

# Improving Transportation Safety, Efficiency, and the Customer Experience with the Internet of Things (IoT)

Kontron\* uses intelligent gateways based on Intel® technology in connected transportation systems.



Driving a data revolution in  
the transportation industry

## Executive Summary

Digital information has become the life blood of the transportation industry with networks of computer chips and sensors integral to nearly every aspect, including public transport, fleet management, surveillance, ticketing, passenger information, etc. Today, most systems operate in relative silos, but this is changing as municipalities see the compelling benefits from improved information sharing. This is what the Internet of Things (IoT) is designed to do: provide the connectivity, security, interoperability, analytics, and monetization capabilities that enable intelligent transportation.

Information in the right hands at the right time opens the door to all sorts of possibilities. In the case of buses, real-time passenger count data allows fleet operators to better optimize timetables to ensure sufficient numbers of buses are scheduled on heavily-travelled routes. Analytics software can provide scheduling suggestions based on passenger patterns correlated to the time of day, holidays, local events, weather, etc. Vehicle diagnostic information helps operations crews perform preventive maintenance, as in making a preemptive repair (e.g., replace

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brake pads, worn tires) to avoid a breakdown or an expensive major repair. Up-to-date timetables on information displays give passengers en route a higher level of customer service.

But standing in the way of shared transportation information, much of the existing infrastructure is made up of many decades-old systems, and getting them all connected to an IP network could take considerable effort. Helping overcome this issue, IoT-based solutions from Kontron\* and Intel are designed to make it easier for legacy and new systems to communicate with each other so municipalities can take advantage of the power of data-driven transportation.

### Key Business Objectives

Improve transportation safety, efficiency, and customer experience with a connected transportation system that takes full advantage of data.

### Business Challenge

Rather than replace existing infrastructure with new Internet-enabled systems, municipalities require a compatible solution that delivers seamless and secure communication between legacy systems and the cloud.

## Solution Benefits

Intelligent transportation based on IoT technologies from Kontron and Intel can ultimately help municipalities achieve their major objectives:

- **Improved Safety:** Intelligent transportation systems use [video surveillance](#) to protect customers' physical well-being and monitor driver performance; [proactive maintenance](#) to keep public transport vehicles running well; and [informed navigation](#) to enable drivers to avoid routes with dangerous situations (e.g., chemical spill), just to name a few capabilities.
- **Higher Efficiency:** Maintenance issues can be addressed more promptly and before costly breakdowns occur by enabling drivers and operations personnel to see exactly what is happening on a heavy commercial vehicle, based on data from its hundreds of sensors.
- **Enhanced Customer Experience:** With wireless connectivity and infotainment solutions, customers on the move can access travel information, like updated timetables, smart parking, points of interest, street maps, etc., to make their journey as smooth as possible.
- **New Revenue Streams:** Incremental revenue can be generated by offering new services on trains, such as on-demand video for passengers or ad space for advertisers.

