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A **BELDEN** BRAND

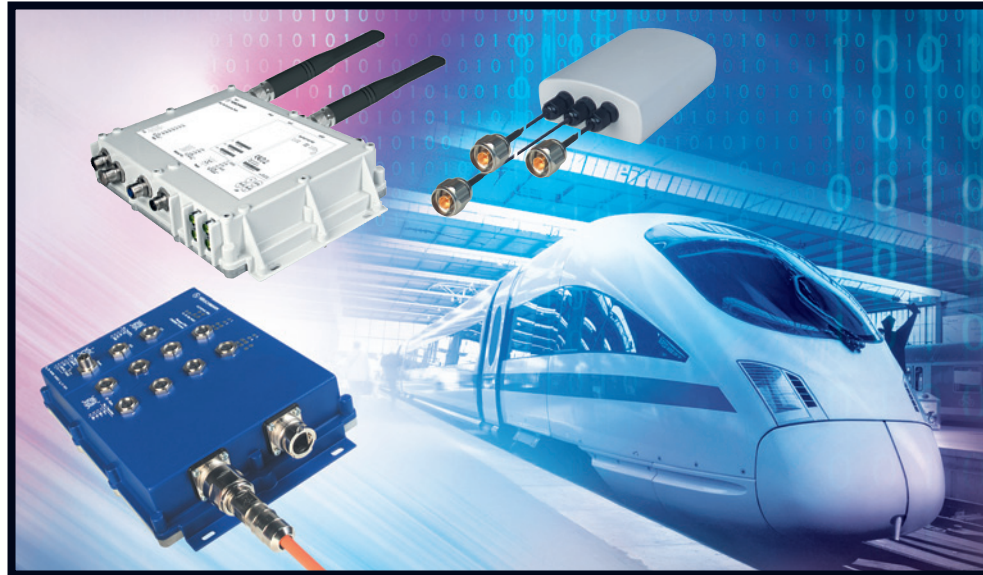
Application Note

AN 101HE

Transportation

Hirschmann™

Wireless LAN in trains



Railcar Couplings With Wireless Network Technology

Anyone who frequently travels by rail will know the situation: the train arrives on time, but even before it reaches the platform the station tannoy announces that the cars are not in the order shown on the display board. Sometimes there are even cars missing. The result of this is that passengers on the platform, and subsequently in the train, have extreme difficulty locating their reserved seats. When some of the expected cars are not included, the corresponding reservations will also be missing.

The reason for this confusion is that the onboard technology lacks flexibility. Once a train has been put together the car and seat numbers are fixed and cannot be changed. If shunting considerations cause the train to leave the shed in the wrong direction, then it will remain the wrong way around until it reaches its destination. There is no way of then renumbering the cars and seats. Customers

who are familiar with modern Ethernet technology and flexible programming facilities justifiably want to know why such straightforward adjustments are totally impossible for modern high-speed trains.

If trains were equipped with broadband Ethernet networking it would be possible to implement this and numerous other applications that airline passengers, for instance, have learned to take for granted: onboard entertainment offering a selection of films that can be shown on request, e-mail access via an on-train internet service, up-to-date information about connections to other trains, delays, etc.

A broadband network would enable the onboard staff to improve their proffered service by providing a central overview of the occupancy of individual cars. Video monitoring and fast-response emergency services could also serve to improve safety.



Wireless Networking as the Basis for a Solution

But even now, trains are equipped only with cable-based networking. There are two reasons for this – its robustness and its durability. Broadband connections on board a train suffer primarily from the fact that each of the couplings between cars is a bottleneck that impedes the flow of data. They are the most heavily used connections and are subject to a great deal of wear. Temperature fluctuations, rain, snow and sleet, dirt and impacts from loose chippings all demand extremely robust, well-designed plugs and sockets for the cable connections that have to pass through the couplings. This is why trains still offer – at best – digital bus technology or modulated Ethernet via the UIC line. For many years, Ethernet has been gradually ousting conventional bus technology from the field of industrial automation.

