Comparative Analysis of Modern Processors using Technical Parameters

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Abstract
A processor is the fundamental component of a computer system responsible for executing instructions and performing arithmetic and logical operations. Deeper understanding of the properties of processors plays a crucial role in determining the overall performance of a computer system. Prior studies have been conducted using different benchmark results, but there is still inadequate rigor and number of processors considered. The comparative analysis in this paper provide insights into strengths and weaknesses of key technical parameters, through an in-depth examination which enable a better understanding in term of suitability for various computing tasks. The four prominent processors: IBM Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon were compared using fabrication technologies, clock speeds, transistor counts, instruction set architectures, data paths, cache sizes, memory architectures, and application domains. Each processor's architecture is dissected to uncover its underlying design principles, and their fabrication technologies are evaluated for their impact on performance and power efficiency. Clock speeds and core configurations are compared to assess computational power, while transistor counts are examined as indicators of complexity and potential performance gains. Furthermore, the instruction set architectures, data paths, and cache hierarchies of these processors are compared to understand their implications on software compatibility and execution efficiency. The memory architectures and cache sizes are evaluated to determine their effects on memory access and data handling capabilities. Real-world application scenarios are explored to highlight the processors' specific domains of excellence, ranging from high-performance computing to mobile and embedded systems. In conclusion each processor is good and provides distinct competitive features and services for target application domain, this paper offers valuable insights for researchers in selecting the most suitable processor for diverse computing requirements.

Keywords: Processor Performance, Technical Parameters, IBM Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon

INTRODUCTION

A processor, also known as a central processing unit (CPU), is the fundamental component of a computer system responsible for executing instructions and performing arithmetic and logical operations. It serves as the "brain" of the computer, interpreting and executing instructions from software and controlling the flow of data within the system [1]. Processors are designed with specific architectures, which determine how they handle instructions and data. The two primary processor architectures are Reduced Instruction Set

Computing (RISC) and Complex Instruction Set Computing (CISC). RISC processors use a simplified set of instructions, which allows them to execute instructions quickly. They typically have a smaller number of instructions and utilize pipelining to achieve high performance. Examples of RISC processors include the ARM Cortex-A7, commonly used in mobile devices, and the IBM Power9, used in high-performance computing systems [2, 20, 21]. On the other hand, CISC processors have a larger and more complex instruction set, which can execute more operations in a single instruction. This makes them well-suited for complex tasks but may lead to increased power consumption and more challenging design. The Intel i7 processor is an example of a CISC processor, widely used in personal computers and workstations [2, 11]. Processors are manufactured using different fabrication technologies, such as the widely-used complementary metal-oxide-semiconductor (CMOS) process. These technologies dictate the transistor count and feature sizes, directly impacting the processor's performance and power efficiency [1].

Furthermore, processors incorporate cache memory, which stores frequently accessed data and instructions to speed up processing. The size and hierarchy of the cache significantly influence the processor's performance in handling memory-intensive tasks. Memory architecture is another critical aspect, as it determines how the processor accesses and interacts with the system memory. Efficient memory architectures can improve overall system performance, especially in memory-bound applications [1].

Processor comparison is essential in various scenarios to evaluate and understand the strengths and weaknesses of different processors.

Comparing processors helps in assessing their computational capabilities which is crucial for choosing the right processor that meets the performance requirements of specific applications or workloads. Different processors excel in specific application domains. By comparing processors, one can determine which is best suited for particular tasks, such as gaming, multimedia processing, artificial intelligence, data analytics, or server applications [3] Processors can also have different instruction set architectures, memory architectures, data paths, and cache hierarchies. Comparing these features allows understanding how each processor handles data and instructions, influencing software compatibility and performance [4]. Thus, this paper provides a detailed analysis and comparison of four prominent processors in the market: IBM Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon. The comparison was done based on various technical aspects such as fabrication technologies, speed, transistor count, instruction set architecture, data path, cache size, memory architecture, and application domains.

Figure 1: IBM POWER9 Processor and Intel i7 Processor [9, 11]

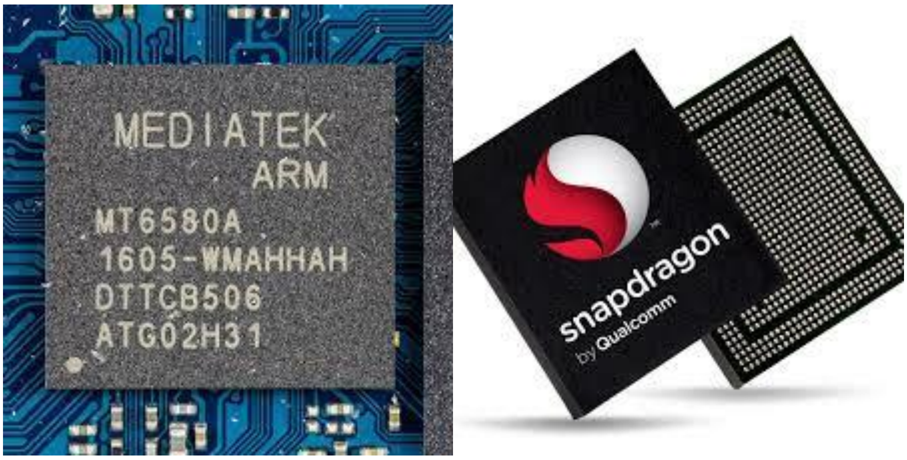

Figure 2: ARM Cortex A7 and Qualcomm Snapdragon Processor [15, 17]

