of connections between the ECNs in each car. The requirements and applications of ETB are defined in IEC 61375-2-5, while the requirements and applications of ECN are defined in the IEC 61375-3-4 standard.

Please refer to the Figure 1 that shows a typical rail vehicle configuration for an ETB and an ECN data network.

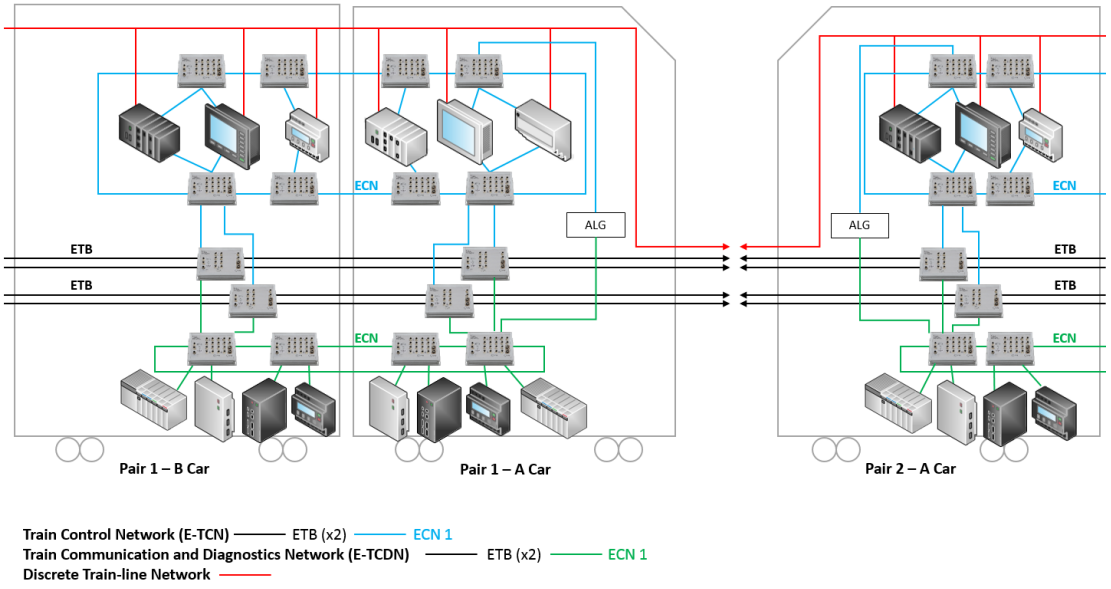


Figure 1 – Typical rail vehicle configuration

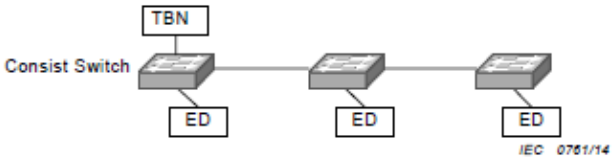
Specifications of Network Topology in IEC 61375-3-4

IEC 61375-3-4 defines that each End Device (ED) in a train car can be configured with Ethernet switches and a Train Backbone Node (TBN) in the following topologies:

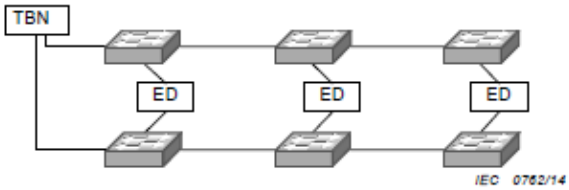
1. Linear topology
2. Linear topology (parallel network) with dual homing
3. Ring topology
4. Ring topology with dual homing
5. Ladder topology with dual homing

Please refer to the Figure 2 of each of the different possible topologies.

