Selecting the Right Platform for a Media Centric Embedded System Solution

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Abstract

An embedded system is a system designed to operate for a particular end application and perform a set of dedicated tasks. Such systems have been developed for many consumer electronic appliances (printers, microwave ovens, dishwashers, video game consoles, washing machines, PDAs, etc), infrastructure devices (routers, network bridges, telephone switches, etc) and automobiles (GPS receivers, anti-lock braking systems, etc). Even with the integration of the functionality across systems (digital cameras and mobile phones, for example), embedded systems remain an attractive option due to their ease of programmability and their ability to provide real time performance, which many of these systems require.

In most cases, since the scope of operation for such a device is known *a priori*, system designers are able to achieve high performance and reliability while also being able to optimize it in terms of size and cost. However, fierce competition in the market amongst various vendors results in a demand to offer more features at a lower cost with the ability to reach the market in minimal time. In this pursuit, the choice of the platform that system designers make for developing their solution plays a crucial role in the eventual success of their product. The term “platform” here refers both to the processor and operating system chosen.

Usually, system designers have multiple platform options and the call to select one of these is not trivial. In this article, we have presented the primary factors which influence this decision making process, and consideration to which can help developers and architects in making the right choice of platform for their application.

Introduction

There are multiple factors that influence the choice of platform for an embedded system. Some of these are technical, while others are purely non technical. These include:

1. Platform capability
2. Achievable System Specification
3. Market Fitment
4. Feasibility of Product Realization
5. Cost and Competitive Pricing
6. Time to Market
7. Scalability for Future Enhancements
8. Readiness or Current Expertise
9. Customer Interest
10. Ease of Upgrade and Scope for Reuse of IP
11. Technical Support From The Vendor

Figure 1 categorizes these under three classes, as per the nature of these factors – technical, strategic or business.

Some factors are listed under multiple categories, in case they impact the decision making process in more than one ways.

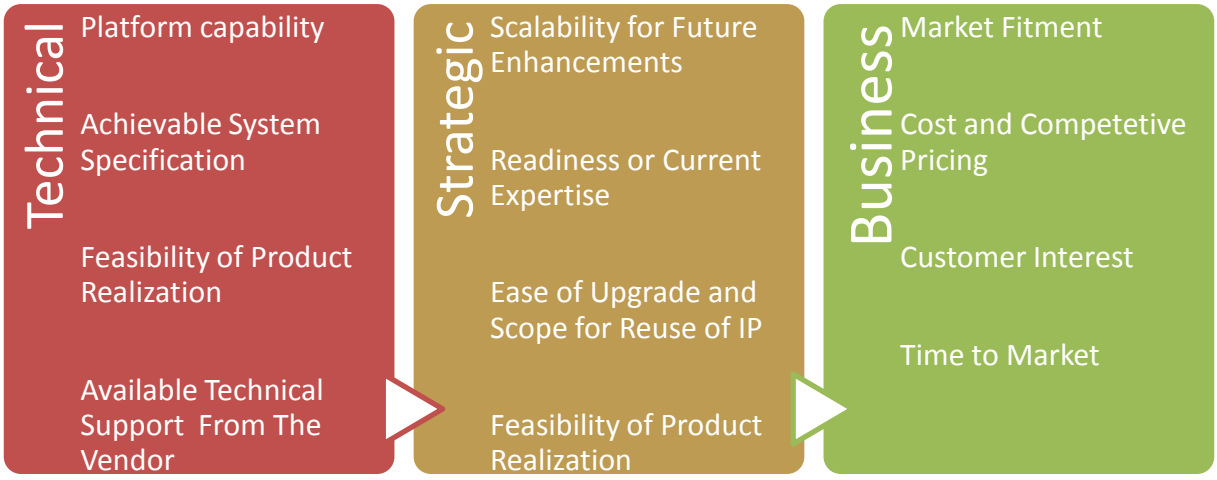

Figure 1: Classification of factors affecting the choice of platform

When analyzed from the perspective of time, not all these have immediate impact on the choice of the platform. Figure 2 categorizes these into long term and short term categories. Any one of these can acquire more significance depending on whether the system targets a volatile market (like mobile phones or portable music players) or long shelf life ones (like automobiles, routers, etc).