LITERATURE REVIEW

Processor comparison is indeed a common practice in computer science and engineering literature. Researchers often perform comparative studies to evaluate the performance of different processors under specific workloads or scenarios. Such studies provide valuable insights for industry professionals, system designers, and researchers to make informed decisions and improve processor designs [3]. Literature often includes benchmark results, simulations, or real-world performance metrics to back up the claims made during processor comparison. The adequacy of processor comparison in literature depends on the rigor of the evaluation, the relevance of the metrics used, and the transparency in reporting the experimental setup.

[5] Conducted a comparative study of microprocessor, using the three major processors; Apple, Intel and AMD. Their comparison was based on 64 bit microprocessors i.e., A 64-bit computing processor uses data path widths, integer size, and memory address widths of 64 bits (eight octets). The study concluded after comparing various important parameters that

contribute to the performance of a microprocessor in the current trend. The three micro-processor compete for the top spot in modern high performance microprocessors. The latest Intel, Apple and AMD microprocessor seem to be very close in terms of performance.

Reference [3] compared Intel, AMD and IBM POWER processors based on their hardware virtualization techniques. Unlike Software virtualization techniques, hardware virtualization offers a good solution to face to face works in cooperation with VMM. Additionally, hardware virtualization technique removes the need for binary translation, provides a new architecture upon which the operating system can run directly, it. Thus, increased performance enhances the reliability, supportability, security, and flexibility of virtualization solutions [4]. From survey in [3], IBM emphasizes on load balancing and live partition mobility, Intel is working on increased hardware virtualization supports for both server and desktop computer. The findings also made it clear that IBM POWER6 is the most powerful machine with enhanced virtualization capabilities. Although IBM offers better output as it uses robust hardware support for virtualization, it is more costly than Intel and AMD. The study also noted that the fastest microprocessor used in POWER6 has hit speed of 6Hz, for the first time ever. The user interaction also makes a security hole and vulnerable to the intruders [3].

The study in [6] emphasis on the need to need to invest in a good processor by defining ''processor is responsible for interpreting input provided by the user (through hardware) and creating outputs through its programs and software which the user receives''. To make sure this continuous chain or cycle of action occurs smoothly, the study compares the two most relevant processors Intel and AMD using metrics; prize and performance. The findings show that Intel undoubtedly offers a lower price compared with AMD. However, despite the expensive range of AMD, it offers truly efficient performance. Hence, if budget is not the criteria, you can opt for AMD. From the performance point of view, The performance of a processor can be judged on the basis of editing, gaming and streaming task; Both the processors are equally capable of extensive editing work, AMD lags behind Intel in term of gaming, AMD series have much better performance in streaming, and also inter of power consumption AMD can be up to 2x more power-efficient than the 11th Gen series of Intel.

Study in [7] present a comparison of two processors namely; Intel and AMD quad-core processors based on virtualization support technology, HP ProLiant server built, and hybrid servers. Findings from the research shows that; Intel and AMD have the same design philosophy but different approaches in their microarchitecture and implementation, AMD technology uses more cores than Intel, but Intel uses Hyper-threading technology to augment the multi-core technology, Intel uses Quick Path Interconnect (QPI) technology to connect processor to one another and Memory controller Hub for memory access. On the other hand AMD uses Hyper-Transport technology to connect one processor to another and Non-Uniform Memory Access (NUMA) to access memory, Moreover, the QuickPath Interconnect in Intel ProLiant server have self-healing links and clock failover, hence their technology focuses more on data security while AMD ProLiant servers focuses more on power management. The Ivy-Bridge hybrid and HGCC technology indeed proved that two good heads are better than one. Furthermore, AMD supports virtualization using Rapid Virtualization Indexing and Direct Connect architecture. While Intel virtualization technology is Virtual Machine Monitor. Finally, the study concluded that despite the popularity of Intel, AMD has been in the front line of most innovative technology.

