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Information Appliances: The Next Challenge for Embedded System Designers

A convergence between different industries begins to shape new information appliances. For example, the combination of Internet and television created the interactive, Web based digital set-top box; the Internet and the telephone created the Web phone. However, at this stage no one really knows for sure what combination of features or business models will eventually lead to a profitable product or service. This information gap leaves designers in a difficult situation; they must be flexible to react quickly to this evolving and fluid industry. This article addresses these concerns by looking at some different approaches for developing cost effective, flexible, and, above all, time-to-market friendly solutions.

INTRODUCTION

We live in a world deeply dependent on personal computers - they perform a majority of our day-to-day tasks such as e-mail, word processing, banking, entertainment, Web surfing, as well as a variety of other personal and work-related tasks. This dependency is directly linked to the recent explosion of the Internet, and as society becomes more Internet connected and mobile, people are requiring access to the Internet anywhere and at anytime. As this reliance intensifies, a convergence between different industries begins to shape new information appliances. For example, the combination of Internet and television created the interactive, Web based digital set-top box; the Internet and the telephone created the Web phone. These are just some examples of information appliances on the market today. Undoubtedly, many more combinations of information appliances will follow; however, at this stage no one really knows for sure what combination of features or business models will eventually lead to a profitable product or service. This information gap leaves designers in a difficult situation; they must be flexible to react quickly to this evolving and fluid industry. This article addresses these concerns by looking at some different approaches for developing cost effective, flexible, and, above all, time-to-market friendly solutions.

INFORMATION APPLIANCE DEFINITION

As of yet, a standard definition for an Information Appliance has not been established; however, for the context of this article, we will attempt to define an Information Appliance as an information centric embedded system with a dedicated task that can be connected in some way to another device or a network. This definition covers applications such as cell phones, personal digital assistants (PDAs), digital video recorders, and digital set-top boxes. Within a constantly changing industry, we can expect more and more complex devices to be prominent. These devices will combine functions such as cable/xDSL modem, voice over IP (VoIP), digital entertainment, e-mail, and web browsing into a single box. Only time will tell how these functions will be packaged and which combinations of features a consumer will consider to be important. Designers will be forced to choose between designing an optimized appliance that implements exactly what the marketing department wants today, or a flexible design that accommodates new features as the market twists and turns.

FACTORS FOR PRODUCT SUCCESS

The world of Information Appliances is revolutionary and is evolving at an exponential rate. There are many combinations of products to be designed. For engineers, this abundance of choices can be a dilemma. Since product paths have not been established or are being driven by others, looking to a "cloning" method will not work for these new wave of products. Designers are now required to analyze their target interfaces by understanding the root of Information Appliances, which is the underlying network infrastructure. It must be looked at from physical network architectures to new communication standards. Having this knowledge is important for understanding how a device will communicate effectively to the real world.

After analyzing the infrastructure, a designer will have an idea of what processing power their device needs to seamlessly communicate between the network and the user. A factor to consider is the type of services being delivered through the network infrastructure by Service Providers. In most cases, if rich media content such as compressed video and audio are being delivered, high-performance processing will be required. To facilitate these requirements, the trend has been to use 32-bit processors such as x86, MIPS, SH, Arm or StrongArm. This 32-bit requirement could change in the near future to a 64-bit requirement; however, this requirement will depend on future network infrastructures and what service providers are willing to make available.

In this ever changing and fast moving market of Information Appliances, a product's success on the market is directly related to its time-to-market. System designers are aware that time-to-market is not just a hardware issue, but a software problem too; therefore, software must not become a bottleneck in the product development cycle. This leads to the conclusion that the correct choice of Embedded Operating System is imperative to ensure smooth integration of hardware and software.

Another important factor and part of the equation for ultimate product success is cost. A price range that consumers are willing to pay should be established early in the product development cycle. This price point will help decide which feature sets are realistic and which features are just nice-to-have.

Power dissipation can also be a consideration with respect to portability. Portability is an attractive feature for an Information Appliance, especially because society is becoming more mobile oriented.

Lastly a critical choice must be made on the design approach to be used in order to develop a marketable product. In the following paragraphs, we will be looking at three possible approaches that can be used in designing an Information Appliance: an Embedded PC, System on a Chip and a Modular approach that leverages V3 Semiconductor's off-the-shelf hardware and software solutions.

THE EMBEDDED PC APPROACH

When time-to-market is the only concern, the Embedded PC approach is the best choice. The main advantage of this approach is the ability to leverage well-known PC hardware and software in order to meet timelines; however, the legacy baggage of the well-known PC hardware and software is what makes this platform unsuitable in the first place. Other disadvantages like the power consumption of the processor and legacy code that the x86 derivatives must support can lead to increased heating and costing issues. Some silicon vendors have recently developed highly integrated low power x86 based SOCs that provide many of the functions required for an Information Appliance; however, in addition to not being flexible, these x86 based SOCs don't provide enough computing power for more demanding applications involving rich media content. Many Information Appliances require the processing power of a commercial PC in an inexpensive low power package. That is why other processor architectures, such as MIPS, SuperH, and StrongArm have become more popular for Information Appliance applications.