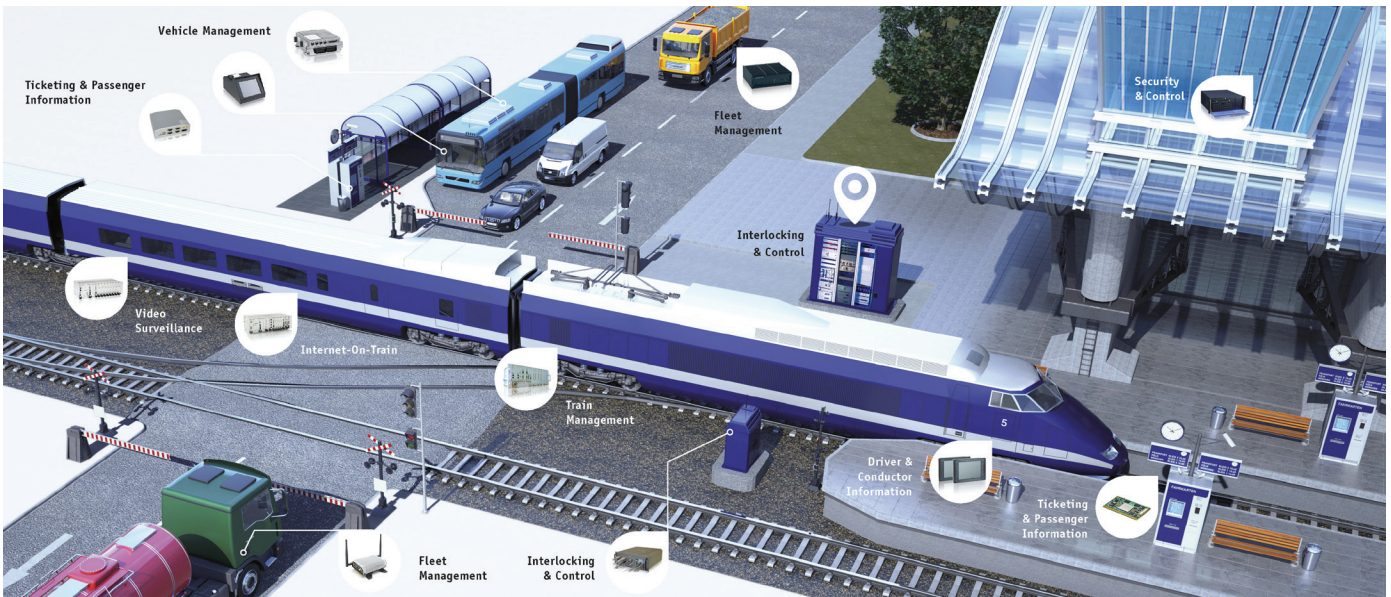


Figure 1. Examples of Electronic Systems Used in Transportation

### Solution Overview

Bus lines, truck fleets, and rolling stock (e.g., trains, metro) are increasingly using more electronic systems to lower transportation system cost, improve reliability, and increase passenger comfort and services. Figure 1 shows some examples, including video surveillance, Internet-on-train, fleet management, driver information, and ticketing. However, the complexity of this infrastructure requires a uniform device structure with respect to data acquisition, control, and security. Kontron, with help from Intel, is addressing these challenges by applying IoT technologies, which were developed to handle such requirements.

In particular, Kontron offers a comprehensive line of operational computers that are proven, rugged, and designed expressly for the transportation market. The computers function as gateways, control management systems, network

video recorders, and transportation computers. In addition, Kontron offers environmentally-hardened display units for drivers and passengers.

These platforms feature high performance density and low power consumption in a small footprint, low-profile design that offers integrators more flexibility in terms of the number of available I/O. The family of computers also provides long-term support by design, based on its modularity and seamless technology insertion of the processor, storage, I/O, and power supply unit. The computers are equipped with a dedicated microcontroller, which continuously monitors all functions and independently reports on application status while the CPU is in normal operation. These innovative capabilities allow transportation OEMs to significantly decrease development efforts for faster time-to-market, while also reducing maintenance costs and the total cost of ownership.

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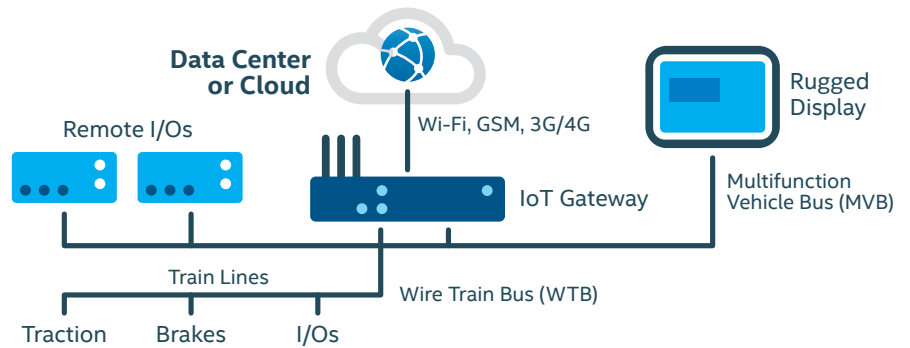


Figure 2. Train Management System Usage Model

**Solution Implementations**

The following covers four transportation usage models geared toward improving efficiency, security, and the customer experience:

**1) Train Management System – Improved Efficiency**

The train management system monitors and runs diagnostics on a wide variety of non-critical systems in and around the car, including door locks, heating and cooling (HVAC), traction, and brakes, as shown in Figure 2. It provides a single view of train car status, thus making the driver and operations team more efficient. For instance, the driver can view vehicle status, speed, and warnings on a ruggedized display.

