
Specialized Devices in The Enterprise: Considerations for Deploying Embedded Devices

Introduction

This paper is intended to provide an informed discussion of embedded devices in an enterprise setting. For purposes of scope, this paper focuses on embedded devices running 32-bit operating systems on either an ARM, x-86, MIPPS or SHS chipset. This excludes lower-performance 16-bit and 8-bit computing devices that have a different set of deployment considerations. As near-PC level computing power spreads to a range of devices, consideration of deploying these devices as an extension of the IT department becomes more complicated.

There are a number of embedded operating systems from which to choose. This paper will not try to establish an answer for which is best as that can vary by situation and need. This paper aims to provide the Technical Decision Maker (TDM) and Business Decision Maker (BDM) of an embedded device rollout with a framework from which to build an understanding of how to approach the project. Throughout this paper, we will raise the types of questions you will need to consider when determining the full impact of the total cost of the project.

“If you pay a little bit more for the license and services that allow you to build a product that is differentiated from the competition, then you will quickly realize your ROI.”

–Gaming Industry Manufacturer

Focus

on TCO/ROI

The variety of embedded operating systems (OS) available support a number of different chips, and appropriate functional pairing is a prime concern. This paper, however, is focused on building a framework with which to consider the financial impact an embedded device deployment can carry. The Total Cost of Ownership (TCO) and Return on Investment (ROI) involve a comprehensive view of the embedded device across its service life.

Many inexperienced TDMs/BDMs put a large emphasis on upfront licensing costs when calculating TCO. While important, these licensing costs are the tip of the larger TCO iceberg that includes more than the licensing and remains hidden. The TCO of a device involves understanding that the OS licensing costs are simply one of many costs that can be attributed directly to the deployment of an embedded device. These costs are real and often quantifiable. We do not intend to address the financial impact that the productivity gains of a particular device

may or may not bring. The financial impact we will discuss is a more tangible and sobering consideration of the many areas that can affect the TCO/ROI of a device.

Beyond Licensing and Toward Value

The licensing costs of an embedded OS are one of the easier cost elements to understand and assess. As stated above, licensing is not the most important cost, but is the most visible. There are a number of licensing models available to an embedded device Original Equipment Manufacturer (OEM). There are the commercial licensing models offered by companies such as Microsoft, with its Windows Embedded OS and Intel, with its Wind River offerings. There are open source alternatives including Android and embedded Linux that come with no licensing costs. There are also open-source-based offerings from companies such as Redhat that do come with licensing costs.

Considerations of commercial licenses can often bring passionate debates around the nature of technology: Open vs. closed, free vs. paid. The reality is each different licensing model brings pros and cons, and these need to be considered

in a larger context. For any embedded OS, licensed or not, the TDM/BDM needs to evaluate the “value” of the technology versus a “feature”

comparison. When determining the “value” of any technology, many elements beyond licensing fees need to be taken into account.

“We have aspirations to bring a rich UI to our products, using new technologies, such as internet radio, broader flash experience, etc... with our former platform that was less well-known, when we wanted to integrate these technologies we would have to go get the source, port it over and integrate it, and there is a long lead time in doing so.”

–Product Development Outsourcing Company

Domain Expertise and the Cost of Customization

Embedded devices operate in specialized domains. Each domain has unique features that drive costs and value. These features are designed and improved upon through direct experience in the industry, something that can take years. There is a cost to that expertise and that cost is reflected in the development time and expense. In this section, we will talk about different aspects that the TDM/BDM should consider.

Industry Expertise: The embedded industry is a truly specialized field. Because of this, it is difficult to discuss the embedded space as a common environment with common business values. Each device type, even within verticals, can have widely varying models and form-factors. These include the standards and regulations governing specific device types as well as common industry requirements. For example, automotive-space knowledge and the requirements that in-vehicle infotainment devices have for boot times, Bluetooth integration, and codec support, are very different from the requirements of industrial automation devices or Point-of-Service devices. Each vertical is, in many ways, a domain unto itself. The embedded OS plays a root function in each device category’s success. As a TDM/BDM considering a device deployment, understanding the

supply chain expertise of your development partner in the industry is very relevant to costs. The more customization required to shape a device for an industry, the greater the time and costs required to complete the customization. This effects time to market, support costs, and the chance of success a device might have. Each embedded OS provider should be evaluated on:

- Their focus on your device category
- Their history of success in your market
- The industry expertise “designed into” the OS

Cost of Customization: Much of the value in an embedded device is based on the device’s functionality and how it helps solve your problem or enabling your opportunity. As discussed above, each device type in the industry has its own unique requirements. Further, each device within a product line has its own strategy for market success. Because of this, the embedded OS and the device’s application development often require significant customization. Unique to the embedded industry, each OS is built for a specific device and to defined requirements, reducing the potential to scale development across device applications. Customizing an OS can bring high development costs as well as the need to license third party functionality. A TDM/BDM should understand the total costs associated with customization:

- The required security standards for the device and how they will be met
- The existing applications the device will need to integrate across
- The amount of time required to customize the OS and the total costs of the development effort
- Which codex, languages, and input requirements the device will need to support

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– Product Development Outsourcing Company

Time to Market: An OS provider’s industry expertise combined with the customization a device requires all factor into the time to market you can expect. The more customization required, the greater the need for integration and testing. The more customization required, the greater the likelihood of incompatibilities and unforeseen problems – increasing the uncertainty of the device and creating cost. To put it a different way, the more certainty an embedded OS brings, combined with greater industry influence and domain expertise, the higher the value of the OS to you. You pay for faster time to market, faster integration, more agility and shorter development cycles. These all have value, even if that value is not directly quantifiable. The business savvy TDM/BDM will consider the value to place on:

- Agility to quickly meet changing customer demands
- The amount of focus to place on differentiating their devices versus building in-house, basic device functionality
- The value placed on increasing a device’s probability of success in-field

Sales, Service, and Support

Deployment is only the beginning of the embedded device's life. Once the design is refined, the product is launched, and continuing its life cycle, support is needed. How that support will be provided, and who will provide it, should be a factor in selecting an OS. In this section, we will discuss some considerations for sales, service, and support that should be included in the OS selection process.

Company-to-Company Relationships: The overall life cycle of an embedded device is generally longer than that of consumer devices. This means an embedded device has a long operational tail, and that tail comes with a long-term relationship between the OS provider and the OEM. These company relationships go beyond simple, supplier relationships into the realm of a true partnership. The longer the relationship, and the more complex the device, the more important it is that both parties remain operational, provide support, and operate in a true partnership that can stand the test of time. The TDM/BDM who is thinking long term will consider:

- How long the OS supplier has been in operation and if it will still be in operation through the entire life of the device
- The ability of the OS supplier to be an active partner who can sustain a level of involvement
- The cost to maintain the relationship over time

Maintaining and Updating the OS: Over the life of an embedded deployment, most OS' will undergo improvements and updates. This is more significant with customized solutions that rely on mixtures of off-the-shelf and custom-developed components. You will have to rely on a long-term OS partner to maintain and update the OS. This reliance becomes stronger at higher levels of customization or if more components must be added to the OS for functionality. Simply put, an OS that is highly customized requires more support and updates that are more complicated. A BDM/ TDM needs to understand the costs, in time and money, and risks for these elements:

- Access to OS code updates and the ability of the partner to maintain current OS versions
- The time and resources that will be required to work with the supplier to keep the OS functioning and working in a customized enterprise environment
- The cost to keep a customized OS updated
- Ability of the OS partner to stay current with OS updates

"The scariest part for us in developing with Linux was the absolute lack of commitment, there is no stake-holder. When we were running into problems integrating the OS software with the browser, there was no one there to help us, we were on our own."

– Product Development Outsourcing Company

We were using a commercialized version of Linux, and we really had great success from the company in giving us support, were they could help...but were we really ran into problems was when we wanted to integrate new technologies. We were really on our own.

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Managing OS Versions: Many OS releases are modified over time and new versions are released. As the length of time from the version release increases, version proliferation becomes more of a factor. For the TDM/BDM, the challenge of managing the different versions is an ongoing concern. As more versions of the OS are released, tracking and ensuring compatibility is maintained becomes a difficult task. If the OS is rapidly evolving, with multiple sources responsible for the evolution, that tracking process becomes more difficult. For the TDM/BDM, there is a cost to this tracking and they should consider the following:

- The cost of keeping up to date and deciding which new version to use when multiple versions are in the field
- The cost to support an older version if compatibility with newer versions is not provided
- The time required to properly evaluate each new version as it is released and determining the impact it will have on the installed base

Updating the Development Environment: The embedded device development pace has increased as new OS have emerged. Keeping up with the latest development, and knowing how it will affect an installed base, can be a full-time effort. When the OS is highly customized, this becomes more complex and the costs to maintain the OS can rise over time. A rapidly changing OS environment requires significant time to monitor, which can be a burden on the OEM. The partner's capabilities and their ability to stay current should be integral elements in the decision. In that evaluation, the TDM/BDM should consider:

- Partner involvement in the development of the OS and connection to the developer community
- Cost to maintain internal OS expertise and continued participation in the development
- Time, and cost, required to stay current with OS environmental changes and understand their impact on the installed base

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Field Support: Once an embedded device is integrated into the enterprise environment, providing support becomes a long-term commitment. For example, some installations may need support 24/7. How this support will be provided, and by whom, is a consideration that may be missed in the rush to select an OS. There are significant costs associated with maintaining a field support operation and these costs can be hidden or not clearly stated in initial discussions on choosing an OS. A TDM/BDM needs to engage in field support discussions on the following:

- Who will provide the support once the development is completed
- The ability of the partner to actually provide field support over the entire life cycle of the device

- Anticipated support needs, and how those needs are likely to evolve over the device life cycle
- Geographic coverage capabilities of the partner at both national and global levels

Enterprise Ready Devices

Embedded devices can operate as stand-alone or as part of an enterprise system. For this discussion, we are addressing devices that are integrated into an enterprise environment. These systems have unique requirements. In this section, we will address some of the considerations that should be incorporated into a TDM/BDM's decision.

Managing the Embedded Devices as an Extension of IT: Most embedded devices will become a part of your enterprise and as such, are likely to be supported by your IT department. Device OS complexity and ability to smoothly integrate into your enterprise environment are key drivers to cost. When the enterprise system is already in place, you need to consider the impact of device OS on the rest of the enterprise system. You will need to evaluate these issues:

- The compatibility between the device OS and the enterprise OS
- How well equipped the OS partner is to work within your enterprise system
- The impact upgrades to the enterprise system will have on the device OS, as well as the impact of changes in the device OS on the enterprise system

Enterprise Security: Most devices in the field will be connected to an enterprise system, creating concerns that the device will adversely impact the enterprise operations. Security at the device level, and with the device's interactions to the enterprise system, is a concern for all parts of the IT group. Devices may operate in open environments where potential hackers can gain access to enterprise infrastructure. Device security, and use of devices as a port to the enterprise, is a common concern for IT managers. Some device OS are more open than others are, which can increase the potential of security breaches. The TDM/BDM will need to include the IT department in the following discussions:

- The cost of maintaining the security protocols for the device and its integration into the enterprise
- How the device OS will be managed for security and how updates to the devices will be integrated into the enterprise system
- The cost to maintain and manage security for the devices

"If you want to deliver an embedded product that is finalized and stable, you should absolutely NOT rely on the open-source community as a reliable resource to help you sort out issues such as drivers and middleware, you need professionals that are ready to deliver and are accountable."

