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How To Build A Gaming PC

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A Short Introduction

Modern games grow more graphic-intensive by the day. Hardware needs to keep up with the increasingly better graphics and more powerful gaming engines. Because of this, gaming hardware becomes obsolete at a tremendous age; what was considered ‘new’ a year or two ago already needs to be left behind.

Every self-respecting gamer needs a computer to match up with the growth of today’s games. Because of the constant upgrading, gaming can become a very expensive hobby. By building our own computer and reducing cost, we can save up to a few hundred bucks.

Apart from the money, building your own PC also comes with customizing options that are never found in store-bought systems. By carefully selecting all your computer’s components, you can create a machine that perfectly matches its purpose, without shortcomings, or abundances.

In this guide we’ll be focusing, not only on what’s out there, but what’s important for a gamer and how to get a PC that really fits your needs.

The Components of a Gaming PC

In this chapter we'll be going over all the necessary components for a computer. The thinking process may be rearranged differently than you'll see in other guides. We'll be emphasizing the parts important to a gamer, and try to build the remaining system around those components.

Video Card

The video card, graphics acceleration card, display adapter, or graphics card is technically a side component. Nevertheless, it's one of the most important parts for a gaming computer.

The graphics card is an expansion card with a GPU (graphical processing unit) chipset, dedicated to graphics rendering. Their main purpose is to render, and output (3D) images to a monitor. Though most motherboards (more about them later on in the guide) have built-in GPU chips, they are normally not sufficient for gaming. Rather, we'd like to use an external component that can be switched and upgraded without need to buy a whole new computer.

This is also one of the main reasons *against* buying gaming laptops. When the built-in GPU chip is outdated, you'll need to purchase everything anew, without the possibility to reuse most of the other parts.

There are a few things we must look at when picking out the right graphics card:

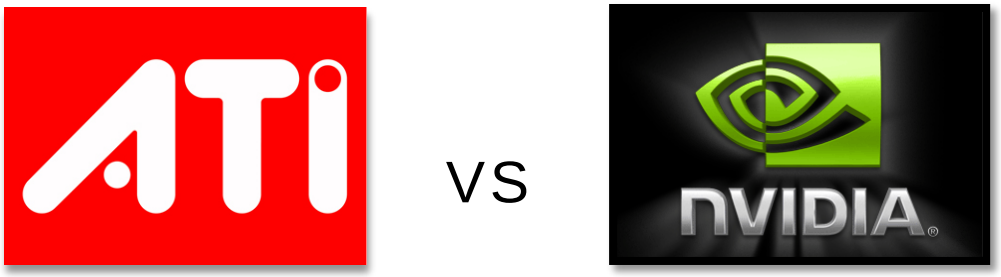
- How powerful a card do I require?
- What additional functionality do I want?

Following the 'there is no overkill' philosophy, those two choices would be easy. However, most wallets require their owner to weigh functionality against cost, and to look at what you need, rather than what you want.

We won't tell you which cards are *good*, because that'd be rather useless and merely a temporary statement. Instead, we'll try teaching you how to look for the good ones yourself.

GPU Manufacturers

The two main manufacturers of GPU chipsets at this moment are NVIDIA[1] and ATI[2] (the graphical department of AMD). It's hard to say which is best, as there is no right answer to that question, although most people prefer to go with NVIDIA.



In shops, you'll often see graphics cards of other makes. These are made by other computer companies, but most of them still use ATI or NVIDIA chipsets.

How Powerful a Card?

When thinking ahead, you should not only buy a card that's powerful now, but a card that'll still be sufficiently powerful in the near future.

Most often the best choice is to buy a high-mid range card. The high ranged cards often have too large a price difference for the graphical superiority they offer, and because proportions are redefined over time, this slight graphical difference will matter even less as the gaming industry progresses again. The only reason to buy a high ranged card is a near-fanatic seriousness about gaming and an abundance in cash.

On the other hand, low range cards, or low-mid range cards that are *just sufficiently powerful enough* at the moment, will be the first to be left behind. The gaming industry won't even require a big leap to get these cards outdated. The gaming business is a hard one, and whichever card you choose, chances are good that you'll be disappointed in the long run. Those *good cards* suddenly aren't all that good anymore, or they cost half what you paid for them a few months ago. This is something you just need to accept, a sacrifice you need to pay.

How do I know which cards are powerful?

Once you've got that understanding, the trick is to be able to weigh those graphics cards against the competition. Not an easy thing to do – contrary to most other components and electronic products, graphics cards can't be judged on one variable. Here, there are tons of factors that play their role.

It's often hard to see which are best solely based on the specifications. There are three things we can learn from reading the back of the box:

[1] http://bit.ly/pPehK
[2] http://bit.ly/4ahmUR

Series – cards are nearly always released in series (e.g. the NVIDIA GeForce 9600 and NVIDIA GeForce 9800 both belong to the 9000 series). What series a card belongs to is important to look at. It's nearly always advised to pick a card from the latest possible series. One of those can sometimes be superior to a *more powerful* card from a lower series.

