IoT Takes Mass Transit to a New Level

eBus Solution Enhances Fleet Management and Safety

Mark Chen, Product Manager, Digital Logistics and Fleet Management Department, Advantech

The dramatic growth of cities worldwide is fueling demand for safe, efficient public transportation. Many municipalities are turning to Bus Rapid Transit (BRT) systems in response. These innovative buses connect to intelligent transportation system (ITS) infrastructure, creating highly effective transit at a fraction of the cost of rail.

The Internet of Things (IoT) is critical to BRT. It enables real-time collection and transmission of data, helping improve fleet management, scheduling, ticketing, safety, and advertising revenues. In this article we look at the technology required for an IoT-powered BRT system, using the Advantech TREK-674 in-vehicle box computer as an example. We show how this computer uses a dual-core Intel® Atom™ processor to deliver a long list of capabilities.

The Need for Bus Rapid Transit

Managing an urban bus fleet is no easy task. Traffic congestion, road construction, mechanical failure, driver behavior, weather, and other factors make it difficult to keep buses on time. In addition, modern systems must provide passengers with up-to-date information so they can plan their trips efficiently.

BRT offers an increasingly popular answer to these demands. Less expensive to build than rail systems, these enhanced buses offer raillike experiences through dedicated lanes, enclosed stations, and high quality vehicles (Figure 1). Among other benefits, these features help keep buses on schedule and passengers informed.

To deliver these benefits, BRT uses the IoT to enable system-wide communications. IoT connectivity enables administrators to optimize routes and fuel usage based on the location, speed, and load. This same information gives customers precise bus location and arrival times via smartphones or digital displays on the bus and at stations. In addition, real-time matching of passenger and ticketing data

Figure 1. A bus rapid transit (BRT) system offers a convenient, economic transit option.

enables fleet managers to identify freeloading and alert fare inspectors.

System-wide connectivity also aids safety and comfort. On-board systems can monitor driver behavior and surveillance systems can protect against crime. On-bus digital displays can provide information, entertainment, and advertising to improve the passenger experience and supplement operator revenue.

The Smart Bus Solution

To help cities meet their transportation needs, Advantech developed its eBus bus monitoring solution (Figure 3). The solution incorporates the TREK-674 in-vehicle computer, the vehicle-grade TREK-303/306 DH Smart Display, and the Mobile Resource Management Software Development Kit (MRM SDK). As shown in Figure 2, this platform connects bus components to ITS infrastructure.

The eBus solution provides a comprehensive record of vehicle operations, including location, engine speed, tire pressure, braking, throttle position, and surveillance video. Other real-time information processed by the system includes data from payment card readers, door controls, and passenger counters.

Comprehensive Video Capabilities

Safety is a primary goal forthe eBus system. The TREK-674 supports eight analog camera input channels for high-quality H.264 D1 (720x480) 30 frames per second (FPS) video recording and four-channel audio inputs. The unit's dual storage system uses SSDs for fast performance on video backup. The 2.5" SSD tray is quickly swapped through a locked compartment that protects evidence.

Video data can be encoded, previewed, and streamed to a backend server. Analysis of this data provides fleet managers and first responders with information to safely respond to emergencies. Fleet managers can also use video information to diagnose onboard issues and create training videos.

In addition to monitoring the passenger compartment, the TREK-674 aids driver safety. The system's intelligent video analytics (IVA) software enables a lane departure warning system (LDWS), forward collision warning system (FCWS), and pedestrian detection system (PDS). If the system detects a dangerous situation or inappropriate driving, a warning message appears on the driver's screen. If a driver does not respond, information is transmitted to the control room, alerting staff to contact the driver. Built-in intelligent voice recognition allows hands-free control, helping reduce accidents caused by driver distraction.

The TREK-674 also functions superbly as a media player. The unit includes interactive applications accessible to smartphones to enable passenger engagement with advertising. Passengers can adjust volume, download information, and send feedback. By enabling interaction, the unit helps transit agencies expand advertising services and boost revenue.

The eBus Power Plant

To handle all the video data and signal inputs while displaying advertising on multiple screens, TREK-674 in-vehicle box computers use a high-performance, low-power, industrial-grade 1.75 GHz Intel Atom processor E3827. This dual-core processor enhances digital signal processing through Intel® Streaming SIMD Extensions (Intel® SSE) 4.2. These extensions

