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TRENDS IN EMBEDDED INSTRUMENTATION & DEVELOPMENT

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ABSTRACT

Embedded systems are important and essential part of the fast moving technology and have become an integral part of daily life. Be it a cell phone, a smartcard, a music player, a router, or the electronics in an automobile, the technology of embedded systems are touching the lives as never before. An embedded system is a combination of computer hardware, software, and additional mechanical or other technical components, designed to perform a dedicated function. Most of the embedded systems need to meet real time computing requirements. The need for Test and the Management equipment is pervasive for any type of electronic system in virtually all end-user applications, including communications, electronics manufacturing, automotive, industrial, aerospace, military, and others. With board and chip complexity increasing rapidly, it is extremely critical to test for the proper functionality of both the chips themselves and the printed circuit boards (PCB) where they have been installed. For decades now, traditional external instruments have been used to collect and analyze test data. However, it is presently becoming more difficult to use these older types of instruments. The future is about software-based Testing and Management of the existing systems and, more generally, embedded instrumentation.

INTRODUCTION

The embedded system is the heart of the intelligent systems part of the every smart phone and the smart device that controls and have become the most essential part of the daily life. The major building blocks of an embedded system are listed below:[1]

1. Microcontrollers / digital signal processors (DSP).
2. Integrated chipsReal time operating system (RTOS) - including board support package and device drivers.
3. Industry-specific protocols and interfaces
4. Printed circuit board assembly

Usually, an embedded system requires mechanical assembly to accommodate all the above components and createa product or a complete embedded device. The Figure 1 illustrates the architecture layers for an embedded system. The lowermost layer comprises the printed circuit board that accommodates all the semiconductor devices, buses and related electronics. The semiconductor devices may include integrated chips, microcontrollers, field-programmable gate arrays (FPGAs) or asystem-on-chip (SoC). The uppermost layer is the application layer. In-between, there are other layers which may comprise components like device drivers and communication protocols. A special genre of operating systems known as the real-time operating system (RTOS) is usually required to cater to the deadline-driven requirements of an embedded system.

There are some key differences in the design and use of embedded systems as compared to the general computing devices.

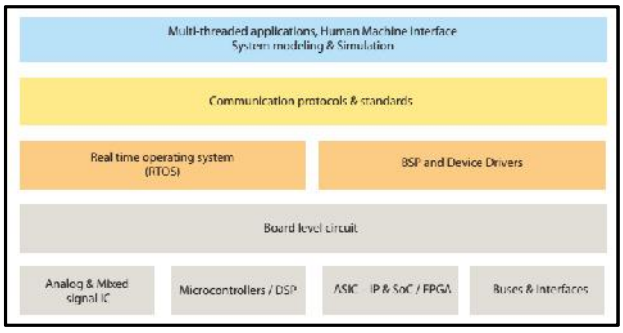

Figure 1 Architecture Design of Embedded System

They perform a limited set of pre-defined functions and have a limited field configuration capability. The packaging into which they are embedded is also standardized. These features enable embedded systems to berelatively static and simple in functionality. However, there is a requirement for low cost, small physical footprint and negligible electrical / electronic radiation and energy consumption. Simultaneously, they need

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to be physicallyrugged and impervious to external electrical and electronic interference.

Therefore, embedded systems invariably have limited resources available in terms of memory, CPU, screen size, alimited set (or absence) of key inputs, diskless operations - these parameters play a crucial part during the design, development and testing of such systems. They also require a host of diverse skill-sets related to hardware, embedded software, electronics and mechanical domains, which renders further complexity to their development.

Embedded systems are deployed in various applications and span all aspects of modern life. Figure 2 details the main application areas of embedded systems.

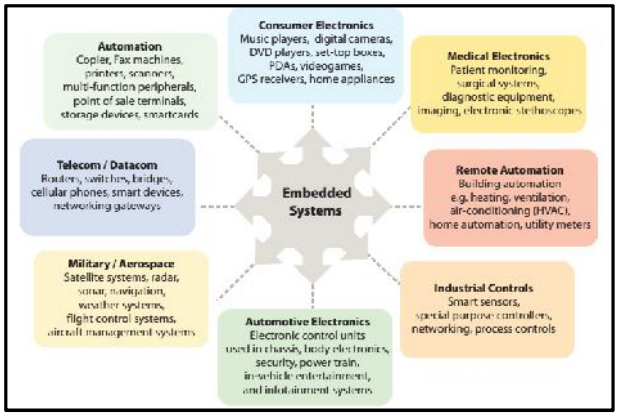

Figure 2 Major application area of embedded system

Need of Test and Management in Embeddded System

The need for T&M equipment is pervasive for any type of electronic system in virtually allend-user applications, including communications, electronics manufacturing, automotive, industrial, aerospace, military, and others. With board and chip complexity increasing rapidly, it is extremely critical to test for the proper functionality of both the chips themselves and the printed circuit boards (PCB) where they have been installed. For decades now, traditional external instruments have been used to collect and analyze test data. However, it is presently becoming more difficult to use these older types of instruments. The future is about software-based T&M systems and, more generally, embedded instrumentation.

The interface between bench top T&M equipment and PC-based T&M equipment has been evolving for a considerable period of time.