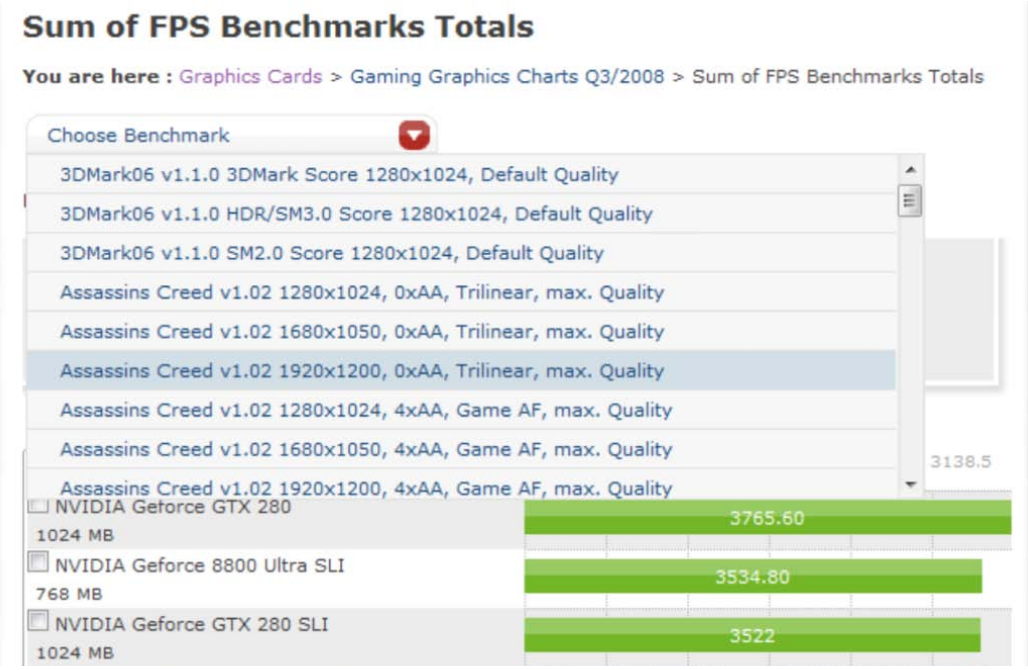
Memory – all cards have a graphics-dedicated portion of memory. Obviously, the larger the number, the better. The memory size is most often stated in the specifications, if not in the card's name.

Suffixes – learning the existing suffixes is also important. In NVIDIA's case, GTX marks the best cards, then GTS, and the weakest cards are marked with a GT suffix. ATI cards use these same suffixes, as well as a few additional ones that are often a little bit more forward. The HD suffix is obviously something you want to look for, as well as X and XTX. To ultimately pick our graphics card, we're going to use this knowledge, and look at benchmarks.

What Benchmarks Are

Benchmarks, in this part of the digital world, are data that show how cards performed during intense graphical testing, e.g. frame rates during a specific game sequence, while running through different screen resolutions. With these, we compare the performances of each card.

The best place to look for benchmarks is probably Tom's Hardware[3]. You can find an extensive benchmark chart and comparison tool here[4], where you can look at the total sum of the benchmarks, or choose to view the results a specific test.



Know that these charts include most, but not all recent graphics cards. For those missing, Google is a great tool.

[3] http://bit.ly/1cKtNO
[4] http://bit.ly/2m6Wgw

Thinking ahead

To *keep in business*, we need to account for recent developments, and hop on any of them as soon as possible. Remaining stuck with older technology is one of the best ways to get left behind in the long run. Hence, there are a few additional things we need to look at.

Output

There are two types of connectors on the market, VGA (the older, analog output) and DVI (the newer, digital output).

Though you can get by with both of them, it'll prove better to take a card with a DVI connector. Apart from DVI's better image, a lot of the newer screens are already stopping the VGA support, and chances are that you'll be stuck with a ton of convertor cables. If you're not tight on money, you can also pick cards with additional S-Video or HDMI connectors.

DirectX

It's also advised to pick cards that have support for the latest DirectX versions (currently DirectX10) if you don't want to miss out on cool new stuff like the latest shading technologies.