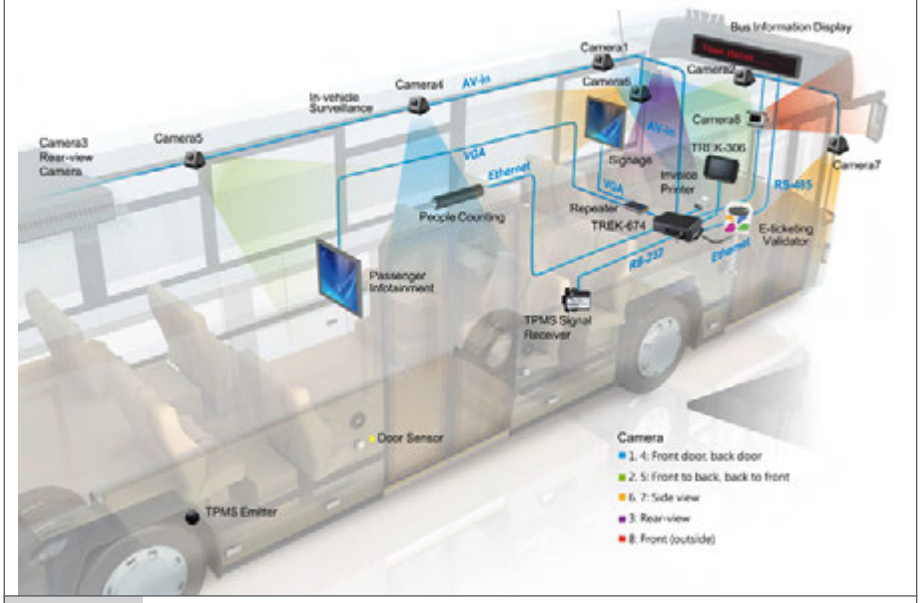

Figure 2. The Advantech eBus solution is a comprehensive platform for connecting buses.

Figure 3. The TREK-674 rugged vehicle computer pairs with the TREK-306 in-vehicle display.

give the processor excellent performance in demanding tasks like video analytics and audio processing.

A system on chip (SoC) design, the processors include Intel® HD graphics (Gen 7) for excellent graphics performance. The SoC supports OpenGL 3.2 and DirectX11, and delivers a wealth of options for creating compelling graphical interfaces. For HD video decoding, the graphics engine delivers full hardware acceleration, allowing multi-screen video playback with minimal CPU loading.

Processor security features include secure boot functionality when used with Microsoft* Windows 7 or higher. Hardware-assisted virtualization enables securing safety-critical code. For fast data encryption and decryption, the Intel Atom processor E3827 provides Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI). (Like Advantech, Microsoft is a member of the Intel® Internet of Things Solutions Alliance. Advantech is a Premier member and Microsoft is an Associate member.)