The study in [21] conducted a comparison three different processors (IBM POWER8, IBM POWER9, and Intel Xeon Platinum 8160) running parallel application. Memory bandwidth, operation modes and capabilities of simultaneous multithreading technology and parallel technology were compared based on OpenMP and MPI technologies. The study carried out by using the NAS Parallel Benchmarks. The results of the experimental calculations showed that almost similar maximum bandwidth across the three processors, however each require different number of threads for efficiency. Based on the results of numerical experiments, the study finally recommends that given similar hardware grade can be utilized to solve various scientific problems.

Intel and AMD processors were also compared in study [22] using parameters such as power, number of cores, memory types, caches, power, graphic, and speed. Single core and multi-core types of processor were also presented in their study together with design methodology. The study provided a general idea of Intel and AMD processor in market including their history and strategies. Finally, the study concluded that Intel has been on the top market, while AMD are potential competitors. However, different processors have their pros and cons.

Though Intel has been the giant in the microprocessor industry, AMD however, has been in the frontline of most innovative technologies. AMD manufacturer has succeeded in setting Intel on their toe. We are also of the opinion that if AMD was not in the processor world, probably Intel would have monopolized the industry. The slogan would have been "Intel and others". Further research can be carried out on a streamlined and thorough comparison on one subsystem in the Intel and AMD microarchitecture such as Memory Access technology or power management subsystem in a distributed environment.

From the above reviews, we can see that previous comparative studies have been conducted using different benchmark results, simulations, or real-world performance metrics to back up the claims made during processor comparison. However, it is essential to consider other context in methodology of comparison. This study present adequate of processor comparison with its rigor on the evaluation using on various technical aspects such as fabrication technologies, speed, transistor count, instruction set architecture, data path, cache size, memory architecture, and application domains. This study also consider for most prominent processors unlike prior studies that mostly compare two or three processor.

METHODOLOGY

Processor comparison is a valuable tool for understanding the capabilities of different processors and aids in making informed decisions when selecting the most suitable processor for a given application or system. To achieve the objective of the research, we used secondary source such as books, articles, reviews, essays, websites which are synthesized, described, interpreted and presented in results and discussion section. The study compares four prominent processors in the market: IBM Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon. The comparison was done based on various technical aspects such as fabrication technologies, speed, transistor count, instruction set architecture, data path, cache size, memory architecture, and application domains.

TECHNICAL ASPECT OF PROCESSOR

Fabrication Technology:

Fabrication technology is the process used to create the processors' physical components, including transistors, interconnects, and packaging. The two most common fabrication technologies used in modern processors are 14nm and 10nm. The size of the technology directly affects the processor's speed, power consumption, and transistor count. Smaller fabrication technologies offer more transistors per chip, which leads to a faster processor and lower power requirements.

Speed:

The speed of a processor is measured by its clock frequency, which is the number of cycles per second it executes. The clock speed is measured in gigahertz (GHz). The clock speed's impact depends on the specific instruction set architecture employed by the processor, and how efficiently it can execute instructions. Higher clock speeds translate to greater computing power, but they also require more power and generate more heat.

Transistor Count:

A transistor is a semiconductor device used to amplify or switch electronic signals. The transistor count indicates the number of transistors present in a processor. Increases in the transistor count lead to faster processors and more complex instruction sets. The transistor count is affected by the fabrication technology, with smaller transistors allowing for more transistors per chip.

Instruction Set Architecture:

The instruction set architecture (ISA) defines the set of instructions a processor can execute. There are two types of instruction sets: RISC (Reduced Instruction Set Computing) and CISC (Complex Instruction Set Computing). RISC processors are simpler and execute instructions

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quickly, while CISC processors are more complex and can execute multi-step instructions in a single cycle. The ISA impacts the overall processor efficiency and performance.

Data Path:
The data path is the route through which data is transmitted between the processor and other parts of the computer system. The data path is composed of the memory bus, the address bus, control lines, and data lines. A wider data path allows the processor to transmit and receive data faster, leading to faster performance.

Cache Size:
The cache is a type of memory used to store frequently accessed data and instructions. The faster the cache, the faster the processor can access data and instructions. The cache size can affect overall processor performance, with larger caches leading to faster processing.

Memory Architecture:
The memory architecture is the organization of the memory system, including the type of memory, its size, and its speed. There are several types of memory, including dynamic random-access memory (DRAM) and static random-access memory (SRAM). The memory architecture can significantly impact the processor's performance, particularly with memory-intensive applications.

Application:
The processor's application defines the intended use of the processor. Different applications require different properties in a processor. For example, gaming requires high processing power, while scientific applications require high memory and cache size.

KEY FEATURE OF THE PROCESSORS

IBM Power9 Processor:
The IBM Power9 processor is a high-performance central processing unit (CPU) designed by IBM as part of their Power Architecture. It is a significant advancement in IBM's server and high-performance computing offerings, delivering enhanced performance, scalability, and energy efficiency compared to its predecessors [8, 9, and 10].

