Riding the Rail Boom with CompactPCI*

Meet Reliability and Longevity Requirements with Off-the-Shelf Hardware

By Walter Furter, Director, Transportation, Kontron

As countries around the world commit to a greener, more connected future, transportation applications—including rail, road, air, and shipping applications—are booming like never before. China alone is spending 700 billion RMB (about $100 billion USD) annually to expand its rail network. Even the United States is entering the high-speed rail game, with a $40 billion USD system under development in California. These new rail networks will require a broad range of embedded systems for conductor terminals, automatic piloting, centralized control centers, safety monitoring, and passenger information systems, among other applications.

Meeting the needs of this growing market is a major challenge. Transportation applications are constantly pushing for more performance and networking, while also requiring the highest levels of ruggedization and reliability. Rising to the challenge, designers are finding that proven, standards-based Commercial-off-the-Shelf (COTS) boards and modules with advanced Intel® architecture processors can put them on the fast track in this demanding industry.

Unique Design Challenges

System designers in the transportation market must take extraordinary steps to ensure reliability and longevity. For example, rail applications must adhere to the demanding EN50155 standard, which requires electronic systems to operate without failure 24 hours a day for 30 years—or approximately 250,000 hours. To meet this standard, train control systems must be designed to withstand the toughest environmental conditions: extended temperature ranges of –40 °C up to +85 °C; humidity, shock, and vibration; and power fluctuations. Even heat buildup and energy absorption have to stay within narrow ranges.

Thermal management is a particularly critical design element. Failure-prone fans are prohibited as a cooling method, and only passive thermal management technologies are permitted. Combine these constraints with growing processor performance requirements and the presence of heat-generating motors, and the challenge becomes intense.

In addition to growing processing demands, next-generation transportation systems require new network protocols with flexible, higher-bandwidth connectivity. For example, Gigabit Ethernet is in demand for automated transport systems.

Further testing the limits of system design, the transportation industry has placed extended product lifespan and obsolescence management on its systems. To meet these requirements, the system designer must make extremely careful supply-chain decisions.

Without question, all of these requirements add up to make transportation one of the most challenging embedded industries.

However, the challenges become much smaller with rugged COTS platforms based on Intel architecture processors.

Processor and COTS Platforms Up to the Task

The benefits of COTS platforms are two-fold. First, using a high-volume standards-based solution can significantly lower both non-recurring and recurring costs. Non-recurring costs are reduced because off-the-shelf systems require less up front engineering. Recurring costs also come down because the COTS hardware vendor can order components in large quantities, giving them greater leverage over pricing. Secondly, standardized products can ensure long-term availability and future system scalability. COTS vendors who target the transportation industry—such as Kontron—make long-term hardware availability a top priority. In addition, the use of standards-based, modular designs make it easier to adapt a system as requirements change and new technologies arise.

CompactPCI* is a particularly appealing COTS platform for transportation systems. CompactPCI is an industrial computer standard based on a passive PCI backplane. It offers ruggedization and longevity along with features optimized for transport systems, including passive thermal management, hot swap capabilities (which supports high reliability and availability), and intelligent cabling (which reduces system size). When combined with power-efficient Intel architecture processors, CompactPCI is an excellent match for the transportation system requirements of low power, space, and cost.

A prime example of transportation-ready solution is the Kontron CP305, a 3U CompactPCI board that integrates the Intel® Atom™ processor N270 1.6 GHz (Figure 1). The Intel Atom processor N270 provides excellent performance per watt and features a single core that supports two parallel threads using Intel® Hyper-Threading Technology (Intel® HT Technology) for enhanced performance and increased system responsiveness. The Kontron CP305 also supports the Mobile Intel® 945GSE Express Chipset, which features a potent graphics engine for high-resolution and dual display applications. Designed for reliable operation in a temperature range from 0 to +60 °C for convection-cooled environments, the CP305 boasts a typical power consumption of only 10 Watts. The Kontron CP305 is EN50155 compliant and enables extremely rugged design with soldered processor, chipset, and memory for harsh environments.

