WHITE PAPER

How to Choose a Good Computing Platform for Your IIoT

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Abstract

The market today is flooded with embedded solutions for the Industrial IoT. You can now choose from a wide variety of RISC-based embedded computers, single-board computers, and development boards to implement your IIoT solutions. With single-board computers such as Raspberry Pi available for as low as US$ 40 per board, is it a good strategy to cast your lot with these development boards merely going by their low price. What are some of the key factors that you must consider when choosing an embedded computing solution for your industrial applications? Can the development boards handle the complex requirements of the IIoT applications and deliver reliable performance for your critical industrial activities? What is the best way to take your IIoT prototypes from the development board to a customized industrial solution that meets all your computing needs? In this white paper we discuss the pros and cons of using single-board computers or development boards for your IIoT applications versus adopting an industrial-grade embedded solution. We cover the following points:

- *Development Boards vs. Industrial-Grade Solutions*
- *Hardware Perspective*
  - ✓ *Ready-to-deploy platform*
  - ✓ *Multi-IO support*
  - ✓ *Certifications for industrial safety standards*
  - ✓ *Ingress protection*
  - ✓ *Product warranty*
- *Software Perspective*
  - ✓ *Software service and support*
  - ✓ *Platform optimization*
  - ✓ *Utilities and libraries*
  - ✓ *Long-term support*
  - ✓ *Cybersecurity*
  - ✓ *The open-platform advantage*

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Moxa is a leading manufacturer of industrial networking, computing, and automation solutions. With over 25 years of industry experience, Moxa has connected more than 40 million devices worldwide and has a distribution and service network that reaches customers in more than 70 countries. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for automation systems. Information about Moxa's solutions is available at www.moxa.com.

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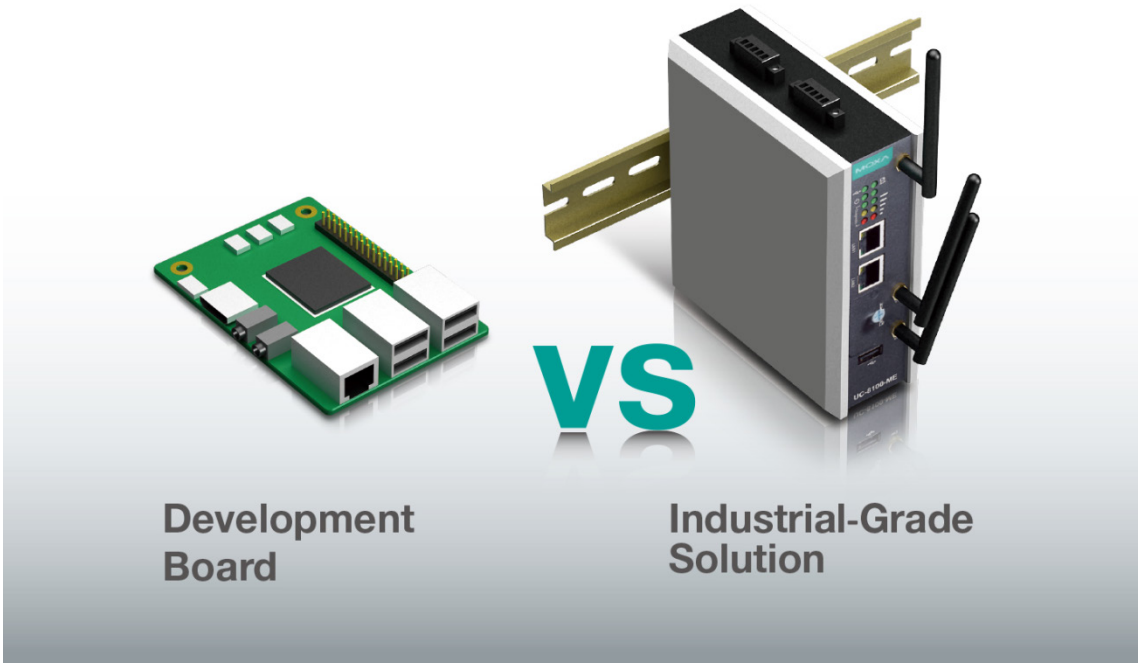
Development Boards vs. Industrial-Grade Solutions

Development boards such as Qualcomm DragonBoard 410c, Raspberry Pi, Arduino, Intel Galileo, BeagleBone Black, and Spark Core provide a cost-effective way to test out your automation ideas. But, when it comes to implementing these ideas in real-world industrial scenarios, such as the IIoT, a tested and proven industrial-grade embedded computing solution is the best choice because it provides a high-performing, stable, and secure system that can meet most of your automation needs.



