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On Digital Convergence and Challenges

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Abstract

In the center of the current digital revolution is the digital convergence phenomenon. The ability to convert various types of analog data to digital form has made it possible for such data as voice, music, photographic images and video to be stored in computers, processed using computers, transmitted via digital communications networks, and presented on both digital and analog devices. Digital convergence has already brought about, and will continue to bring about, sea changes in how people live, work, interact with others, and entertain themselves. In this article, I will provide a brief overview of the digital convergence phenomenon, and outline some of the challenges that need to be addressed.

1 INTRODUCTION

Today the mankind is witnessing the unfolding of the digital revolution. Consumer electronic devices are increasingly becoming indispensable parts of every-day life today in industrialized parts of the world. Cell phones, PDAs, MP3 players, digital cameras, DVDs, DVRs, digital televisions, etc. are already in wide use. DMB devices, digital phones, etc. are expected to be in widespread use in the foreseeable future. The digital revolution is being led by several industries, including semi-conductor, communications industry, entertainment, consumer electronics, and of course computer. The consumer electronics industry is delivering cell phones, home entertainment products, etc. The entertainment industry is delivering the contents, such as television programs, movies, music, etc. The communications industry is providing the communications infrastructures for delivering the contents, including the Web pages, both wirelessly and via the Internet. The semi-conductor industry is providing the microprocessors, memories, and flash memories that form the brains of the digital devices.

One of the key enabling technologies for the digital revolution is the analog-to-digital conversion and digital-to-analog conversion technology. The analog-to-digital conversion technology has made it possible to transform analog data to digital data. Once analog data takes digital form, truly breath-taking possibilities open up. The data may be stored in computer memories, computer hard disk drives, flash memories, and a variety of digital storage devices that contain such memory devices, including DVDs, DVRs, digital

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cameras, digital video cameras, etc. The data may be transmitted over the network, including the Internet. This makes possible music downloading, file sharing of multimedia data such as photographs and music, etc. The data may also be output on digital presentation devices, such as computer monitors of differing resolutions, digital televisions, MP3 players, printers, faxes, cell phones, etc. Of course, the data stored in computer memories may be tagged, organized, indexed, searched, edited, combined into composite data, compared in digital form against sample data, etc. The digital-to-analog conversion technology allows digital data to be presented on analog devices, such as conventional phones, televisions, printers, photo-processing machines, etc. Seemingly endless scenarios now open up for capturing, storing, processing, transmitting, and presenting a wide variety of data. For example, photographs may be taken using a digital camera. They may be transmitted wirelessly to a computer or stored on a flash memory card and the memory card may be used to move the photographs to the computer. The photographs now stored on the computer may be edited and uploaded to a personal homepage, and someone may download them and view them on a cell phone. The photographs may be sent to a photo-processing machine to create hardcopy prints.

2 CHALLENGES

Just as any revolution rooted in technology, the digital revolution poses two types of challenge: technological and societal. Societal challenges come in two types: One is the new problems that arise from the pervasive availability of digital devices. Examples are the increase in traffic accidents due to people using cell phones while driving, invasion of privacy due to the tracking of the physical locations of the users of cell phones, students conspiring to send exam questions and receive answers in instant messages using cell phones (as happened in South Korea in 2004), children downloading or receiving pornographic images on the cell phones, etc. This type of problem becomes an issue because of sudden mass proliferation of certain devices and the unforeseen and less-than honorable, mature, responsible, or self-constrained behavior of certain segments of the users.

Another type of problem is the challenges in identifying ways in which the advances in digital technologies can make life better for people and solve certain existing problems. This type of challenge will surely be addressed by the hundreds of thousands of creative people and organizations that will try to identify and develop applications and business models to disseminate solutions for profit. Solutions will include both technologies and contents.

Technological challenges touch on several areas, including user interface, software, hardware, communications, semi-conductor, and manufacturing. The challenges on the hardware, communications, semi-conductor, and manufacturing fronts are the usual – faster, smaller, cheaper, and more reliable. As these are not my areas of expertise, in the remainder of this article, I will outline only the challenges facing the vendors on the user interface and software fronts.

