EtherNet/IP Based Networks Enable CBTC to Realize Increased Capacity

The United Nations predicts that by 2020 over 80 percent of the world's population will live in cities. This trend of increasing urbanization, coupled with climate change and environmental concerns, means the demands on urban railway capacity have never been greater.

Historically, increasing capacity on an urban rail network has involved large levels of capital cost for infrastructure. Common solutions to capacity challenges involved laying additional running lines, boring new tunnels and lengthening platforms to enable longer trains. These large civil projects are not only expensive; they also potentially disrupt operational service.

By using exact, real-time train positioning information, Communication Based Train Control (CBTC) provides a solution to capacity challenges and avoids the disadvantages of civil engineering projects. Operators benefit from an increased rail infrastructure capacity through the removal of fixed signaling blocks and instead managing train headways, speed and acceleration profiles continuously in real time.

CBTC System Elements

The typical architecture of a CBTC system includes the following main subsystems:

1. **Wayside equipment**, which includes the interlocking and the subsystems controlling every zone in the line or network (typically containing wayside ATP and ATO functionalities).

2. **CBTC on-board equipment**, including ATP and ATO subsystems in the vehicles.

3. **On-board ATP system**, continuously managing train speed according to the safety profile, and applying the brake if necessary. It is also responsible for communication with wayside ATP subsystems.

4. **On-board ATO system** is responsible for automatic control of traction and braking efforts to keep the train under the threshold established by the ATP subsystem.

5. **Wayside ATP** system manages all communications with trains in its area. Additionally, it calculates the limits of movement authority for every train while operating in the control area, making it critical for operational safety.
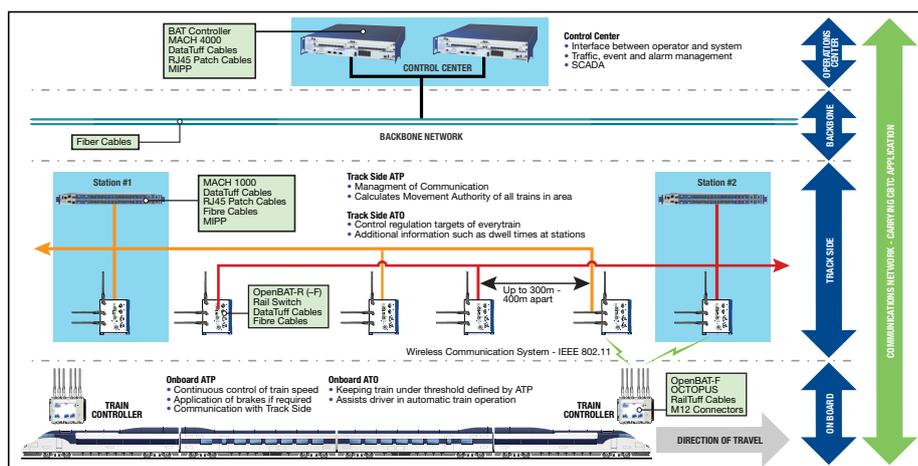
Belden offers a full portfolio of IEC (EN) 50155 and 50121-4 certified products and is uniquely positioned to provide a complete Ethernet communications system for CBTC applications, including switches (wired and wireless), connectivity and cables for everything from on-board the train to the Control Center.

6. **Wayside ATO system** controls destination and regulation targets of every train. This provides all trains in the system with specific destinations, station dwell time and other data.

7. **ATS system** is the interface between operator and system, managing traffic according to specific regulation criteria.

All of these elements of a CBTC system have one thing in common; they rely on robust and reliable data communication. The communications network needs to operate on-board rail vehicles, from train to ground, trackside and finally over backbone systems to the Control Center.

Communications Network

Through the use of an 'end-to-end' EtherNet/IP based network, the CBTC system runs as an application over the communications network. This enables the CBTC elements to communicate seamlessly with each other. While the CBTC system is Safety Critical (SIL4), the EtherNet/IP network does not need to be SIL rated, as the safety layer is managed by the CBTC application.

EtherNet/IP networks are therefore an ideal solution for CBTC, meeting or exceeding the following performance criteria.

Requirement	Benefit
Fast Secure Roaming	Any disruption in the CBTC service will bring trains to a stop. Because of this, a roaming handover time of <50ms is essential to provide uninterrupted train-to-ground communication.
Error Tolerance	Loss of the data being transmitted will result in system errors, so a packet loss of less than 0.1% is required throughout the system.
Sufficient Bandwidth	The network must be capable of carrying all of the required data from train to the Control Center. To provide this service a bandwidth of at least 4Mbps is required throughout the communications network.
Network Latency	Since the CBTC operation relies on real-time information for the control of trains, the maximum latency from end-to-end must be less than 5ms.

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