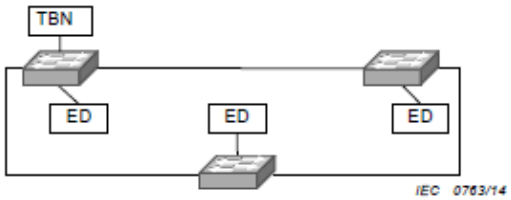
1) Linear topology



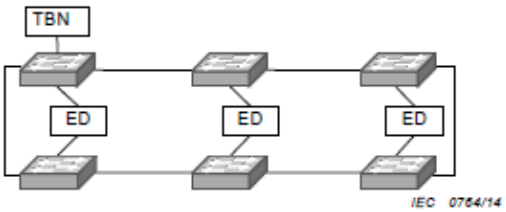
2) Linear topology (parallel network) with dual homing



3) Ring topology



4) Ring topology with dual homing



5) Ladder topology with dual homing

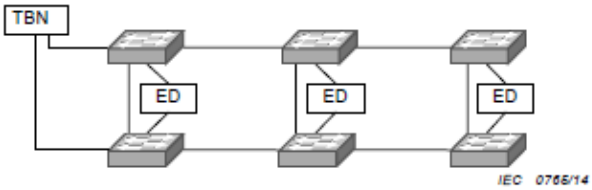


Figure 2 – Possible topologies in IEC 61375-3-4

Specifications of ECN Networking Data in IEC 61375-3-4

IEC 61375-3-4 defines networking data that is transmitted over the ECN into five types: Process data, Message data, Stream data, Best effort data and Supervisory data. Any Ethernet switch installed in an ECN must be able to forward these five types of data packages and provide for redundant protection.

For example, in the IEC 61375 standard, Train Real-time Data Protocol (TRDP) is defined as Supervisory data. An ECN Ethernet switch must be able to forward TRDP packages and provide

redundant protection when the switch is malfunctioning or the network is down. Thus, all the devices that communicate via TRDP can operate normally under these situations.

At the same time, IEC 61375-3-4 requires that an Ethernet switch installed in an ECN must be able to support Quality of Service (QoS) and set priority levels of the transmitted data in the ECN. Please refer to the Figure 3 that describes a data network without and with QoS.

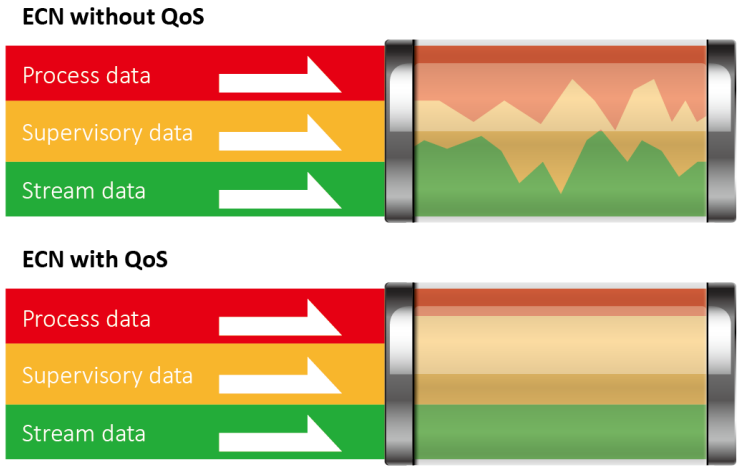


Figure 3 – Data network without and with QoS

The definition of priority levels are made by the control application in the ECN. In the default value, Supervisory data is set to have the highest priority. With QoS management, an ECN Ethernet switch should follow the definition given by the control application and send critical data to the host or TBN network according to the assigned priority level.

Cross train-car communications – Integration with R-NAT in IEC 61375-2-5

Since each train car is seen as an independent domain in the IEC 61375-2-5 standard, the communication between two cars needs to be preceded via a routing function. The IEC 61375-2-5 standard requires that the networking devices in the ECN need to transmit data through the TBN by R-NAT from one car to another car.