Figure 3 shows an IoT gateway that collects and sends data to a machine data cloud via a secure protocol, such as HTTPS. Cloud hosted web-based applications can remotely monitor, manage, and control train devices. The data is then transferred from the cloud to the train company's data center, where it can be processed further by logistics, diagnostics, and analytics applications.

**2) Passenger Service Systems – Enhanced Customer Experience**

IoT technologies can help improve the customer experience on trains and buses by delivering the services passengers now expect in an increasingly connected world. For instance, passenger information

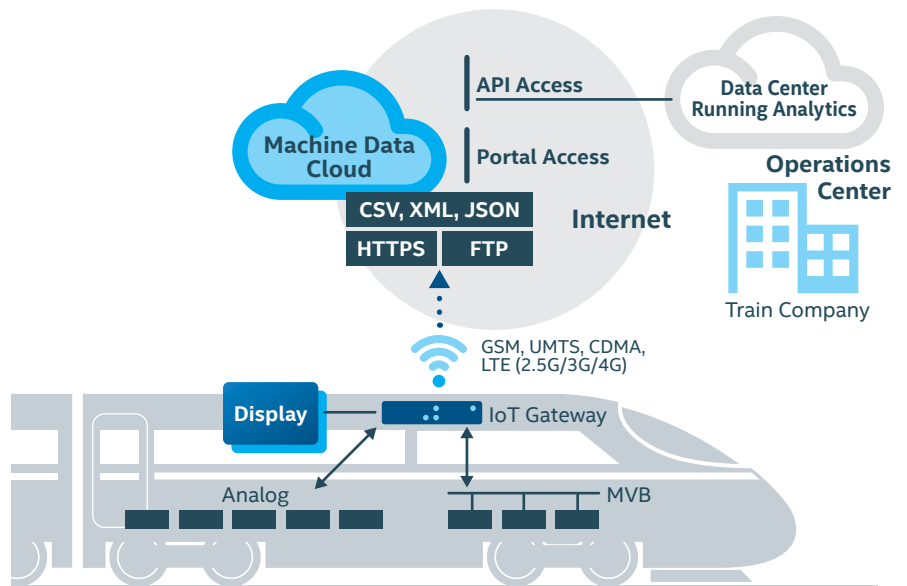


Figure 3. Machine Data Movement

systems provide up-to-the-minute updates on route stops, schedules, and train changes. Internet-on-train enables passengers to stay in touch via email and social media, and provide access to weather forecasts, news, and entertainment. Video on demand can be streamed to passengers' mobile devices, making long trips more fun.

These usage models are made possible by a local network video recorder that connects passengers to the Internet and service providers, as shown in Figure 4. Train companies can generate incremental revenue by streaming content to passengers or showing ads for a fee.

### 3) Video Surveillance – Increased Safety

To stay ahead of the growing demand for passenger security, cameras and network video recorders can be used for station and platform observation, or video recording in local trains to prevent vandalism. Cameras also help train companies monitor individual cars, and track conditions and component wear.

In addition, video is used to score driver performance in real time, providing alerts when a driver is in the wrong gear, has passed a speed threshold, or is idling too long. This information can be used to ensure safe driving and increase fuel economy by up to 10 percent.<sup>1</sup>

A network video recorder captures and records streams from cameras, which can be sent to a local monitor, emergency response team, data center, the cloud, etc., as shown in Figure 5.

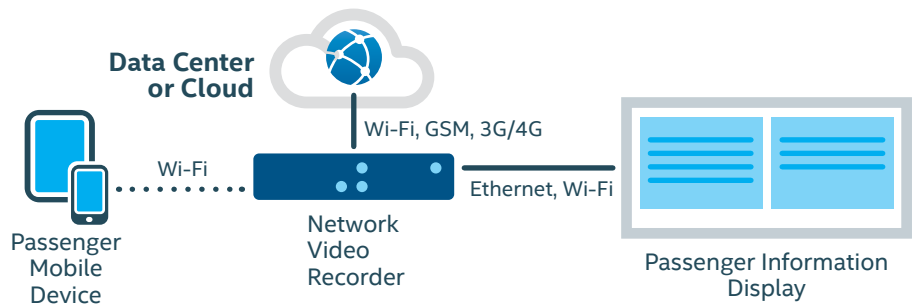


Figure 4. Passenger Service Systems Usage Model

### Technology

This section describes the technology ingredients available to deploy intelligent transportation solutions like the ones previously described.

Transportation control systems must be designed to withstand the toughest environmental conditions: extended temperature ranges (-40°C to +85°C), humidity, vibrations, and power fluctuations. Even heat build-up and energy absorption have to stay within narrow ranges. Only passive cooling technologies are permitted.

Kontron's comprehensive line of TRACe\* operational computers are designed specifically for the transportation market, delivering proven, rugged, and feature-rich building blocks that allow design flexibility. EN50155 certified, the TRACe family is based on Kontron's COM Express\* Computer-on-Module (COM) that features the quad-core [Intel® Atom™ processor E3845](#), which

delivers power-efficient computing performance. The rugged design ensures stable operation in harsh environments and is ideal for any transportation (bus line, truck fleet or railway) application, such as passenger information systems, video surveillance, and transport vehicle management systems.



Figure 6. Kontron TRACe B304-TR Intelligent Transportation Computer

### Intelligent Transportation Computer

The extensible and modular design of the [Kontron TRACe B304-TR](#) computer gives integrators the ability to set up their own configuration through multiple configuration extensions and Mini PCI Express\* (PCIe) slots. Its

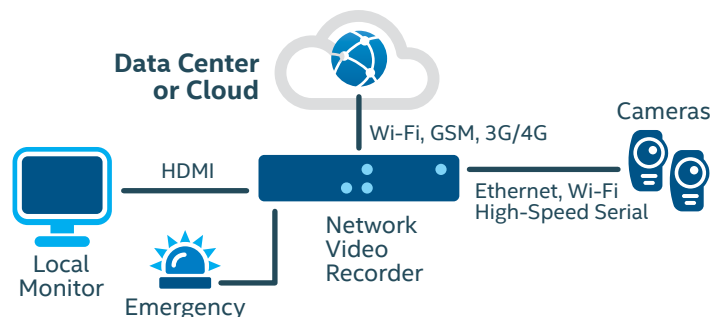


Figure 5. Video Surveillance Usage Model

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front plate is dedicated to operational connectors with certified I/O according to the EN50155 standard, including Ethernet, USB, serial ports, audio, and digital inputs and outputs. The rear plate allows for additional application-specific connectors for GSM/GPRS/3G/LTE/4G, GPS, Wi-Fi, Bluetooth\*, MVB, CAN Layer2, CAN Open, or Profibus to support I/O coming from optional Mini PCIe cards.



**Figure 7.** Kontron TRACe M304-TR Train Management Computer

### Train Management Computer

An ideal computing solution for TCMS (Train Control Management Systems), the [Kontron TRACe M304-TR](#) computer is optimized to ensure stable operation in harsh environments, and offers Multifunction Vehicle Bus (MVB) and Ethernet field busses. Its MVB Class 4 interface features process data, message data, bus administrator, and EMD/ESD+ physical interfaces. It also provides two independent Gigabit Ethernet LAN connections through isolated and lockable M12 connectors so it can be used as an Ethernet-MVB gateway. In addition, TRACe M304-TR features a WLAN 802.11 a/b/g/n Wi-Fi network interface.



**Figure 8.** Kontron TRACe V304-TR Network Video Recorder

### Network Video Recorder (NVR)

Designed for surveillance data recording in harsh environments, the [Kontron TRACe V304-TR](#) NVR can record and transmit up to 16 H.264 video streams, making it ideally suited for transportation video surveillance. The unit includes a pre-installed internal 256 GB solid-state drive (SSD) for data storage, and its storage capacity can be increased to up to 2TB with optional SSD/HDD storage. Wireless connectivity via dual-band 802.11n 2T2R and 802.11 a/b/g Wi-Fi supports bandwidth up to 300 megabits per second (Mbps).