Hardware Perspective

The first thing engineers typically tend to look at when evaluating computing platforms is the price. This behavior is specifically relevant to IIoT applications where the decentralized architecture of the communication network and the large number of devices deployed on the network translate to high deployment costs. While development boards can give you a head start in prototyping your applications and creating a proof-of-concept, it is quite a challenge when you want to implement these ideas in an industrial environment. Most of the development boards are designed to be hobby boards and are not suitable for complex industrial-grade applications as discussed in the following sections:

Ready-to-Deploy Platform

The development boards are usually bare-bones components that need to be put together based on specific application needs. Most of the development boards in the market today come with only a computer board; they typically have no power interface, OS, memory, and external case. When you are ready to deploy these computer boards in your project, you will have to put everything together piece-by-piece, which is a time-consuming and labor-intensive process. Most of the industrial computing platforms on the other hand are ready-to-deploy and come with some or all of the following capabilities:

- Rugged design with multiple mounting options that can withstand extreme industrial environments
- Customized OS, utilities, libraries, and applications
- Multiple I/Os and communication interfaces with built-in remote communication capabilities
- Support for industrial protocols such as Modbus and optimized for data acquisition from field devices
- Easy monitoring and troubleshooting capabilities
- APIs for additional customizations and integration with other systems and applications

Depending on your application needs and the complexity of your project, you might be able to deploy and use these computing platforms right out of the box, enabling faster time-to-market.

Multi-IO Support

In most cases, the low-cost development boards come with only 1 Ethernet port and a few USB ports. Serial ports, which are essential for interfacing with the field devices and wireless interfaces that are required for remote data acquisition, are most often not provided. Any additional interface that you require, you will have to build, integrate, test, and optimize on your own. On the other hand, industrial computing solutions typically come with multiple communication interfaces that include Ethernet, serial, and cellular interfaces for maximum flexibility in large-scale industrial deployments.

Certifications for Industrial Safety Standards

UL and CE certifications are a must for equipment deployed in industrial environments. These certification standards apply not just to users but also equipment manufacturers. The computer development boards often do not comply with these standards. Hence, there is no guarantee that these boards will survive the harsh industrial environments. Industrial computing solutions on the other hand go through rigorous testing to meet various certification requirements. Depending on the needs of your industrial application you can choose a computing solution that is optimized and certified for safe use in your application.

Ingress Protection

Industrial equipment runs a high risk of exposure to dust and water on a regular basis. Any equipment that is not protected against the ingress of industrial dust and water will simply fail. Most computer development boards do not have an enclosure and hence a conformal coating, which is necessary for protecting electrical circuits against moisture and corrosive elements to ensure the long life of the product, cannot be applied to these boards. Industrial computers, on the other hand, must comply with ingress protection requirements. An IP certification that guarantees a high-level of protection against the ingress of water and dust is a must for deploying these computers in some applications such as marine and oil and gas. Compliance with the IP standards ensures that the industrial computing platforms can withstand the harsh industrial environments and have a long lifespan.

Product Warranty

The development boards often come with just a one-year warranty. An industrial-grade product should have a warranty of at least 5 years. Due to the high cost of replacing industrial equipment, industrial operators expect their equipment to work without failure for 10-15 years, or more. This standard applies to industrial computing solutions as well. Development boards simply cannot match the lifetime requirements of the industrial-grade products.

In summary, at first glance, computer development boards might be appealing due to their low cost and popularity. However, after considering their lack of features and functions, you will most certainly agree that the actual cost of using development boards in IIoT applications could be higher than deploying a tried and tested industrial computing solution.

Software Perspective

Software components are used in an IIoT system to extend the capabilities of the industrial hardware, including computers. Some typical applications include data acquisition, device monitoring and control, and data conversion. Besides software applications, we must also consider the operating systems that host them and the software development kits that developers use to customize software or build new software. The following factors could lower your software development cost as well as the time to market:

Software Service and Support

Software consulting and services are lifelines that developers depend on when they do not have enough knowledge of certain software components in the system or cannot solve the issues that arise on a daily basis. For example, when a developer faces an operating system related issue and is not able to quickly fix it, rather than reinventing the wheel the developer can contact the product support team, which should have the expertise and experience needed to fix such issues. This way the developer can focus on building software applications instead of spending time fixing platform related issues. If you are using a development board and run into such issues, the only option that you have is to post your questions on the developer forum and hope that some other user has faced a similar issue and will respond to your post.

Besides, developing an embedded computing platform requires in-depth knowledge on how these systems work. For example, a modern RISC platform comes with a NAND/NOR flash disk for the root file system. An inexperienced programmer will often design an application that frequently reads and writes data without proper acknowledgement, thereby limiting the performance of the hard drive. This could also result in bad sectors in the disk and eventually cause a boot failure. If you hire a software support and consulting firm for the platform, they can help you design your application better and give you advice on things like where to save temporary data in the RAM file system and other best practices.

Most industrial computing platforms come with various levels of software service and support packages that you can choose from. For your IIoT applications, we recommend that you work with a company that can also provide software services and technical support, along with the hardware and R&D support you'll need to help solve problems. The support team can learn from the problems and issues that you face and gain valuable experience, and you can benefit from their expertise, creating a win-win situation for all parties concerned.