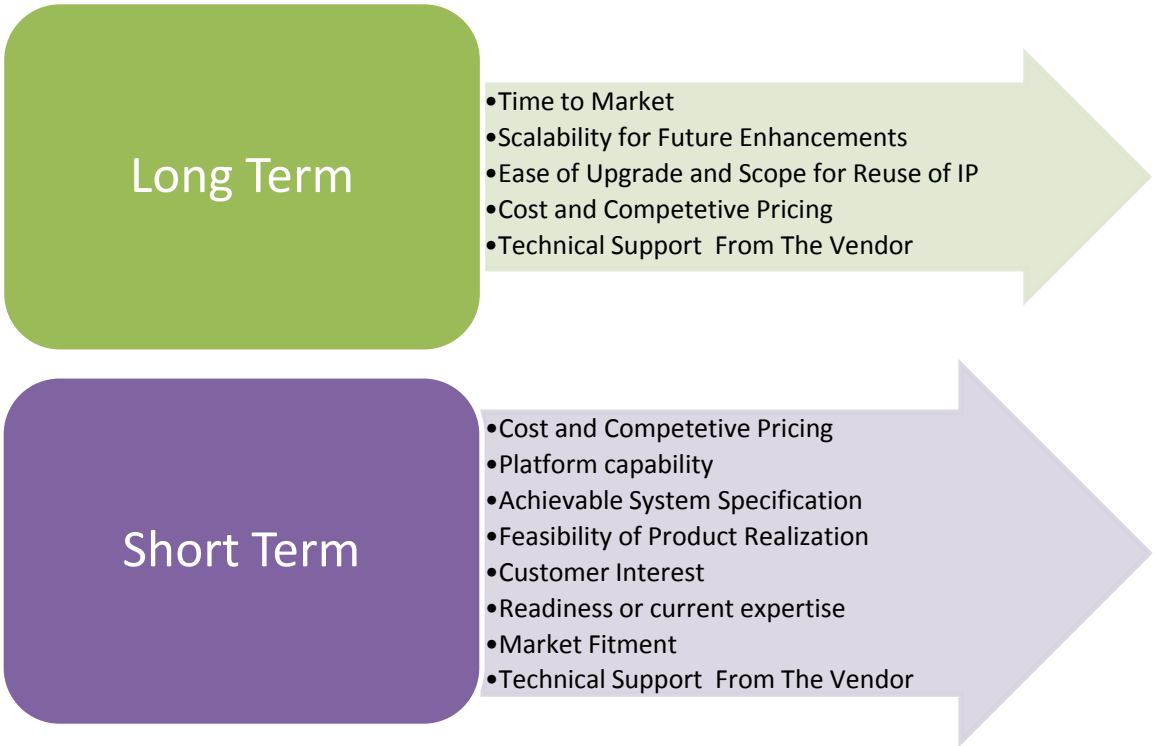

Figure 2: Time criticality based classification of factors affecting the choice of platform

The subsequent sections present these factors in more detail. Relevant examples are included to illustrate the point. Subsequently, a case study would be used to showcase how this discussion can be used in practice.

Factors That Influence Decision Making

Platform Capability

An integral underlying constituent for a platform is (are) the processor(s) that define the core processing capabilities offered by the platform. The horsepower required to execute the various tasks needed of the system at the required level of performance forms the first data point to determine the suitability of the processor for the target system or solution. This forms the very first gating criterion for the selection of that processor. For instance, consider a system where one needs to do simultaneous video H.264BP encode and decode of D1 resolution video at 30fps. On TI's DM6446 DaVinci platform, doing this is not feasible, just like on Freescale's i.MX27 processor due to processing capabilities these platforms offer. i.MX21 or i.MX31, on the other hand support only MPEG4 video codec operations and not H.264BP, though at the required frame rate. TI's DM6467 can provide both the right codec and the desired frame rate, and can be a candidate in the discussion.

Beyond the processor, the other integral component for the platform is the operating system (OS) that is used. Capabilities and performance vary across various OSes - in terms of the type of scheduling for multithreaded applications, implementation of remote procedure calls, memory footprint, in built diagnostics / debug features and processing overheads. For example, in case of multimedia systems, royalty free Linux OS distributions are quite popular. These are quite lightweight and easily portable across processors and has open access to a community maintained source code of the OS. WinCE, though with a higher overall processing footprint, provides a user friendly and strong IDE to efficiently execute the development and debugging tasks. Many Windows desktop applications like Messenger, Media Player or Internet Browser are also available with the standard distribution of the OS. Besides these, WinCE provides a built in support for development of rich user interfaces (akin to Windows desktop), language packages, device drivers and network management tools without the need to integrate segments of code or applications from multiple sources. Another choice of OS is the vxWorks Real Time OS (RTOS). However, of late, Linux OS seems to be a more preferred option as compared to vxWorks; and significant players like WindRiver have taken the Linux route and joined the likes of Montavista in the embedded Linux OS domain.