Motherboard Interface

There are several possible motherboard connection services. The main ones are:

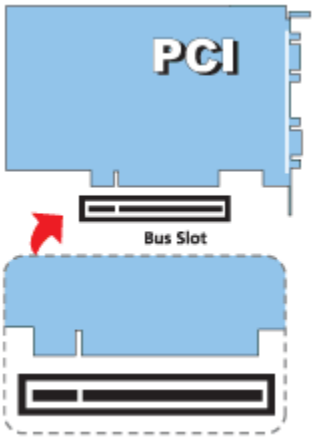


Figure 1 - PCI Bus

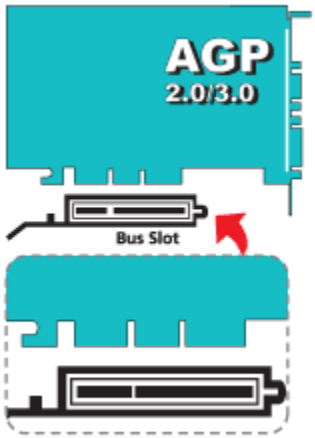


Figure 2 - AGP 2.0/3.0 Bus

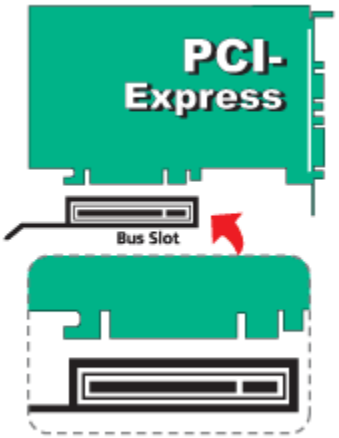


Figure 2 - PCI-Express Bus

- PCI
- AGP x1 / x2 / x4 / x8
- PCIe x1 / x4 / x8 / x16 / x16 2.0

PCIe (or PCI Express) is currently the newest – and fastest – connection interface on the market. You can barely get by with PCI these days, and you'd have to venture off to a flea market if you're still looking to score an AGP card. So go with PCIe - not negotiable.

A PCIe card ensures not only a higher speed, but compatibility with newer motherboards as well. Choosing an older connection might oblige you to go with older motherboards, and thusly overall older apparel.

Write your slot on the component reference guide at the end of the guide once you've made a pick.

SLI and Crossfire

Other books might dedicate a chapter to this. Here, I'm just barely going to lay out you the basics. In my experience, people who are interested in this usually don't need, nor read these guides. If you're really interested after reading this, be sure to hit Google.

If you *really* want your gaming PC to kick some polygon ass, you won't be satisfied with one those mid-, or high-ranged graphics cards they try to sell you. At least, it won't be enough. SLI and Crossfire enables you to take multiple of those cards, and make them work together for a (hopefully) optimal performance.

You will need a SLI-, or CF-compatible motherboard. This basically means that it's got two graphics card slots. But be advised - it really pays to spend some money here, as older motherboards tend to divide the maximum data stream over those two PCI Express-slots, thereby making sure that neither of those are used to their full extent. If you go this path (and know that this is hardly needed to enjoy graphical supremacy), you'll end up paying extra for nearly all those other components in your system. Conclusion? Only for the real pro's.

Finally - Picking a Card

Make sure you've understood all above, and that you have a clear idea of what you're looking for. You should already be sure of the interface and output and have a semi-steady budget limit. With that in mind, you need to start looking at benchmarks and weigh off your options. A good pick won't cost a fortune, but still scores relatively high in the benchmarks.

Processor

The CPU, central processing unit, or simply processor, is the most central part of every computer. It's the communicating agent between all your different computer components. When one part of your system tries to send data to the other side, it always passes by the **C**entral **P**rocessing **U**nit – this is why having a decent CPU is of the innermost essence. A slow CPU can and *will* make sure that not all of your components are used to their full extent.

Like with the graphics cards, again we have two choices: AMD[5] and Intel[6]. Both are valid options and popular in the computing community. Nevertheless, Intel still seems to be the more popular candidate. Don't be confused by the numbers they tend to put in their product names, those aren't specs, but low-level competition.

Below we'll review the different aspects that you'll need to look at upon buying a CPU.

Although you'll need to keep your budget in check, I'd advise you to look for a high-midrange or high-range CPU if you want it to last at least 3 or 4 years. You'll often be able to make a decent pick while hovering around 100 bucks.

When picking a CPU, you'll also be picking a certain CPU socket. Doing so will limit - and thusly partly determine - your future motherboard possibilities. You'd do good writing that CPU slot on the component reference chart we've included at the end of the guide.

Clock (Cycle) Speed

Clock speed, expressed in **G**iga**H**ert**z** is how we measure the speed of the CPU. It's the size of the supported data stream, or in other words, how fast the CPU can handle information. Obviously, if your clock speed is too low, your other computer components will be held back.

Clock speed can be used to judge two processors from the same series. However, because two other factors - cache and bus speed - play a reasonable role as well, end performance may deviate unrelated to the clock speed.

Take a look around and see what's the current norm. If you look at current game requirements, you'll quickly be able to make out if you're thinking too low, or aiming too high. At the time of writing, you should be well beyond 2GHz.

Cache

As clock speed is the main factor, you don't have to spend too much time digging into the cache of every processor. That's right, **you don't *need* to know this**, as with most specs, a higher number means a better processor, but it'll help you understand how some CPU's can be slightly better, and *why*.

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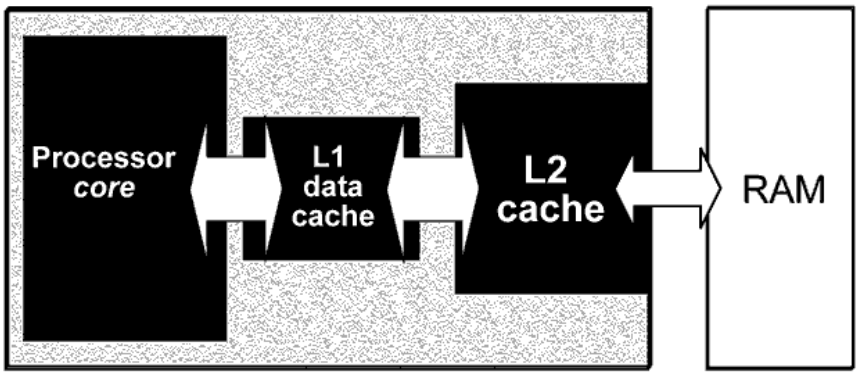
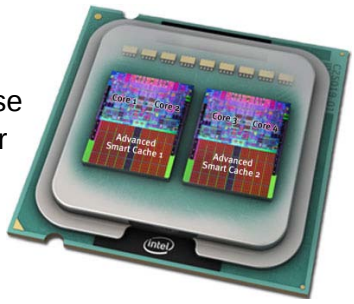
[5] http://bit.ly/EuKFx
[6] http://bit.ly/tZTks

Because some data needs to be accessed repeatedly, it can be inefficient for the CPU to reach (far) beyond itself, time and time again. This is why all CPU's these days have small memory deposits, further divided into a first (L1 Cache), second (L2 Cache), and very occasionally third (L3 cache).



The L1 cache holds the most frequently accessed data, followed respectively by L2 and L3. The CPU always searches the L1 cache first, before going on to the other(s). To create the most time-efficient searches, each deposit is distinctively smaller than the next. Larger caches means more data storage, but also means your CPU will spend a longer time strolling around before it can 'get on with it'.

Multiple Cores



An increasingly popular trend are the multiple-core CPU's. These host *several* semi-independent agents, to allow a faster communication between different computer components. It's like having two people at a desk instead of just the one fat guy. This technology is more and more present in new CPU's and it's highly advised to go with the flow on this one.

Although we started out with two, we've already moved on to four cores in a single processer. For a casual gamer, a mid- to high-range dual core is an advisable and economic decision. However, the quad core CPU prices have been going down, and this is now a very realistic decision as well. If you can afford it, go with it. Note that when you have a quad core processor of 2 GHz, you'll now have four cores, operating at a 2 GHz clock speed!

> **HINT** In the Intel camp, *'Core 2'* is just the name of the CPU series, so you'll have to look for **Core 2 Duo** for dual core and **Core 2 Quad** for quad core. Their latest series **Core i7**, features a minimum of 4 cores.

Boxed versus Non-boxed CPU's

Technically, boxed CPU's are the retail ones, and the ones Intel or AMD wants you to buy. And rightly so, because contrary to non-boxed processors, boxed CPU's include a heatsink and/or fan, often not included in the former and thusly making extra costs and problems. Play safe, go boxed.

Motherboard

The motherboard is the battleground of your computer. It'll be the host of all your hardware components and will allow them to interact. Below we'll review the things you'll have to consider upon picking yourself a motherboard.

CPU Socket and Graphics Card Slot

Your choice of motherboard will not only be limited by your budget, but also by your previous choices of graphics card and CPU. Although most people would do it the other way around, we'd rather limit the massive array of motherboards, than those former two components.

If you've written down those two slot types, you can eliminate a few motherboards, and move along.

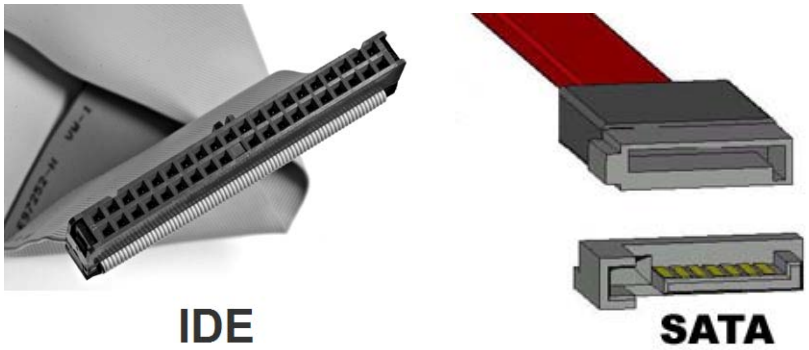
Some newer CPU's are not yet supported by all motherboards. If you're playing around with multiple cores, **be sure to check CPU compatibility - even *if* the socket is correct**. This information should be included on the motherboard's page on all decent web shops, and available in most hardware stores. The increase of instantly available information is one of the reasons why shopping online pays.

Additional Slots

Obviously you're planning to add more components than just a CPU and graphics card. If so, you should make sure that your motherboard of choice not only has the *right*, but also *the right amount* of slots.