Key Features:
1. Architecture: The IBM Power9 processor follows the Power Architecture, a RISC-based instruction set architecture known for its efficiency in handling complex workloads.

2. Multicore Design: Power9 processors feature a multicore design with support for multiple threads per core, enabling parallel processing of tasks and boosting overall system performance.

3. Fabrication Technology: Power9 processors are manufactured using advanced fabrication technologies, such as 14nm and 12nm FinFET processes, which contribute to their high performance and energy efficiency.

4. Memory and Cache Hierarchy: Power9 processors integrate various levels of cache, including L1, L2, and L3 caches, which reduce memory access times and accelerate data

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processing. They also support high-bandwidth memory interfaces for efficient data transfers.

5. AI and Accelerators: Power9 processors are designed to excel in artificial intelligence (AI) and machine learning workloads. They feature specialized accelerators, like the NVIDIA NVLink and OpenCAPI interfaces, that allow seamless integration with GPU and FPGA accelerators for enhanced performance in AI tasks.

6. Scalability: Power9 processors are highly scalable, enabling the creation of large-scale systems with multiple processors and high-speed interconnects for handling demanding workloads in data centers and supercomputers.

7. Application Domains: Due to their robust performance and scalability, IBM Power9 processors are commonly used in data centers, cloud computing, enterprise servers, and supercomputing environments for tasks involving big data analytics, AI, scientific simulations, and more.

8. OpenPOWER Foundation: IBM has collaborated with the OpenPOWER Foundation, a consortium of companies and organizations, to promote an open ecosystem around the Power Architecture. This collaboration fosters innovation and development of hardware and software solutions tailored to Power processors.

Intel i7 Processor:

The Intel Core i7 processor is a line of high-performance central processing units (CPUs) developed and manufactured by Intel Corporation, one of the world's leading semiconductor companies. It is part of the Intel Core series, which includes a range of processors targeting various market segments, from mainstream desktops to high-end workstations and laptops [11, 12, 13].

Key Features:

1. Architecture: The Intel i7 processor is based on the x86-64 architecture, also known as Intel 64 or AMD64, which offers a wide range of general-purpose registers and advanced instruction sets.

2. Multicore Design: i7 processors come with multiple cores, allowing them to execute multiple tasks simultaneously. They also support Intel Hyper-Threading technology, enabling the processor to handle multiple threads per core, effectively increasing the number of virtual cores and enhancing multitasking capabilities.

3. Turbo Boost: Intel i7 processors feature Turbo Boost technology, which dynamically adjusts the clock speed of individual cores based on workload demands. This allows the processor to operate at higher frequencies when required, delivering better single-core performance.

4. Smart Cache: Intel i7 processors incorporate a large, shared Smart Cache that dynamically allocates cache resources based on core demands. This helps reduce memory access latency and improves overall system performance.

5. Fabrication Technology: i7 processors are manufactured using Intel's advanced fabrication process, such as 10nm or 14nm, which enables improved energy efficiency and higher performance.

6. Graphics Processing: Many Intel i7 processors come with integrated graphics processing units (GPUs), known as Intel HD Graphics or Intel Iris Graphics. These integrated GPUs provide decent graphics performance for everyday tasks and some light gaming without the need for a discrete graphics card.

7. Application Domains: The Intel i7 processor is widely used in high-end desktops, laptops, and workstations, catering to tasks that demand substantial computing power. It is popular among gamers, content creators, and professionals who work with resource-intensive applications like video editing, 3D rendering, and software development.

The i7 processors have since become synonymous with high-performance computing and are continually updated with new features and improvements to meet the demands of modern computing workloads.

ARM Cortex-A7 Processor:

The ARM Cortex-A7 is a low-power, energy-efficient processor core designed by ARM Holdings, a leading semiconductor intellectual property (IP) company. It is part of the ARM Cortex-A series, which targets mobile and embedded devices, offering a balance between performance and power efficiency [14, 15, and 16].

Key Features:

1. Architecture: The ARM Cortex-A7 processor is based on the ARMv7-A architecture, which includes support for the ARM Thumb-2 instruction set. Thumb-2 combines 16-bit and 32-bit instructions, reducing memory footprint and improving code density.

2. Multicore Design: Cortex-A7 processors are often used in multicore configurations, providing scalability and parallel processing capabilities. This allows for improved performance in multi-threaded applications and multitasking scenarios.

3. Power Efficiency: The Cortex-A7 is designed with a focus on energy efficiency, making it well-suited for battery-powered devices and systems with stringent power constraints. Its low power consumption contributes to longer battery life in smartphones, tablets, and other mobile devices.

4. Fabrication Technology: Cortex-A7 processors are typically manufactured using advanced fabrication processes, such as 28nm or smaller, to further enhance energy efficiency and performance.

