

ADLINK's SMARC Module Brings Increased Customization to Automated Fare Boxes

Introduction

A globally established manufacturer of transit equipment faced an interesting challenge when building an automated fare box for many common means of transportation. This system was to be installed on the vehicles themselves in settings including fixed-route buses, trams, metro railway systems, trains, and highway shuttle services, which presented some distinct challenges.

In previous designs, the manufacturer used Single-Board Computers (SBCs) as the heart of its product, but when introducing new features that cater to the modern traveler, excessive power consumption and the SBC form factor limited customization. Understandably, a new computer module was sought out.

The solution was found with ADLINK's SMARC module, a high-performance computer-on-module with a wide range of features and reduced power consumption. Additionally, the open-standard form factor allowed for increased design flexibility, meaning the same central core could be used in multiple designs for different customers.

In this application note, we discuss the requirements of an automated fare box, common approaches to design, and how ADLINK supported the customer in delivering its objective. Lastly, we introduce the latest generation of SMARC modules and outline the development resources available.

Building an on-board automated fare box

A modern automated fare box requires many features to serve all travelers effectively. More than just printing tickets, destination and fare selection must be easy and quick to do. This points to a sophisticated touch display as the best option for user interactions.

Similarly, such a machine is also expected to accept a wide variety of payment methods: cash payments require sensors and mechanical control systems for cash intake and distributing change. Additionally, the modern age requires options – and the technological provisions – for contactless and PIN card payments, mobile device payments, and pre-paid travel cards. These non-cash payments present another challenge as the fare box requires a secure, reliable internet connection for processing payments.

This wide range of user-facing features is only possible with a high-performance computer module working behind the scenes. Given that the automated fare box is on the vehicle itself, the compute module must be able to perform these tasks within a highly constrained power envelope with minimal maintenance requirements, ideally using a fanless design.

Beyond these specific application requirements, the customer faced the usual constraints towards creating a market-ready design:

Hardware and software development present a key hurdle to overcome when considering realistic time to market. When developing and testing a system, additional costs and delays may occur, which may be especially true for a ruggedized, on-vehicle system.

Before the design is finalized, the cost of manufacturing must also be considered so that pricing can be agreed before starting mass production. During this process, it is important to form good supplier partnerships to ensure that a product is well supported throughout its production lifetime.

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How ADLINK supports customer product development

While we have established that a sophisticated computer module was integral to building this automated fare box, this leaves the question: what is the best way to develop this embedded computer system?

The first approach is to design and develop a single-board computing solution in house. There are some benefits to this approach, such as full design customization, typically lower board-level manufacturing costs, and ruggedness against shock and vibration, but significant costs may be incurred on the hardware, software and NRE development fronts. A single-board approach also removes any flexibility from the system, which may present issues if new needs are identified after the system is already installed. Moreover, time to market is slowed significantly, so this option may not fare well in a fast-paced, competitive industry.

An alternative is to use an off-the-shelf SBC. This slashes time to market and non-recurring engineering, but there are drawbacks in terms of cost optimization, design customization, and long-term board availability. Many SBCs feature a wide range of large physical connectors that increase the size of the computing unit and make it difficult to build sleeker designs. These connections may also not be reliable in high levels of shock and vibration, thereby decreasing the overall robustness of the system.

When choosing ADLINK's SMARC module (Figure 1), the best of both worlds can be achieved. This comes with only minimal increase in board-level cost when compared to using the self-developed, single-board approach, but the faster time to market, superior robustness, and compact size when compared to the SBC should not be understated. Furthermore, when a module reaches its end of life, it can be replaced by the next generation of SMARC module to dramatically extend the lifetime of the complete system.

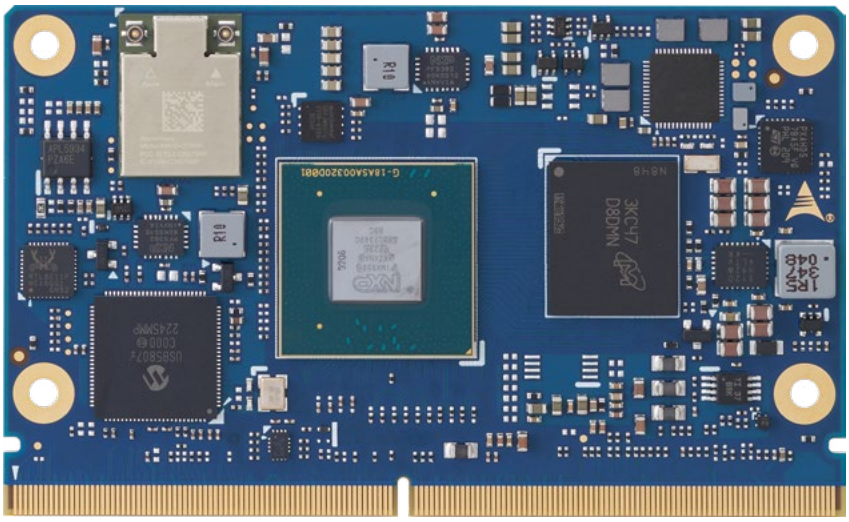


Figure 2. The ADLINK LEC-IMX95 module offers a powerful, fanless computing architecture that can be securely integrated into space-constrained designs. (Source ADLINK)

It is for these reasons that the SMARC module was designed into the customer's latest generation of automated fare boxes. The highly integrated nature of the computer-on-module form factor and power-efficient, fanless design enabled the customer to fully embrace product customization by simply building an MXM3-compatible carrier board for SMARC module integration. This way, the main computing unit was mounted securely and discreetly, without the need for the additional cables required by an off-the-shelf SBC.

ADLINK was first introduced to the customer via a local distributor, showing strong partnerships in the industry. Once a brief was discussed, one of ADLINK's many local offices then provided support and conducted regular meetings with the customer to ensure the automated fare box was delivered on schedule. The result was a win-win for ADLINK, its local distribution partner, and the customer.

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Building efficient IoT devices with ADLINK SMARC LEC-IMX95 module

The LEC-IMX95 is the latest model in the ADLINK family of SMARC devices. It is based on the NXP i.MX 95 application processor (Figure 2), which features a six-core Arm Cortex-A55 architecture with additional Cortex-M7 and Cortex-M33 cores and an eIQ Neutron NPU for machine learning at up to 2 TOPS. This and dual image signal processors for two camera inputs make the LEC-IMX95 ready for many image-recognition AI tasks, without the usual power drain associated with on-device AI. Built-in security features also ensure the safety of your device and the data it handles at all times.

