



TROUBLESHOOTING CLIO INSTALLATION USING THESYCON DPC LATENCY CHECKER

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INTRODUCTION

CLIO is a high performance real-time streaming audio application.

If any kernel-mode device driver in your Windows system is implemented improperly and causes excessive latencies of Deferred Procedure Calls (DPCs) then probably drop-outs will occur causing malfunction of your CLIO system.

Thesycon (www.thesycon.com) has realized a freely downloadable application called DPCLat that showed to be such a valid companion in everyday activity that we suggest anybody involved in real-time applications to have it readily available on her/his desktop.

WHY DROP-OUTS OCCUR

Processing of streaming data in real-time is a very challenging task for Windows based applications and device drivers. This is because by design Windows is not a real-time operating system. There is no guarantee that certain (periodic) actions can be executed in a timely manner.

Audio or video data streams transferred from or to an external device are typically handled by a kernel-mode device driver. Data processing in such device drivers is interrupt-driven. Typically, the external hardware periodically issues interrupts to request the driver to transfer the next block of data. In Windows NT based systems (Windows 2000 and better) there is a specific interrupt handling mechanism. A device driver cannot process data immediately in its interrupt routine. It has to schedule a Deferred Procedure Call (DPC) which basically is a callback routine that will be called by the operating system as soon as possible. Any data transfer performed by the device driver takes place in the context of this callback routine, named DPC for short.

The operating system maintains DPCs scheduled by device drivers in a queue. There is one DPC queue per CPU available in the system. At certain points the kernel checks the DPC queue and if no interrupt is to be processed and no DPC is currently running the first DPC will be un-queued and executed. DPC queue processing happens before the dispatcher selects a thread and assigns the CPU to it. So, a Deferred Procedure Call has a higher priority than any thread in the system.

Note that the Deferred Procedure Call concept exists in kernel mode only. Any user-mode code (Windows applications) runs in the context of a thread. Threads are managed and scheduled for execution by the dispatcher.

While there is a pre-emptive multitasking for threads, DPCs are executed sequentially according to the first in, first out nature of a DPC queue. Thus, a sort of cooperative multitasking scheme exists for Deferred Procedure Calls. If any DPC runs for an ex-

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cessive amount of time then other DPCs will be delayed by that amount of time. Consequently, the latency of a particular DPC is defined as the sum of the execution time of all DPCs queued in front of that DPC. In order to achieve reasonable DPC latencies, in the Windows Device Driver Kit (DDK) documentation Microsoft recommends to return from a DPC routine as quick as possible. Any lengthy operation and specifically loops that wait for a hardware state change (polling) are strongly discouraged.

Unfortunately, many existing device drivers do not conform to this advice. Such drivers spend an excessive amount of time in their DPC routines, causing an exceptional large latency for any other driver's DPCs. For a device driver that handles data streams in real-time it is crucial that a DPC scheduled from its interrupt routine is executed before the hardware issues the next interrupt. If the DPC is delayed and runs after the next interrupt occurred, typically a hardware buffer overrun occurs and the flow of data is interrupted. **A drop-out occurs.**

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DOWNLOADING AND USING DPCLAT

A) Connect to Thesycon web site and download the DPC Latency Checker (http://www.thesycon.com/eng/latency_check.shtml).

Place the executable on your desktop, NO INSTALLATION IS NEEDED!



B) Follow instructions given to analyze your computer hardware (<http://www.thesycon.com/dpclat/dpclat.pdf>).