Platform Optimization

More often than not, hardware manufacturers do not spend time integrating peripheral components such as USBs or PCIe interfaces that are bundled with their hardware platforms. They often sell third-party components as part of their platform without thoroughly testing the compatibility of these components. In addition to hardware components, vendors must also take steps to optimize the overall performance of their hardware platform, which include things like boot speed, as well as kernel and device driver integration. Providing device drivers and utilities for download on a piecemeal basis is not very helpful as users sometimes have to deal with conflicts in device driver functionality on their own, especially in the case of multi-device drivers. In some extreme cases, these drivers might corrupt the operating system. Our recommendation is that you select a hardware platform vendor who will provide you with a full software image that is tested and verified. This will save you a lot of trouble and help you develop stable applications and solutions at a much faster pace.

When it comes to operating systems, we recommend companies who can provide you with a system that is fine-tuned and optimized to your development needs rather than the ones who provide you with a basic operating system. The company must work with you on removing unnecessary processes and applications that you will not use in industrial applications, build a kernel that is most suited to industrial applications, and constantly provide system patches and upgrades to plug any security holes.

Utilities and Libraries

Software utilities and libraries are a developer's best friends. The key to the success of any hardware platform is an extensive set of libraries and utilities that are available to customize the platform and make it more user-friendly. Without these libraries, developers would have to spend a lot of time building platform related functions. This time could otherwise be used on building new applications. Hardware auto-diagnostic functions are also very useful in an industrial environment. For example, a push-button function that triggers self-diagnostics in industrial equipment helps developers quickly analyze problems in the field. Other useful functions, such as system save, restore to system default, auto dialup, as well as tools and utilities that can read Wi-Fi and cellular signals, can reduce the time a developer has to invest in troubleshooting issues, especially issues relating to system partition. This also eliminates the need for developers to memorize all AT commands and their various command options.

Software libraries that implement industrial automation or IIoT specific functions and protocols, such as OpenSSL hardware library, Modbus, Ethernet/IP, CAN bus, and MQTT, give a distinct advantage to developers working in the IIoT field.

A good platform provider will commit resources to optimize their hardware platform by developing software utilities and libraries. Developers can benefit from these extended features without having to write a single line of code.

Long-Term Support

The typical lifetime of an industrial platform is 5 years or longer. Industrial-platform vendors must therefore commit their resources to long-term maintenance of their software environment. All updates to the kernel or libraries of a computing platform must be thoroughly tested before release so as to not cause application software failure on these platforms. Development-board vendors typically do not adhere to these requirements because these boards were originally created as educational tools to help developers create proof of concept. Although some organizations, such as the Raspberry Pi foundation, are known for their large active developer communities, long-term support is usually not a top priority.

Cybersecurity

Incidents of cyber-attacks on industrial systems have increased in recent years. As more and more devices are brought online on IIoT networks, system security is a key concern for both users and operators. Unauthorized access to critical industrial networks is a real threat that operators have to deal with. Your embedded applications should be built on a secure platform that can extend the security features to the applications that it hosts. In addition, compliance with cybersecurity standards, such as IEC 62443-4, guarantees a high level of security.

Make sure that the development platform you choose supports the cybersecurity level and standard that your application requires. Additional functions, such as security boot, which provides protection from unauthorized access, can help strengthen the security of your embedded applications.

The Open-Platform Advantage

Open source software and an open source OS provide developers with maximum flexibility. In this model, developers are co-owners and have an equal stake in adding new functionalities and solving existing issues, which means that the software is constantly evolving. Since any security issue affects the entire user community, solutions are found rather quickly and are available to everyone. Debian Linux is a good example of a popular operating system distribution. Many companies have dedicated teams that work on building libraries and drivers for this distribution. The rule of thumb when developing such libraries and drivers is to follow the existing architecture and guidelines for the open source platform.

If a computing platform does not support a key functionality, developers have to spend a lot of time creating workarounds. Consider the example of a watchdog timer. Many platform vendors did not adapt their watchdog drivers to be compatible with watchdog applications that exist in current distributions because it is difficult and time-consuming to understand the complete functionality of a watchdog. The result was that developers had to spend additional time and effort to change the way their function calls were written in standard Linux for these watchdog functions to work. Make sure that the open platform you choose meets your system requirements and gives you the ability to develop libraries or utilities around it, either in-house or with the help of external consulting firms.

Moxa's Industrial Computers

Moxa's industrial computers are designed to provide reliable rugged systems that ensure the best user experience for a variety of vertical markets, including smart grid, marine, oil and gas, and rail automation.

The UC-8100 computing platform is designed for embedded data-acquisition applications. The computer comes with one or two RS-232/422/485 serial ports and dual 10/100 Mbps Ethernet LAN ports, as well as a Mini PCIe socket to support cellular modules. These versatile communication capabilities let users efficiently adapt the UC-8100 to a variety of complex communications solutions.

The UC-8100 is built around a Cortex-A8 RISC processor that has been optimized for use in energy monitoring systems, but is also beneficial in a variety of other industrial solutions. This compact embedded computer with flexible interfacing options is a reliable and secure gateway for data acquisition and processing at field sites as well as a useful communication platform for many other large-scale deployments.

Additional Reading

https://wiki.debian.org/Apt

http://www.moxa.com/product/uc-8100.htm