Achievable System Specification

Besides the core processing requirements, the system also involves a framework that binds the processing modules together using some controller or state machine logic. Beyond that, embedded systems typically also provide a man-machine interface to facilitate easy handling by the end users. The achievability of these features for the intended system must also be studied holistically before making a decision to choose a certain platform.

For example, on TI's DM6446 DaVinci platform, with its support for multiple video and OSD (On Screen Display) windows, and a sophisticated video processing back end (VPBE), is quite apt for a full interactive Graphical User Interface (GUI), and can serve as an asset for an application like a portable media player where the richness of GUI and user experience plays a significant role in the eventual success of the product. A platform like TI's OMAP3530, or Freescale's i.MX31 also provide excellent 2D and 3D graphics acceleration options to facilitate this. On the other hand, since an aerial surveillance system may not require extensive GUI controls, a lower end processor like TI's DM355 or Freescale's i.MXL can be used for that system.

Another aspect to consider is the fact that the end system can only work to when the processor is accompanied by the right peripherals. For example, an SDHC (Secure Digital Host Controller) peripheral that can controls the MMC (Multi Media Card), SD (Secure Digital) memory, and I/O cards is a must for portable personal movie player. Therefore, when selecting the right platform, we also need to study whether the parts other than the processor are suited to realize the product. Also, one needs to ensure that these parts are available or can be procured (with the desired performance metrics) by the required time.

The argument can be extended to the choice of OS for the embedded system. For instance, in the mobile phone applications and multimedia world, Linux competes with Symbian OS and Windows Mobile. While Linux boasts of high customizability and low costs, the others have very strong ready to use portfolio of features like messaging, telephony and web browsing. Based on which of these is scoped as a part of the final product specification, system designers can make their choice.

Feasibility of Product Realization

Although a platform may look like the right fir based on its capabilities and achievable system specification, it may still not be the right choice. There are a few other factors that impact product realization:

1. Platform Roadmap

Each organization has its own roadmap for the products it plans to roll out. If the vendor's released information on the availability of the processor is not aligned well with these plans, the selection criteria may rule out this processor from the list of the candidates, although it may be most suited from a platform capability or suitability perspective.

2. Competitive Or Strategic Business Advantage

Companies usually form partnerships and business alliances with other organizations like chip manufacturers and software IP provider. This may include partnerships on platform design or software development to achieve better times to market. Platform vendors, if a part of such partnerships, can provide the software IP providers with an early access to hardware and board support packages. In such cases, the choice of a platform may involve making a decision to compromise on some other aspect (optimality, platform roadmap, etc) especially if the platform looks promising from the perspective of design wins with customers.

Available Technical Support from the Vendor

Along with the processor, is the important ingredient of the Board Support Package (BSP) which includes the OS (kernel, boot loader, file system etc) and drivers (for all peripherals). Additionally, important ingredients required for starting and sustaining development include required tools and dependency packages. It is critical that the vendor be committed to providing the required support and updates at the commencement as well as during the course of the product development. Often, this becomes a critical factor in determining the vendor, and hence the platform, to go with.

Most vendors therefore provide reference designs, software development kits (SDKs) and evaluation modules to help potential customers start on product development on their platforms. In case of project partnerships amongst multiple companies or organizations, it is important that the platform roadmap and required support commitments be understood from all involved parties.

Cost and Competitive Pricing

When the choice of parts in terms of capabilities and feasibility of product realization is done, usually, the decision makers would weigh their pros and cons against the cost benefits that some other platform might yield. Depending on the criticality of a particular product specification requirement, the cost – functionality trade off may or may not be acceptable.

For instance, to realize a low cost access control device like a door phone, one could either use TI's DM6446 or DM355 DaVinci platforms. The former is a dual processor solution while the latter is a single processor one. While DM6446 allows multiple software video encoders and decoders (H.264, H.263, MPEG4), the latter allows only MPEG4. However, the price of the latter is approximately 40% of the former. The trade off in this case is quite clear.

Cost also needs to be analyzed in conjunction with the aspect of time. For example, when deploying infrastructure devices like network switches or routers, the manufacturer and consumers are usually not too concerned about the cost of deployment (given small volumes or numbers). What matters more is the reliability and ease of programmability, given that it's usually a long term investment. The system designer can therefore chose the processor and peripherals that provide such advantages. However, while designing for a digital photo album, one should keep in mind the short shelf life for the product. Therefore, emphasis must be laid on time to market fast and with minimal costs.