Along with its rugged low-power design, the Kontron CP305 CompactPCI board offers a comprehensive set of interfaces that include on-board dual Gigabit Ethernet (GbE) ports, up to six USB 2.0 ports, two SATA interfaces, and a CompactFlash* socket. The graphics accelerator, integrated into the Mobile Intel 945GSE Express chipset, delivers superior 2D, 3D, and video features through the VGA connector on the front.

Successful Transportation Application Example

One example of a successful CompactPCI transportation system is the Video-Based Traffic Control (VBTC) automated tunnel surveillance package developed by Center Communications Systems in Austria. This system monitors road traffic through tunnels with the knowledge that seconds saved in automobile accident response can save lives

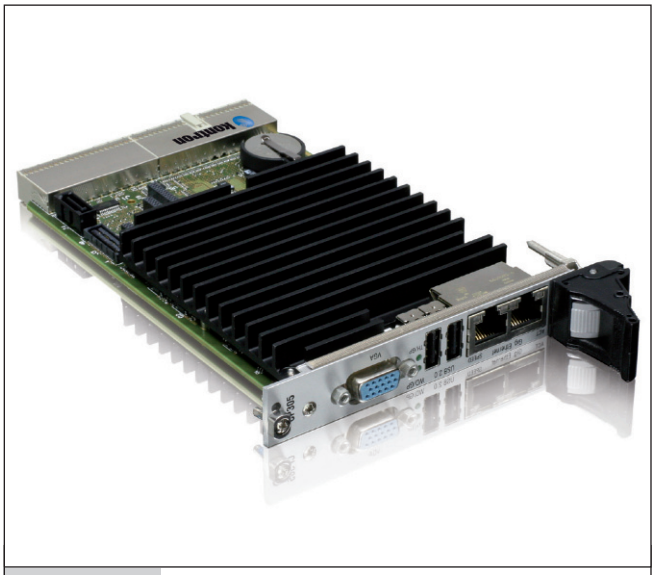

Figure 1. The Kontron CP305 is an EN50155-compliant 3U CompactPCI board that integrates the Intel® Atom™ processor N270.

and prevent large-scale structural damage—all while reducing risk to rescuers. The VBTC is an innovative video content analysis system that emulates human decision-making processes. It performs compute-intensive real-time video analytics to recognize vehicle type, speed, and distance from other vehicles. These capabilities let the VBTC detect potential safety hazards such as pedestrians on the road, smoke, fog, wrong way drivers, vehicle breakdowns, and other traffic hazards. The system can also measure traffic flow and density to report only relevant and potentially dangerous events as alerts, which reduces the amount of work that must be handled at the centralized control center. Figure 2 illustrates the system in action.

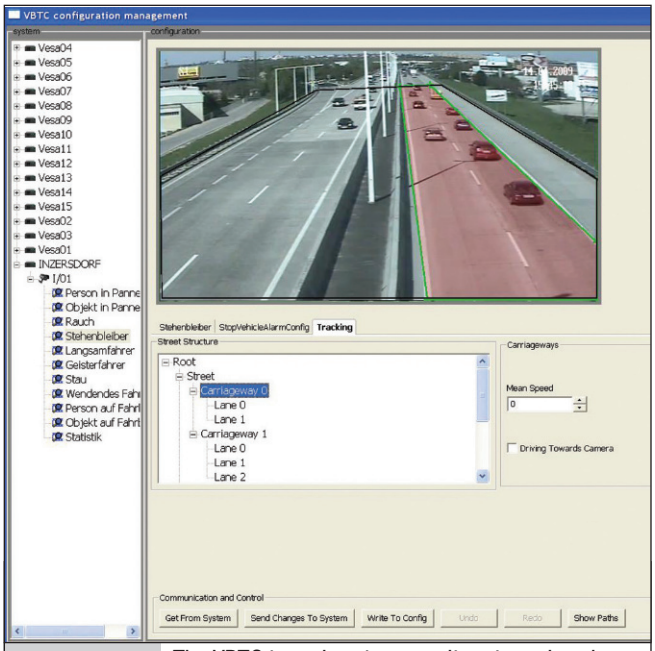

Figure 2. The VBTC tunnel system monitors tunnels using video analytics algorithms optimized for road traffic, as well as an intelligent automated alert system.

