RailCabs: The Railway of the Future

- University of Paderborn uses dSPACE hardware
- Modular rail system for flexible passenger and freight transport
- ControlDesk used for RailCab control

A completely new railway system using individual RailCabs is being developed at the University of Paderborn in Germany (see dSPACE NEWS 1/2002). The project was initiated by the research initiative Neue Bahntechnik (New Rail Technology) Paderborn, or NBP for short, some years ago. The control technology for the new rail system is supported by dSPACE hardware. The RailCabs are driven by a linear drive similar to that of the Transrapid. The aim is to utilize existing rail track to run automated, driverless cabs for both passenger and freight transportation.

An outdoor test track for the RailCabs was set up at the University of Paderborn in 2003 as part of the NBP research project. RailCabs are driverless, railbound vehicles that are driven and braked by a dual-feed linear drive. The test site includes a 530 m long track on which two RailCabs run at a speed of up to 36 km/h.

The drive is not in the cabs themselves, but on the track, and consists of two independently powered components with rotary field coils:

- The primary is installed along the track, between the rails.
- The secondary is mounted on the underside of the RailCab chassis.

This creates a magnetic field in the primary. The field moves along the rails and takes the RailCab with it.

The RailCab in Outdoor Test Runs	
Weight	1,200 kg
Length	3 m
Height	1.2 m
Width	1.2 m

Power Supply to the Linear Drive

▲ *The RailCab test track with conventional ballasted ties at the University of Paderborn: testing in real-world conditions.*

The primary is divided into a total of 84 sections, each 6 m in length. A separate converter with a CANopen interface is assigned to each section. The converters are grouped at four locations along the test track and can be controlled via the CANopen network. No power rails or overhead lines are needed, as energy is transferred to the vehicle when the linear drive is run asynchronously in oversynchronous mode. To control the power flow via the drive, the frequency of the traveling wave needs to be regulated dynamically without impairing the slip ratio, which would put the drive out of step. This all makes tough demands on the control system with regard to the data transfer rate, real-time capability, and safety.

CANopen
The CANopen protocol is a standard for industrial CAN-based system solutions. It allows both cyclic and event-driven communication between the devices on the CANopen network.
For further information, see *www.can-cia.org*

The Control and Instrumentation Technology

Each RailCab has an industrial PC (IPC), to which a dSPACE system with two DS1005 PPC Boards and several I/O boards are connected. This performs the entire control of a rail cab for the drive, the active suspension and tilt technology, and the track guidance of the vehicle. The IPC of each RailCab is connected to a host PC in the test site's control station via a WLAN. The IPC is remote-monitored from the control station by means of software called PC-Duo and remote-controlled using ControlDesk. The thrust of each RailCab is proportional to the strength of the magnetic field of the primary and secondary. The reference variables of the primary, consisting of the current and frequency, are therefore transmitted to the CANopen network master via a second radio channel with a serial interface. This distributes the values to the converters for the track sections which the RailCab is currently passing over. As the RailCab travels along, the control systems of the converters on the track are synchronized with one another. This prevents angular errors occurring when the traveling wave is switched from one section to the next, which would result in a gap in the traveling wave. The control system needs to know the current position of the electrical field in the primary, so that the electromagnetic field in the secondary can be set to provide optimum thrust. This prevents situations in which the RailCab suddenly accelerates in the opposite direction.

Synchronization of Real-Time Data

The communication paths via the field bus and radio are integrated into the vehicle control under real-time conditions. A synchronization mechanism was designed for the distributed control hardware on the track and in the vehicle to ensure the reliability of the overall system. The synchronization mechanism guarantees that the system will work safely even if there are breaks in radio transmission or data transmission faults – as amply proven by more than two years of constant, successful test operation.

Running 3 RailCabs Simultaneously

The plan is now to extend the existing controls and instrumentation to allow 3 RailCabs to run simultaneously. Communication between the vehicles will play a vital role in ensuring safety.

For further information, visit *www.railcab.de*.

