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| Technische Hochschule Rosenheim |
| How to build your own computer |
| English Compulsory Assignment |

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| Anton Bertram pages 1-4, Fabian Ansorge pages 5-7, Maxi |

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As a computer science student you have to understand how the software and the hardware of a pc work together. In order to get a deeper insight we explain how the different parts of a pc work and what their functions are. This assignment is about the motherboard, the storage and the cooler.

The different parts of a computer are communicating over the motherboard. It “provides connectivity between the hardware components of a computer, like the processor (CPU), memory (RAM), hard drive, and video card”1. They cannot work with every processor or memory because everyone is designed for a special type or brand. Most hard drives are not affected by the motherboard thus you can use nearly anyone without considering the type or brand. The modern motherboard include sockets or slots in which one or more microprocessors can be installed, memory slots, a clock generator which produces the system clock signal to synchronize the various components, power connectors which receive electrical power from the power supply and distribute it to the different connected parts of the computer and connectors for hard drives.

The storage, not to confuse with memory (RAM), is a hard disk drive where the data is recorded. In contrast to the memory the storage does not forget what was stored in it after you shut your pc down. “Stuff written to disk stays there permanently until it’s erased, or until the storage medium fails.”2 Computers need non-volatile storage so you do not have to re-do everything you have done when you restart a pc. There are two kinds of storage. The hard drive (HDD) and the solid state drive (SSD). It “can be used to store applications, documents, data and all the other stuff you need to get your work done (and your computer needs to operate)”2. The only reason hard drives are still in use is because they are cheap. SSDs are more performant but you get less space for more money. They “use a special type of memory circuitry called non-volatile RAM (NVRAM) to store data, so everything stays in place even when the computer is turned off.”2. Unlike the hard drive a solid state drive does not use mechanical platter to store something but it uses memory chips instead. Even though they are way faster then the HDD SDDs are still much slower than RAM. Nevertheless a way to improve the performance of a computer is to upgrade your storage to a better one. “Even with plenty of RAM installed, computers need to write information and read it from the storage system – the hard drive or the SSD.”2. There are different speeds and sizes for hard drives. Most operate at 5400 RPM. RPM means that “their central axes turn at 5400 revolutions per minute”2. But you can also get a 7200 RPM drive or a 10 000 RPM drive. And with new technologies we are able to create bigger and faster hard drives. For example instead of air they fill the drive with helium. That causes a reduction of disk platter friction. Or they improve disk density by using heat or microwaves. But SSDs have chips instead of spinning disks so they are still faster and need less power, less space and produce less heat and that is the reason why they are more expensive than hard drives.

A cooler does exactly that what it says. It is “designed to draw heat away from the system CPU and other components in the enclosure” 3 and cool them down. Its purpose is to improve the systems stability and efficiency. Since it is not silent a cooler increases the noise level of your computer. Only two different types of coolers are mainly used in modern pc systems. One is the air CPU cooler. “The CPU cooler may consist of a heat sink (a component designed to lower the temperature of an electronic device by dissipation heat into the surrounding air) or combination of a heat sink and a fan.” 3 Systems which are designed to improve airflow are often used with air cooling. Then there is also the liquid CPU cooling, called liquid cooling. “A liquid cooling system (LCS) circulates liquid through small pipes in a heat sink attached to the processor in your system. As the liquid passes through the heat sink, heat from the hot processor is transferred to the cooler liquid. The warmed liquid is then cycled to a radiator on the side or rear of the casing where it is released into the ambient air outside of the unit. The cooled liquid then travels back through the system to the CPU to continue the process.”4 Liquid cooling systems are more efficient and make less noise than air cooling systems but it can be very complicated to install them and they are quite expensive.

to affect (affected):

The word affect is often confused with the word effect even though they have quite a difference in meaning. The effect is mostly used as a noun meaning the result or impact of something. To affect is a verb meaning to influence something.

to circulate (circulates):

When something circulates it goes around or through something.

non-volatile:

Non-volatile is an adjective mostly used in combination with computer memories. Data does not get deleted even if there is no power.

“Only two different types of coolers are mainly used in modern pc systems.”

The emphasis is placed on the action and there is no action subject and that is why the sentence is written in passive voice.