Cost also plays an important factor in the choice of OS. While Linux is royalty free, options like WinCE and VxWorks require licensing and support fees. However, the memory footprint of the Linux OS is bigger than that of VxWorks, thus requiring bigger memory maps and hence increased costs. The trade off needs to be analyzed and evaluated for the particular product in consideration. Symbian OS (used in Motorola MOTORIZR Z8, Nokia E- and N-series products) and Windows Mobile (used in Motorola Q and Samsung Blackjack products) also falls in the same category as VxWorks and WinCE when it comes to the mobile phone products. Compared to Linux (multiple smart phones from Samsung, Motorola and Panasonic), these usually are more cost intensive choices.

Market Fitment

Certain classes of platforms are more suited for certain operating scenarios. For example in applications like robotics, video conferencing and reconnaissance, real time performance requirements usually need to be fully deterministic in the end operations performed by the device. In such cases, Linux (with its soft real time scheduling) is not the best option. VxWorks, WinCE or BIOS are more suited with their hard real time scheduling behavior. On the other hand, soft real-time scheduling may be okay for most consumer appliances like washing machines and microwave ovens.

Time to Market

Although a certain platform might not be the most viable option to select at a given time, it may still be selected for long term benefits. When taking into account the roadmap of the vendor providing that platform, it may so turn out that starting development on that platform might provide advantages in terms of readiness to market and building platform expertise. In either case, the time to market the product would be greatly reduced when the demand arises for the product on that platform. The advantages might outweigh the projected hit that one may take at the start of the development cycle. Needless to say, any such decision must be based on meticulous marketing study and communication with the vendor on available support and platform roadmap.

Scalability for Future Enhancements

Once a system is implemented and proven on a particular platform as a first generation product, it might not encompass all the functionality of features that would be needed from a niche product of its category. Usually, follow up phases are planned with extended functionality and performance aspects which can serve to ensure a longer shelf life and wider appeal for the product. The platform chosen should allow such flexibility. More rigid realizations of the product would only need more platform migrations and repeated decision making exercises as these.

Scope for Reuse of IP

If the solution has been developed already on one platform, it can be of huge advantage if some of these can be re-used on another platform. Similarities in platform architectures play a critical role in this sometimes. For example, a controller implemented on ARM9E for Freescale i.MXL platform with an ARM9E core for the microcontroller can be reused seamlessly for TI's DM320 platform or other platforms from the same processor family (i.MXS, i.MX21, i.MX27 or i.MX27L). Similarly, drivers for peripherals for TI's DM6446 can partly or wholly be reused for other platforms from the DaVinci family, given similar (or in some cases identical) underlying hardware architecture.

On a similar note, organizations may decide to develop multiple products on an erstwhile new platform from development perspective. In the process, however, parts of development done on one product can significantly help the other. Therefore, in an overall sense, the overall time to market and develop

expertise on the new platform can be brought down. It is therefore important to consider the possibilities of reuse of existing or future IPs across products / product-lines to leverage the decision of migrating to the new platform.

Customer Interest

Although not always true, there are occasions when there is customer interest on a certain platform, which may in turn be driven by their marketing vision or their short / long term roadmap. This is especially true in the case of software IP development. In cases like that, an organization might sometimes need to forego their own choice of platform to cater to the customer drive. In other cases, where customers are provided with a complete system or solution within the required functionality expectations and cost constraints, this may not be a relevant factor at all.

Readiness or Current Expertise

Sometimes, an organization would decide in favor of a processor from vendor 1 as against another (sometimes stronger or better suited) processor from vendor 2 due to the fact that there has been a history of previous development on the processors from vendor 1. The resident skill and expertise in the organization can be best put to use and leveraged for fastest results if they continue future development on similar processors. For instance, given the differences in the processors from Analog Devices and Freescale Semiconductors, an existing user of the either may have apprehensions in switching, due to different processor architectures and functionality knowhow. This readiness to change gears may also be determined by the roadmap of the organization and future expertise that it plans to develop.

Ease of upgrading from existing deployments / products

There are occasions when organizations would chose new platforms to serve as second or third generation extensions to their previous products. In such cases, the backward compatibility of the new platform is quite important, specifically to retain the existing customer base. Therefore, the readiness to move to a new family of processors or to a new operating system is usually quite low. This would apply to a software or IP licensing software organization to a great extent. In cases where the organization is releasing end systems, this usually is not a concern.

Case Study: Ittiam's Video Phone on TI's DM6446

As a case study for this paper, we'll look at a case study for Ittiam's decision in using TI's DM6446 platform for implementing a high end video phone. In doing so, the chief concern was to make sure that not only does the processor satisfy the basic telephony requirements, but can also provide scalability for the coming year or two in terms of rich media centric features like media recording, playing and

streaming. The required functionality included peer to peer (up to D1 resolution) & conference / bridge calls with H.264 / H.263 and MPEG4 video codecs and a choice of narrow or wide band speech codecs. Additionally, it should be possible to develop a full system with a rich user interface and other integrated applications like phone book, instant messaging and remote upgrade.