Bus technology is relatively simple and extremely reliable, but it does not lend itself to networking and many of the available forms are mutually incompatible. Ethernet, on the other hand, allows individual subscribers to be networked and is a well standardized technology (IEEE 802.3) that can therefore be upgraded step by step at relatively low cost anywhere in the world.

Ethernet networking not only permits high data speeds, it also facilitates fast recognition of the train configuration and is readily extensible. To date, however, connections through train couplings have – at best – achieved rates of 10 Mbps. This is why a wireless solution is so attractive.

Wireless LAN (WLAN), as described in the IEEE802.11 standard, is a wireless Ethernet network. To date the WLAN standard has diversified into four variants, from the venerable but still common IEEE802.11b standard, offering gross data rates of up to 11 Mbps, right up to the brand new IEEE802.11n standard, which currently offers up to 300 Mbps and is scheduled to reach 450 Mbps in a subsequent stage.

These rates are perfectly adequate for implementing the desired facilities and services in the train, and for future requirements such as electronic rear-view mirrors or front cameras to improve passenger comfort. A wireless network can be installed in an existing network – the existing cables and couplings do not need to be modified.

Great Challenges Call for Great Solutions

In practice there are a number of technical problems that remain to be solved even with a wireless LAN. Retrofitting WLAN access points and (particularly) antennas in previously delivered trains can be quite a challenge. Every inch of space is already taken up. Naturally, small easy-to-install units will be advantageous here.

A further advantage can be achieved by reducing the number of devices, e.g. by integrating several WLAN interfaces into a single access point. Naturally, the units also have to meet all the standards required for equipment that is installed in trains. These are stringent requirements, and cannot be fulfilled by just any device.

But the greatest challenge is due to the simple fact that a wireless network has no external boundary: electromagnetic waves do not stop when they reach the side of the train. A connection that is set up between two cars or train sections needs to bridge only a very short distance. It is particularly important to prevent nearby trains from setting up unwanted connections. And, naturally, there have to be safeguards to prevent unauthorized persons from gaining access to a train's internal network.

Modern WLAN equipment is perfectly able to meet these requirements. Authentication and encryption are mechanisms that are described in the WLAN IEEE802.11i safety standard, which is supported by almost all modern products.



The solution to the second task – setting up correct one-to-one connections between one train section and another – calls for equipment features above and beyond those stipulated by the standards. The embedded operating systems in the WLAN access points are capable of supporting the verification of connections, thereby providing a certain native intelligence. With appropriate system programming and powerful management software to monitor and control the wireless and cable-based network, the solution is as good as complete.

As a manufacturer of both industrial standard Ethernet hardware and powerful management software, the Hirschmann™ product range includes just such complete solutions. The management software uses LLDP (link layer discovery protocol) to recognize the topology of the train's onboard network. This information can then be used to flexibly assign numbers to cars, seats, etc. The industry's tried-and-tested redundancy mechanisms reinforce the reliability of the network.

Hirschmann™ WLAN access points support all the usual rail standards including the very latest WLAN standard. This IEEE802.11n standard offers transmissions at rates of up to 300 Mbps and with markedly increased stability. A further benefit of a WLAN is the possibility of transmitting video signals.

Railcar Couplings with BAT Access Points

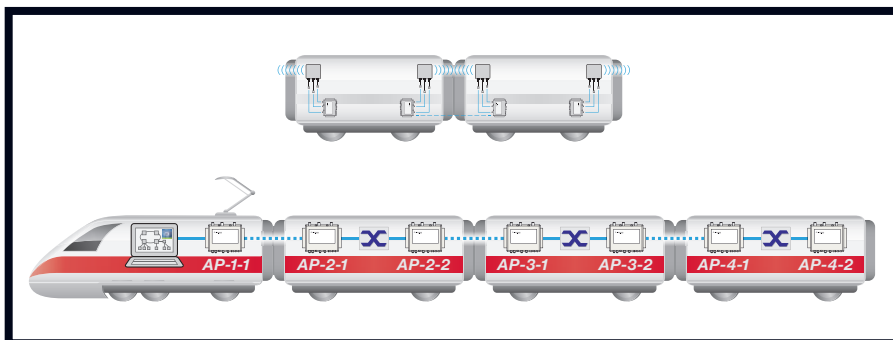
A 100% one-to-one wireless coupling between the cars in a train can be set up only if the WLAN connection can subsequently be verified via a cable link, but this connection demands very little in the way of bandwidth or transmission quality and BAT access points from Hirschmann™ are equipped with a serial V.24 interface (RS232) that is used for this verification. The integrated software sets up the WLAN connection and verifies it autonomously.

