

Calypto's LatencyGuide

Smother, more responsive gameplay and input.

Latency is the time between a cause and an effect. An example of latency is input lag, or the time between moving your mouse and the cursor moving on the screen. A good portion of latency comes from the operating system. In this guide, I list methods to decrease input lag. This guide is mostly oriented towards gamers, but would help for any realtime application on Windows. CPU usage is important, but you need to avoid something in this guide (avoid forums and Reddit). These tweaks aren't listed in any particular order, but they are all important, otherwise I wouldn't bother listing them. Individually, many of these tweaks probably won't provide a noticeable difference, but if you do every single tweak you will end up with a significantly more responsive system, even if you usually can't tell.

You'll have to change the way you use a PC. In terms of programs, you will need a minimalist approach. Don't run anything in the background that you don't absolutely need. Heavy programs such as your web browser (Spartan and Discord are reckinned Google Chrome) will slow down your system and cause stuttering. Close them before gaming and reopen them when you're done. This goes for other programs. Windows will allocate CPU time to any service or program that is running in the background and will halt all other programs until the designated program gets its CPU time. This is how multitasking works on operating systems. If you're curious about scheduling and multitasking, read [this](#), or [this](#).

Measure your latency

Before doing anything in this guide, measure your latency using [LatencyWiz](#), then compare after doing everything. Go to 'Stats' and record your average interrupt to DPC latency. That is what we want to decrease. You may have to restart the test a few times to get consistently low averages. The lowest to average is reproducible, so make a mental average. Anything under .4us is good, under .3us is ideal but difficult to achieve, and impossible to achieve on Ryzen due to its architecture and limitations of Windows. When testing latency, every background program should be closed.

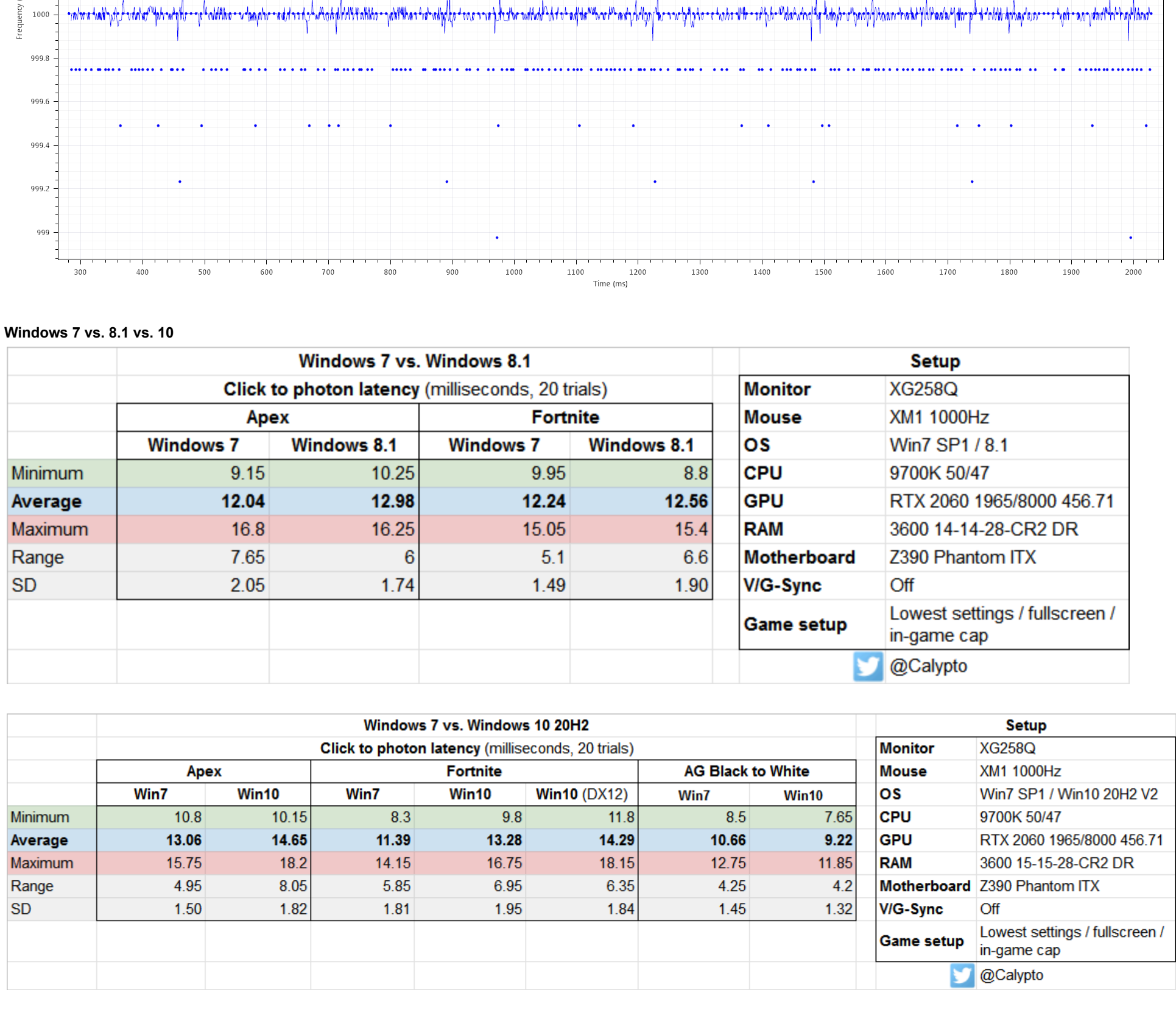
Highest measured interrupt to process latency (µs):	8.248478
Average measured interrupt to process latency (µs):	0.458110
Highest measured interrupt to DPC latency (µs):	7.679319
Average measured interrupt to DPC latency (µs):	0.119828

The averages are quite low. The averages are what you are looking to improve. Intel will have lower averages than AMD. Different timers (TSC/HPET/PMT etc.) will give different results.