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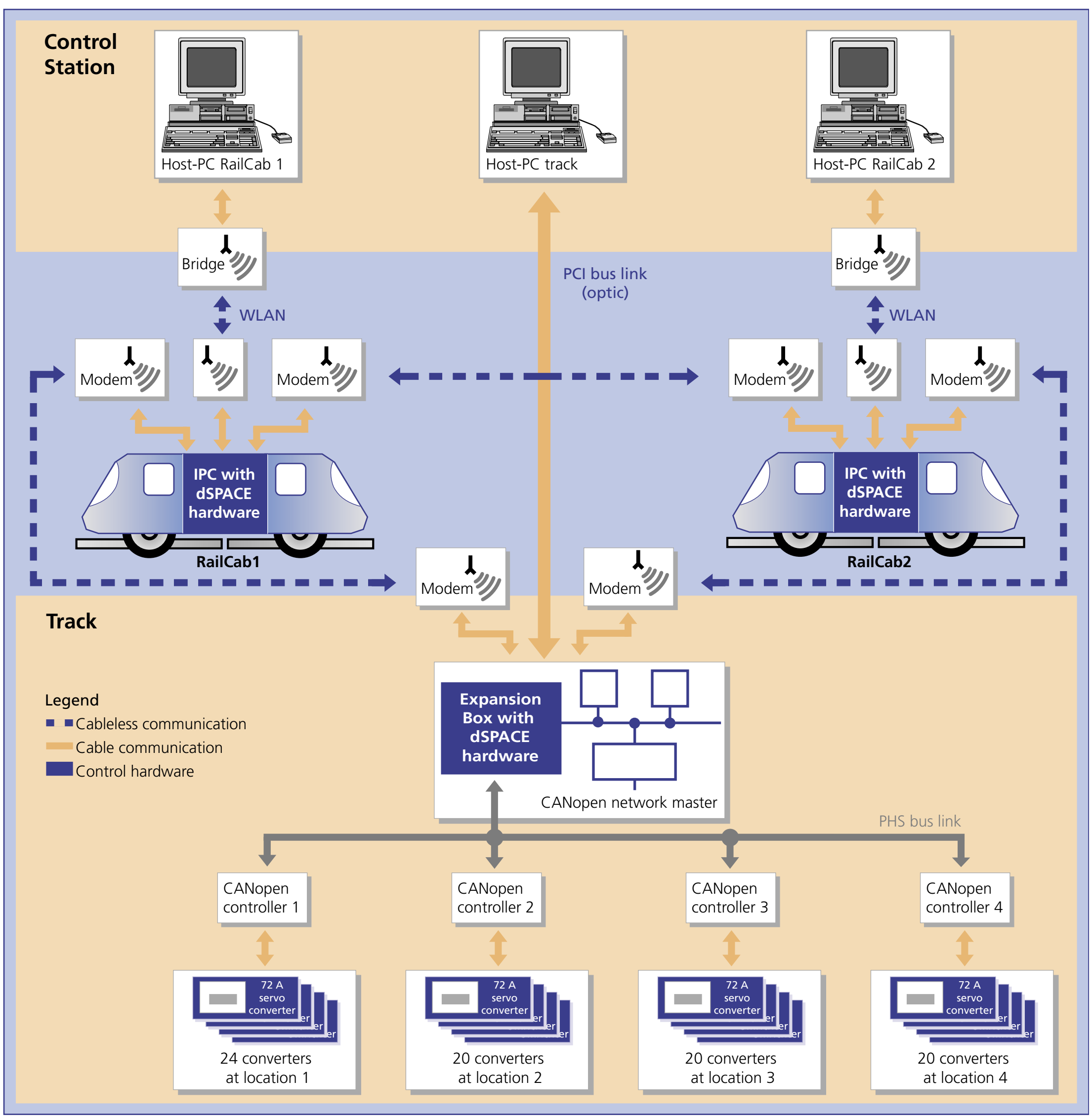

◀ *Overview of the test site's control and communication technology for autonomous RailCab operation.*