5. Application Domains: The ARM Cortex-A7 processor is commonly used in a wide range of mobile and embedded devices, including smartphones, tablets, smartwatches, Internet of Things (IoT) devices, and automotive infotainment systems. It is often paired with other ARM cores or accelerators to create heterogeneous computing systems for various workloads.

Qualcomm Snapdragon Processors:
Qualcomm Snapdragon is a family of mobile system-on-chip (SoC) processors developed and manufactured by Qualcomm Technologies, Inc., a leading semiconductor company. Snapdragon processors are designed for a wide range of mobile devices, including smartphones, tablets, smartwatches, and other connected devices, offering advanced features and performance [17, 18,19].

Key Features:
1. Architecture: Snapdragon processors are based on ARM architecture, featuring ARM Cortex CPU cores that provide a balance between performance and power efficiency. Some Snapdragon processors also integrate custom-designed Qualcomm Kryo CPU cores for enhanced performance and efficiency.

2. Integrated Modem: One of the standout features of Snapdragon processors is the integration of cellular modems. Many Snapdragon chips come with integrated 4G LTE, 5G, or multi-mode modems, enabling seamless connectivity for mobile devices.

3. Graphics Processing: Snapdragon processors incorporate Adreno Graphics Processing Units (GPUs), delivering advanced graphics capabilities for gaming, video playback, and graphical user interfaces. The Adreno GPUs are known for their power efficiency and support for popular graphics APIs.

4. AI Capabilities: Qualcomm has integrated artificial intelligence (AI) acceleration capabilities in some Snapdragon processors, enabling on-device AI tasks like voice recognition, image processing, and more.

5. Power Efficiency: Snapdragon processors are designed with power efficiency in mind, helping to extend battery life in mobile devices, making them suitable for all-day usage.

6. Camera and Multimedia: Snapdragon processors support advanced camera features, such as high-resolution image capture, video recording, and image signal processing. They also offer multimedia capabilities for smooth playback of high-definition videos and audio.

7. Quick Charge Technology: Qualcomm's Quick Charge technology is often integrated into Snapdragon processors, allowing compatible devices to charge rapidly and efficiently.

8. Application Domains: Snapdragon processors power a wide range of smartphones, tablets, and other mobile devices across different price points, catering to both budget-friendly and flagship devices. They are known for their strong presence in the Android smartphone market.

RESULT AND DISCUSSION
This section of the paper present the results of comparative analysis of the four prominent processors in terms of the fabrication technologies, speed, transistor count, instruction set architecture, data path, cache size, memory architecture, and application domains

Table 1: Result of comparative analysis of IBM Processor, Intel i7, Arm Cortex A7 and Qualcomm snapdragon

ATTRIBUTE/ PROCESSOR	***IBM power9 Processor***	***Intel i7 processor***	***Arm Cortex A7 processor***	***Qualcomm Snapdragon***
Processor FT	1.0*10^{-8}meter [8,10]	1.4*10^{-8} meter[11,12]	4.0/2.8 *10^{-8}meter[15]	*1.0**10^{-8} *meter*[17]
Paradigm (RISC, CISC or Hybrid	RISC[9]	Hybrid [11]	RISC [15]	RISC [17]
Processor speed	4*10^9Hz[9]	Base Clock 4.2*10^9Hz , a turbo-boost of 4.5*10^9Hz [11]	1.5*10^9 Hz[14]	2.45*10^9GHz[19]
Number of Transistor	8*10^{12} transistors count/ size[9]	731 *10^9 transistors arranged into a 263 mm²[13]	578 *10^9million transistors arranged into a 68.51 mm²[14]	10.3 *10^{12} transistors[18]
ISA	Power ISA 3.0[9]	x86 [13]	ARMv7 [15]	ARMv8-A ISA[18]
Data path (in bits)	2^6[8]	2^6[12]	2^7[16]	2^6[17]
Memory architecture (cache sizes and levels)	L1 = 2^5 KB I (Indirect) 64 KB D (Direct) per core L2 = 512 KB per core L3 = 120 MB per chip[8]	L1 = 2^5 kB (it's 8-way set associative) L2 = 256 kB dedicated(it's 8-way set associative) L3 = 8 MB (16-way associative) [12]	L1 = 2^3-2^6KB L2 = Up 1MB (optional) L3 = Null[16]	L1 = 2^5 KB. 2^5B/line. L2 =2MB. L3 =Null[19]
Performance (Overall) on different benchmarks	It is about 50% - 125% faster compared to previous generation. Maximum 4 TB of main memory using 256 GB memory sticks architecturally	It recorded 35% faster multi thread improvement compared to previous generation.	It recorded 30% greater performance than the previous generation	It recorded 25% greater improvement in term of performance compared to the previous generationIn graphics tests, an improvement of 40% was recorded which jump the CPU between 15% and 20%.
Application of each processor, Recommendations and reasons for that.	Purposely, they are built to solve problems in big data which comes from collection of huge databases, finance and security because of it use quad (128 of bit) precision floating which give more decimal accuracy [9]	It is mostly used in coding games, movie industries. They number of core present makes it good for parallelism which is good for gamming [13]	They are mainly used in mobile computing, tablets, and other mobile devices, because of it emphasizing power efficiency and sustained peak performance[16]	Used in processing images from a big dataset, because it support parallel processing using GPUs which improve performance. [19]