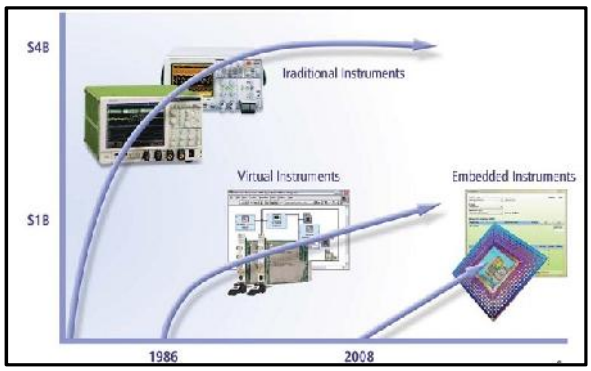

Figure 3 Trends of Market

The initial interfacing was provided by parallel and serial interfaces, including the general-purpose interface bus (GPIB). However, the current technological trend requires a more powerful interface, which is provided by implementing universal serial bus (USB), PXI, VXI, and LXI/Ethernet ports.

Traditional Instrumentation

In the past, traditional T&M instrumentation and systems were comprised of pre-defined hardware components that cater to a specific task or kind of analysis. These instruments, such as digital multimeters, oscilloscopes, signal generators, and logic analyzers, have been limited to fixed- or vendor-defined functionality. These conventional instruments are expensive, and upgrades to augment or enhance their functionality only add to their cost and the cost-of-test.

Virtual Instrumentation

Virtual instrumentation is a concept developed in the mid-1980s, which deals with the use of customizable software and modular instrumentation hardware. In essence, virtual instruments are user-defined measurement systems. Certain software packages like National Instruments' Lab VIEW are examples of virtual instrumentation. The major difference between traditional instrumentation systems and virtual instrumentation is the software in the latter, which can be programmed to replace the prescribed hardware functionality of traditional instrumentation. The software of virtual instrumentation assists in reducing the cost of testing by replacing the composite and expensive hardware components in the traditional test systems with a software package. Test-related software, which can capture data and process it for high-speed, real-time analysis, holds the key for the future in the T&M marketplace.

Embedded Instrumentation [8]

Embedded instrumentation is a concept of entrenching and enhancing the capabilities oftraditional external test equipment as an additional resource on the chip and/or ondedicated instrumentation chips on a circuit board. Then, through industry standard accessmechanisms, software is used to run the instrument and collect data for analysis.

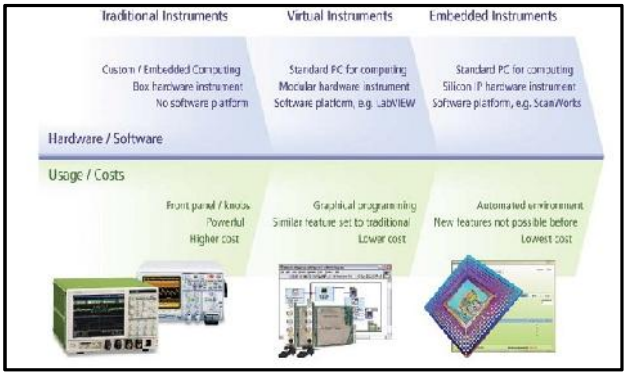

Figure 4 Essence of Test and Measurement

SoC Architectures

There have been developments in the architecture of wireless devices targeted towards low-cost innovative applications. A significant development in this direction is the integration of a microcontroller with the radio modem in a regular 64-pin out

single chip (called system-on-chip architecture). An example of such a device is MC13213from Free scale. Similar devices are available from Texas Instruments, Radio Pulse, and other vendors.

Power Consumption

Another key parameter that is used as a differentiator among the available products is ultra-low power consumption. Zigbee-based applications require battery life to extend up to more than two years. In this case, smart scheduling of transmission and reception will only help to a certain extent. The onus is on the device manufacturers to reduce the power consumption, particularly during the time interval in radio communication. The device should remain in sleep mode the rest of the time. The current consumption during a radio interface is typically 30–35 mA. In most of the "sense and transmit" applications, the sensing is scheduled so that the device is mostly sleeping (formore than 99% of the time) with current consumption of the order of 1–2 uA. Thus, the sleep mode's current consumption becomes critical for effective solutions.

Trusted Computing

There is a need to have more secured computing environment across multiple platforms, peripherals and devices, without compromising on functional integrity, privacy or individual rights. The Trusted Computing Group aims to establish a methodology and define open standards upon which a reliable and secure computing environment can be built. This has led to the introduction of the trusted platform module (TPM). The TPM is a stand-alone secure processor, which resides separately from the host CPU and handles the verification, storage and management of digital certificates. It controls the loading of all software from the boot level. Thus, when fully implemented (as it is in Window Vista), all software executables and data must be digitally signed and verified by the TPM prior to loading and further processing in the host CPU.

Authentication Techniques

Organizations are looking for more secure authentication methods for data access, physical access, and other security applications. The use of biometrics in identification management is drawing attention across markets, even as organizations and individuals demand more reliable, highly accurate and efficient methods of confirming aperson's identity.

CONCLUSION

Wired or wireless communication between embedded devices or a back-end server is increasing and is resulting in newer functional areas and business models. It is not surprising that out of the three billion embedded devices forecast to be shipped this year, two-thirds are going to be "connected". Plug and play kind of connectivity is the need of the day. Deployment of multi-core architectures, internationalization, efficient security algorithms and usage of open source platforms is poised to grow; hence, product managers, architects, engineering teams need to understand the implications of this growth.

The key factor for success in the PCB testing market is to provide ease-of-use with flexibility. Price-to-performance ratio is also another key factor, which lures manufacturers to purchase a particular type of test technology from a vendor. Embedded instrumentationis expected to have the potential advantages of effective and efficient testing of complex circuit boards, shorter test times, higher test coverage, increased diagnostic capabilities, and lower capital equipment cost. This will improve the price-to-performance ratio of many types of products like consumer electronics, avionics, computers, defense systems.

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