The End of Personal Computer

Siddartha Reddy N

Computer Science Department
San Jose State University
San Jose, CA 95112
408-668-5452
siddartha.nagireddy@gmail.com

ABSTRACT

Today, the dominance of the PC as our primary computing device is on a decline, the fall in sales of PC year after year indicates the same. The emergence of mobile devices such as tablet's and cell phones has been the primary cause for such a rapid decline in the role of PC as our primary computing device. The success of these new models, such as the Google Nexus or the Apple iPad is leading many to believe that the end of PC has arrived. Advances in semiconductor process technology especially in the areas of power consumption and power/performance trade-offs has played a major role in the success of such models. But is the PC really dead? Or are advances in technology simply allowing the PC to morph into something new. This paper will concentrate of the factors affecting the decline of PC and the advancements in technologies which lead to the emergence of high performing mobile devices.

1. INTRODUCTION

When we look back at the past fifteen years, we see that the personal computing industry has changed and grown a lot. Some of the major changes are the advent of cheaper desktops, the internet revolution & the laptops, there has been constant shifts and changes in this industry. However even in this continuously changing industry we see some constants, Microsoft has dominated the operating system with their flagship Windows product whereas Linux and Apple never really been a dominance in this area. There are various key trends which are now looking to shake up this personal computing industry, netbooks have marked drastic transformation in consumer preferences from processor-intensive and memory heavy mindsets of incumbent computer manufacturers; the virtual cloud is growing in strength and viability, providing rich services for all to use; emerging user interfaces are creating new experiences for consumers across platforms; and the speed of convergence between mobile phones and computers continue to increase.

The cloud is putting more of an emphasis on services rather than local applications. There is a drop in selling price of OEM's and operating system producers due to the rise of netbooks. And we see a huge growth in the smartphone market despite the recession which shows the value users see in these devices[1].

The below graphs depict the fall of PC simultaneously comparing it with the other mobile devices which have seen tremendous growth. The first graph talks about the number of shipments and second one about the % of PC as computing device.
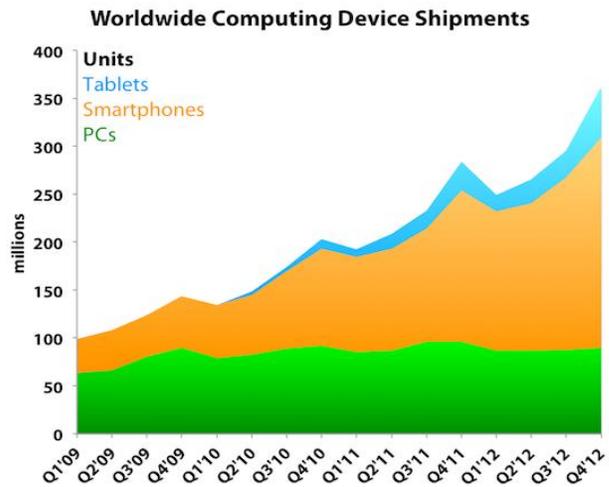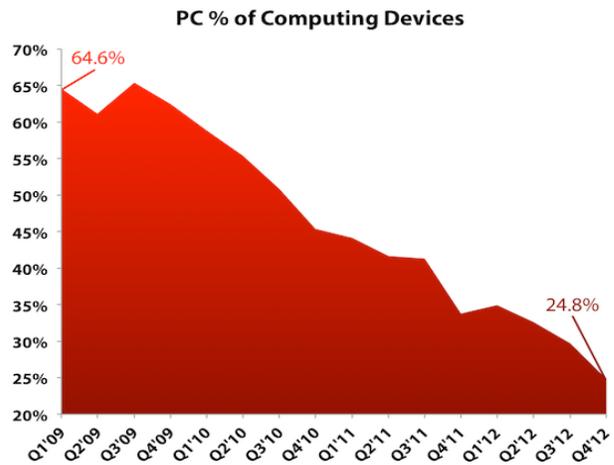

Figure 1: Worldwide shipments of devices [7]

Figure 2: PC as computing device[7]

2. TRENDS

Here we analyze the factors which have led to the decline of Personal Computing Industry, factors such as the rise of netbooks, emergence of smartphones, availability of wireless networks and experimentation with alternative user interfaces.

