XV International Conference on Recent Trends in Engineering Science and Management
Osmania University Centre for International Program, Hyderabad (India) (ICRTESM-18)
20th October 2018 www.conferenceworld.in ISBN:978-93-87793-51-4

New Detailed Study of Mac Book Pro 2018 Computer Systems Architecture

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ABSTRACT

The paper is investigated the three technologies behind the success of the mobile computers that is supporting to human being in today life. This paper also investigated the technologies behind the success of the mobile computers. Besides that, this paper had discussed about how the mobile computers benefit to people and how the operating system plays an importance role in any mobile computers. On the other hands, this paper have shown the information about the cpu specification and block diagram of the chosen mobile computer which is the latest laptop MacBook Pro 2018 of Apple Company.The future of mobile computing also discussed at the end of this paper.

Keywords: MacBook Pro 2018, Block Diagram, CPU Specification, Instruction Sets, Registers

1. INTRODUCTION

The first part of this paper was researching about the three most common technologies behind the success of mobile computing which includes wireless technology, cloud computing technology, and eventually portable technology. Wireless technology provides the user to manipulate the devices without restricted to one location, cloud computing technology allows the user to store the document to online server, and the portable technology allows the user to hand-carry the devices to anywhere. Moreover, it has discussed about the classification of the mobile computers which are PDA, Smartphones, tablet PCs and iPads. These mobile devices bring to the user many benefits which include increasing in productivity for the users, entertaining with the clients, portability that more conveniences to the users, allowing the users to store the document to online and to eliminate the paperwork, and eventually improving the social skill to enhance the relationships with the clients. Operating system is the significant software as it makes the users more conveniences while performing any tasks. Therefore, the operating systems plays a main role in any mobile devices, which means the mobile devices should operate the devices with the operating system. The second part of this paper was investigating about the latest MacBook Pro laptop by Apple Company. It was discussing the several components of the chosen mobile computers which include the CPU specification and the block diagram of the architecture, memory management, instruction sets and registers, problems in installing OS or upgrading, I/O specification, and presents the growth of five mobile computer in graphical form. The last part of this paper was to conclude the entire report and provide the future mobile computing regarding to the chosen mobile computers. At the same

time, the poster was provided the functionality of the chosen mobile computer was to promote the consumers, it can make an attractive to the users more interests to the chosen mobile computer.

2. TECHNOLOGIES BEHIND THE SUCCESS OF MOBILE COMPUTER

Mobile computer is an interaction between users and computers that can be used to motivate during normal usage [1], the following factors have been identified as the principle of mobile computer which includes portability, connectivity, interactivity, and eventually individually [2].

2.1 WIRELESS

Wireless has become the largest carries of digital data all over the world. This technology made the operations of many industries smoother and faster. The ability of wireless is to operate the devices with a thousand of kilometres away, shown in "Fig.1". By using wireless technologies to perform the tasks, this technology is considered as the faster, smarter, and more efficient ways. This new network technology improves the speed of many devices and boosting the ever-expanding IoT [3].

Figure.1 Wireless [4]

2.2 CLOUD COMPUTING

Cloud computing becomes a main technology nowadays, because this service provides the users with accessing to IT resources at a lower price. This benefit related to the cost reduction, it can remove the IT infrastructure along with its direct and indirect costs in the organization. Moreover, it allows users to access from any computers that is connected to the internet, have shown in "Fig.2". Therefore, users can store the document to the internet, and download from its drive [5].

Figure.2 Cloud Computing [6]

2.3 PORTABLE TECHNOLOGIES

Portable technologies have changed the generation as it helps people nowadays to more conveniences. It helps the users to solve the current tasks from any multiple portable devices have shown in "Fig.3", and it also helps the users to get the job done from anywhere, at any time. By having portable technology, it makes the users be more productive and generates more sales for any businesses. The user can easily finish the tasks when the portable devices is along with the user [7].

Figure.3 Portable Technology [8]

3. BENEFITS OF MOBILE COMPUTERS

There are many individuals and organizations fully depending on technologies nowadays, because the technologies bring many benefits to them. Therefore, there are several benefits of mobile computers listed below, such as increase in productivity, entertainment, portability, cloud computing and eliminate paperwork, and improved social relationship. The benefits of mobile computers help the users to perform the task more effectively [9].

3.1 INCREASE IN PRODUCTIVITY

The main benefits that users are seeking for as it helps users to increase their work performance in shortly time such as mobile computers help users to reduce their time and cost while managing a task or a project, have shown in "Fig.4". Therefore, users can easily perform a task effectively [10].

Figure.4 Increase in Productivity [11]

3.2 ENTERTAINMENT

Entertainment is a need for every individuals and employees especially when everyone having a mobile computer device, have shown in "Fig.5". Nowadays, e-devices contains many of applications, online videos and games may entertain the users [10]. For example, user nowadays can easily read the latest news and information over the internet [12]. On the other hands, employees can present the work progression to the employers or clients [10].

