System on Chip (SoC): A Comprehensive Review of Modern Mobile Computing Technology

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Abstract - A system on a chip is an integrated circuit which has all the components of an electronic system integrated on a single chip. It is a completely new technology that is being implemented and used in embedded systems, low powered devices such as mobile phones, tablets etc. Although similar to a microcontroller, it integrates even more powerful processors and memory which make them capable of running operating systems such as Linux, Windows etc. The introduction of this technology has ushered a new era of mobile computing. This paper gives an overview of the technology including the SoC Structure, its applications and its comparison with x86 processors.

Keywords - SoC, Microcontroller, x86 Microprocessors, Mobile Computing.

I. INTRODUCTION

System-on-a-chip (SoC) technology is the packaging of all the necessary electronic circuits and parts for a "system" (such as a cell phone or digital camera) on a single integrated circuit (IC), generally known as a microchip [1, 2]. The SoC chip includes processors and numerous digital peripherals, and comes in a ball grid package with lower and upper connections. The lower balls connect to the board and various peripherals, with the upper balls in a ring holding the memory buses used to access NAND flash and DDR2 RAM. Memory packages could come from multiple vendors [6].

II. STRUCTURE OF SOC

Typical SoC consists of the following :

- A microcrontoller or a microprocessor.
- Memory blocks including RAM , ROM.
- Timing sources such as ocsillators and PLLs.
- External Interfaces such as USB , USART ,Ethernet.
- Analog interfaces such as ADC , DAC etc.
- Voltage regulating circuits.

These blocks are connected using buses. These components are also comatible with DMA controllers, ie. the data transfer can be entirely processor independent saving a whole lot of processor resources. Fig. 1 shows the structure of a typical micrfocontroller based SoC.

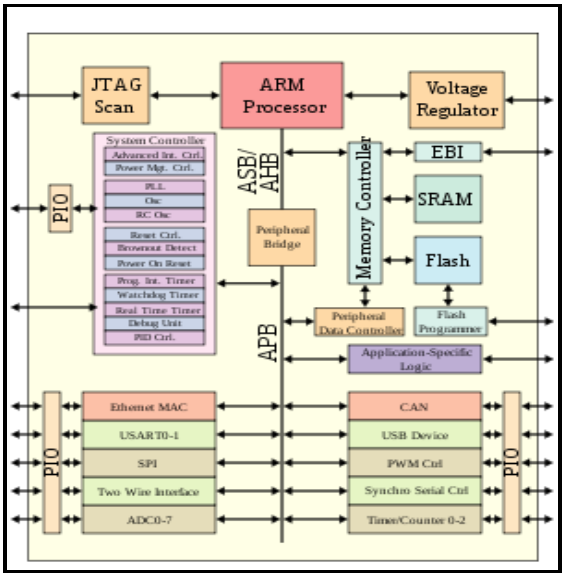

Fig. 1: Structure of a typical microcontroller based SoC.

III. ADAVNATAGES OF SOC [2]

- Small Size
- Low cost.
- High performance.
- Can even perform dual boot.
- No fans / Heat sinks required.
- Universal for all operating systems.
- Low Power requirement for operation.

IV. DISADVANTAGES OF SOC

While SoC offers many benefits, there are some disadvantages though. These include:-

- Difficult to integrate large components on a small chip.
- Whole chip needs to be replaced even if a single component gets damaged.
- Upgrade or addition of new features/components is nearly impossible.
- Significantly lower performance than the x86 or x86_64 CISC processors in tasks like compiling, debugging etc.
- The chip is prone to bottlenecks and bugs. So it needs to be debugged by using software such as SystemC.

V. Applications of SoC

Typically scenarios for use are:

- Tablets
- Smartphones
- Music Devices.
- Netbooks / Low cost PCs.
- Miniature Electronic devices.

Companies like Apple Inc., NVidia Corp., and Samsung Electronics etc. design SoCs for use in the devices. Fig. 2 shows the Apple A6 SoC being used in an iPad3 Prototype.

Fig.2: Apple A6 SoC

Likewise, NVidia is also not behind [4]. Fig. 3 shows an NVidia tegra 3 SoC.