PCI and PCIe slots are for extension cards in general, not solely graphics cards. If you want to add an extra internal network card, TV tuner, sound card, or USB HUB, you'll need a few of these to spare. How many you need depends on your requirements, and you probably know the answer to that question yourself, but a minimum of three is advised.

IDE and S-ATA are used to connect hard drives and CD/DVD/Blu-Ray drives. If you want to reuse old parts from a previous computer, you should check the connections you're going to need. In an open scenario, focus on the faster S-ATA connectors. The production of IDE apparel is already dwindling and will soon come to a full stop.

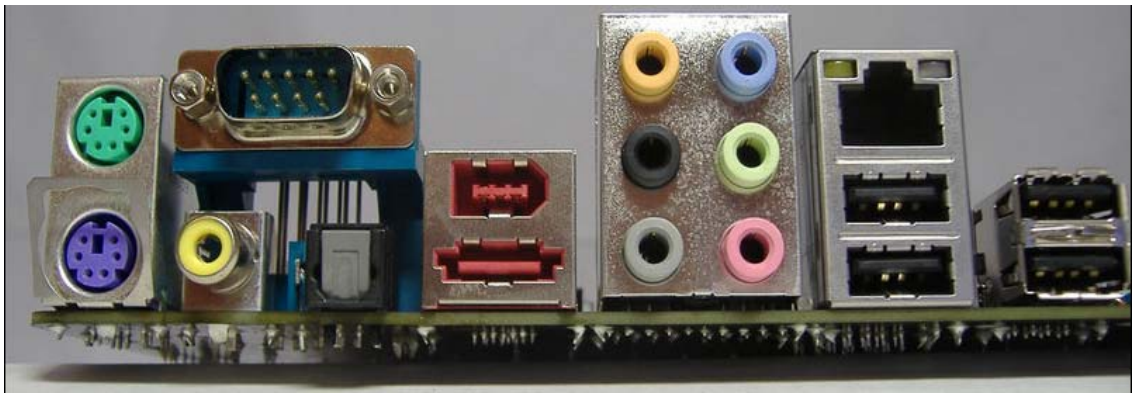


USB and FireWire can be used to connect external devices. FireWire is less used, but you should have your fair amount of USB ports. Both can be increased in number by purchasing special extension cards (see PCI/PCIe).

Internal Sound and Network Functionality

The functionality of some of those extension cards we discussed earlier can already be incorporated in some motherboards. Sound- and network cards are the obvious examples.

You'll hardly find a motherboard without a built-in network card these days, and rightly so, because nearly *every* computer is intended to connect to the internet. The sound card is often a bit less evident. True, you'll find sound functionality in all motherboards, but if you keep your eyes open, you can have a built-in, 5.1 surround system for just a few extra bucks. Unless you're going to use a headphone, you'll need this if you're serious about gaming.



RAM

RAM, short for Random-access memory, can be best described as the 'temporary memory'. It's where data gets stored if it's relevant for just a short while, contrary to the almost static data on a hard drive.

The advantage of RAM is that, due to its architecture, the transfer speeds are infinitely faster than that of a hard drive. On the downside, it is also infinitely more expensive per GigaByte, and because the data is stored by means of electrical charges, information cannot be stored *or maintained* unless your computer is running.

If you want applications and games to run smoothly, you'll need to provide enough RAM for them. With a shortage of RAM, games will be unable to use large amounts of data, thereby causing lag and visual deficiency.

How much RAM do I need?

With the price of RAM these days, you almost cannot buy too much. However, you must know that once you pass the limit of 4GB, you will no longer be able to operate in a 32bit environment. The future lies in 64bit, but 32bit is at present still far more stable and more widely supported.

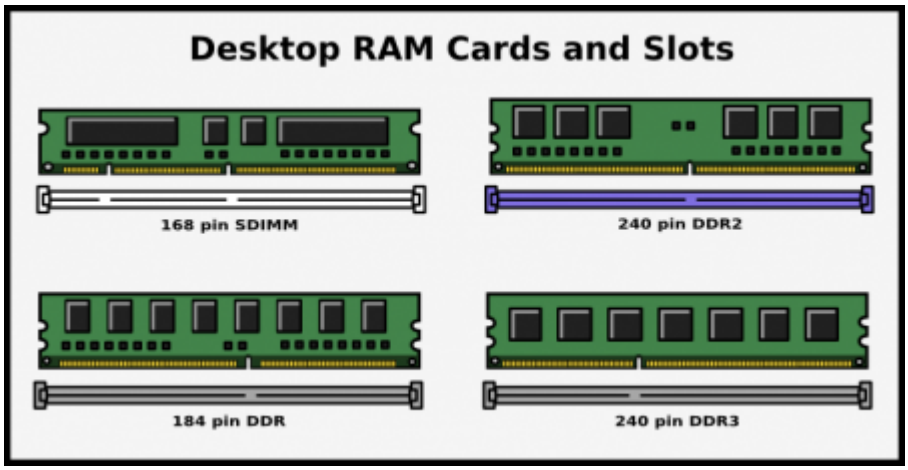
My advice would be to stay below 4GB until 64bit systems are more stable - especially concerning games. However, you should certainly have a good 2-3GB at your disposal. The times that we were talking 'MegaBytes' have long since passed. By the way, with most new motherboards having up to four RAM slots, you can just expand your RAM in the future.