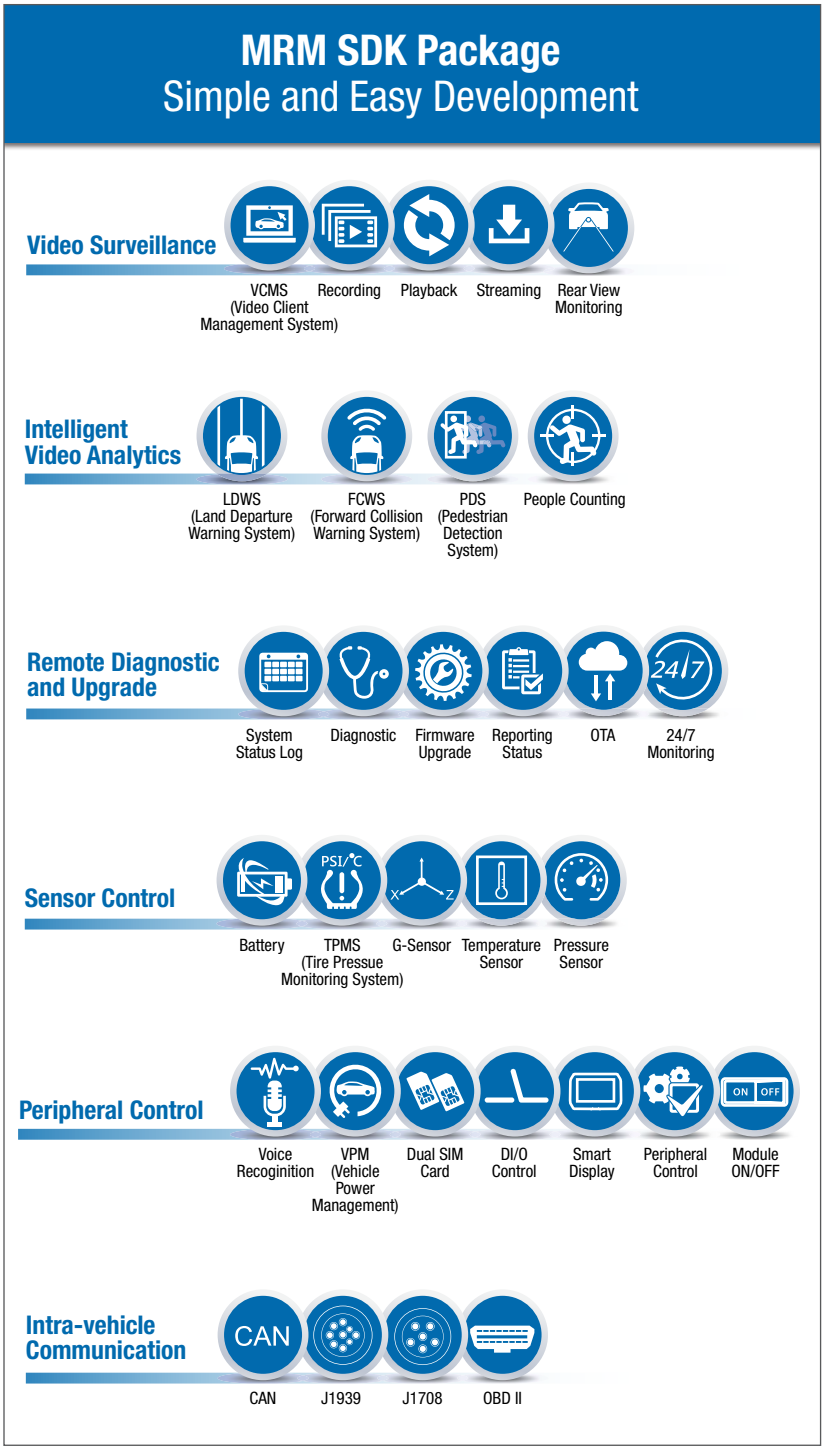

Figure 4. The Advantech Mobile Resource Management Software Development Kit (MRM SDK) provides valuable shortcuts.

Other Hardware Requirements

An important and often under-developed aspect of a vehicle PC system is addressing the power handling requirement. A bus's routine battery power dynamics are erratic at best. Dips, power spikes and frequent shut-offs are common in the bus's daily activity. Therefore it is important to implement a proper PC system that has a certified vehicle power management (VPM) solution to handle power fluctuations and "dirty" power issues. The TREK design is compatible with 12V/24V vehicle power, supports a wide 9VDC to 32VDC power input range, and is ISO 7637-2 and SAE J1113 compliant.

To communicate with door locks, alarms, and various diagnostics, CAN bus and J1708 interfaces have become the mainstay in intelligent vehicle systems, and will be considered more necessary in those implemented for IoT. The CAN interface on the TREK-674 supports the J1939 and OBD-II/ISO 15765 standards while the J-bus supports the J1587 protocol, making it ideal for attaining sensor information for compiling and sending to central offices by Wi-Fi.

Considerations on Deployment and Maintenance

Standardizing on Intel® processor to offer the wide range software compatibility, an in-vehicle computer platform can then support multiple operating systems – Microsoft* Windows XP Embedded, Microsoft* Windows 7, Microsoft* Windows 8, and Linux* – enabling good application portability and future proofing. The TREK-674 includes an MRM SDK to provide valuable development shortcuts (Figure 4). Instead of having to program system calls to device drivers communicating with the hardware layer, system integrators can interact instead with an SDK layer between the application layer and the operating system. Using this MRM SDK, developers can more rapidly develop and deploy applications, evaluate platform performance, add peripheral support, and provide post-installation maintenance/debugging support.

Built for Life on the Road

The TREK-674 provides a suite of I/O, vehicle diagnostic tools, and video capabilities. Key features include:

- Dual core 1.75 GHz Intel® Atom™ processor E3827
- 8-channel analog video input
- Video outputs for driver console and passenger displays
- CAN and J1708 interfaces
- GPS with AGPS and dead reckoning
- Wi-Fi*, Bluetooth*, and cellular modules
- Externally accessible solid-state drive (SSD) tray
- -30 ºC to +70 °C operating temperature
- Anti-shock/vibration
- 12V/24V power system with power management features for 24/7 reliability

Moving Cities Forward

Modern cities have challenging transportation needs. BRT systems based on IoT-ready in-vehicle computers, such as the TREK-674 can be a great way to meet these demands. Taking advantage of the compute and connectivity capabilities of Intel Atom processors, the TREK-674 intelligently combines fleet management, vehicle diagnostics, and in-vehicle functions into a compact, easy-to-use, fanless vehicle monitoring system. With this powerful solution as a starting point, transit systems can bring commuters the safe, efficient, and cost-effective trips they desire.

For more information on the TREK-674 see http://Buy.Advantech.com or call 888-576-9668

Contact Advantech

Advantech (intel.com/MR-advantech) is a Premier member of the Intel® Internet of Things Solutions Alliance. Advantech offers a comprehensive range of hardware, software, design services, system integration, and global logistics support. We cooperate closely with our partners to provide complete embedded computing solutions for a wide variety of applications in diverse industries.