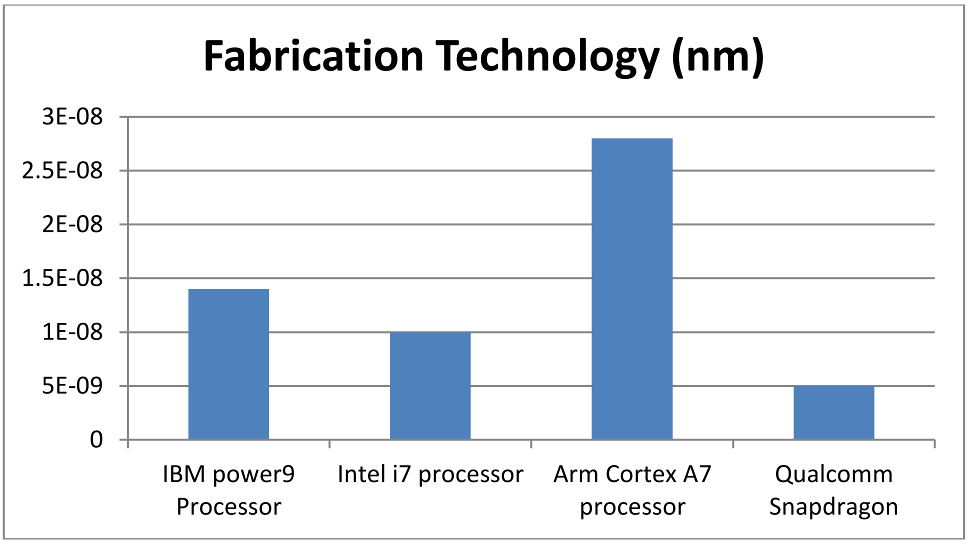

Figure 3: A chart depicting the size of fabrication technologies of the four processors: Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon

Comparing the fabrication technology of the processor is made easier by looking at their measurement in nano-meters (nm). The values can be seen in Figure 3 where Intel i7, and IBM Power9 processor used 10nm and 14nm respectively as their fabrication technologies. Smaller fabrication technology accommodates more transistors per chip which results to increase in performance and lower power requirements []. This implies that Qualcomm snapdragon processor with 5nm is the fastest and have lowest power requirement among the four compared Processors.

From the Table1, we can observe that only Intel i7 uses Hybrid paradigm in term of designing architecture in handling instructions and data. All other processors used RISC ISA while Intel i7 used both RISC and CISC. This gives it an advantage of allowing more operations in single instruction that to say it can execute multi-step instructions in a single cycle.

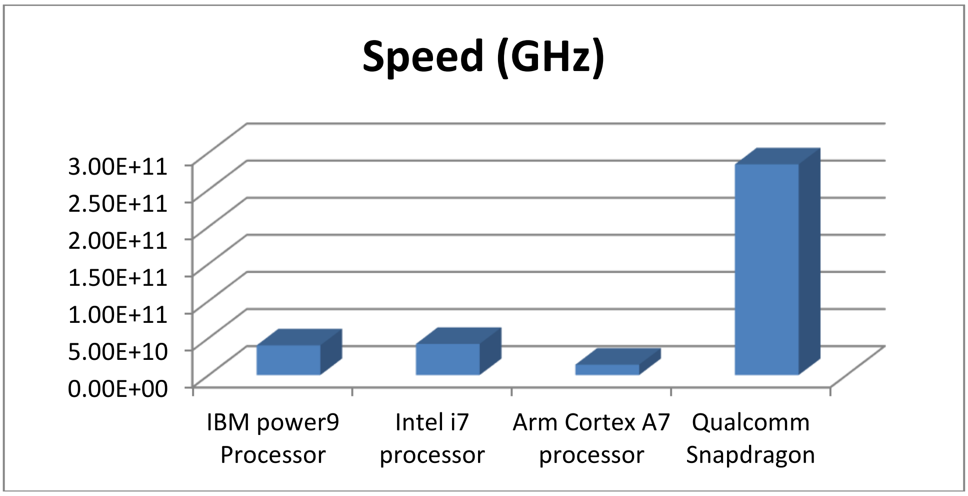

Figure 4: A chart depicting the Speed of the four processors: Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon

Form the Figure 4 above, we can easily observed which processor is faster by considering speed of a processor that can be measured by its clock frequency, which is the number of cycles per second it executes. Higher clock speeds translate to greater computing power, but they also require more power and generate more heat. Intel i7 has the highest speed of 4.5 GHz, followed by IBM Power9 among the four compared processors which make them to have better computing power.

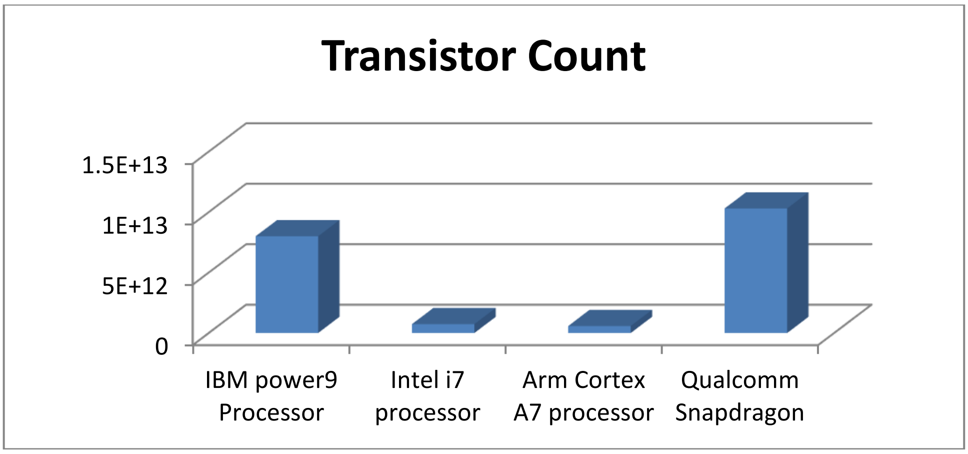

Figure 5: A chart depicting the size of number of transistors in each of the four processors: Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon

Transistor count indicates the number of transistors present in a processor which is determining by the fabrication technology used. The size of the fabrication technology informed number of transistor on a chip. Figure 5 reveals Qualcomm snapdragon processor has the highest number of transistors. Closely following it is IBM power 9, Intel i7and ARM Cortex A7.

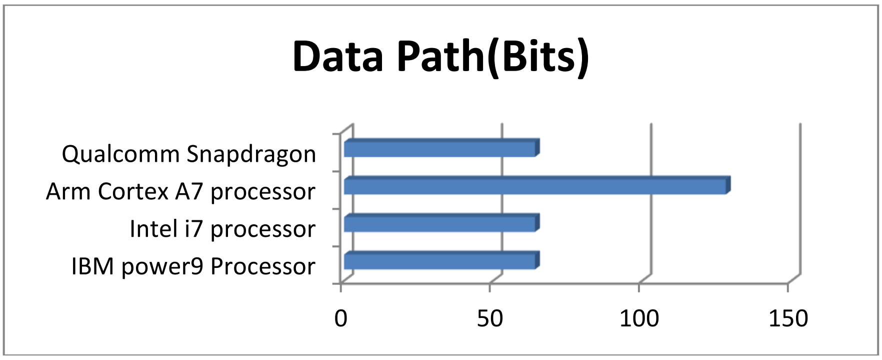

Figure 6: A chart depicting the size of data bus of the four processors: Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon

Figure 6 also present comparison of the four processors in term of data path is the route through which data is transmitted between the processor and other parts of the computer system. The data path is composed of the memory bus, the address bus, control lines, and data lines. A wider data path allows the processor to transmit and receive data faster, leading to faster performance. This implies that ARM Cortex A7 processors have the fastest performance in terms of data path, while other processors have the same data bus

