Managing Smart Cities' Mobility with Intelligent Technologies

The world's urban population has **grown by more than 25 percent since 2007**, and is projected to represent **68 percent of humanity by 2050**. This mass migration to large cities has altered the transportation landscape forever.

To handle the influx of commuters, many large metropolitan areas began implementing intelligent transportation systems (ITS) as early as 2010. These platforms integrated data from traffic and surveillance cameras, parking systems, weather monitoring stations and other devices to provide better long-term insight into roadway infrastructure and mass transit systems.

But transport has evolved rapidly with the advent of ridesharing, e-bike and scooter rentals, and semi-autonomous vehicles. Similarly, improvements in AI, IoT and embedded processing now enable real-time awareness of city-wide transportation situations. For example:

- **Vehicle and people counting** can monitor roadways and transit centers for congestion or overcrowding. This information could be used to suggest detours during rush hours or incentivize commuters to use other forms of transportation.

- **Automatic license plate recognition (ALPR)** can identify illegally parked vehicles, help determine the efficiency of ride-share loading zones or track perpetrators fleeing authorities.

These applications require connected, high-performance platforms that can execute advanced workloads efficiently and at low power. By deploying these solutions out to the furthest edges of ITS systems, transit managers can improve safety, reduce traffic congestion and increase the overall efficiency of smart cities.

Smarter Systems for Smarter Transit

Of course, upgrading an entire city's transit infrastructure is no small task. Figure 1 shows just a few of the systems and technologies that contribute to ITS on a single city block.

Figure 1. *Multiple systems and technologies contribute to intelligent urban transportation today (Source: House of Bots).*

As the diagram shows, many different types of infrastructure are needed to complete the picture of a truly modern ITS:

- Starting with **traffic signals**, connected embedded controllers run vehicle counting and ALPR algorithms. They also communicate with V2X-enabled vehicles and the cloud to improve traffic flows.

- For **onboard mass transit** like buses and trains, passenger safety and communications are highly critical to its operations. These vehicles are a lot like miniature moving cities that need embedded computers, gateways, human-machine interface and onboard displays to smoothly run onboard surveillance and mass transit vehicle operations to effectively meet the growing city needs.

- At **transportation centers**, intelligent touch panel displays can provide commuters with up-to-the minute transit information and information for route planning. Its connection to other informational systems on real-time basis is key to accurate communications.

Given the varied use cases and safety regulations as well as the harsh operating environments that these electronic systems are commonly deployed in, computer solutions serving their needs must be extremely scalable, rugged and reliable. They also must meet the required safety certifications/compliance and have other key functionalities to support smart transit applications.

ITS in Overdrive with Advanced Embedded Hardware

These requirements dictate that transportation providers partner with experienced embedded system and networking OEMs. **Axiomtek**, for example, brings nearly thirty years of design expertise to its **broad portfolio of ITS and mass transit surveillance solutions**.

Intelligence at the Endpoint

For instance, the company's eBOX fanless embedded controller platforms are ideal for bringing localized intelligence to traffic signals (See Product Reference 1). These scalable computing platforms come in variants based on the latest Intel® Core or Celeron processors, with expansion slots that support SIM, PCI Express or MXM add-on cards. The PCIe and MXM ports allow additional GPU performance to be added to any system to accelerate applications like ALPR, vehicle/people counting and other forms of AI.

What makes Axiomtek's eBOX family stand out in long-life cycle transportation deployments is their rugged design. These DIN-rail or wall-mountable systems are built with aluminum die casting and heavy-duty steel, tested to extreme environmental conditions under the IEC 60068 family of standards, and available in waterproof IP67-rated packages. Select models even come with M12-lockable connectors and N-Jack waterproof antenna openings for robust wired or wireless interfacing with the rest of the smart transit infrastructure.

