



AMD Technical Bulletin – TSC Dual-Core Issue & Utility Fix

Current AMD Dual-core processors, including AMD Opteron™, AMD Athlon™ 64 X2, AMD Athlon 64 FX, and AMD Turion 64 X2, provide power management mechanisms that independently adjust the performance state ("P-state") and power state ("C-state") of the processor; these state changes can affect the rate at which a processor core's Time Stamp Counter (TSC) is incremented. Some operating systems and applications may use TSC as part of their time keeping algorithms. Because AMD documents the TSC as being affected by these state changes, most modern operating systems are well aware of the effect of these state changes on the TSC and the potential for "TSC-drift" across multiple processor cores and properly account for it. TSC drift occurs when the computed (expected) difference between the TSCs of two cores is no longer a constant value but varies by a significant amount. Although cores may drift with respect to one another, an individual core's TSC is always monotonically increasing. This drift can *not* occur on single-processor single-core platforms.

Applications should avoid using the TSC directly (through the RDTSC instruction) for time keeping and instead rely on the appropriate operating system calls. Using the TSC directly means that an application is not protected from TSC-drift and does not benefit from the logic in the operating system to work-around it; as a result, applications using TSC directly could get confused by TSC-drift. Some applications, which bypass the Windows API for timing by directly using the RDTSC (Read Time Stamp Counter) instruction, are experiencing performance issues on dual-core client systems due to TSC drift. Specifically, games seem to be the most heavily impacted, sometimes showing slow and/or stuttering game performance or speeding up some of the processes.

Recommendation for Developers Moving Forward

Microsoft and AMD recommend that instead of RDTSC, applications use the Windows API which exposes the correct way to access this functionality through the *QueryPerformanceCounter* (QPC) and *QueryPerformanceFrequency* (QPF) routines. For more information, please visit the Microsoft knowledge base article at: <http://support.microsoft.com/kb/909944>

Microsoft has also written a white paper for developers (**Game Timing and Multicore Processors** - <http://msdn2.microsoft.com/en-us/library/bb173458.aspx>) further describing the issue and the recommended solutions for games currently in development as well as already released products that are experiencing the issues. Please read over this white paper and follow the instructions laid out by Microsoft to ensure that your products will perform well on dual-core and multi-processor systems.

Solution for Applications Still Using RDTSC

For those applications which still continue to use RDTSC and are having problems on AMD single socket dual-core systems, we have recently created a special AMD Dual-Core Optimizer utility which synchronizes the TSCs on AMD Dual-Core Processors.

The AMD Dual-core Optimizer Utility is available for download on AMD's website at the following links:

http://www.amd.com/us-en/Processors/TechnicalResources/0,,30_182_871_13118,00.html

http://www.amd.com/us-en/Processors/TechnicalResources/0,,30_182_871_9706,00.html



If your application is using RDTSC, please feel free to either include the utility itself as part of the install of the game or, if your game is already released, please include a link to the AMD site noted above on your patches or game updates websites as well as on any technical help forums. Be sure to note that this utility is specifically for AMD single socket dual-core users who are having issues with your product. Note that the utility will not install on single core systems as it is not a problem on single core. If you choose to include the utility in your game install, please follow and include the software license agreement that is part of the install.

AMD is actively working on ensuring that future generations of AMD processors will have per-core TSCs that are unaffected by Power Management.

Recommendation for Developers Using QPC and Still Having Problems

We have noticed that some developers who are already using QPC and QPF are experiencing some problems although this has been infrequent. If you are experiencing problems, we recommend that you install the latest AMD Athlon™ 64 X2 Dual Core Processor Driver available for Windows XP Edition and Windows Server 2003 Editions (64-bit and 32-bit versions) which can be found at:

http://www.amd.com/us-en/Processors/TechnicalResources/0,,30_182_871_13118,00.html

Feel free to distribute this driver in your application installs as long as you follow the software license agreement.