**Figure 9.** Kontron TRACe G304-TR Wireless Gateway

### Wireless Gateway

Offering excellent Wi-Fi connectivity capabilities, the [Kontron TRACe G304-TR](#) transportation computer gateway is well-suited for passenger infotainment or operator remote control and maintenance. It features a WLAN 802.11 a/b/g/n Wi-Fi network interface that supplies ample support for high transmission data rates and reliable performance needed for streaming multimedia applications. In addition, WWAN network connections

are enabled through a 2G/3G/4G cellular modem (dual SIM support) offering LTE/HSPA+/GSM/GPRS/EDGE/EV-DO Rev A/1x RTT interfaces. The gateway provides 3-stream MIMO configurations that are ideal for a broad range of wireless applications that include high-end mesh network, wireless monitor, and computer Wi-Fi applications.

To enable IoT connectivity, Kontron plans to support the Intel software stack from the [Intel® IoT Gateway](#), which combines Wind River\* Intelligent Device Platform XT 2.0 and the McAfee Embedded Control. The software provides key building blocks to enable the connectivity between legacy and new transportation systems by integrating technologies and protocols for networking, embedded control, enterprise-grade security, and easy manageability.

The Intel IoT Gateway enables:

- Connectivity up to the cloud and enterprises
- Connectivity down to sensors and existing controllers embedded in the system
- Pre-process filtering of selected data for delivery
- Local decision making, enabling easy connectivity to legacy systems
- A hardware root of trust, data encryption, and software lockdown for security
- Local computing for in-device analytics

Intel IoT Gateway includes the extensive software stack, including Wind River Intelligent Device Platform XT and the McAfee Embedded Control.

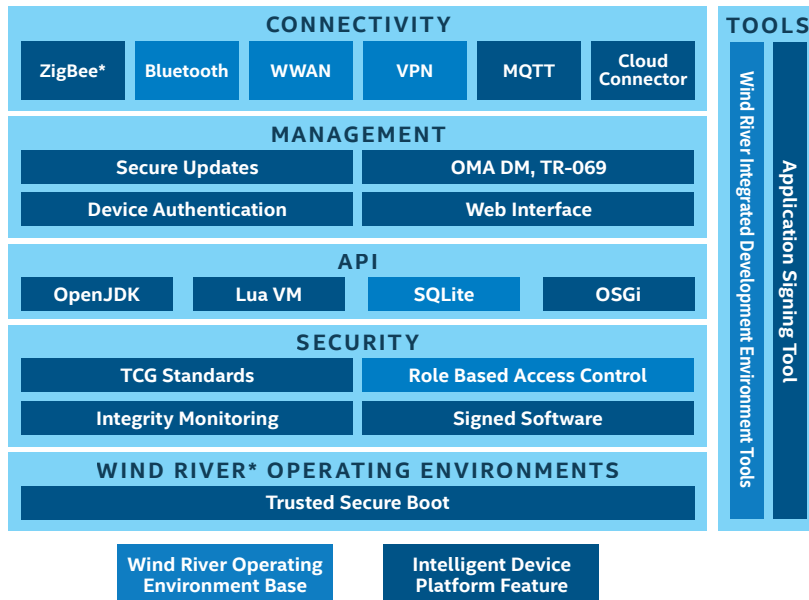


Figure 10: Wind River Intelligent Device Platform XT Components

>Wind River Intelligent Device

**Platform XT** is a scalable, sustainable, and secure development environment that simplifies the development, integration, and deployment of IoT gateways. It is based on Wind River industry-leading operating systems, which are standards-compliant and fully tested. The main components are shown in Figure 12, and the key features are:

**Gateway Security:** Delivers built-in security features designed to secure the communication channel, the data, and the end device

**Application Enablement:** Provides Lua, Java\*, and OSGi application environments to enable portable, scalable, and reusable application development on both resource-constrained and full-featured devices