DDR, DDR2 and DDR3

Currently, we make three distinctions in the active SDRAM standard; DDR, DDR2 and DDR3. In plain English? Three successors of the same RAM-type. Each generation has managed to develop a higher operating frequency, and a lower power usage. Although DDR has been left behind, DDR2 is the current standard, while DDR3 is emerging slowly.

DDR SDRAM Standard	Frequency (MHz)	Voltage
DDR	100-200	2.5/2.6
DDR2	200-533	1.8
DDR3	400-800	1.5

At this time, DDR3 is still too expensive for those slight differences, so you should go with DDR2. You'll also be glad to hear that DDR2 is lowest in price, both below DDR3 and the older DDR.



Different RAM Modules

After the DDR-generation distinction, there'll be another choice to make. When looking around, you'll encounter different types of RAM, more specifically DDR2-400, -533, -667, -800 and -1066 (in the case of DDR2).

These indicate the data transfer speed, more specifically, the number of transfers per second. They also vary in size, so most motherboards will only support one or two standards. If you've chosen a relatively new motherboard however, there's little chance you'll be caught off balance.

Although it's ill-advised to use low-range RAM, both mid-range and high-range RAM standards should suffice for the majority of people, if not everyone.

Power Supply

A computer's power supply is both one of the simplest and most delicate component. This is due to one simple reason. If your power supply goes haywire, it could fry some, or even all of your precious components with it. Don't worry, this doesn't happen very often - just be sure you buy from a decent make, not a low-budget eastern-webshop-gadget without a manufacturer.

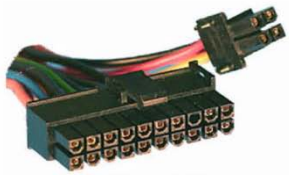
The Wattage

Above all, you should make sure that your power supply has enough horsepower to animate your system. Most components mention a minimum wattage in the specifications. This is a simple matter of adding numbers.

Always leave a wattage margin, additional to what you think you need. A current-day gaming computer should have at least 500 Watt.

The Right Connectors

As you might've noticed, a computer's power supply has near to a dozen different connectors. A lot of your components and other computer hardware might need different connectors. Check the specifications and make sure you've got enough of each. If you end up short, you can always head to eBay for convertors, but that's a bother you want to avoid.



20/24-Pin ATX Connector

4-Pin 12V P4 Connector

Molex IDE Connector

Floppy Drive Connector

SATA Power Connector

HDD's and DVD-RW's

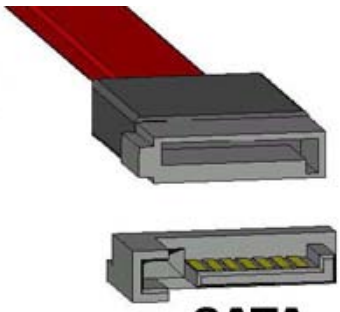
The Hard Drive Disk (HDD) is where you store your data, and without it you won't be able to pull anything out of your system. If you're building a gaming PC, you might want to invest in a slightly bigger storage, as multiple installations can quickly fill up your system. Where laptops require 2.5" disks, you'll need a 3.5" one for your desktop (gaming) PC.

Your DVD-R, DVD-RW, or perhaps even Blu-Ray-RW device will allow you to read and, depending on your choice of device, write optical media. If you plan to install games on your system, and I take that you do, you're probably going to need one or two of these as well.

IDE versus S-ATA

As discussed before, there are two possible connections for HDD's and DVD drives; IDE and S-ATA. Apart from buying your (right) motherboard, you also need to keep a watchful eye when ordering new components. IDE (also known as PATA) is the older of the two. It's not only slower, but also increasingly less supported. If you're buying new, it's highly advised to go with S-ATA.

IDE



SATA

Case and Casemodding

Technically not a component, but you're probably going to need one if you plan on building that gaming PC.

Although some people will prefer a case like displayed on the manual's cover, complete with flashing lights and a puff of smoke whenever you pull off a one liner, most people will prefer a simple, plain case. It's up to you - give it some personality, or, well, don't.

Mini, Midi, Big

There are three standard 'tower' sizes; mini, midi and big. Unless you're doing something special, you're going to need a Midi Tower. Big towers are intended for people who want to put a little extra in their computer, midi if you're sticking to the minimum number of components and want to save space.

Fans and Ventilation

An important thing to look at is the ventilation of your case. You need to consider the number of fan slots, as well as how many are already built in. It's often easier to pay an extra ten bucks and have some decent ventilation already installed. Otherwise that's an extra component you'll have to order.

