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CSC 482 02

11/28/2021

PLEDGED

Core Count for a PC

Have you ever thought about the specs that you need when building a PC? Arguably the most important component is the CPU, or central processing unit. The CPU is known as the brain of the system and one of, if not the most expensive component in a computer build. It is an essential part that no one wants to undercut on with their budget to ensure proper power. At the same time, nobody wants to waste money when already investing in so much when building their own PC. Thankfully, there are many ways to find out which parts are the best for your budget and criteria. These methods all depend on what you are planning to use your computer for. The three most common categories would be gaming, productivity or a combination of doing both and even streaming. Finding what CPU is best for a gaming computer is arguably the easiest to determine, a good start being looking through the Steam hardware surveys. Then again, not all PC gamers are equal in what games they play. They could play triple A (high budget, high resource) story games, competitive Esports games, or just casual gaming. Even as the best and newest games constantly require better specs, games that are easier on the computer to run are also continuing to be produced. Productivity has a fairly easy resource: softwares that they plan on using and should have published recommended system requirements. However, things get a little more complicated when we get to a combination of both. On top of all of this, we have to take into consideration if the user building or buying their computer is wanting to future-proof their PC.

To make things easier to understand, it should be further clarified why a CPU is such an important and crucial decision compared to many other parts essential to a computer. Starting off, the main components of the computer are of course, the CPU, the motherboard, memory, storage, at least one video/graphics card, and a power supply. The motherboard does not affect performance much whatsoever. Therefore, from a performance perspective, the motherboard chosen does not make much of a difference and the builder or buyer simply needs to assure that it is compatible with all other hardware. Memory is a very easy component to decide upon, considering the fact that you can always start small and upgrade later with more if you so need to. Storage has a scenario similar to that of memory but is easier to gauge and upgrade as it can be upgraded as simply as plugging in a USB drive. The video card can be complex to determine, however generally the more is spent the better the performance will be as the two factors have a fairly linear relationship. The power supply is rather flexible as long as the wattage required for the computer as a whole is met, and having an “80 plus certification,” meaning to be safely 80% efficient in testing, is always good to have. This leaves choosing the CPU as the most complex decision to make. One of the most, if not the most important specifications of the CPU, is how many cores it contains. A CPU core is an individual processor within the unit, and the more processor cores it contains the faster you can do multiple tasks at once. As simple as this seems, the reason why choosing a CPU is complex in the first place is because unlike a graphics card, you can not spend more and more money on a CPU and expect better performance each time. For example, a core i5 6600K and a core i7 6700k have identical gaming performance despite the i7 having double the cores and instruction capacity of the i5.

A big reason that overspending on a CPU can be so bad is not only because it can be a waste of money but also because that money could be used somewhere else. This concept is called bottlenecking. Bottlenecking occurs when one component is noticeably stronger than one or multiple others.The term comes from the visual representation of all of the power from one component being choked by the lack of power by the other(s). It is very easy to fix this and there are multiple ways to fix this for multiple people. Say a PC Gamer was going to get an 8 core CPU but would be just as well off with a 6 core, they could save $100 instantly and put that towards a better graphics card and gain a substantial boost in frames per second. Another point is, a video editor could use that same $100 and use it for RAM so they could render their videos faster and preview them at higher resolutions and use any extra towards storage, that way they can store their footage or files without having to move around a bunch of space. Lastly, a streamer can use that money on any of those parts, or even peripherals like headphones, a better microphone, or even just nice little accessories to help control their stream better. Either way, the money saved can go a long way when put towards something else.

The first target audience out of three is a PC Gamer. This is a very simple yet at the same time complex scenario to find a CPU for. This is because many different games vary on CPU intensity and many different PC gamers play games differently. After looking through the Steam hardware charts, the most popular core count used right now is 4 cores. The second most popular and one of the quickest growing counts are 6 core CPUs. Then after that is 8 cores which is growing slowly but will eventually overtake 6 cores. After looking through this data, it is safe to say that 4 cores is best for building a starting computer to get into gaming and not spend a whole lot on components. If someone wants to buy a computer that will last them average lifespan without upgrading they should get 6 cores. Lastly, an 8 core count is best for future-proofing and having a computer that will last the longest at the expense of being the priciest option. It can get much more specific from there, as there are three main subcategories of PC gamers to be discussed: high-demand story games, indie games, and games that are a part of the Esports community.

