A Comparative Study of 64-Bit Microprocessors Apple, Intel and AMD

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**Abstract-** Living in an era of computers, lots of complex servers and systems take care of the world. With the constant technological advancements, applications need more processing powers thereby creating an urgent need for research on the microprocessors.

In this paper, we will present a technical and comparative study of these microprocessors. We will discuss different issues and aspects of such devices. In this study we will study and compare two microprocessor families that have been at the core of the world’s most popular microprocessors of today- 64-bit microprocessor and apple microprocessor.

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**Introduction-** The aim of the project is to study different aspects of technologies devices. It includes the technical findings, possible explanations for technologies being used in today’s world, its limitations and comparison between different technologies.

In computer architecture, 64-bit integers, memory addresses, or data units are those that are 64 bits (8 octets) wide. Also, 64-bit CPU and ALU architectures are those that are based on registers, address buses, or data buses of that size. A 64-bit computer architecture generally has integer and addressing registers that are 64 bits wide. The term may also refer to the size of low-level data types, such as 64-bit floating point number. In general, the design of CPUs is such that a single integer register can store the address of any data. Therefore, the total number of addresses in virtual memory is determined by the width of these registers.

In 1970s and 1980s , registers up to the size of 64-bit were used in some supercomputers. However, 32 bits remained the norm until the early 1990s, when the continual reductions in the cost of memory led to installations with quantities of RAM approaching 4 GB, and the use of virtual memory spaces exceeding the 4 GB ceiling became desirable for handling certain types of problems. Some companies like HP, HAL Computer Systems, IBM, Silicon Graphics developed 64-bit architectures for their workstations and servers, by 1990. The Nintendo 64 and the PlayStation 2 had 64-bit microprocessor much before their introduction to PCs. 64-bit computing started to drift down from 2003 onwards, when some models in Apple's Macintosh lines switched to PowerPC 970 processors and AMD released its first 64-bit x86-64 processor.

**Architectural Implications-** Processor registers are typically divided into several groups: integer, floating type, SIMD, control. However, more general-purpose integer registers are used in modern designs. In most processors, only integer and/or address-registers can be used to address data in memory; the other types of registers cannot. The size of these registers therefore normally limits the amount of directly addressable memory, even if there are registers, such as floating-point registers, that are wider.

Most high performance 32-bit and 64-bit microprocessors have integrated floating point hardware.

**AMD**

AMD 64 is the 64-bit version of the x86 instruction set. The primary defining characteristics of AMD64 is the availability of 64-bit general purpose processor registers, 64-bit integer arithmetic and logical operations, and 64-bit virtual addresses.

The original implementation of the AMD64 architecture implemented 40-bit physical addresses and hence could address up to 1TB of RAM. The architecture permits extending this to 52 bits in the future, this would allow addressing of up to 4PB of RAM.

**INTEL**

Intel architecture have seen lots of changes in past years. Although every branch of the broad Intel architecture family tree retains the same basic features and

functionality as the earlier chips, and retains backward

compatibility with them, each new generation also adds its

own unique features to the mix. mix. For example, Intel Pentium

processor added multimedia extensions that accelerated

audio and video processing. Extended temperature Intel

Pentium processor with MMX technology (multimedia

technology) is with more streaming-media capabilities

known as Intel Streaming SIMD (Single instruction Multiple data) Extensions and Intel Streaming SIMD Extensions 2. Floating-point units went from optional upgrade to standard feature of Intel architecture processors, and today encryption / decryption extensions,

power-management features, and multilevel caches are

now founds on most Intel architecture processors.

**APPLE**

Apple first used system-on-a-chip (SoC) in early versions of iPhone and iPod touch. They combine in one package a single ARM- based processing core, graphics processing unit and other electronics necessary for mobile computing.

The APL0098 is a package on package (PoP) SoC that was introduced on June 29, 2007, at the launch of original iPhone. The iPhone 3G and the first-generation iPod touch used it.

The APL0278 is PoP SoC introduced on September 9,2008, at the launch of second-generation iPod touch. The Apple A7 is a package on package 64-bit

system-on-a-chip designed by

Apple. It was introduced on September 10, 2013, appearing first in iPhone 5S.

