

An analysis of the technical differences between Intel Core i9 and AMD Ryzen Threadripper 3990WX

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Abstract---

This paper discusses briefly on the technical differences between the two leading microprocessors from Intel and AMD, highlighting their properties and usage. The paper also provides basic knowledge on microprocessors.

Keywords--- CPU, Processor, clock speed, cache, architecture, threads, core, transistors.

I. INTRODUCTION

In this planet where computers play an essential role in everyday activities, computers keep getting better and cheaper. Computers have transformed from being bogus machines used for mathematical calculations to being small and capable of handling millions of tasks simultaneously.

As interesting and captivating as the history of the computer is it is not the aim of this research paper. It is what makes a computer so powerful, the microprocessor that this paper will discuss. It should be noted that without the microprocessor the computer will just be another machine that displays stuff no different from a television or refrigerator.

But what exactly is the microprocessor? Why is it so important? How does it work? What makes one microprocessor different from another? These

are few of many questions that this paper objective to answer. It is our objective to make the seemingly technical concept to be represented in a language that will be understood by everyone.

This research paper looks to examine the technical differences between the new gen Intel Core i9 and latest AMD Ryzen Threadripper 3990WX. To do that we must have a basic understanding of what microprocessors are.

II. MICROPROCESSORS

A microprocessor can be seen as the engine of any computer system. It is a system of one or more integrated circuits (IC) that incorporates the functions of the central processing unit (CPU). The microprocessor is a multipurpose programmable device which accepts data as input, process it according to the instructions stored in its memory and throw a result as output. This data is represented in the binary numeral system. From this definition it can be seen that a microprocessor is no different from the computer itself. That's why processors are generally referred to as the brains of any computer system.

The microprocessor contains most or all of the CPU and functions based on a set of instructions provided by the computer's basic input/output system (BIOS). The first set of instructions that get the microprocessor fired up when the computer is turned on comes from the BIOS itself and later from application programs or the operating system that the BIOS loads from the computer's memory [3].

The memory of a microprocessor (called registers or caches) are temporary high speed memory locations that are only in use when the microprocessor is in use. The first microprocessor to be used on a PC is Intel's 4004. It was introduced in 1971 used on IBM's PC and had a processing power of 60,000 instructions per second. It processed 4 bits at a time and had a clock speed 740 kHz; it was made from 2,300 transistors. As the years passed, microprocessors grew smaller and contained more transistors. This made them faster and more energy efficient; to this effect Moore gave out a law that states that the number of transistors incorporated in a chip will double every 24 months.

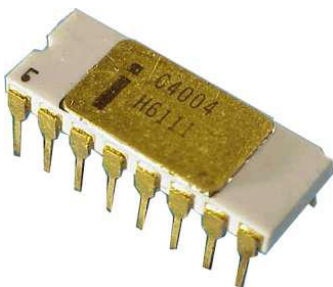


Fig 1 Intel®'s 4004 microprocessor

III. THE COMPARISON

Here is the brief description of both microprocessors. Intel Core i9 is among Intel's 9th generation processors. It was brought in as an improvement on

the Core i7; it is found predominantly in PC's, laptops and minicomputers. Introduced in May 2017, the core i9 was extremely efficient. It has many variants like the i9 9900K, i9-8950HK, i9-7900X. With greater processing power, Core i9 is the fastest CPU made for PC and it was seen as the processor of the future. But the future had more things planned out.

The AMD Ryzen Threadripper 3990WX processor is a member of AMD's 3rd generation processors for Desktop PCs. The difference is that Intel uses a mesh design which clearly gives it a competitive edge to compete with AMD's Threadripper as more and more core count are added for processing unit. AMD build Threadripper by adding two 8-core dies together with infinity fabric, which uses on dies attached sensors to monitor die temperature, speed and voltage across all 64 cores, this high speed network also allows AMD to fully utilize Dynamic Random Access Memory (DRAM) available to any SoC(System on Chip) or GPU.

Intel opted to use a standard thermal interface material to place the CPU die to metal heat spreader in place of efficient indium tin solder. Although there is guesswork(speculation) surrounding the premium added to using solder, intel's big switch has its implications. By adding a huge die and a thermal design power with a relatively high watt, Intel users are straddle with CPU thermals that strongly bounds overclocking and require expensive cooling solutions to counterweigh. Intel recommends liquid cooling even at stock frequency of a CPU. On automatic settings, CPU temperatures fly around 152° F.

Threadripper CPUs use solder and their heat escalator are big enough that AMD attached a set of dummy chips just to structurally support them.

Threadripper units come with bracket adapters which work with the most of liquid cooling solutions. Neither the Intel's i9 nor the AMD's giant Threadripper can be passively cooled that means a cooling solution is a necessary investment.

Performance: Gaming continues to be a key for system upgrades and this is where Intel outperform. Irregardless the higher clock speed of the Threadripper, the Intel's i9 cores prove more powerful due to higher boost and single core speed. The i9 can also help graphics card achieve higher frame rates and handle layup claim ultra-graphic settings in 4K resolutions as well as 3D graphics. Intel's processing power means, users can play much more realistic games. AMD takes the lead in real time strategy games that can seriously exercise and unsuspecting processor. Someday soon, extra cores will be making a huge difference in frame rate for high resolution gaming.