THE SYSTEM ON A CHIP APPROACH

When low production costs are the main concern, a System on a Chip approach is an apparent choice. With this approach, an Information Appliance design would employ a custom SOC silicon that is tuned precisely for the given application. Certainly, this approach was used successfully in designing cell phones; however, there are many emerging applications where the time-to-market constraints make custom silicon unfeasible. The result of this level of integration is mediocre performance.

Contrary to popular belief, SOCs may not be cost effective. In many cases, integrating a processor and all possible peripherals can dramatically increase the pin count leading to a larger, more expensive die than is necessary to support the core of the design; therefore, scalability in an SOC becomes an issue. Typically, these highly integrated processors become abandoned in the roadmaps of the processor vendor. When the next generation processor core is introduced, it is unlikely to be a pin compatible upgrade. By basing a design on one of these SOC processors, scalability or expansion cannot be maintained. Fortunately, off the shelf solutions do exist that provide cost effective and flexible solutions.

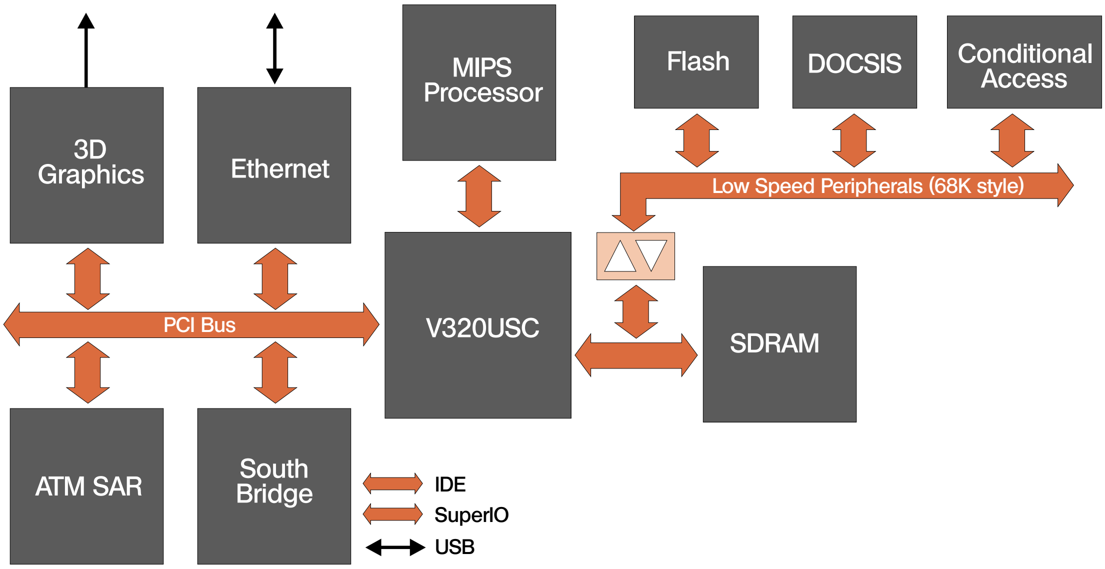

Figure 1. Generic Architecture of an Information Appliance.

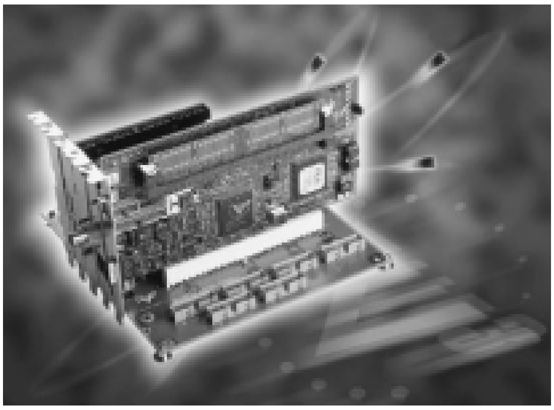

Figure 2. V3 Semiconductor's Linux Board Support Package platform.

MODULAR APPROACH

V3 Semiconductor provides off-the-self solutions to developing an Information Appliance which is cost effective, flexible, and time-to-market friendly. The modular approach only leverages what makes sense from the PC and chooses more embedded friendly components elsewhere. With the many inexpensive PCI peripherals available on the market, it makes sense to use a standard, such as PCI, as a system connection bus. PCI has become the standard of choice for interfacing peripheral components such as LAN/WAN and video. In fact, it is difficult to find peripheral components that do not incorporate PCI. The first major benefit of a PCI based Information Appliance is flexibility and expandability. With PCI available in the system, products can easily respond to changing market demands.