> *The consistency of the Intel architecture makes it easier to maintain the code base.*

Advanced, high-performance hardware is an essential prerequisite for this powerful video-processing application. To ensure safety, the hardware must also be highly reliable despite the harsh environmental conditions often present in tunnels. To meet these needs, the system relies on the Kontron CP307, a 3U CompactPCI board based on the powerful Intel® Core™ Duo processor (Figure 3). This board is available with dual-core processors running at up to 2 GHz, providing plenty of horsepower for the demanding real-time video analytics.

One distinct advantage of using this Intel-based board for video content analysis is that the software development is simpler with Intel architecture than it is on esoteric Digital Signal Processors (DSPs). In addition, the consistency of the Intel architecture makes it easier to maintain the code base from generation to generation and to scale the system to higher or lower performance levels based on the number of cameras.

The processor card is housed in a 19-inch enclosure that also includes PCI-based frame grabber cards, a RAID controller, four hard drive slots, and two power supply units (see Figure 4). Together these components take inputs from eight cameras per tunnel, analyze video images in real time, and record the signals from each camera. The video is stored in a self-overwriting circular buffer for up to 30 days or the specific period of time defined by the system requirements. The data is further protected by either RAID-5 or RAID-10 technology depending on the specific application requirements. The system can also track the time, date, and location of incidents if this information needs to be shared with law enforcement or during a court proceeding.

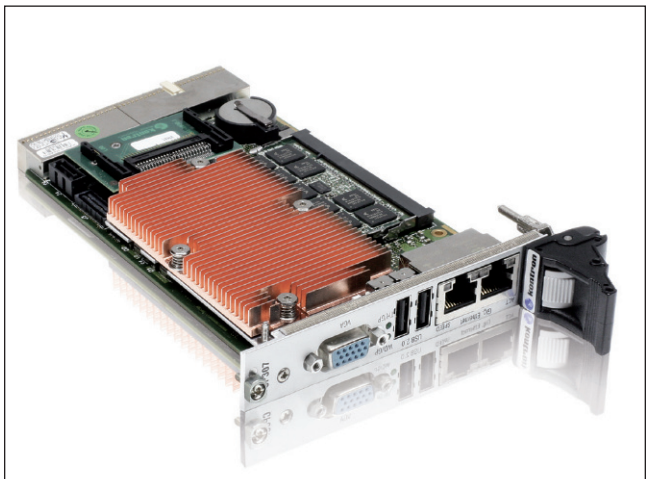

Figure 3. The VBTC tunnel monitoring systems use the Kontron CP307, a 3U CompactPCI board with a powerful Intel® Core™ Duo processor.

Figure 4. VBTC Tunnel's VESA units are constructed (left to right) by PCI-based frame grabber cards, a RAID controller, a Kontron CP307 CPU board, four hard drive slots, and two power supply units.

Capitalizing on the inherent rugged, cool operational benefits of the CompactPCI platform, the VBTC units can operate reliably under the extreme temperature fluctuations found in roadway tunnels. Since the units have a fanless design, they resist dust, soot, humidity, gases, and salts. Each 19-inch system is equipped with redundant hot-swappable power supply units, and has an adapted backplane designed in conjunction with Kontron, enabling PCI-based frame grabbers to be incorporated via a CompactPCI-to-PCI converter.

Riding COTS Standards to Success

Transportation systems present a long list of demanding requirements and strict standards, but COTS platforms based on Intel architecture processors are proven solutions. Standards-based Kontron CompactPCI boards are a particularly good choice. These boards are optimized for the transportation market and meet key market requirements including high performance, ruggedization, high reliability, and long life support.

As a Premier member of Intel® Embedded Alliance, Kontron (intel.com/go/ea-kontron) is committed to delivering Intel-based solutions that help designers solve today's tough design challenges with a comprehensive portfolio of innovative, cost-effective solutions.