A Robust Gateway to Wayside Communications and Control

While the eBOX platform's I/O enables sufficient connectivity, certain transportation applications demand a full-blown industrial IoT gateway. These networking-centric devices

can bridge the divide between embedded controllers operating at the endpoint and higher-level traffic management, analytics and visualization dashboards by supervising multiple nodes simultaneously.

Axiomtek's ICO line of edge gateways integrate support for multiple operational technology (OT) communications protocols such as RS-232/422/485 and CAN that are widespread in smart transit applications (See Product Reference 2). Available with Intel® Core, Celeron or NXP i.MX6 multicore processors, ICO platforms pack enough performance to run gateway-level analytics before transmitting actionable information to cloud platforms over GbE LAN ports or wireless interfaces.

Along with this performance and flexibility, ICO networking platforms are as rugged as they come. The fanless embedded systems support wide operating temperature ranges of up to -40ºC to +70ºC, and can be certified up to EN 50121-4 for rail use cases. Like their eBOX counterparts, the devices are packaged in aluminum and heavy-duty steel, and can be mounted on walls or DIN rails. This not only makes ICO devices a functional fit for stationary networking applications, but also wayside control for buses or trains.

Efficient Train Control

Train operators now have advanced touch panel computers for safer and more effective operations. New requirements driven by technologies such as Positive Train Control (PTC) can only be implemented with different onboard components such as a data center controller, video and imaging processors and storage, wireless network for communications and more. Touch panel computers such as those of Axiomtek's GOT 700 Series are designed to be the key component of train operations. They can support PTC and train engineer's control function of train doors, lighting, temperature control and more. The touch panel PC can display alerts, warnings and key operating status for accident avoidance and operation monitoring. Real-time track conditions, stops and route changes can be communicated to the train operator and onboard passengers.

GOT rail touch panel PCs like the 10.4-inch **GOT710-837** are certified with the EN 50155 railway safety standard. The wide operating temperature range of -25°C to +70 °C

(T3 level) and the IP65-rated front bezel make this touch panel PC highly reliable in harsh operating environments such as onboard train while its M12-lockable connectors ensure that the system remains safe from onboard vibration and unauthorized access. GOT railway products include the 12.1-inch **GOT712-837**. EN 50155-compliant and based on the Intel® Atom® E3845 SoC, they feature XGA TFT sunlight-readable displays backlit by LEDs that provide 800 nits of brightness (Figure 2). An auto-dimming feature comes standard so that information can be consumed easily regardless of the ambient lighting conditions.

Engaging Commuters Wherever They Are

Modern smart transportation not only means ingesting data from across a smart city, it also means relaying that information to commuters. These commuters now expect relevant information to be presented to them in an efficient but also interactive manner. That requires immersive touch panel displays and comprehensive video management platforms.

To deliver infotainment to riders at transportation stations or onboard mass transit vehicles, Axiomtek's comprehensive GOT line of fanless touch panel PCs offer extensive features such as options between heavy-duty, light and stainless steel, as well as an EN 50155 compliant touch display for onboard and wayside communications.

Figure 2. Axiomtek's GOT touch panel PCs are certified/compliant with the EN 50155 standard for use in vehicle or rail environments (Source: Axiomtek).

Improved ITS: Next-Gen is Now

For some, the capabilities enabled by Axiomtek's advanced transportation solutions offer a glimpse of the possibilities with next-generation ITS technology. Collaborations between Axiomtek and Genetec, a leading IP video surveillance and ITS platform company, has enabled the future of smart transportation and made it a reality now.