Casemodding

By no means required, but if you want to impress your friends (or yourself, for that matter), you can make a few tweaks without spending too much money.

Find yourself a fancy case, perhaps even with one side out of Plexiglas. You can buy fans with colored LEDs in most webshops and hardware stores for just a few bucks, and caselights and luminous cables if you want your own red light district.

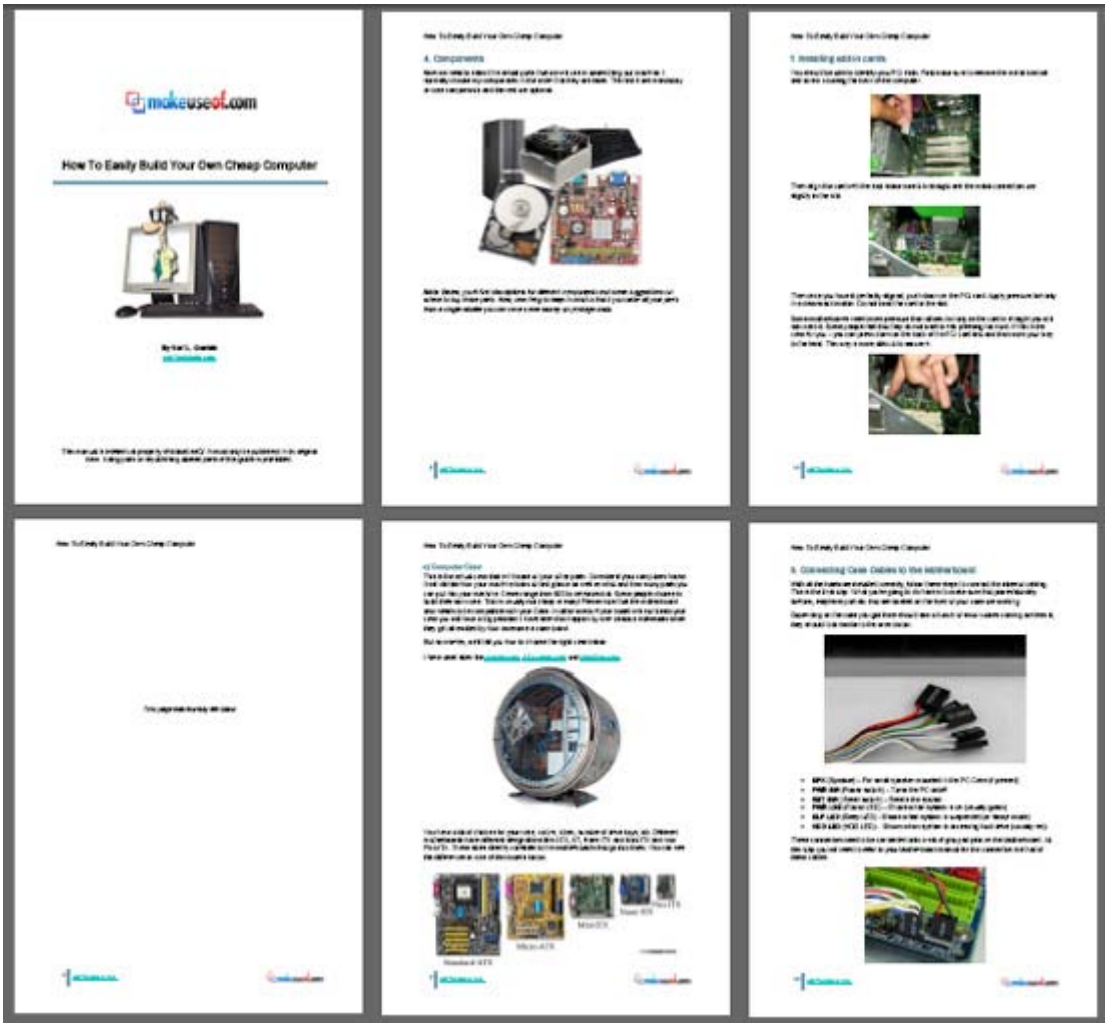
If you're willing to take out the power tools, you can do some pretty cool stuff, but I won't be able to help you with that in the slightest.

Actually Building Your System

In this guide, I wanted to focus primarily on familiarizing you with the different computer components, and getting to look at them from a gamer's perspective. We won't be telling you in detail how to put your system together.

If you're technologically gifted (read: a nerd), the kind of guy or gal that usually skips the product manuals and has broken enough things in his/her life to become somewhat 'experienced', you might be able to do this without help. After all, it's basically just tightening a few screws and connecting a few cables.

If you're not certain, you shouldn't. It's that simple. You don't want to go breaking all that pretty stuff you just bought. MakeUseOf has written a guide in the past about building your own system, and will almost literally hold your hand during the process.