Additional features that make Hirschmann™ BAT products ideal for use in trains:

- Configurable transmission power up to 0.5 dBm, connection of modems via V.24 or RJ45 (LAN, DSLoL, PPPoE, etc.)
- Damping to ensure that only the strongest signal is recognized
- Strongly directional antennas
- Controller solution available

Bandwidths

- Modem via UIC cable: 9k6 baud
- Powerline: at most 10 Mbps
- BAT54: up to ca. 30 Mbps net (turbo mode)
- BAT300: up to ca. 100 Mbps net



With a one-to-one physical connection this provides a 100% secure high-bandwidth WLAN railcar coupling.



All BAT-F devices are suitable for use in trains. Among other things, this calls for certification under EN50155. The IRIS certification of the entire Hirschmann™ company constitutes a solid basis for this.



The Hirschmann™ Product Range

Belden's Hirschmann™ products are notable for their robustness and high quality. They are expressly designed for use in rugged environments and possess sturdy metal housings and redundantly configured technology supporting authentication, security and safety standards providing for maximum operating, transmission and network security.

BAT products also possess an extremely powerful yet flexible operating system that is able to adapt to a wide range of applications. This ability is a fundamental requirement for their support for coupling railcar network segments independently of the physical train couplings.

Customers who use Hirschmann™ products benefit from their long useful life and sustainable safe operation. Belden also offers comprehensive project management for the integration of its products into customers' own solutions.

Product Details

BAT54-F

- Industrial WLAN access point with an IP65/67 housing
- Two WLAN interfaces compliant with IEEE 802.11a/b/g/h/i
- 1x LAN/PoE, 2x24 V



BAT54-F Client

- Industrial WLAN access client with an IP65/67 housing
- One WLAN interface compliant with IEEE 802.11a/b/g/h/i
- 1x LAN/PoE, 2x24 V



BAT54-F Single

- Industrial WLAN access point with an IP65/67 housing
- One WLAN interface compliant with IEEE 802.11a/b/g/h/i, two PoE LAN interfaces
- 2x LAN/PoE



BAT300-F

- Industrial WLAN access point with an IP65/67 housing
- One WLAN interface compliant with IEEE 802.11a/ b/g/h/n/i
- 1x LAN/PoE, 2x24 V

BAT54-Rail

- Industrial WLAN access point for mounting on a top-hat rail
- Two WLAN interfaces compliant with IEEE 802.11a/b/g/h/i
- 2x LAN/PoE, 2x24 V, 1x12 V



BAT54-Rail Client

- Industrial WLAN access client for mounting on a top-hat rail
- One WLAN interface compliant with IEEE 802.11a/b/g/h/i
- 1x LAN/PoE, 2x24 V, 1x12 V



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- Industrial WLAN access point for mounting on a top-hat rail
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BAT300-Rail

- Industrial WLAN access point for mounting on a top-hat rail
- One WLAN interface compliant with IEEE 802.11a/ b/g/h/n/i
- 2x LAN/PoE, 2x24 V, 1x12 V

Antennas

BAT-ANT-N-MiMoDB-5N-IP6

- Order number: 943 981-012
- Dual band MiMo 11n omnidirectional



BAT-ANT-N-8G-DS-IP65

- Order number: 943 981-009
- 2.4 GHz sector dual slant



BAT-ANT-N-9A-DS-IP65

- Order number: 943 981-010
- 5 GHz sector dual slant



BAT-ANT-N-MiMo5-9N-IP65

- Order number: 943 981-013
- 5 GHz MiMo 11n sector



BAT-ANT-N-LC-G-50m-IP65

- Order number: 943 981-001
- 2.4 GHz leaky waveguide



BAT-ANT-N-LC-G-100m-IP65

- Order number: 943 981-101
- 2.4 GHz leaky waveguide