2.1 NETBOOKS & TABLETS

The introduction of netbooks in 2007-08 took the personal computing world by storm which then went on to become the fastest growing business segment for some time. People have opted for these devices and this shows that people are interested in owning a device that is sufficient enough to browse the web and run basic applications[1]. This caused the industry to worry about the impact these netbooks will have on the sales of laptops, but subsequently netbook sales where choked by tablets which is a different story altogether. This means that consumers are interested in lightweight, portable devices that are connected to the web. Furthermore, it indicates that people are spending a lot of their time on PC to browse the web and by which it means they do not need faster and stronger computers.

During the late 2010's Apple's iPad came out and revolutionized the mobile industry. It fit perfectly for people who are looking for lightweight devices to browse web and run basic applications which are not too processor hungry. The sales skyrocketed and subsequently created an impact over the laptop sales. The below graph depicts the impact suffered by PC's due to advent of tablets. After the emergence of tablets especially from the year 2010 – 11 we see a dip in the sales of PC's worldwide which faces a tough competition from the rising sales of tablets eventually surpassing PC in the year 2015.
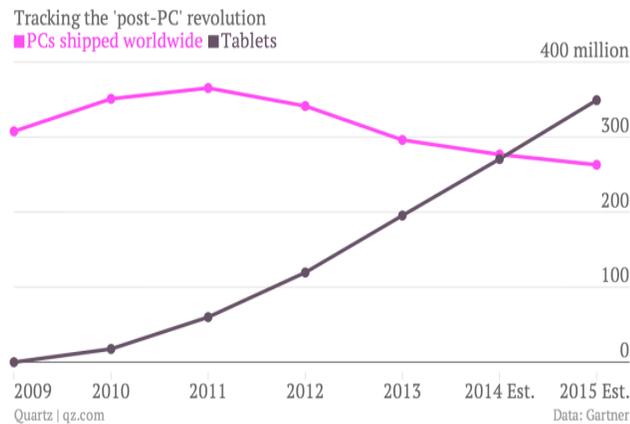

Figure 3 Tablets Vs PC Shipment estimates

Now consider an industry where computers are getting faster and requirement of some people is a lightweight, portable product. This is where the netbooks, tablets have a role to play and subsequently this led to users shifting to these devices which led to the fall in sales of PC's.

2.2 EMERGENCE OF SMARTPHONES

Initially it may not be clear as in how smartphones can affect the Personal Computing industry but as they grow stronger and stronger there will be a huge impact on this industry. Let's look back twenty years ago, telephones made calls and that was all that they did. Ten years ago cell phones allowed people to leave their home and still make calls. Soon after, text messaging was introduced. Then photos, internet, games and video all made their way onto these modern phones. Nowadays, a smartphone performs many of the same functions of a computer, and in some ways performs better. For example, why use a computer to look at a map

and find out route to a destination, why use computer to check emails and reply to them. These tasks can be easily and effectively handled by smartphones. Indeed smartphones are absolutely a small computer in your pocket, and that could mean big changes for the PC industry. If one can think about these smartphones as miniature computers then it's not hard to predict that in coming 5 or 10 years these smartphones will be powerful enough to become our main computing devices.

PROCESSORS IN SMARTPHONES

For these smartphones to reach that level of computing power chips used must be more powerful and more energy efficient. The evolution of CPU processors in smartphones will play a major role in their future as the main computing device. Already with the advent of multi core processors such as dual, quad and octa -core processors which are currently being used by current smartphones. One main distinction between smartphones and computers is that the computers can perform multiple tasks much more easily when compared to a smartphone. Mobile devices perform various tasks such as browsing, video playback, messaging, location based services, gaming etc. They are also used for various performance intensive tasks that were previously handled by traditional PC's. The below diagram depicts the DSP architecture for mobile phones which was one of the earliest architectures used in a mobile phone[2].
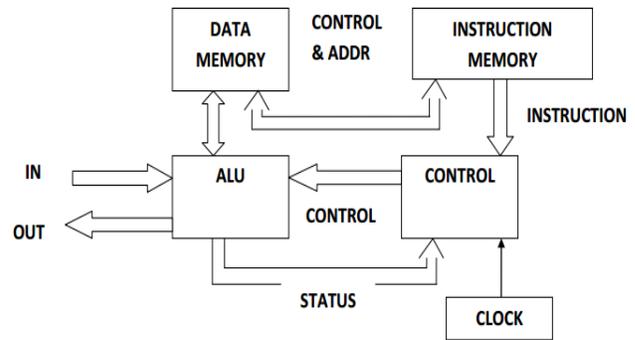