1 <https://www.computerhope.com/jargon/m/mothboar.htm>

<https://study.com/academy/lesson/what-is-a-motherboard-definition-function-diagram.html>

2 <https://www.backblaze.com/blog/whats-diff-ram-vs-storage/>

4 <https://www.webopedia.com/TERM/L/LCS.html>

3 <https://www.webopedia.com/TERM/C/cpu-cooler.html>

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Finding the right Graphic card is a hard task to master. There are so many things you have to consider while evaluating for the most suited piece of hardware.

First of all graphic cards should not be exponentially more powerful in comparison to the CPU. Since the processor basically tells the GPU what to process, the processing unit can be a bottleneck.

This means that the GPU can handle more than the CPU provides it to process and you are losing a lot of the potential power the graphic unit could theoretically handle.

Another peripheral device you have to combine with the GPU is the monitor. If you are using a display with lower resolution rates, try to consider a less powerful card. An important feature a monitor for high performance displays should have is either NVideas VSync or AMDs counterpart Freesync. These are 2 methods of synchronizing the game’s frame rate to your display’s refresh rate. That is needed to be protected from screen taring, a phenomenon that happens if the GPU sends pictures to the monitor halfway through the displaying process and then the displayed image is teared into 2 or maybe more distorted pictures. If either of these techniques is supported by the display go for the suited manufacturer. Or of course go the other way around and buy a monitor that fits the needs of the GPU.  
But does NVIDEA or AMD make the better video cards? NVIDEA has the most powerful cards at their repertoire. Nothing of AMDs products comes even close to the sheer performance these high end cards offer.

(A rhetoric question was used here to directly speak to the reader. It has no informational gains for him but makes him think about this topic and makes him curious about the answer later given in the assignment.)

But most importantly NVIDEAs top models can handle Ray tracing. This is a method to display a lot more realistic shadows and reflections on surfaces. This is achieved by calculating how light is hitting an object and how it is reflected by it. But ray tracing is definitely not a new technique. Blockbuster companies like Disney and PIXXAR used this for ages. The real innovation lies in the real time calculation capability of the top RTX cards by NVIDEA.

The average price and performance segment has a lot more competition. Both manufacturers offer all kinds of cards here and there is not a great difference in performance. If you consider official tests. But in practical use programs and games are more optimised for one or the other. That is why cards from the opposing brand have some differences in benchmark test for games even though they have comparable specifications.

Furthermore you should take the size of the card into consideration. Some customers want an extra small build and that requires of course a tiny card and a lot of space management. But there are some downsides with a smaller build. The airflow can not be that efficient compared to a larger, more open case. In addition to that smaller variants normally are a bit pricier.

Another important point is that you should avoid using two GPUs in double use. Although there are techniques to link two graphic cards like NVIDEAs SLI (Scalable Link Interface) that links two cards together and provides scalability and increased performance1, double usage of GPUs does not result in double the performance. This means that you should get the best single card you want to afford.

But if you really need to have two GPUs be aware that your motherboard has the respective support and that these options are just for the most powerful builds.

To have a better overview of the contrasts of NVIDEA vs. AMD two cards with a similar price range are compared now. The NVIDEA GTX 1080 and the VEGA 64. Both are around 400€ at the time this paper is written. The GTX 1080 has 3 display ports that should be used for connecting a monitor (other ports will be ignored here), has around 1600 to 1700 MHz frequency and 8GB of memory. The Vega 64 in comparison has two display ports, around a 1400 to 1600 MHz frequency and 8GB memory as well. So both specifications are very comparable. But the AMD variant normally uses a bit less power and therefore is a bit more efficient whereas the NVIDEA can be tightly faster. It really comes down what program you are using it for. Take for example the parallax software to render detailed surfaces. Parallax is a typical performance testing program to get comparable results. The GTX 1080 only gets around 400 frames per second whereas the VEGA 64 gets up to 530 fps. Opposing results are made in a video game like Witcher 3. The GTX 1080 can handle a average fps count to 100 at high settings whereas the VEGA 64 only gets to an average fps count of 90.

1. <https://www.webopedia.com/TERM/S/SLI.html> (28.5.2019)

This leads to the conclusion that neither GPU is superior and neither GPU manufacturer is the best.   
For the future AMD has announced a new technology to attack the best performing NVIDEA GPUs. These cards are probably being available in late 2019 or more realistically in early 2020. This will shake up the GPU market a lot and NVIDEA has to be prepared if they want to continue being the best high end GPU producer.