Genetec software platforms like **Traffic Sense™** (Figure 3) helps improve traffic flow and offer higher efficiency commute in a smart city. Traffic Sense is a unified transportation management platform that integrates transit data such as traffic pattern, combined with security and incident management. It can be efficiently run on a rugged embedded controller such as Axiomtek's **eBOX800-511-FL**. The fanless eBOX800-511-FL offers scalability with its choices of CPU from the high performance Intel® Core™i5-7300U or Celeron® 3965U. It comes in an IP67-rated housing, accepts wide range power input 9V to 36V DC power supply, features lockable M12 connectors, lockable I/Os and waterproof N-Jack antenna openings. It has been operationally tested in a wide temperature range of -30ºC to +60ºC. In conjunction with a shock tolerance of 3 Grms, these characteristics make the eBOX800-511-FL ideal for outdoor traffic management applications.
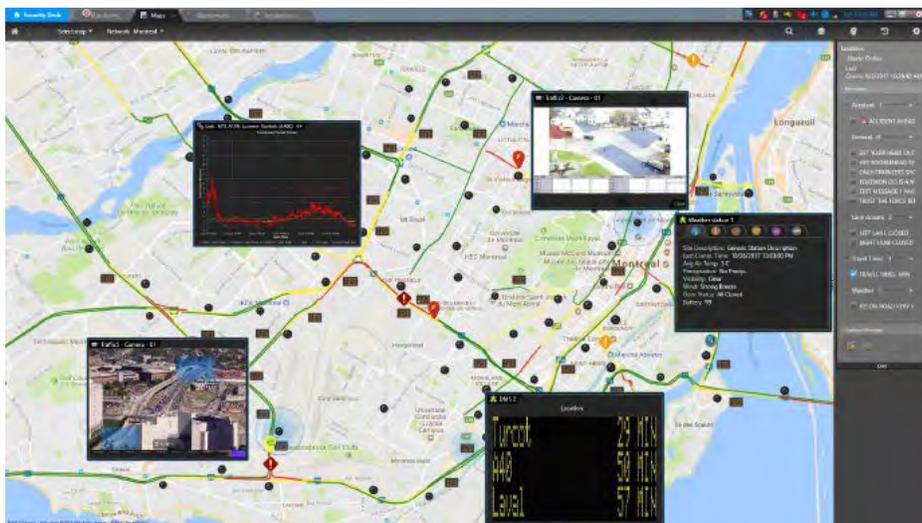

Figure 3. *Information from a variety of sources is integrated into a unified Traffic Sense dashboard to give ITS managers a holistic, real-time view of the transit environment (Source:* ***Genetec****).*

Onboard Surveillance at its Best

For onboard surveillance applications, Axiomtek and Genetec's combined solution is designed to help make transit project system integrators' lives easier. Genetec's leading surveillance platform, the Omnicast™, is an automated video surveillance and analytics software that was tested on an Axiomtek tBOX controller, the **tBOX322-882-FL**, for guaranteed compatibility and ease of deployment.

The Axiomtek tBOX series offers many models such as the **tBOX400-510-FL** (Figure 4). Equipped with 7th generation Intel® Core i3/i5/i7 or Celeron multicore processors, the tBOX400-510-FL fanless embedded box PC provides the performance needed to run onboard surveillance and video analytics. It has CE, LVD and FCC certifications and is EN 50155 and EN 45545-2 compliant. It has flexible wireless connectivity that leverages off-the-shelf I/O modules including Wi-Fi, 4G/3G and GPS via its onboard PCI expansion bus. The tBOX can receive video streams from more than twenty, 2 mbits per camera in both continuous and motion recording mode. Users can view five simultaneous playback windows and live camera data remotely in Genetec Security Center.

Figure 4. The Axiomtek tBOX400-510-FL is an embedded box PC with an integrated Layer 2 Managed power-over-Ethernet (PoE) switch and countless road, rail, and marine certifications. These allow the platform to be deployed with Genetec software as an onboard video surveillance and analytics platform (Source: Axiomtek).

The tBOX's integrated 10-port switch comprises of eight 10/100 Mbps Ethernet ports and two Gigabit LANs. Meanwhile the Intel® processors combine with up to 32 GB of DDR4 SO-DIMM memory and two hot-swappable 2.5" SATA drive trays to handle video management, video surveillance and other demanding workloads.