Starting off with the most demanding subcategory: story games. For this subcategory, the most popular story games on Steam will be compared based on the recommended CPU usage. The most popular story game right now is the Halo Infinite Campaign, a first person shooter (FPS) and action packed continuation of the Halo series. Halo Infinite is recommending both an 8 core count AMD and Intel CPU. Halo Infinite does have a minimum requirement of a 6 core count. The second most popular story game is Final Fantasy XIV, an older Final Fantasy game that has stayed relevant with continuous expansion packs since its release in 2010. This massively multiplayer online role playing game recommends an Intel Core i7, 3GHz or higher. Before 2018, all i7’s were quad core CPUs. Now, unfortunately, the only i7’s worth buying are all 2020 models or newer, meaning that it only makes sense to have an 8 core count for this game. The minimum CPU requirement for Final Fantasy XIV is an i5 with over 2.4GHz which is similar to the i7 but the core count on them now is 6. Lastly, Cyberpunk 2077 is back on the rise once again after the developers, CD Projekt Red, have been spending so much time on it. Cyberpunk is a futuristic action role playing game and shooter, and is a very demanding game. After personal use it has been found that the Steam requirements are undercutting what a computer would really need in order to run the game well. After looking through a few articles, the most informative one was from pcgamer.com who recommended an older i7 which then defaults to an 8 core. The minimum CPU requirement for Cyberpunk is a 4 core CPU. After looking through a few more games, the data seems consistent that story-rich triple A games work best with an 8 core CPU, however one could get by with a 6 core count if they want to save money in exchange for a lesser experience by having to tone down the graphics.

The second subcategory is indie games. Indie games are games made by very small developers. That being said, the requirements tend to mostly commonly range from being not at all demanding due to not having a high enough budget to develop intense games to moderately demanding because a lack of budget can easily cause poor possibility for optimization. This test will be the same as the story games which are looking through Steam requirements of the most popular of the subcategory. Starting off with the most popular indie game on Steam right now: Wartale. It is free to play massively multiplayer online role playing game. Wartale is a simple game and the system requirements clearly reflect that. The recommended CPU core count is a quad core with a minimum of dual core.There are very few if any dual core CPUs that are being manufactured and sold as brand new in this day and age so it is safe to assume that a quad core count is the lowest option for this game. The second most popular indie game on Steam right now is called Teardown, a destructive physics-oriented and puzzle solving game. Teardown has a shared recommended and minimum requirement of a quad core CPU. The third most popular is called Fights in Tight Spaces, a turn-based strategy and fighting game. This game has such little requirements that it will run on any CPU as long as it has more than one core and SSE2 instruction set support, which was first introduced in 2001. A few honorable mentions of some of the most popular indie games of all time by far are Stardew Valley, Terraria and Minecraft. Minecraft is no longer an indie game due to its massive amount of popularity and however it still falls under the subcategory. Stardew Valley and Terraria both have recommended requirements less than dual core CPUs so therefore a quad core CPU would be more than enough. Similarly, while Minecraft is commonly modified and can easily ramp up in CPU requirement, at its base Minecraft has a recommended quad core count. Coming to a conclusion in this subcategory, a quad core CPU is perfect for these games as it exceeds many of the games’ requirements by far but meets the most intense ones.

The final gaming subcategory is Esports. This will be based on judging by not just the recommended requirements of the most popular Esports games but also of the standards Esports players need to competitively play. For example, Esports players that play competitive first person shooter games like Valorant and Counter Strike: Global Offensive (CS:GO) best perform at high refresh rates. This means getting a higher frames per second rate leads to having a better chance at responding quickly to actions in the games. Some of the most popular Esports games of 2021 are CS:GO, Valorant, and two multiplayer online battle arena (MOBA) games: Defense of the Ancient 2 (Dota 2) and League of Legends. From least to most demanding games, League of Legends comes first as an older game from 2009. League of Legends is able to run on very weak CPUs. The game also does not require to be run at higher refresh rates as a MOBA instead of an FPS, so 60 frames per second is more than optimal. Looking through system requirements, a quad core CPU is more than capable for playing this game at a competitive level. Next up is Dota 2, a game very similar to League but a little more demanding. This is to be expected as the game was released in 2013, being four years newer than League of Legends. The minimum requirements call for a dual core while there are no recommended specifications. After digging through a couple of YouTube videos, it has been noted that a cheap Ryzen 3 3200G with integrated graphics can run Dota 2 with high settings for a comfortable competitive experience. Next up is CS:GO, a game like Dota 2 that requires a dual core but has no recommended specifications. After looking through more benchmark YouTube videos, it has been concluded that a quad core CPU can handle CS:GO at competitive frame rates even at high resolutions. Valorant is a newer first person shooter game that is not very graphically intensive but needs to be run at higher refresh rates to play competitively. The recommended specifications for Valorant is a quad core CPU. Going through more benchmark YouTube videos to clarify for competitive instances, a quad core is also capable of handling Valorant at high refresh rates and high resolution. Coming to a conclusion for Esports titles, a quad core CPU is also recommended for this subcategory.

Now to the second category, productivity which like gaming, can be split into multiple subcategories like office suite (word processing, excel, etc), graphic design, and engineering applications. Based on the fact that office suites are made to run on any new computer, it does not need to be considered here. Only graphic design and engineering applications will be discussed. Something worth mentioning is that while video editing is very CPU intensive, the process is sped up most when there is more RAM involved rather than a better CPU. Engineering applications are also different because it is typically a waste to get a common graphics processing unit that is more used for gaming. Engineering computers use workstation graphics cards which of course are made better for workstation applications but they also have a much higher price to performance ratio for said applications than common graphics cards.