2.1 User Interface

In my view, the user interface for most digital devices today is very unsatisfactory, even disgraceful. For example, to do anything other than simply making a call or receiving a call on a cell phone, one has to push a sequence of buttons and/or keys on the keypad. The sequence itself and the keys do not indicate any logical connection with the function to be performed, such as changing international roaming, calendar management, phone directory management, storing and viewing digital photographs, etc. Even a relatively innocuous device such as a microwave oven poses user-interface challenges. The clock on it requires a full cycling when re-setting for Daylight Savings Time. It is confusing to set “Power” level, as on some models it is a single-digit number and on others a two-digit number. Electronic watches come with many functions, including multiple time-zone support, calendar options, various types of alarm, stop watch, calculator, etc. However, they have only four buttons and a key pad to operate all of the functions. Digital devices that come with a clock usually make the re-setting of the clock a major brain teaser: there is absolutely no clue as to how to re-set the clock, and as one comedian on TV cracked one night, “there are millions of VCRs in the US today that blink ’12:00’ on their clock.”

Operating most digital devices, except for a few simple every-day features, requires one to consult the user manuals, and often the user manuals are confusing, too. There are three sources of problems with the user interface on most digital devices. First is the disparity between the number of functions supported and the number of buttons and/or keys on the keypad on the device. There are more functions than the buttons and/or keys on a device, necessitating the use of a combination of the buttons and/or keys. Second is the difficulty in making each of the buttons and keys, and each combination of the buttons and/or keys, correspond to each of the functions in a way that is logical and natural to ordinary users. Third is the different approaches to user interface that vendors have adopted. Each vendor of a digital device has made some, albeit very unsatisfactory, efforts to make the correspondence logical and natural between the functions and the buttons and keys, and combinations of the buttons and keys. However, different vendors of a device of the same type (e.g., cell phones) have adopted different approaches in designing the user interface for their devices. Further, vendors of a device of one type (e.g. cell phones) have adopted different approaches from vendors of a device of different types (e.g., MP3 player).

The ultimate goals of the user interface for digital devices should be, in my view, one that will, at least with respect to certain core principles, apply across different types of devices, and also one that will obviate the need for the user manual (or if there must be a user manual, the user manual should be one that will not require a second reading). Such a user interface would be so logical and natural to most ordinary users that they should be able to operate any digital device based on a small number of simple and common core user-interface principles, and they should be able to operate the device by using a small number of buttons and/keys, and logical and natural combinations of buttons and/or keys without having to consult the user manuals.

2.2 Software

Japanese cell-phone makers estimate that the cost of developing a cell phone today is split 80 to 20 between software and hardware, while the split was 20 to 80 in 1998. Large US software makers now estimate that high-end embedded software will consist of up to 9 million lines of code in the near future. All digital devices are embedded systems. Some consist of hardware and firmware only, while others consist of hardware, firmware, and software burned into flash memory. High-end embedded systems, such as high-end cell phones and digital television, have large-scale complex software. As vendors of such devices are being pushed, by competitive force and their own drive to increase profits, to add more features and improve on current features, the devices are increasingly becoming software-oriented. The current competitive landscape requires vendors to churn out many models of the devices in ever-compressed production cycles. The current production cycle for many consumer-electronics devices is six months; and sometimes it is even 3-months.

The rapid increase in the size and complexity of software in digital devices requires a corresponding increase in trained software workforce – developers and testers alike. Currently, Japanese consumer electronics vendors are being forced to outsource parts of their software development and testing projects to India and China, not necessarily to benefit from the presumed lower cost there, but largely because they simply do not have adequate software workforce. In the end, the lack of trained software workforce may prove to be one key factor limiting the pace of progress in digital convergence. Availability of high-quality and adequate-strength software workforce should certainly be a key competitive factor in the market.

As the software runs on embedded hardware, testing and debugging it requires tools that run on the same hardware. Tools are not available for certain hardware and operating systems. As such, the challenge is to develop and port tools that work on a variety of embedded hardware and operating systems.

Today's software embedded in high-end digital devices may need to be restructured so that it will run on parallel or distributed computer architecture. Although microprocessors, memories, and interconnects in embedded systems will surely improve in performance and capacity for the foreseeable future, simultaneously means should be found in software to improve performance of embedded systems. Just as has been the case with conventional software, parallelism and distribution of workload by making effective use of parallel and distributed computer architecture should be obvious potential opportunities.

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