With PoE capabilities, the tBOX PCs are capable of both connecting to and powering a variety of devices in trains, buses or transportation centers like IP cameras, sensors and low-power displays (Video 1).

Video 1. *Axiomtek's tBOX-400-510-FL is an embedded controller with a built-in Layer 2 Managed PoE switch that supports applications like video management and surveillance in onboard environments (Source: Axiomtek).*

Improving Transportation for Living, Breathing Smart Cities

The partnership between Genetec and Axiomtek demonstrates the requirement for next-generation embedded hardware and software solutions today. Beyond applications such as smart traffic management, license plate recognition and transportation broadcasting and information systems, these foundational building blocks pave the way for more intelligent unified mobility management platforms that will drive the overall success of smart cities. The connection to city-wide security and surveillance is obvious, which can be utilized in the improvement of law enforcement and first responder operations. Other use cases include blending data from vehicle counting platforms, weather stations and gas sensors to detect and inform citizens of high pollution levels via a smart health application. Indeed, the possibilities are endless.

As better AI becomes available and new network paradigms like 5G come to fruition, there will be an increased appetite for data capture and processing at the intelligent edge. With expandable platforms like the Axiomtek eBOX, tBOX, ICO and GOT series, transit operations can hook into today's networks with more than enough performance to enable the intelligent edge, then scale into 5G networks and more advanced computing using a variety of expansion ports.

We're headed into the age of the breathing smart city that survives on the arteries of a more intelligent transportation infrastructure.

Are you ready to bring it to life?

Contact **solutions@axiomtek.com** to learn how.

Product References

Product Reference 1 | eBOX Brings Intelligent Control to Edge Traffic Infrastructure

AI and video analytics-enabled traffic control applications demand performance that was once only available in the data center.

For example, ALPR, vehicle counting and people detection software run neural networks that require high-speed, continuous access to memory devices ingesting real-time video streams. From there, a high performance processor must be able execute these multi-layered algorithms against the media in an instant.

But unlike the data center, such systems must be integrated into low power, small footprint packages that can sustain deployment in unforgiving transportation settings.

Bridging enterprise-grade capabilities and robust embedded systems, Axiomtek's **eBOX800-511-FL** and **eBOX671-521-FL** are examples of intelligent control devices with the horsepower and housing for almost any stationary transportation deployment.

The eBOX800-511-FL, for example, runs on 7th generation Intel® Core i5 or Celeron processors, allowing transit system integrators to balance performance and power consumption with the exact needs of their application (Product Reference 1, Figure 1). The devices include up to 16 GB of DDR4-2133 SO-DIMM memory to enable the fast, repetitive data access needed in neural networking applications. They also support the Trusted Platform Module (TPM) 1.2 specification, which provides enhanced system security without burdening the host processor.

Product Reference 1, Figure 1. The eBOX800-511-FL supports 7th generation Intel® Core i5 or Celeron processors in an extremely rugged package that makes it ideally suited for deployment in edge traffic management and control systems (Source: Axiomtek)

Taking performance and scalability to another level, the eBOX671-521-FL supports either 8th or 9th generation Intel® Core i3/i5/i7 or Celeron processors with the Intel® Q370 chipset (Product Reference 1, Figure 2). Designed for machine/computer vision applications, the eBOX671-521-FL integrates four-channel PoE ports. Its features include six USB 3.1 ports and two Gigabit LANs to connect to different devices or sensors. It comes with great expansion possibilities, including one internal MXM 3.1 type A connector, two full-size PCIe Mini Card slots and two SIM slots.

Product Reference 1, Figure 2. The eBOX671-521-FL packs 8th or 9th generation Intel® Core i3/i5/i7 or Celeron processors, the Intel® Q370 chipset, expansion slots for even more GPU-accelerated computing and four PoE ports for demanding AI/machine vision applications (Source: Axiomtek).