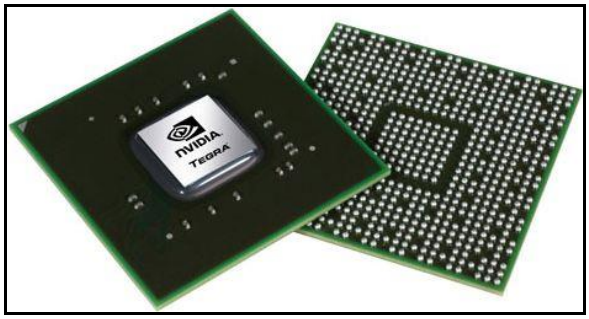

Fig. 3: NVidia Tegra 3 SoC

VI. COMPARISON OF SOC AND X86 PROCESSOR

A brief comparison between an ARM CPU and a low power Intel Atom x86 based CPU is shown. The SoC enjoys better performance in the coremark benchmark. Fig. 4 shows a graph of coremark benchmark comparison between the two [3]. The SoC also wins in the area of power consumption. Fig. 5 shows a graph of power consumption between the two.

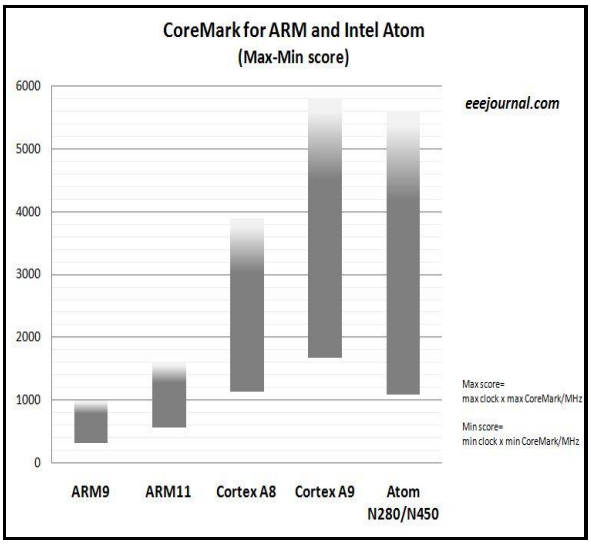

Fig. 4: Comparison of ARM and Intel atom on the coremark benchmark.

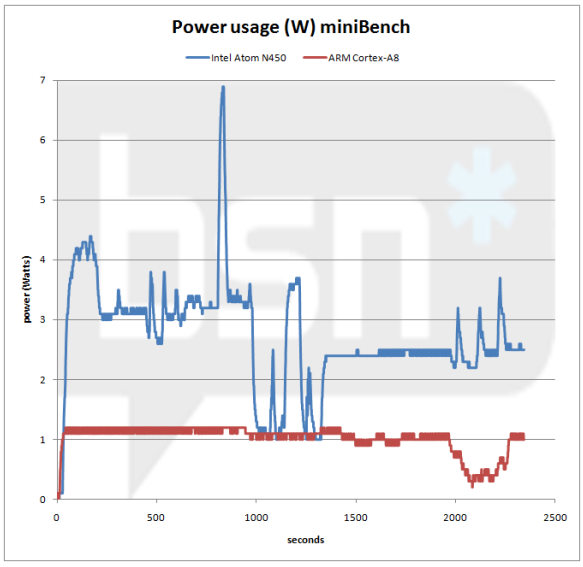

Fig. 5: Graph of power consumption comparison between ARM and Intel atom.

VII. CONCLUSION

System on a Chip is an excellent technology for the low powered / portable electronic devices. It's being widely adapted and used in Smartphones, Tablets, and Portable Music Players etc. Many electronic giants such as Apple Inc., Samsung Electronics, Qualcomm, NVidia, Intel Corporation are actively designing SoCs and researching on their improvements. The latest SoCs now include Dual-Core and even Quad-Core CPUs and faster Graphics to make the end-user's experience even better. This paper gives an overview of

the technology including the SoC Structure, its applications and its comparison with x86 processors.

VII. REFERENCES

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