Another advantage of the modular approach is that software does not become a bottleneck in the development cycle. PCI offers a multitude of existing drivers and software development tools which can decrease software development time; however, you can expect to have an increase in overall development cost with some Embedded operating systems that require major purchases of development tools, source code and licenses. This is not true with Embedded Linux, which can offer fast time-to-market, as well as a lower overall development cost. Since Embedded Linux is an open source operating system, additional development tools, source code and license costs are not present. By using Linux, a minimal amount of development time is usually needed because of the many free resources available. With the proper Linux Board Support Package, software development can begin before a prototype has been designed. As a result, the software is designed in parallel with the hardware. By allowing hardware and software to work hand-in-hand, rather than as separate development paths, products can be placed in the customers hands sooner which allows early adoption, higher volumes and beating the competition to market.

An example of a modular design information appliance using V3 Semiconductors V320USC Universal System Controller is shown in Figure 1.

V3 semiconductor's V320USC Universal System controller allows System Designers to take advantage of PCI connectivity for a wide variety of processors such as MIPS, SuperH, StrongArm, and Motorola's PowerQUICC and ColdFire. It also allows the connection to a wide selection of SDRAM memory and a variety of peripherals.

The advantage of using this PCI support is the flexibility it can provide: WAN connection, LAN connection, video support, and other PC like connections. These PCI modules can be mixed and matched with other PCI modules such as audio for a MP3 player. Practically, there is an endless number of combinations that can be done.

LINUX BASED DEVELOPMENT PLATFORM

V3 Semiconductor has developed a Linux based Development Platform particularly useful for developing Information Appliances.

The V3 Linux Board Support Package shown in Figure 2 is a complete source package for an embedded Linux system. The BSP works in conjunction with the V3 Hurricane single board computer and the Matahari 64 system. The Hurricane kit includes a powerful MIPS processor, V3's V320USC PCI System Controller, an expandable memory subsystem, a flexible boot/initialization scheme, serial and parallel ports and software support tools - the essential features of an embedded PCI system. The Matahari 64 system is a PCI passive backplane that provides additional slots to allow for system expansion. The key advantages for using V3's Linux BSP is shorter development times, lower production costs, modularity, scalability, and reliability.

Figure 3 illustrates one possible system configuration when using the V3 Linux BSP package. The basic system requirements for this configuration are: V3's Hurricane V320USC Evaluation Kit, Matahari 64 Backplane, NE2000 PCI Network card.

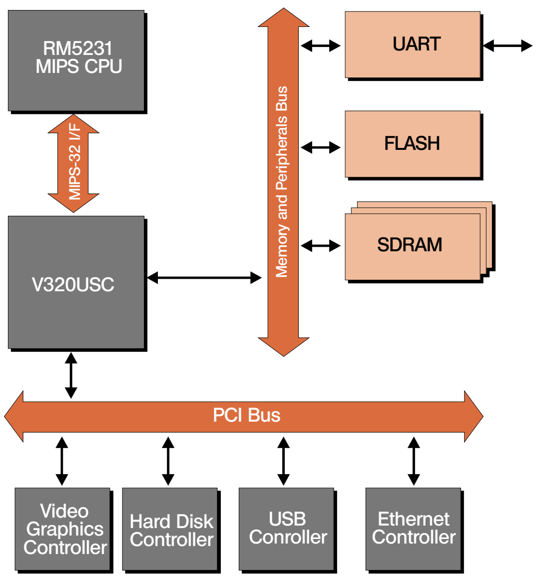

Figure 3. V3's Linux BSP System Block Diagram.

SUMMARY

According to International Data Corporation's Review and Forecast of the World Wide Information Appliance Market (1999-2004), the shipments of Internet-enabled appliances is expected to exceed shipments of consumer PCs by 2002. If Information Appliances are going to be as lucrative as everyone hopes they will be, then competition will be fierce and it will be difficult to obtain a share of this market. Using an efficient design approach will be critical.

The Embedded PC approach will address the time-to-market concern; however, it fails in high-performance or certain power-sensitive applications. The SOC approach suits extreme high volume and cost-sensitive applications, but fails in the area of flexibility, expandability, and scalability. V3's Modular approach provides the best of both worlds by offering rapid time-to-market, while maintaining flexibility, expandability, and scalability of processing power. In addition to knowing the market space, the key factors a system designer should keep in mind while developing an Information Appliance are expandability, flexibility, and time-to-market. These factors will provide a designer with a solid base for becoming successful in the Information Appliance market

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Anselmo Pilla, Application Engineer at V3 Semiconductor Corp. holds a B.Eng.Sci. from the University of Western Ontario. He brings 5 years experience as President of Pilla System Consultants, an Information Technology company providing e-business solutions. This extensive knowledge in sales, marketing and applications in the IT industry has provided vision and insight to the needs of the Embedded Systems Market.

Mr. Alford has served as CTO for V3 since 1999, and prior to that held the position of VP Engineering. Mr.Alford, holds a BESc. (Electrical) degree from the University of Western Ontario. Mr. Alford was one of the original founders of V3, and was the primary Architect for many of the company's first semiconductor products. He has experience in ASIC and custom VLSI chip designs (CMOS technology), and he holds several patents in the area of multi-media architectures. Mr. Alford was the Design Group Leader for Multi-Media Products at ATI Technologies, and worked on semiconductor chip designs for acceleration of digital video, video re-sizing and video re-formatting.