**Features-**

**AMD**

AMD is the second largest supplier of x86 architecture and third largest supplier of graphics processors. The various generations of microprocessors include AM2900 series, x86 architecture processors, K5 series, K6 series, K7 series, K8 series, K9 and K10 series.

An important feature of AMD processors is advance clock calibration, which alters the internal settings of the computer by allowing individual settings of the core and the CPU. Another important feature of AMD is AMD virtualization, which is known as the virtual extension of AMD 86 processors. Cool and quiet is another promising feature of AMD processor which allows for low voltage and power utilization and hence low temperature of the PC. Presidio is a viable feature of AMD processors because it makes use of particular commands for trusted computations.  Thermal design power is a technology and feature which helps the processors to determine the maximum heat they have to deal with.

**Intel**

The new Nehalem microarchitecture Intel moved the memory controller and PCI Express controller from the north bridge to the CPU die, reducing the number of external data bus that the data to traverse. These changes help increase data-throughput and reduce the latency for memory and PCI Express data transactions. These improvements make the Core i7 family of processors ideal for test and measurement applications such as high-speed design validation and high-speed data record and playback.

**Apple**

Apple-designed processors are SoC and SiP processors designed by Apple, mainly using the ARM architecture. They are the basis of Apple's iPhone, iPad, and Apple watch platforms, and of products such as the Home Pad, iPod touch, and Apple TV.

It has high performance microprocessors, high level of integration, low power operation.

**Limitations-**

**AMD**

* It achieves lower working frequencies.
* It has less overclocking scope.
* The cache latencies are higher, so more needs to be integrated.
* Greater dependence on the frequency of the RAM memory.

**Intel**

* Facilitates process jumps, even on processors with a high number of cores.
* Improves the success rate per wafer and helps reduce production costs.
* It enables a high level of utilization of defective chips.
* It enables the design of chips with many cores at a low price.

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| --- | --- | --- | --- |
| ***quality*** | ***intel*** | ***AMD*** | **Apple** |
| **Cost value** | ***6/10*** | ***8/10*** | ***5/10*** |
| **Gaming performance** | ***8/10*** | ***7/10*** | ***9/10*** |
| **Content Creation/Productivity** | **7/10** | **8/10** | **8/10** |
| **Specifications** | **6/10** | **8/10** | **8/10** |
| **Overclocking** | **9/10** | **7/10** | **9/10** |
| **Power Consumption** | **6/10** | **8/10** | **7/10** |
| **Drivers and Software** | **8/10** | **7/10** | **7/10** |
| **Process Node** | **7/10** | **8/10** | **8/10** |
| **Architecture** | **7/10** | **8/10** | **8/10** |
| **Security** | **7/10** | **8/10** | **9/10** |

The other disadvantage of going to 64-bit is that your code

size and DRAM fetches all inflate somewhat. Good code

practices can keep this down, but compare any 32-bit

program to a 64-bit version, and you’ll find that the 64-bit

flavor is slightly larger. That makes power efficiency more

difficult, though Apple can still extract net gains here due

to more efficient use of processor characteristics.

***CONCLUSION***

We finally conclude Comparing all the three major Microprocessors – Apple, Intel and AMD families using

this table alongside where we have compared various important parameters that contribute to the performance of a microprocessor in the current trend. The three microprocessor families described here really compete for the top

spot in modern high-performance microprocessors.

Based on paul alcorn report and benchmark by passmark.com we conclude the following rating -

***KEYWORDS***

AMD- *Advanced Micro Device*

IT-*Information Technology*

RAM-*Random Access Memory*

DRAM-*Dynamic Random Access*

*Memory*

PCI-*Peripheral Component Interconnect*

SIMD-*Single Instruction Multiple Data*

TB-*Tera Byte (1024 Giga Bytes)*

IBM-*International Business Machines*

SoC-*System On a Chip*

HAL-*Hardware Abstraction*

*Layer\Hardware Abstraction Library*

CPU-*Central Processing Unit*

ALU-*Arithmetic logic unit*

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