Now to start off with productivity, there are 3 common types of productivity software. The first is photo manipulation software, the most common is photoshop. Another is video editing software, with popular ones being Adobe Premiere, Sony Vegas, and a Mac exclusive is Final Cut Pro. One more type is motion graphics and visual effects which is commonly created with Adobe After Effects. The method of testing which CPUs are the best for these is by comparing the system requirements, benchmark tests and going through articles and YouTube videos.

First off is photo manipulation, this will be tested using Adobe’s Photoshop. The website’s system minimum and recommended requirements are both the same, consisting of a CPU that has a clock speed of 2GHz or faster at a minimum. Another method that is being used is Cinebench benchmarks. Cinebench is a software that tests CPU’s to see how well they perform with photomanipulation and rendering software. A very useful tool for seeing what to buy for applications like Photoshop. A few CPUs with the same amount of cores will be averaged out to compare with the three cores to see what is worth it and what is not. Three 8 core CPUs were compared and averaged out to a score of just about 2300. Three 6 core CPUs were compared and averaged out and had a score of just about 1800. Quad core CPUs were too inconsistent and not worth the money overall to average out and compare. One more piece of information for both sets of CPUs is that 6 core CPUs are typically $300 and 8 core CPUs are typically $400. The 6 core CPUs have an average $0.166 cents per benchmark point while the 8 cores on the other hand have an average of 0.174 cents per benchmark point. Considering that this amount can add up quickly, it is safe to say that the 6 core is the better value out of the two.

Onto video editing, this process will be comparing Sony Vegas and Adobe Premiere system requirements and benchmarks and leaving Final Cut Pro in the dust since Apple is starting to produce their own CPUs. One thing to note is that video editing softwares is often more demanding than photo manipulation software. First software, Sony Vegas Pro 18 which happens to be on Steam making finding the system requirements much easier. Steam says that the minimum system requirements for Sony Vegas is a basic 2GHz processor but the recommended is a quad core. Also the developers put a special note specifying that the software requires a 4 core MINIMUM for 4K. Meaning to comfortably run the software professionally, a 6 core CPU would be recommended to run it or a user can splurge a little bit and get an 8 core for that extra headroom. Now for Adobe Premiere Pro, a software that requires at least a 4 core CPU while recommending a 6 core CPU for 1080p. The same can be concluded about Premiere as was for Sony Vegas that it would be nice to get an 8 core for that extra headroom. The conclusion for video editing is that it is recommended to have a 6 core CPU but an 8 core is nice if money allows.

Finally for this target audience is Adobe After Effects. There has been a noticeable change in hardware demand for this software compared to a few years ago after After Effects was recently able to be run on a simple dual core processor. However, Adobe now says that the minimum specs to run it is a quad core CPU. The recommendation from the developers is much different, though. They say that they recommend at least an 8 core CPU. A 6 core can get by but an 8 core is recommended. It has been concluded that the best CPU to go with is an 8 core for this software.

Concluding on the productivity target audience, the data shows that the best CPU overall would be an 8 core CPU. If someone wants to just stick to photo manipulation then a 6 core is perfectly fine and more than enough, or they can future proof by getting an 8 core. The best CPU for video editing is an 8 core, but one can get by with a 6 core. Finally, softwares like After Effects would be by far the best with an 8 core.

Finally, the last target audience is the group of people who want to do it all; gaming, photo editing, video editing, graphic design and streaming. Streaming is the only task that has not been explained. Streaming is recording whatever you are doing, most commonly video games and making a live broadcast of it for viewers to watch. Streaming is not usually too intense unless you are doing a lot of demanding tasks while doing it. Unfortunately, there are not many, if any benchmarks to gauge on what the best CPU for streaming is, so we will have to resort to articles and YouTube videos. An article from techsiting.com says that the best CPU for streaming is a 16 core CPU. While it is the best, it is definitely not the most practical with it sitting at $800. An article from logicalincrements.com says that a 12 core CPU is more than capable of streaming at a high resolution for a little more than 30 percent less. That being said, 12 cores is the best option for streaming.

To reiterate the main question of the paper is, how many CPU cores should I invest in for my computer I want to build. While the first option you could get is a 64 core CPU, it is not always ideal for someone to spend $6,000+ on a single component. That being said, it should be easier to decide which is the best value for your use. Splitting between three main categories and subcategories between each of them has made it easier to look at a glance and say, “I want that one” and just place your order. The summary of all of them is simple. Someone who wants to play high end story games should get a 6 core CPU. Another person who wants to play simple indie games is best off with getting a 4 core CPU along with people who are into competitive gaming. The second category which is productivity is easily summed up by saying an 8 core CPU is the best but if the user is on a tight budget, they could get a 6 core if need be. Lastly, for streaming, the best option is to go and get a 12 core so you don’t break your bank for a little bit of extra performance. Hopefully this paper can help with someone save a bit of money from their CPU and can put it towards another component that needs more attention.