– Product Development Outsourcing Company

Back Office Compatibility: When a multi-function, embedded device is installed in the enterprise, it may be required to communicate with the enterprise across functions such as accounting, inventory management, order processing, personnel, and time tracking. Even single purpose devices have to be able to interact with corporate IT systems that provide support functions for the device. Ensuring the device communicates properly, and that the communication continues effectively, is something about which your IT department will be very concerned. This raises some questions about how the management of compatibility will be handled. These include:

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- Understanding what, if any, drivers and CODECs will be needed to support compatibility with back office systems and the cost to obtain them if they are not included in the OS
- Building capacity to develop new drivers or codes as needed when the device or back office OS is upgraded or modified
- The costs and time required to test compatibility between device and back office at start-up and with each subsequent upgrade

The Value of the Ecosystem

Embedded devices operate in complex ecosystems composed of the devices, supporting infrastructure, developer and user communities, and OEMs. Ecosystems that are more complex provide a wider range of supplier and partner options to all participants in the ecosystem. For the TDM/BDM, this translates into the ability to choose from a wider range of potential partners with the specific capabilities to solve development, service, support, or integration issues. This is a virtuous circle; the larger the ecosystem, the more interest it attracts, which in turn leads to more growth of the ecosystem. In competitive ecosystems, each participant seeks to innovate and differentiate, driving more growth and opportunity throughout the ecosystem. For the TDM/BDM, a larger ecosystem generates more choices. This section will discuss some of the more important factors that drive choices in who to pick as suppliers, partners, users, and customers.

Finding Support When You Need Answers: Larger ecosystems offer more choice in support partners and also offer more feedback on which support partners are best matched to your needs. Further, your support needs will continue long after the initial deployment of your device. When you operate in a vibrant, growing, and diversified ecosystem, you are more likely to find support partners at all stages of the product life cycle. However, a functioning ecosystem needs rules and boundaries to ensure that participants within the ecosystem are following standards and protocols. Within newer ecosystems, those rules and boundaries will be less developed, adding to the costs of the OEM who may have to provide that leadership. Some aspects of the ecosystem that a TDM/BDM should investigate include:

- How long support providers have been in the ecosystem, and their commitment to stay in the system and provide support over the entire product life
- Depth of community resources that can be drawn on to provide support when needed
- The value of the support base, in terms of time saved and costs

The Value of Certification Programs for Developers: Ecosystems operate best when there are degrees of control and management over the participants. A certification program offers a formal, and mutually agreed upon tool to evaluate developers who are active in the ecosystem. Advanced and well-developed ecosystems have certification bodies who offer multiple levels of certification, ensuring consistent quality in the developer universe. The certifications also give users of developer services a repeatable measure of competency. When picking a device ecosystem, the TDM/BDM should look for value in:

- A professionally administered certification program that offers multiple layers of certification
- A process to enforce certification rules and a consistent certification protocol
- The cost to certify employees and products according to the accepted protocols of the ecosystem
- The levels of certifications held by the employees of your partners in the system

The Value of Partner Programs: Partner programs are a way to share costs, experience, and capabilities. In larger ecosystems, finding a partner is an easier task and larger ecosystems have more potential partners to choose from. Newly emerging ecosystems, such as those around open source OS solutions, present fewer potential partner options for the device OEM. Older, well-established ecosystems, offer partner options for the OEM and often these potential partners are certified in the OS. When the TDM/BDM looks at the entire ecosystem, the value of the partner program becomes apparent. Some aspects of the ecosystem to consider are:

- The growth rate of the ecosystem and how that rate has changed over time
- Average length of time potential partners have been active in the ecosystem
- The variety of potential partners in the ecosystem and their experience base in the OS

Summary

While evaluating an OS for your embedded deployment, it is important to look beyond licensing costs to get a complete determination of the actual development and deployment costs. In most deployments, the licensing costs are a small part of the total costs you will incur. Many of the additional, and more significant, costs are hidden and only become apparent once development has begun. To avoid being surprised by these additional costs, the TDM/BDM should identify and carefully evaluate all the cost components. This evaluation needs to include service, support, industry knowledge, and enterprise integration. A competent partner can provide you with a full assessment of costs and help you through the entire development and deployment life cycles.

There are many choices a TDM/BDM can pick from for an OS. By including all the costs of the deployment, those choices become more informed and your selection process more effective. Making an informed decision will help you accurately budget and plan for a successful launch.