**Device Connectivity:** Embraces IoT protocol MQTT for data transportation and native support for Wi-Fi, Bluetooth, ZigBee\*, and short-range wireless protocols widely used in IoT devices

**Remote Device Management:** Supports well-established management protocols such as TR-069 and OMA DM

>McAfee Embedded Control

maintains the integrity of vending machines by allowing only authorized code to run and only authorized changes to be made. It automatically creates a dynamic whitelist of the “authorized code” on the system. Once the whitelist is created and enabled, the system is locked down to the known good baseline, and no program or code outside the authorized set can run. Whitelisting helps to prevent viruses, spyware, worms (like the Stuxnet worm), and other malware from executing. Application engineers benefit from a shorter time-to-market and reduced implementation costs.

• **Rugged HMI Display Computer for Transportation**

Featuring an IP54 (splash guard) 10.4 inch TFT display with touch screen or hard keys, the Kontron TRACe-HMI computer, shown in Figure 11, is designed for human machine interfaces (HMI) in harsh environments. With two Fast Ethernet interfaces, up to four serial interfaces, two USB ports, CAN, audio, maintenance interfaces, and SDCard plus SSD Flash socket, all the necessary interfaces are present. It also features a real time clock, watchdog, and temperature sensor.



Figure 11. Kontron TRACe-HMI Display Computer

IoT Tenets

The Kontron TRACe family is designed to provide security and interoperability from edge to cloud in keeping with five key tenets defined by Intel:

- **World-class security** as the foundation
  - The solution implements robust hardware and software-level protection that secures data from public transport vehicles to gateway to cloud.
- **Automated discovery and provisioning of edge devices** to ease deployment
  - Select sensors and actuators operate in Plug and Play fashion with Kontron systems.
- **Data normalization** through protocol abstraction to improve interoperability
  - Software performs protocol translation (e.g., ZigBee, Ethernet, Wi-Fi) automatically.
- **Broad analytics infrastructure** from edge to cloud to realize customer value
  - Software running on gateways and servers analyzes transportation data, generates actionable data, and creates easy-to-read reports.
- **Infrastructure** to monetize hardware, software, and data management from edge to cloud
  - Kontron solutions enable transportation companies to realize substantial savings through increased operations efficiency and incremental revenue from new services.

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### Summary

Transportation companies have a long history of using computing systems to improve safety, efficiency, and the customer experience. However, an increasing number of out-dated, silo'd devices are working against these objectives. Addressing this issue, IoT technologies make it easier to connect new and old systems together, thus enabling data sharing that can lead to a multitude of new opportunities. The paper presented solutions from Kontron and Intel designed to unleash the power of data and the Internet in the transportation industry.

### Resources

#### [Intel® Internet of Things Solutions Alliance](#)

Members of the Intel® Internet of Things Solutions Alliance provide the hardware, software, firmware, tools, and systems integration that developers need to take a leading role in IoT.

#### [Intel® IoT Gateway Development Kits](#)

Intel IoT Gateway development kits enable solution providers to quickly develop, prototype, and deploy intelligent gateways. Available for purchase from several vendors, the kits also maintain interoperability between new intelligent infrastructure and legacy systems, including sensors and data center servers.

For more information about Kontron solutions for transportation, visit <http://www.kontron.com/products/systems-and-platforms/transportation-systems-and-platforms/trace---intelligent-transportation-computer>.

For more information about Intel® solutions for the IoT, visit [www.intel.com/iot](http://www.intel.com/iot).



Kontron is a member of the [Intel® Internet of Things Solutions Alliance](#). From modular components to market-ready systems, Intel and the 250+ global member companies of the Alliance provide scalable, interoperable solutions that accelerate deployment of intelligent devices and end-to-end analytics. Close collaboration with Intel and each other enables Alliance members to innovate with the latest technologies, helping developers deliver first-in-market solutions.

<sup>1</sup> Source: Vnomics\* case study, "Terpening Trucking Improves Safety and Fuel Economy," [www.vnomicscorp.com/content/file/Resources/Vnomics\\_Terpening-Case-Study\\_Final.pdf](http://www.vnomicscorp.com/content/file/Resources/Vnomics_Terpening-Case-Study_Final.pdf).

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