Many processors like Freescale's i.MX27, i.MX31, TI's OMAP2430, TI's DM6446 and DM355 provide one or more of these capabilities. While OMAP2430 and i.MX31 score high on power savings; DM355, OMAP2430 and i.MX27 are very lucrative from a cost perspective. However, with the desired video frame rates for full duplex high resolution (VGA, D1) video calls and the need for a high level of programmability, DM6446 emerges as the perfect fit from a technical perspective.

Further, based on previous engagements on other projects, Ittiam had had an excellent experience with technical support from TI. The choice of operating systems for the video phone system resulted in two winners: Linux and WinCE. Linux allowed for an easy start using TI's development kit, while WinCE was the futuristic OS choice with promise for a complete end application development. Therefore, two flavors of the video phone solution got defined and developed in parallel. These strategic and business factors also helped in making the choice.

Based on the discussion presented above for this case study, we have classified these factors into three categories - A, B and C – in decreasing order of impact on the decision made. These categories signify a relative weight that this decision making process associated with the listed factors. However, this gradation in importance needs to be understood in the context of a video phone, and may be totally different from one drawn for a GPS receiver in an automobile or an air conditioner.

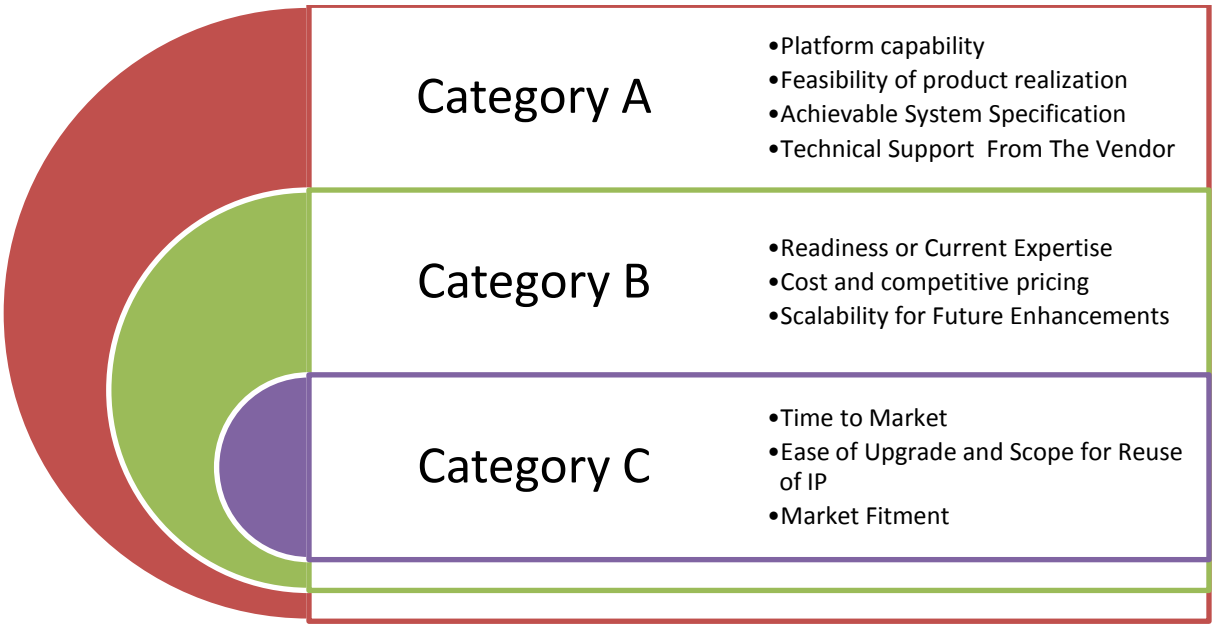

Figure 3: Factors affecting the choice of platform for Ittiam's video phone on DM6446

Conclusion

As must be clear to the reader, there is a multitude of factors that govern the dynamics of platform selection for the end system. The significance and the nature of impact of these varies based on the application scenario. It is for that reason that a general rule of thumb might not be defined to assist in this decision making process. The examples and case study presented in this article showcase the same. However, a general awareness and conscious consideration of these can greatly help arrive at the right decision in a structured and organized manner. Eventually, the decision taken would be case specific but the approach to arrive at that decision can be modeled on the presented ideology.

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