In the Figure 4, device #53 with IP address 10.0.0.53 in car No.5 would like to transmit data to device #21 with IP address 10.0.0.21 in car No.7. The IP address of the TBN Ethernet switch in car No.5 is 10.129.64.53, while the IP address of TBN Ethernet switch in car No.7 is 10.129.192.21. At first, data will be transmitted to the gateway ECN (IP address 10.0.0.1); which can be an ECN Ethernet switch, or a TBN Ethernet switch. Data will then be transmitted to the TBN Ethernet switch (IP address 10.129.64.53). With the transmission of R-NAT, the source IP address will be replaced by 10.129.64.53, then transmitted to the TBN Ethernet switch 10.129.192.21 in car No.7. When the package arrives at the TBN Ethernet switch in car No.7; the destination address will be changed again through R-NAT to 10.0.0.21,

and the source address of 10.129.64.53 will be kept. Finally, the package will arrive at device #21 (IP address 10.0.0.21) in car No.7.

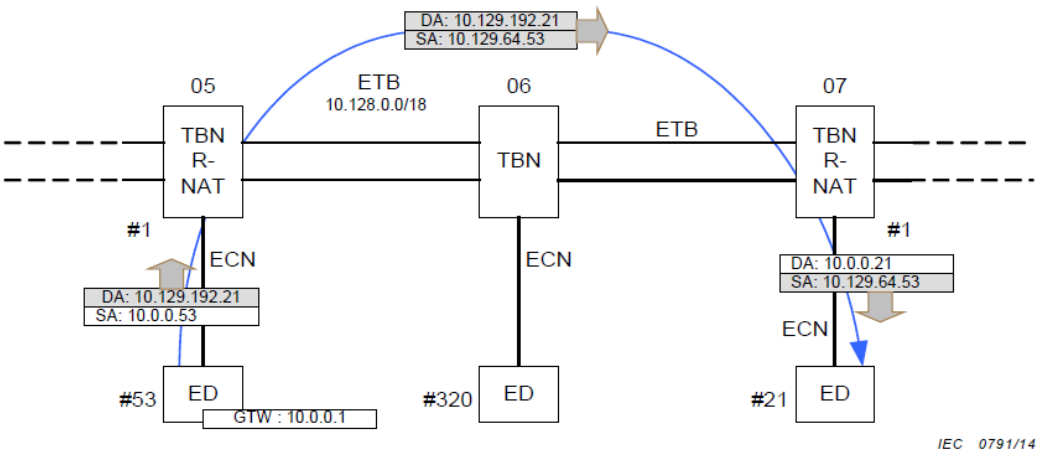


Figure 4 – An example of cross train-car communications

Conclusion

In a normal Ethernet data network, the network is divided into a backbone side and an edge side. However, in a Train Communication Network, the network is divided into an ETB and an ECN. End devices can connect to a TBN Ethernet switch directly when there are not a large quantity of end devices. When the number of end devices is large, and the network flow needs to be managed by QoS or VLAN; the ECN should be implemented with a hierarchical structure. There can be one or more ECNs in each train car with an IEC 61375-3-4 compliant Ethernet switches installed, for easy management. Considering the installation and maintenance costs, Lantech rolling stock Ethernet switch designs can support both IEC 61375-2-5 (ETB) and IEC 61375-3-4 (ECN) at the same time. These products will help train operators & installation companies reduce their capital outlay costs by providing greater flexibility when designing the network topology.

Recommended Lantech IEC 61375 Ethernet Switch Models

		
TPGS-5416MGFT-8/16-TCN 16x10/100/1000T (8 or 16 PoE at ports) + 2x10/100/1000T ports + 2x1G/2.5G Q-ODC fiber ports EN50155 IEC 61375 TCN Switch	**TPES-5424MGFT-16-TCN** 24x10/100TX (16 PoE at ports) + 2x10/100/1000T ports + 2x1G/2.5G Q-ODC fiber ports EN50155 IEC 61375 TCN Switch	**TPES-5408MGFT-8-TCN** 8x10/100TX PoE at ports + 2x10/100/1000T ports + 2x1G/2.5G Q-ODC fiber ports EN50155 IEC 61375 TCN Switch

		
TPGS-5608T-TBN 8x10/100/1000T PoE at ports + 6x10/100/1000T ports EN50155 IEC 61375 TBN Switch w/ R-NAT	**TPGS-6608XT-TBN** 8x10/100/1000T PoE at ports + 6x10G copper ports EN50155 IEC 61375 TBN Switch w/ R-NAT	