The eBOX671-521-FL supports up to 64 GB of DDR4-2666 SO-DIMM error-correcting code (ECC) memory, which facilitates the deep learning workloads mentioned previously while also enhancing data reliability. The system also includes two hot-swappable SATA HDD drive bays and an additional mSATA slot that supports RAID functionality. This storage capacity and redundancy makes it an optimal solution for real-time edge analytics in traffic management and control applications.

And, if more horsepower is needed for advanced AI or multi-camera setups, both the eBOX800-511-FL and eBOX671-521-FL incorporate PCIe (800-511-FL) or PCIe and MXM (671-521-FL) expansion slots that can be used to add even more GPU-accelerated computing.

Product Reference 2 | ICO Series Gateways Bring Intelligent Transport Endpoints Together

Integrating data from the disparate systems that comprise an intelligent edge transportation infrastructure can make or break a smart transit deployment. After all, without reliable, consistent data, analytics and visualization, dashboards can only give ITS managers part of the picture, if any view at all.

For this reason, comprehensive yet flexible transportation network gateways are a must. The **ICO500-518** is one such device, supporting four different I/O modules that can be easily and quickly customized to fit project requirements. It is equipped with enabled GbE, RS-232/422/485 or CANbus 2.0A/B protocols (Product Reference 2, Figure 1). What's more, the system also integrates two full-size PCIe Mini Card slots and an external SIM that can support 3G/4G cellular, LoRaWAN, GPS, Wi-Fi or Bluetooth connectivity. All of this makes it a go-to networking solution for bridging the OT communications data of traffic signals and transit systems with the IP-enabled analytical systems of the data center.

Product Reference 2, Figure 1. *The ICO500-518 is a full-featured, modular I/O design transportation network gateway that supports OT serial communications protocols along with a wealth of wired and wireless IP-based connectivity (Source: Axiomtek).*

But apart from well-rounded networking capabilities, the ICO500-518 also packs a punch in terms of performance, memory and storage. Based on 7th generation Intel Core i3/i5/i7 or Celeron processors and up to 16 GB of DDR4-2133 SO-DIMM memory, it doubles as an edge analytics processing platform for applications that require data filtering or layered computational intelligence. It also supports the TPM 2.0 specification for additional security.

And in terms of environmental protections, the ICO gateway can be dropped into even the toughest of scenarios. Its EN 50121-4 certification makes it suitable for use in railway environments, while a 12V to 48V DC input range with over-voltage, under-voltage, over-current and remote power panel protection mechanisms allow it to withstand wide fluctuations in supply voltage whether in stationary deployment conditions or on mobile platforms like buses or trains.

An operating temperature range of -40ºC to +70ºC and vibration endurance of up to 3 Grms should put to rest any concerns about the ICO gateway system's robustness.

Product Reference 3 | UST Brings Ruggedness & Reliability to Onboard Vehicle Video Management, Networking

Finding the right onboard computers for use on mass transit buses can be challenging. Mass transit vehicles can be thought of as miniature moving cities, and therefore need all of the networking, processing, memory and power capabilities that are available on

on a city block.

But any solutions that enable this functionality have to be compact and rugged enough for the space-constrained, high shock and vibration environments of a bus or train and also meet safety certification requirements for onboard operations.

Axiomtek offers comprehensive transportation product lines that include the tBOX – with a range of products that are rail/vehicle/marine EN-certified/compliant. Axiomtek also offers many viable choices for a highly scalable UST embedded control system product line that integrate a wide range of features with the processing performance of 7th/6th generation Intel® Core i3/i5/i7, Pentium® or Celeron® processors. The UST product line allows for cost effective network video recording (NVR) functions and also video analytics. Its compact size and ISO 7637-2 compliance makes it suitable for onboard automotive use.

Product Reference 3, Figure 1. *The UST100-504-FL is a vehicle embedded controller equipped with scalable CPUs including 7th/6th generation Intel® Core™, Pentium® or Celeron® processors for video analytics (Source: Axiomtek).*

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