Figure.5 Entertainment [13]

3.3 PORTABILITY

By having a mobile computer device, it helps the user to complete the jobs without restrictions on the location, the user can hand-carry the mobile computer to everywhere and get the jobs done at anywhere, have shown in "Fig.6". Therefore, users can receive the project or task at any time and complete during the time frame given easily as long the users have the mobile computer devices with them [12].

Figure.6 Portability [14]

3.4 CLOUD COMPUTING AND ELIMINATE PAPERWORK

The services allow user to store the documents at online server and let the user access the file at anytime and anywhere when user has a connection to the internet [10]. Mobile computing devices allows user to eliminate paperwork as the user can collect, store and transfer the data electronically [15], have shown in "Fig.7".

Figure.7 Eliminating Paperwork [16]

3.5 IMPROVED SOCIAL RELATIONSHIP

Mobile computer devices provide more flexible to access the information that helps the employees to resolve the customer's needs directly. This approach makes the customers feel more satisfied and comfortable about the services, plus it strengthens customer's loyalty toward the organizations. Quick services and convenience always help to improve customer relations [15], have shown in "Fig.8".

Figure.8 Improving Social Skill [17]

4. IMPORTANCE OF OPERATING SYSTEM IN MOBILE COMPUTERS

Operating system is a program that helps the computer's hardware components to communicate with the computer's software components [18]. The operating systems can be defined as differ between hardware components and software components of a computer, this feature provides multiple-tasking so that various applications can share the resources on a single device [19]. OS is the crucial components, which any mobile

computer devices cannot operate without it. An OS performs a wide diversity of useful functions in a system, to interact between users [20].OS is the interfaces between users and computer systems [21]. OS manages all the software and hardware in the computer. It contains not only the language for hardware drivers, it provides the user graphical user interface (GUI) to control the computer. OS works as a translator to help the users to translate user query into machine language and convert the readable form for the users after processing by OS [22].Previously, users were asked to type the commands to start the tasks. However, operating system nowadays is needed when instructions and commands are given by the users to the computers. Hence, users can easily provide commands and instructions procedure through operating system. Such as, user can use an input device such as keyboard, mouse, etc. to provide virtual and programming-based instructions to the computer. In this case, operating system plays an important role in graphical user interface (GUI) as selectable interface and interactive graphics and icons that all display on the screen which are managed by the operating system [18].

5. CPU SPECIFICATION AND BLOCK DIAGRAM OF ARCHITECTURE

Notebook has been elevated to a whole new level of performance and portability by MacBook Pro, have shown in "Fig.9". The high-performance processors and memory, advanced graphics, blazing-fast storage and more, leading the users wherever the user wants [23]. The block diagram have shown in "Fig.10".

Figure.9Exterior of MacBook pro [24]

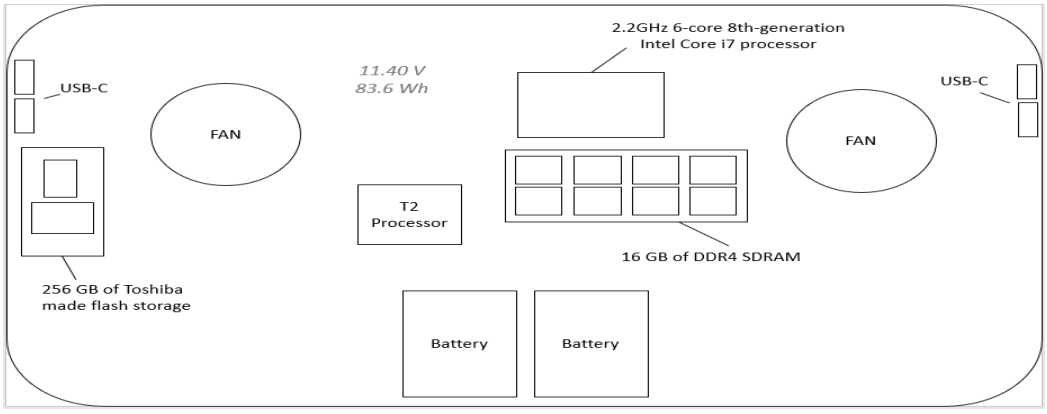

Figure.10 Block diagram of MacBook Pro [25]

5.1 MEMORY MANAGEMENT

Memory management function is the process that is used to optimize overall system performance by controlling and coordinating computer memory effectively. Memory management locates in hardware, operating system, and in programs and applications. In hardware, memory management connects components that physically cache data, for instance random access memory (RAM), memory caches and flash-based solid-state drives (SSD). Besides that, memory management always tracks and updates the status of every memory location and process in the operating system. Furthermore, at the application level, memory management coordinates and ensures that main memory always has enough space for the objects and data structures run each program. So, memory management is a resource management that provide ways to dynamically allocate portions of memory to program at their request [26].