Measure your polling (smoothness)

The next thing you want to measure is your mouse polling using [MouseTester](#). 'Stable' polling is very hard to achieve on a system with lots of programs and services running in the background which consequently makes CPU usage very high. The idea of mouse polling can be used to indirectly measure the smoothness of games. When testing polling, every background program should be closed.

To use MouseTester, click 'Collected', then click and hold an empty area of MouseTester while moving the mouse in the mouse fast circles. Set Plot Type to 'Frequency vs. Time.' Set 'Data Point Start' to a few (1-50) milliseconds after you started moving the mouse to crop off the initial polling rate ramp-up. If you do not move your mouse fast enough, it will report at a lower polling rate such as 600Hz or 250Hz when you expect 1000Hz.



Windows 7 vs. 8.1 vs. 10

Click to photon latency (milliseconds, 20 trials)						Setup	
Apex		Fortnite		AQ Black to White		Monitor	Mouse
Windows 7		Windows 8.1		Windows 7		OS	Mouse
Minimum		9.15		10.25		CPU	XM258Q
Average		12.04		12.98		GPU	9700K SP1 / 8.1
Maximum		16.84		16.25		OSU	9700K 50/47
Range		7.65		6		CPU	RTX 2060 1965/8000 456.71
SD		2.05		1.74		RAM	3600 14-14-28-CR2 DR
						Motherboard	Z390 Phantom ITX
						VIG-Sync	On
						Game setup	Lowest settings / fullscreen / in-game cap

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Apex		Fortnite		AQ Black to White		Monitor	Mouse
Win7		Win10		Win7		OS	Mouse
Minimum		13.08		14.65		CPU	9700K 50/47
Average		10.06		10.15		GPU	RTX 2060 1965/8000 456.71
Maximum		15.75		18.2		CPU	3600 15-15-28-CR2 DR
Range		4.7		13.15		Motherboard	Z390 Phantom ITX
SD		1.50		1.82		VIG-Sync	On
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The Tweaks:

Disable Hyper-threading / Simultaneous Multithreading (SMT) in UEFI!

This feature allows the operating system to use a physical core as two virtual cores. Although good for highly-threaded loads such as rendering or compiling, this feature massively increases the system's latency. This is because cores only have one execution unit, which is exacerbated by the operating system attempting to spread the load across both virtual processors of the same core, which creates a stall while the core's execution unit is busy with the second logical processor.

It is ideal to simply disable HTSMT if you have more cores than your game requires, or force the game to run on separate cores by changing the affinity to every other logical processor in Task Manager or [Process Lasso](#) (examples: CPUs 1,3,5,7,9 or 0,2,4,6,8 etc.). If you have eight or more cores, you can safely turn it off for almost all games. If you have six or fewer cores, you might be forced to leave it on and change the affinity of the game to prevent contention between the logical CPUs. Another benefit to disabling SMT is lower power consumption, which raises overclocking headroom.

- [Latency test of HT on vs. off](#)

Enable Multi-CX Ryzen CPUs (1900X, 2900X, 3900X, 5900X, 7900X)

Earlier Zen CPUs (up to Zen3) have cores called a Core Complex (CCX). Each CCX has four or less cores, and there are two or more CCXs which are connected together via the Infinity Fabric. The Infinity Fabric is fast, but not fast enough to not have noticeable performance loss in games as well as reduced desktop responsiveness due to inter-CX communication. On top of this, Ryzen CPUs also have higher RAM latency than desktop Intel CPUs. Starting with Zen3 (Ryzen 5000), each CCD (core complex die) has an eight core CCX which greatly reduces inter-core latency, and [unifies the split 1.3 cache previous generations had](#). This brings massive performance improvements across the board, but unfortunately the memory latency still suffers due to the memory controller being located on the I/O die.

If you happened to buy a multi-CX Ryzen, you have a few options to minimize latency:

- Use [Downclocking Control](#) in UEFI to disable a CCX (Zen 1/2) or CCD on Zen 3 / Zen 4 (not recommended)
- [Intercore Latencies: Zen1 / Zen1 / Zen1 / Zen2 / Zen3 / Zen4](#)
- Windows 10 1903 has a scheduler update to group threads to CCXs, but this does not have the same effect as disabling a CCX. Another drawback is that you have to use Windows 10
- Set your program/game's affinity to just a single CCX

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Disable your antivirus

Antivirus causes stuttering and unnecessary CPU usage. Instead, scan files before running them and do frequent system scans. Don't visit shady websites, and don't browse the Web without an ad or script blocker ([uBlock](#), [uMatrix](#), [nMatrix](#) (Pale Moon only)). By default Windows uses Defender, which takes a few steps to disable:

- On Windows 7, disable the Windows Defender service
- On Windows 10:

