QuantiSpeed™ Architecture

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Real-World Application Performance

One of the most important aspects of a computer system is the amount of time it takes to complete any given task. The microprocessor is at the heart of the computer, supplying life to the system. For that reason, the microprocessor is a component in determining the effectiveness of a computer system to execute specific tasks in the shortest amount of time. This is referred to as real-world application performance.

Application performance is a combination of two elements:

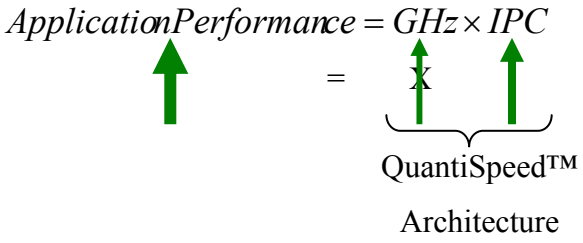
1. Clock frequency of the processor, measured in Megahertz, or Gigahertz
2. The amount of work the processor can accomplish in a given clock cycle, measured in instructions per clock cycle (IPC)

Contrary to a popular misconception, clock frequency alone does not determine application performance. Real-world application performance is the combination of both clock frequency and IPC.

$$ApplicationPerformance = [clockfrequency] \times [workcompleted]$$

$$ApplicationPerformance = GHz \times IPC$$

Without a doubt, different methods can be used to optimize the processor for application performance. AMD has worked to maintain a balanced approach to optimizing performance by increasing the amount of work done per clock cycle (IPC), while improving the operating frequency at the same time. The end result is a processor design that produces high IPC and high operating frequencies, the optimum combination to increase overall performance.



Available on the desktop and mobile AMD Athlon™ XP processor and mobile AMD Athlon 4 processor, QuantiSpeed™ architecture allows the processor to accomplish more work per clock cycle (IPC) when compared to other competing processors, **and** achieve relatively high operating frequencies. For these two reasons, QuantiSpeed architecture is the key element that provides desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors with a "quantum leap" in real-world application performance.

What is QuantiSpeed™ Architecture?

1. **Nine-issue, Superscalar, Fully Pipelined Micro-architecture**

   At the heart of QuantiSpeed architecture is a nine-issue, superscalar, fully pipelined core. This provides more pathways to feed application instructions into the execution engines of the core, simply allowing the processor to complete more work in a given clock cycle (high IPC). The delicate balance between the depth of the pathways (pipelines) and operating frequency of the processor produces high levels of performance. Longer pipelines alone translate into lower IPC, but high operating frequencies. However, shorter pipelines alone result in increased IPC, but lower operating frequencies. Desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors are designed to maintain a balanced approach between pipeline depth and processor frequency to provide extraordinary levels of overall processor performance.

2. **Superscalar, Fully Pipelined Floating Point Unit (FPU)**

   QuantiSpeed architecture features a superscalar, fully pipelined FPU, which completes more floating point operations per clock cycle than competitive x86 processors, and permits high operating frequencies. The end result is the most powerful x86 FPU available today. Desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors have ample computing power to tackle the most computation-intensive software applications.

3. **Hardware Data Prefetch**

   Prefetching instructions from system memory to the processor's Level 1 Instruction Cache is a common technique used to increase the processor's work throughput (IPC) and therefore overall performance. This feature of QuantiSpeed

architecture prefetches data from system memory to the processor's Level 1 Data Cache, which reduces the time it takes to feed the processor critical data, increasing work throughput. As a result, application performance is automatically enhanced when using a processor with QuantiSpeed architecture.

4. **Exclusive and Speculative Translation Look-aside Buffers (TLBs)**

   The TLB structures in QuantiSpeed architecture keep the maps to critical data close to the processor. This is designed to prevent the processor from stalling or waiting when future data is requested. These TLB structures are now larger, exclusive between caches, and speculative. Larger TLB's give desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors access to additional data maps. The exclusive nature of these structures removes the duplication of information, freeing up more space in the Level 2 cache for other useful data to be used by the processor. The aspect of speculation allows the processor to generate future maps of critical data quickly. These three enhancements to the TLB structures further increase the work completed per clock cycle, thus improving real-world application performance of desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors.

As a result of QuantiSpeed architecture, desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors have an optimum balance of IPC and frequency to achieve high levels of real-world PC application performance.

QuantiSpeed™ Architecture Analogies

1. **Let's Take a Walk**

   If a child and an adult are walking together, the child needs to take more steps to keep up with the adult. Since the adult has a longer stride than the child and travels further with each step, the child has to work harder—by moving faster—to try and keep up. The same holds true for processors. Some processors have to move faster (measured in Megahertz or Gigahertz) just to travel the same distance. Desktop and mobile AMD Athlon XP and mobile AMD Athlon 4 processors are more efficient because, like the adult, they cover more ground per stride, therefore they can outperform a processor that simply moves its legs faster.

2. The Fast and the Furious

Two cars are in a race. The Blue Car has a 6-cylinder engine while the Green Car has an 8-cylinder engine. While the Blue Car's engine works hard in terms of high RPMs, it doesn't actually go all that fast down the road. In contrast, the Green Car's more powerful engine doesn't have to run at high RPMs. Yet on the road, the Green Car blows the doors off the Blue Car. The more powerful Green Car engine is designed to run efficiently and to deliver a faster, more powerful driving experience.

The same goes for processors. Some processors have to rev their engines to higher RPMs (measured in Megahertz or Gigahertz) just to achieve similar levels of performance. A system running with a desktop or mobile AMD Athlon XP processor or mobile AMD Athlon 4 processor is like having a more powerful engine because it does more work per revolution, therefore it can outperform a processor that simply revs its engine higher but is less powerful.

3. Staying Afloat

You and a friend are out on the lake in a rowboat. At some point, you both notice that the boat is taking on water. Your friend starts bailing water with a cup while you start bailing water with a bucket. In a panic, your friend bails faster than you, but since your container is larger, you end up bailing more water in the same amount of time.

The same can be said for processors. Some processors have to move faster (measured in Megahertz or Gigahertz) just to do the same amount of work. Desktop and mobile AMD Athlon XP processors and mobile AMD Athlon 4 processors are more efficient, like the bucket, because they move more water per scoop, therefore they can outperform a processor that simply scoops faster but collects less water on each scoop.

4. Tour de Performance

Two cyclists ride together on 10-speed bikes. One cyclist uses the 10^{th} gear, pedaling slower but moving faster down the road and covering more distance with each stroke. The other cyclist uses first gear and has to pedal like a lunatic to achieve even close to the same speed on the road and cover the same ground.

Processors work like this as well. Some processors have to pedal faster (measured in Megahertz or Gigahertz) just to travel the same distance. Desktop and mobile AMD Athlon XP processors and mobile AMD Athlon 4 processors are more efficient because they travel farther per stroke, therefore they can outperform a processor that simply spins its pedals faster.

AMD Overview

AMD is a global supplier of integrated circuits for the personal and networked computer and communications markets with manufacturing facilities in the United States, Europe, Japan, and Asia. A Fortune 500 and Standard & Poor's 500 company, AMD produces microprocessors, flash memory devices, and support circuitry for communications and networking applications. Founded in 1969 and based in Sunnyvale, California, AMD had revenues of $3.9 billion in 2001. (NYSE: AMD).