5.2 VIRTUAL MEMORY

Meanwhile, the classic Mac operating system comes with a limited amount of physical memory installed by default which is virtual memory. Instead of the real memory on the system, virtual memory can be extended more capacity on the main memory of Mac OS. It is because the Mac OS X often isn't enough physical memory to run all the applications that you have opened. So, when all the memory is used up, the computer will start to use virtual memory automatically to run the programs. Apart from that, while the hard disk is processing, the virtual memory will run slower than the normal RAM due to the speed performance of memory chips and hard disk [27].Finally, secure virtual memory is used by Mac OS to secure your information safe. It can also transfer your data temporarily from random-access memory (RAM) to the hard disk if the storage amount of RAM is limited. If an unencrypted data is written to the hard disk as a virtual memory, it could be detected if the hard disk is scanned. In Mac OS, secure virtual memory reduces this risk by encrypting the data in virtual memory. Hence, data is always secured while the secure virtual memory is on [28].

5.3 INSTRUCTION SET AND REGISTERS

In 1965, Dr Stuart Madnick is the creator of Little Man Computer (LMC) and it also known as Von Neumann Architecture [29]. It is a device that simulates numbers of the basic functions of a modern computer. Meanwhile, it includes a central processing unit which consists an arithmetic logic unit and registers. In addition, it is also composed of a control unit that contains an instruction register and program counter, input and output components, and to store both data and information in memory [30].In year July 2018, Apple released their latest MacBook Pro which uses Intel X86 CPU Intel i9-6 core processor, codename Coffee Lake [31]. With this Intel Core i9 processor, the MacBook Pro can run up to 2.9 GHz and boost up to 4.8 GHz. Meanwhile, the latest MacBook Pro have 32GB of DDR4 Memory, 4TB of SSD storage space and running a Radeon Pro graphic card which also contains 4GB of VRAM. In addition, MacBook Pro able to provide up to 10 hours of battery life as DDR4 needs larger battery power to function [32]. Besides that, MacBook Pro utilise the Apple's True Tone to display a stunning retina display on the screen that will changes colour temperature according to the user's environment [33].Fortunately, Intel x86 CPU is a Complex Instruction Set Computer

(CISC) as it emphasis on hardware and has multi-clock complex instructions. Besides that, it also contains transistors that used for storing complex instructions, etc [34].On the other hand, there is another processor in MacBook Pro which is T series which is a Reduced Instruction Set Computer (RISC) and created by Apple Company its own. T series divided into two types which is T1 and T2. T1 processor was created for MacBook Pro since year October 2016 [35] and follow by T2 processor which launched in December 2017 [36].In 2016, MacBook Pro started to use T1 processor. This processor brings a huge change to the MacBook Pro which it provides the security for the Touch ID sensor and secures the camera, the keychain which stores the user passwords and the Touch Bar [37]. The Touch Bar also contains some important controller and a Touch ID fingerprint sensor that allows user to "one-touch login" and do Apple Pay confirmation, etc [38]. Just then, it continues to upgrade the T1 processor, have shown in "Fig.11" to T2 processor, have shown in "Fig.12"which bring more convenient to the users. In T2 processor, it increases some new controllers such as System Management Controller, Image Signal Processor, Audio Controller and SSD Controller [36]. It also improved the FaceTime HD camera [36], also able for "Hey, Siri" function to provide convenient to the users so that users do not need to use shortcut keyboard as assistant and upgraded the keyboard to make typing quieter [33].

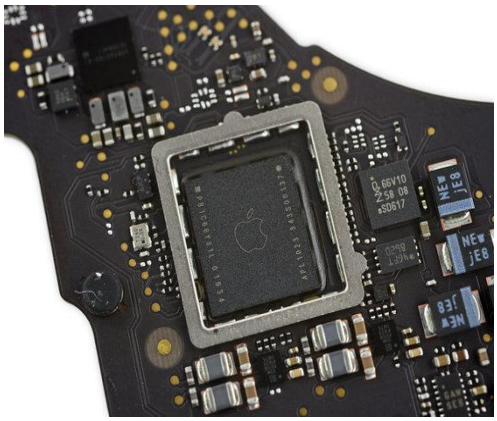

Figure.11 Apple T1 Processor [39]

Figure.12 Apple T2 Processor [40]

5.4 INPUT SPECIFICATION

5.4.1 MICROPHONES

Any digital phones have at least one microphone for many operations, that is used for transmitting, capturing and taking the voice as an input in dictation, over a digital network to the other phones [41]. The MacBook Pro built-in microphones are designed under the speaker grill on the left side of the keyboard. That is used to create an adaptive audio beam that intelligently detects the voice of surroundings [42].