Figure 1: Traditional DSP Architecture (Harvard Architecture)

Figure 4 Traditional DSP Architecture

Programmable DSP's provide a cost effective and flexible architecture for mobile phones. AT&T first introduced DSP in 1979 and subsequently Texas Instruments came up with various other DSP's[5]. The below table depicts the evolution of DSP's over the years.

Parameter	1980	1990	2000	2010
Die Size (mm)	50	50	50	5
Technology (micrometers)	3	0.8	0.1	0.02
MIPS	5	40	5000	50000
MHz	20	80	1000	10000
RAM (bytes)	256	2000	32000	1000000
Price (dollars)	150	15	5	0.15
Power (mW/MIPS)	250	12.5	0.1	0.001
Transistors	50000	500000	5 million	50 million
Wafer Size (inches)	3	6	12	12

Figure 5 Table depicting DSP evolution over years

ARM PROCESSORS FOR MOBILE

However in modern smartphones ARM based processors are most widely used. ARM is a 32 bit instruction set based on RISC architecture. They are particularly used in smartphones due to its low power consumption but great performance mantra. The low end phones use ARM v5 whereas high end mobile devices use ARMv6 and ARMv7, ARMv7 consists of hardware floating point unit which yields improved speed[3]. ARM architecture is the main hardware architecture for most of the mobile operating systems like Android, Windows, Blackberry and Apple.

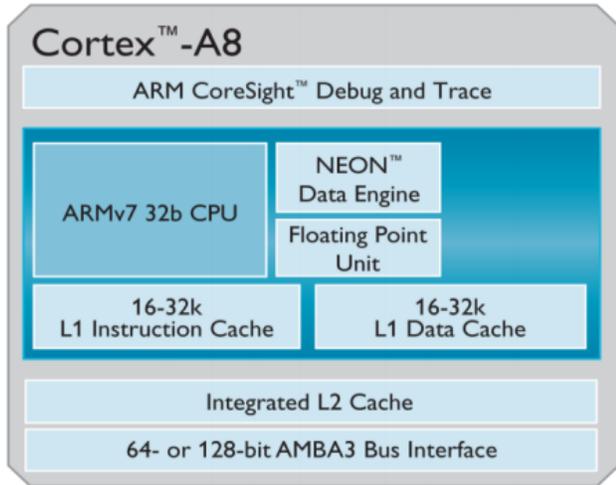The below picture depicts the ARM Cortex-A8 Architecture.

Figure 6 ARM Cortext-A8 Architecture

Until 2011 it was considered that a single core ARM Cortex – A8 processor clocked at 1.4GHz speed was sufficient, this year ARM processors have clocked at 3GHz speed. These upcoming processors are expected to up the clock speeds by 30% and reduce the power consumption by 25%[4].

Also mobile computing is getting ready for a drastic change this year with the advent of new 64-bit ARM based processors which are expected to provide up to 50% performance improvement when compared with 32-bit processors. Android 5.0 will utilize this new 64-bit architecture to effectively handle tasks.

QUALCOMM SNAPDRAGON PROCESSORS

Snapdragon is based on SoC processor architecture provided by Qualcomm. They are built around Krait processor architecture as shown in the figure below. It includes LTE modem, Adreno GPU for graphics and with the Hexagon DSP's this architecture provides low power consumption for a variety of multimedia applications like enhanced audio/video.
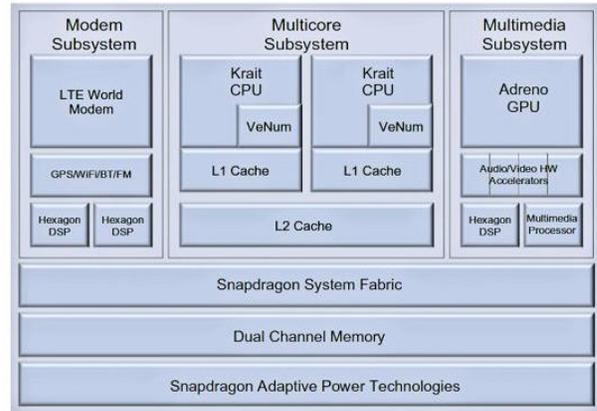