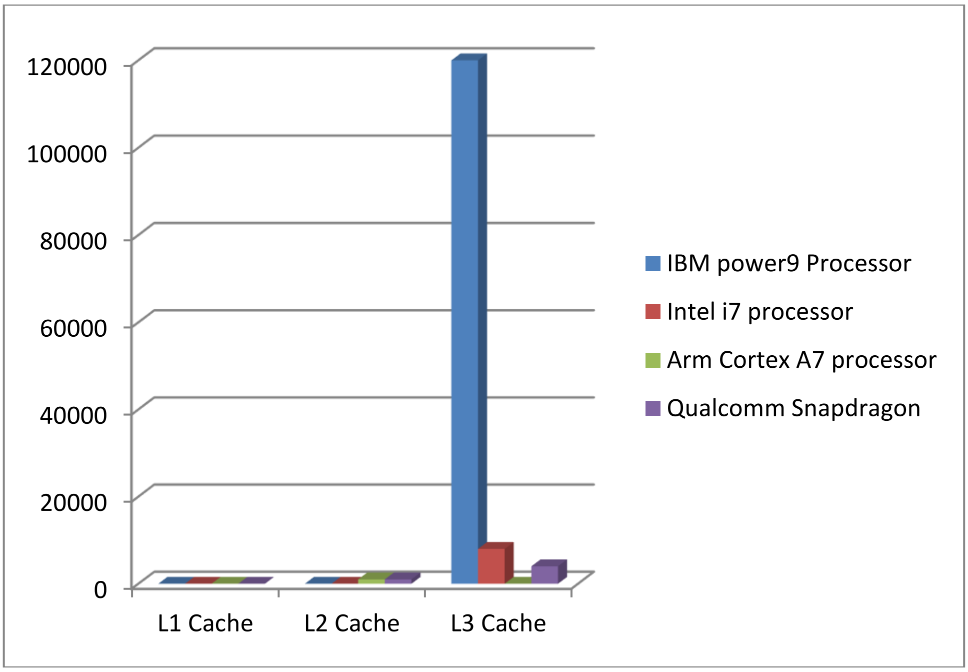

Figure 7: A chart depicting the size of caches of the four processors: Power9, Intel i7, ARM Cortex A7, and Qualcomm Snapdragon

From the table above, we can also see how the four processors differ in term of cache size IBM power9 and Intel i7 have a distinct improved cache smart L3 Cache which latency response time. Whereas ARM cortex A7 has L1 cache with L2 optional and Qualcomm snapdragon has Only L1 and L3 cache. It's also important to note that the faster the cache, the faster the processor can access data and instructions. The cache size can affect overall processor performance, with larger caches leading to faster processing. Additionally, each processor's benchmarking is presented with its previous predecessor. The intended use of processors where also presented in the table. Different applications require different properties in a processor. For example, gaming requires high processing power, while scientific applications require high memory and cache size.

The overall findings is the IBM Power9 processor is a high-performance computing solution that offers significant advantages in terms of scalability, energy efficiency, and support for demanding workloads in various domains, making it a preferred choice for enterprise-level computing and research applications Intel has been a favorite processor to all for a very longtime. Among the two most recently update released is core processor chip i7. It marked a significant leap in performance and power efficiency compared to its predecessors. It comes a new platform architecture, improved cache latency response time with the smart L3 Cache, higher performance multiprocessor systems with Quick path Interconnect (QPI), optimized performances through hyper threading and improved virtualization performance CPU boost performance through Intel boost facility. In other word Intel continued to refine and improve the i7 lineup with successive generations, offering higher clock speeds, increased core counts, and architectural enhancements. ARM Cortex-A7 was developed with a focus on improving power efficiency while maintaining a reasonable level of performance for mobile and entry-level devices. The Cortex-A7 is designed to work alongside other cores in ARM's big.LITTLE architecture, where it can be paired with more powerful Cortex-A15 or Cortex-A17 cores. This architecture allows devices to dynamically switch between the low-power Cortex-A7 for lighter tasks and the higher-performance cores for demanding tasks, further optimizing energy consumption and overall performance. The Cortex-A7 gained popularity due to its excellent energy efficiency and wide range of applications in various consumer electronics and embedded systems. The first Qualcomm Snapdragon processor combining the CPU, GPU, modem, and other components onto a single SoC. The Snapdragon brand has since evolved and expanded to include a wide range of processors catering to different market segments and use cases. Over the years, Qualcomm has continued to innovate and introduce new Snapdragon processor generations, offering increased performance, improved power efficiency, and enhanced capabilities to keep up with the demands of the mobile industry. The result of comparison of the four processor presented in this paper is however limited to only the technical parameters described in the methodology section. The same comparison of the four processors can be done using other parameters because different studies used different benchmark results, experiment, simulations, or real-world performance metrics to back up the claims made during processor comparison [3, 4, 5, 6, 7]. It is also worth noting that the processor benchmarking present is based on the comparison with individual processor with its immediate predecessor. Dedicated studies are essential to conclusion on performances of the four processor which is possible only if the relationship between the performance and all other aspect of processor are established

CONCLUSION

In conclusion, the properties of processors play a crucial role in determining the overall performance of a computer system. This research paper has provided a detailed analysis of the properties of processors, including fabrication technology, speed, transistor count, and instruction set architecture, data path, cache size, memory architecture, and application. Processor comparison is a valuable tool for understanding the capabilities of different processor beforehand which aid in making informed decision. The study also elaborates from the summary for which processors are suitable for what types of applications. For example, the ARM Cortex-A7 excels in power efficiency and is commonly found in smartphones and embedded systems.

The Intel i7 is favored for its robust multi-core performance, making it ideal for desktop and high-end computing tasks. The IBM Power9 is known for its scalability and is often used in data centers and supercomputers. Qualcomm Snapdragon processors are widely used in mobile devices, offering a balance of performance and power efficiency. Finally, it is crystal clear that the each processor is good and provides distinct competitive features and services for target application domain.

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