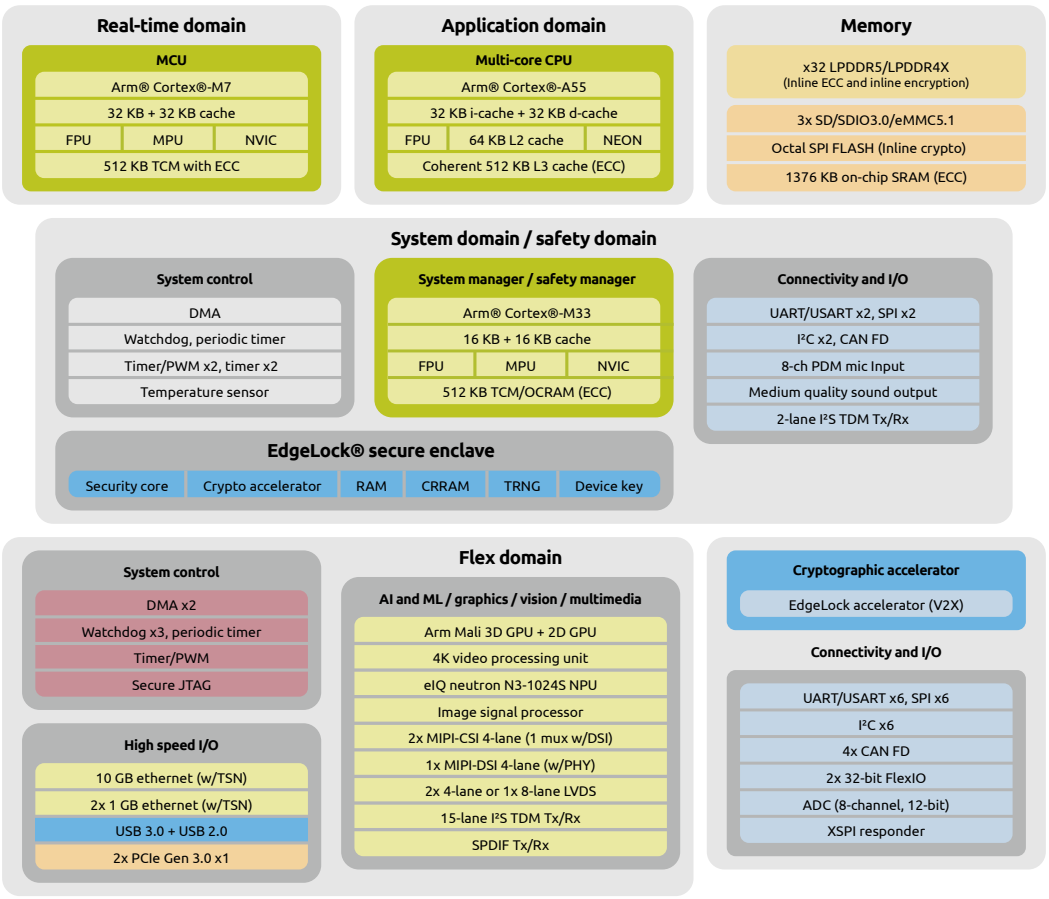


Figure 3. The i.MX 95 application processor features a wealth of systems that cater to high-performance processing, graphics, and AI. (Source NXP)

In addition to this computing power, the LEC-IMX95 supports high-resolution displays with an Arm Mali G310 GPU and LVDS, DSI, and optional HDMI output interfaces. This comes alongside ample I/Os and connectivity options to support your application, including:

- Dual CAN bus
- USB 2.0 & USB 3.0
- 2x Gigabit Ethernet with PHY
- 1x 10 Gigabit Ethernet via SERDES
- Wi-Fi & Bluetooth

With options for operation in -40°C to 85°C conditions, the SMARC LEC-IMX95 is well suited for many next-generation IoT deployments in smart home, smart building, smart city, medical, and industrial applications.

For those excited to get started developing with the SMARC LEC-IMX95 module, the I-Pi SMARC IMX95 development kit features the 82 x 50-mm module mounted on a carrier board for instant connection to peripherals. The open-standard build of this carrier enables faster hardware development of your own ecosystem, and a GitHub repository grants software developers the same advantage. ADLINK also has curated support areas like its forum and documentation library to further aid product development.

The ADLINK SMARC LEC-IMX95 modules and I-Pi SMARC IMX95 development kit are currently under preliminary status for early access to interested parties. Mass production is expected in Q4 2025.

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A new route to computing-intensive IoT development

Equipment designers in the transportation sector face distinct challenges as their products evolve to meet new demands. Compact computing devices like the ADLINK SMARC modules provide an ideal heart for these systems thanks to their superior power efficiency and robust, streamlined integration when compared to SBCs. The open-standard form factor also enables high levels of product customization and promotes faster time to market.





Figure 4. ADLINK's I-Pi SMARC IMX95 development kit based on LEC-IMX95 SMARC R2.2 module.

Ready to create the next generation of transportation equipment? Contact ADLINK now to discover latest IoT solutions with top-tier computing performance and excellent reliability.

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