Figure 7 Qualcomm Snapdragon Architecture

In 2013, Qualcomm Snapdragon 800 processor clocked at 2.3GHz clock speed outperformed all other processors. The below diagram is of a Qualcomm Snapdragon 800 processor with Adreno 330 GPU and Hexagon DSP.
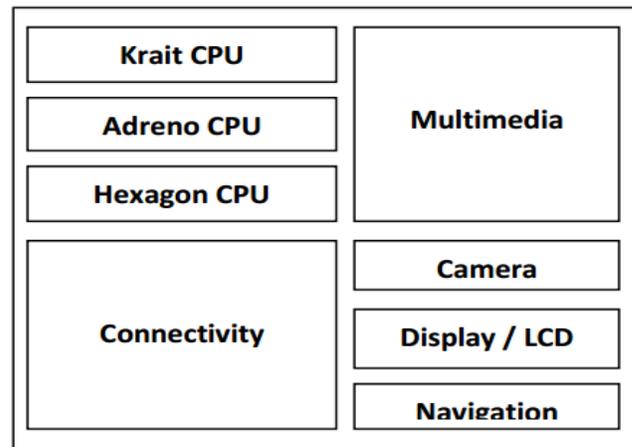

Figure 8 Qualcomm Snapdragon 800

Snapdragon 800 processors are designed to facilitate fast apps, browsing, stunning graphics while gaming, seamless connectivity and outstanding battery life.

NVIDIA TEGRA PROCESSORS

Tegra is a SoC series for mobile devices developed by Nvidia. It integrates ARM Architecture CPU, graphics processing unit, memory controllers etc. on a single package. Nvidia Tegra 4 processor is a quad core Soc with increased GPU cores, faster clock cycles and improved efficiency. The below picture depicts the Nvidia Tegra 4 processor.
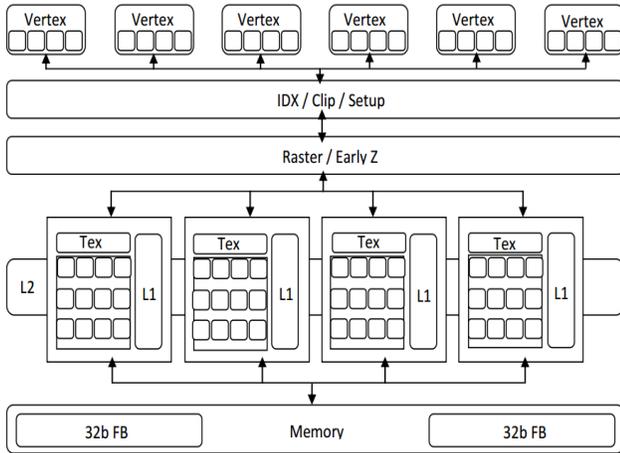
Figure 9: NVIDIA Tegra Architecture

All the modern processors are basically ARM-based, with newer versions of mobile CPU's we will have more powerful smartphone with new GPU cores, memory interfaces and many more advanced features.

The development of mobile processors is driven by factors such as low-power consumption, performance and time to market, the next generation processors must be designed considering new approaches. The evolution in these processors will facilitate higher multitasking and eventually place smartphones as our main computing device in the near future.