Fig 2 Ryzen Threadripper 2970WX



Fig 3 Intel Core i9 Extreme Edition Chip

Table I: Comparison Table

PROPERTIES	Core i9	Ryzen Threadripper
Platform sold	Desktop	Desktop
Release date	May 2017	July 2019
Max Boost Frequency	4.4 (Turbo Boost 2.0) / 4.5 GHz (Turbo Boost 3.0)	4.2 GHz (Precision Boost Overdrive)
Cores(Higher Side)	18	64
Threads(Higher Side)	36	128
Integrated graphics	No	No
L3 cache/cache per core	24.75 MiB	124 MiB (expected)
Memory Support	DDR4-2666	DDR4-2933 (Varies)

Memory Controller	Quad Channel	Quad Channel
Maximum Operating temperature	105°C	152°C
Power Consumption	165 Watts	250 Watts
Socket	R4	TR-4, LGA 4094
Process	14nm	7nm
Turbo clock speed	5.0 GHz	4.2 GHz
Architecture	Skylake	Zen 2

- Based on Intel Core i9-7980XE specifications and AMD Ryzen Threadripper 3990WX specifications.

In comparison, it can be easily seen that AMD Ryzen Threadripper is a better processor than Intel's i9. Almost twice number of cores is there on the Red Team (AMD) so that we can expect a very high performance from the team red and it should be easily beat team blue that is Intel's Core i9 CPU.

Here we can see Threadripper is a clear winner in terms of its technical specifications and on paper due to big cores count. Intel also needs liquid cooling system even for its stock clock and it will be costs very high but if I talk about Ryzen Threadripper, it does not need liquid cooling for stock frequency, liquid cooling

requires only when we need to overclock the Ryzen CPU.

1. Motherboard options: Ryzen Threadripper CPU should be paired with the latest X399 based motherboard with a TR4 Socket. Asus, MSI, Gigabyte and ASrock are the companies make motherboards for AMD Ryzen Threadripper's linup.



Fig 4 Srock X399 Motherboard

On the other hand, Intel's core i9-7980XE CPU should have X299 motherboard which is less cheap than X399 and availability of X299 is high as compared to AMD's X399 around 30k-60k whereas X399 pricing at more than 50



Fig 5 Msi X299 motherboard for Core i9 CPU

IV. Gaming Performance

We'll be edgeless here, if you are looking for a gaming PC, you should look elsewhere because these chips are too expensive for gamers. But if you have money to burn then the core i9-9900K will be the better option than either a i9-7980XE and i9-9980XE or Threadripper 3990WX.

A. Clock Speed: It is the speed on which a processor executes instructions. Every processor has an internal clock that regulates the rate at which instructions are executed and synchronized. The faster the clock speed (frequency), the more and more instructions executes per second. One more thing should also be noted that performance of a CPU or processor is also based on its architecture. It is clear that in terms of clock speed Intel's Core i9 is ahead from TR (Threadripper) but it doesn't mean that i9 perform faster than AMD TR. AMD TR will perform faster because it has high number of cores as compared to Core i9, whether it has less frequency.

B. Multicore Processing: This means when a processor comprises with two or more than two processor called as multicore processor. And when it processes multiple instructions at one time, known as multicore processing. A physical chip comprises with multi internal

circuits referred to multicore CPUs. The advantage of multicore processing, it can handle multiple applications simultaneously and execute the instructions parallelly. The core i9-7980XE has 18 cores in a single CPU chip and the AMD Ryzen Threadripper 3990WX is having 32 cores which will be rapid as compared to Core i9 in terms of number of cores. The multicore score of Ryzen TR will be very high from the Core i9 and the single core score will be less as compared to Core i9.

C. Multi-Threads: Threads depends upon Cores of the CPU. Earlier processors was not supported multithreading but nowadays there is no processor which does not supports multithreading. Multithreading is a process in which each core works as a dual core and this work is done by Operating System itself. Single core logically works as dual core when processor requires to do more tasks simultaneously. AMD Ryzen TR as well as Intel Core i9 both supports simultaneously multithreading and it does a decent job.

D. Cache memory: This is a memory storage used by the control unit to access data from the main memory at high speed. It holds copies of the data from mainmemory locations. They are arranged in a certain hierarchy of cache levels (L1, L2, L3, etc.). Higher cache memory means higher speed and more efficiency. We are having 64MB cache available in AMD Ryzen Threadripper and 24.75MB cache in Intel Core i9. When any program/application executes frequently, that goes to CPUs cache memory and if

further need to use that particular application or program then it opens quickly due to large cache memory.

- E. Power Consumption: AMD Ryzen TR and Intel Core i9 both required high power to run due to the large number of transistors and registers which consumes power to load. We also can consider this as the disadvantage of both the blue and red team. Around 160-250W power needs to power on these CPUs.
- F. Architecture: This deals with the structure of the microprocessor; its instruction set, how it performs the execution cycle (fetch, load, execute, write), the synchronization of its components, and its data size. There are many different CPU architectures that are available and their details are not the aim of this paper. The Core i9 processor uses the x86-64 (also written as x64) architecture which has an extensive instruction set. AMD Ryzen Threadripper uses Zen+ architecture which is based on 64-bits or x64.

V. CONCLUSION

The aim of this paper is not to show the superiority of one processor over another, rather it strives to inform readers on the technical differences of processors in general (i.e. what makes one processor different from the other). So that one person can be easily decide which processor is good for him/her and which will fulfill its requirements in less pricing. Processors are made for different purposes; from the ones in mobile phones to those in

supercomputers. The specifications of each processor are dependent on what kind of tasks it would be performing. Of course you don't expect a PC processor that will perform ordinary tasks like word processing and gaming to be of the same power with the processor of a supercomputer that calculates the orbits of space satellites to avoid collision and analyzes census figures to produce projections for future planning.

Understanding microprocessors is important in the understanding of the computer system in general. In no way is this research paper a sufficient information source on the topic microprocessors. More research should be done for greater and more comprehensive in-depth information.

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