5.4.2 KEYBOARD AND TRACKPAD

One of the input devices that is used for entering the characters and the functions into the computer systems by pressing the keyboard [43]. The MacBook Pro keyboard adapts a butterfly mechanism, providing four times key stability compared to a traditional scissor mechanism, along with a greater comfort. The models with Touch Bar now feature a keyboard with a quietly typing experience. Besides that, the wide Force Touch trackpad gives the user's fingers adequately spacing for gesturing and clicking [24].

5.4.3 TOUCH ID

Touch ID is the Apple's fingerprint identity sensor that is used for biometric security [44]. Advanced security to unlock the MacBook Pro in an assistant. A quick way to access system settings and locked the notes. And even switching between the users, all with the touch of an identified finger. The features allow the users to unlock the Mac notebook, to buy with Apple Pay, and eventually to use for authentication [24].

5.4.4 TOUCH BAR

There is a small strip that located at the top of the screen that features a light-up panel with several options, it is based on what user is doing on the MacBook Pro [44]. The function keys have been replaced by Touch Bar. It changes to become that can be customized the tools by the users, that are intuitive to use. Moreover, that is allowed the user to tap, hold, flick, and slide. The familiar gestures make the user easier to use the Touch Bar. Tapping to expand the control bar, flicking to set the volume and brightness, or sliding to reverse or forward while playing any movies [24].

5.4.5 THUNDERBOLT 3 (USB-C)

MacBook Pro uses Thunderbolt 3 (USB-C) ports to transfer data faster which can up to 40Gbps, charge and provide power from any ports and support Two 4K and 5K display. USB-C is a truly universal port as it contains and takes over all USB Adapter, Lightning cable. Micro-B cable, Ethernet Adapter, HDMI and Display Port, etc [45].

5.5 OUTPUT SPECIFICATION

5.5.1 RETINA DISPLAY

The best display in a Mac notebook is Retina Display that is embedded in MacBook Pro because there are the two most important elements to whether pixels are perceptible: density and distance [46]. It provides bright LED backlighting and a high contrast ratio and provides deep blacks and bright whites. This model with the Touch Bar features True Tone technology. The white balance will adjust automatically according the color temperature of the light around the users [24].

5.5.2 SPEAKERS

The speakers can be generally used for a wide variety of uses, not only limited to the computers and laptops but are extremely useful for entertainment systems as well [47]. In MacBook Pro, the user can play an audio through the built-in speakers, which are directly connected to the system power, enabling greater peak enlargement [24].

6. FUTURE OF MOBILE COMPUTING

The operating system of the chosen mobile computer is provided the High Sierra. The expectation of the future of mobile computer from MacBook Pro is the upcoming macOS Mojave, as "chock-full of new features inspired by Pro usersbut designed for everyone" and "a huge leap forward".It allows the users to stay better focused on work in Dark Mode, having a black interface will help to avoid eye strain. Organizing the files systematically using Stacks, Stacks will automatically group the files, folders, and photos that users drag onto the desktop [48]. It provides the users to get more out of every single click [24]. Moreover, touch screen function is the most users trend to looking into, a quite important function for many devices as it allows the user to interact directly with the system by touching the screen. It may save the time to drag the touchpad or type on the keyboard. Besides that, 360-degree Yoga hinge is one of the expectations from many consumers nowadays. This is an outstanding feature as user can change to “Stand” mode for looking at pictures or watching movies and also “tent” mode for playing games, video chatting or whatever else user likes. At the same time, when the screen rotates past 180 degrees, it will disable the keyboards and touchpad automatically.

7. CONCLUSION

Due to the high competing market, the high quality of the mobile computers is required by the company as many consumers trends to get the job done in a short time and convenient way. Hence, the basic input and output system are required to each mobile device to convenience users. However, by fulfilling the consumer’s needs, it causes every mobile device must have the three common technologies which includes wireless, cloud computing, and portable. These three technologies will helpusers to have a comfortable life. Therefore, it also caused high-level of operating system is required to every mobile computer, then only can perform a good performance to the users. MacOS Mojave is very important to the next notebook of the Apple company. Therefore, mobile computers are needed to be kept improving and creating more creatives according to the consumer’s needs to attract more customers.In conclusion, there are many different types of mobile devices in the market nowadays, but it is consumer’s choice to choose which mobile computer to purchase based on their budgets and needs.

8. ACKNOWLEDGMENT

The authors would like to share gratitude to Mr Umapathy Eaganathan, Lecturer in Computing, Asia Pacific University, Malaysia for the constant support and motivation also to Miss Angle Rubavathy for making this paper to participate in this International Conference and journal publication.

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