2.3 AVAILABILTY OF WIRELESS NETWORKS

Since the early 2000's the internet has become an essential part of our lives. As the importance of intern grew it became more important for wireless connectivity. Wireless connections to internet drive productivity and efficiency since you can access internet from anywhere. With the coverage of this wireless connectivity growing more and more services and storage will shift to cloud. From the below graph we can already see that Tablets & Smartphones overtake PC as the devices used to connect to internet.
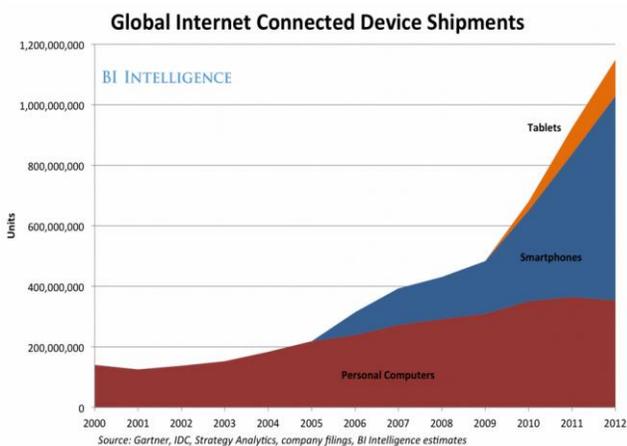

Figure 10: Gartner analysis on device shipments[8]

This shift will drive the lack of demand for high end machines and the high consumer demand for portability. As the cloud grows in importance, the need for stronger computer diminishes. The computer will now only be a client used mainly to access storage and services on the web.

2.4 DEMOGRAPHIC OVERVIEW

Looking at the current demographics will give a good idea of what people will use in the future. One of the statistical analysis done from a Pew Research study of tablet user demographics is given below:

16% of very young people use tablets (15-20)

18% of young people use tablets (20-29)

25% of adults use tablets (30 -55)

This is somewhat odd than what we would have expected, we see that older people use tablets more while compared to younger people. It is assumed that younger people would have been more since they are the earliest adopters of technology trends.

The reason for this is that older adults who grew up with traditional computers have developed habits that a tablet naturally extends such as browsing the internet, checking emails. These people buy tablets as a secondary replacement for laptops for same kinds of tasks with similar context.

Whereas younger people are more adopted to their mobile devices because that's what they are grown up using. Older adults use tablets mostly and younger people use smartphones.

55% Teens use phones to connect to internet (14 – 22)

15% adults use phones to connect to internet (23 – 55)

Smartphones are favorite for teens and hence they use it to connect to internet. Since young people have grown up on smartphones it has fundamentally changed the way they use and think about internet. Tablets are not that particular for them, whereas the adults who grew up on computers have a degraded experience with smart phones. Hence they are little more generous towards using tablets to connect to internet. This behavior will continue and as the young people grow up it will be even more striking.

2.5 ADVANCEMENTS IN UI DESIGN

Ever since the introduction of the graphic user interface (GUI) for the computer operating systems have used it extensively with slight modifications and updates but fundamentally sticking to interface of icons and textual input. Recently we have seen new interfaces such as touch, voice recognition, hand gestures, eye tracking etc. which have made it into the mainstream market.

With the introduction of iPhone the mobile industry quickly migrated towards the touch based usage of phones from a keyboard based usage. This has also surged into the PC market with laptops being implemented with touch based sensitivity and removable keyboards etc.

As there various interfaces mature, it is likely that different devices will adopt which ever interface best fits.

3. CONCLUSION

In conclusion we can say that the personal computing industry will continue towards rapid change. This industry has become largely commoditized, I believe consumers will be on the winning side here with lower priced and better products on the pipeline. Many of the developers / manufacturers will be forced to change the way they currently do the business, while some look to diversify some will consolidate.

The next five or ten years should be an exciting period for smartphone market as the processors become more and more powerful and energy efficient. Slowly but steadily the common man will find all his needs addressed by a smartphone or tablet and will eventually rarely use a personal computer.

4. REFERENCES

[1] Sujoy Banerjee : The Future of Personal Computing

[2] Dr. Margarita Esponda: "Trends in Hardware Architecture for Mobile Devices".

[3] "ARM Processor architecture", SOC Consortium

[4] Leonid Ryzhyk: "The ARM Architecture"

[5] Andrew Fallows and Patrick Ganson: "Smartphone Hardware Architecture"

[6] Teens, Social Media, and Privacy by Pew Research Internet Project

[7] Evan Niu, CFA : Simple chart that proves PC is dead

[8] Gartner IDC Strategic analysis Global internet connected devices

[9] Mainak Chaudhuri: Smartphone Hardware : Anatomy of a handset

[10] Kiezer Gregg. "Windows marked shares dive below 90% for the first time." Computer World. December 1, 2008

[11] Oreskovic. Alexei. "Google, Microsoft, Palm rev up smartphone race" Forbes.