Download **The Idiot's Guide to Build Your Own PC**[7], written by our very own Karl Gechlik.

Instead of repeating ourselves, we're going look at other hardware that every gamer needs.

[7] http://bit.ly/3gaVav

External Computer Hardware

Sure, you've got your computer, but what are you going to do with it without a display, without a mouse? In this chapter, we'll be focusing on the external computer hardware, the last things you 'need' to run that gaming system.

Computer Display

Although a crucial part of your system, you've got a really wide choice here. There are a few different classes of displays, but you can follow your personal opinion for 100% here. Although the joy of gaming might be partly visual, it is definitely not a requirement to buy the best display of the market. On the other hand, it'd be a waste to spoil the visuals of your graphics card with a mediocre screen.

CRT, LCD, TFT

When you're in the market for a display, you'll be buried beneath terms like this – so it pays to know what they mean.

CRT is the oldest of the bunch. Those are the classic, bulky displays, which are often thicker than they are wide. The colors are often of a lesser quality and the image may be slightly distorted near the sides. On the plus side, you can already obtain one of these for five to ten bucks. So if you feel you've been spending quite enough money already, go CRT.

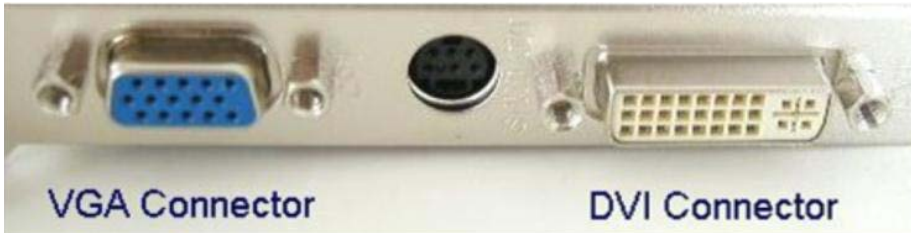
LCD and TFT are the flat screen monitors, the latter being an improvement on the original LCD. The (not excessive) difference lies in price and color quality, but both are infinitely better than CRT. If you accept that a good display deserves a bite out of your budget, take one of these for the eye-candy and so as not to be left behind.

3:4 versus 16:9

This is the difference between the classic ‘square screen’ (3:4) and widescreen (16:9). Like TV-sets, most new displays have been following the trend of widescreen. Although this is a personal choice, I suggest you to go with it. Widescreen displays will prove better when watching a movie, but also when playing a game.

VGA versus DVI

VGA and DVI are two display connector interfaces. The older of the two, VGA, is an analog connection and will be known by many. Rising up is DVI, the digital alternative. DVI bests VGA and will allow better image quality and a higher resolution.



DVI is the better choice, but you’ll have to take into account which output your graphical card has. It’ll do little good to buy a DVI display for a VGA graphics card.

Mouse

Contrary to what most people think, serious gamers don't *have* to spend a hundred bucks on that gaming mouse. It all depends on how you intend to use it. For everything except First Person Shooters, you're probably well off with an optical mouse of five to ten bucks. Believe me; these will work a lot better than you'd expect.

For more serious gamers, and those planning to compete in First Person Shooters, that *gaming mouse* might be considered. The companies with the best price-quality ratio are probably Logitech[8] and Razer[9]. For 50 to 100 bucks, you'll have a pretty good optical mouse, with adjustable speed and a few custom buttons. Personally, I use the Logitech MX 518.

A special gaming mousepad is something everyone should consider. It'll maybe cost you fifteen instead of two bucks, but the difference is incredible. Take a look at SteelSeries[10] for some of the best mousepads.

Keyboard

Although there are special gaming keyboard, only a minority of people will end up using them. In general, I'd advise you to buy one that 'feels' good. Instead of buying online, go to your local hardware store, and start typing away on the stalled-out keyboards. It doesn't matter what make, or for what purpose it was intended, it mostly matters that you feel good typing on it.

If you've got the choice, you might also want to look for keyboards with customizable buttons. They aren't a necessity, but can be quite useful during games.

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[8] http://bit.ly/Jl8sO
[9] http://bit.ly/byW5I
[10] http://bit.ly/1WUQsF

Audio

The importance of a decent audio installation once again depends on the kind of games you're going to be playing. For everything except First Person Shooters, you can follow your personal preference. In some other games you use your ears as well as your eyes, and a ten-dollar 2.0 audio set won't suffice.

Stereo versus Surround

As I'm sure most of you know, stereo only has two sources of audio. Surround (5.1) has five sources of audio (front-left, front-right, center, rear-left and rear-right) and a subwoofer.

Surround sound will make you feel like you're part of the action. In games, you'll be able to *hear* where the action's coming from, and if you're pretty decent at it, you can make good use of it. That said, the prices of surround sets have been in steep decline and are now affordable for the everyday Joe. I grabbed mine for 30 bucks, and although most audiophiles might frown at the make, I've always been perfectly satisfied with it.

Headsets

An alternative to full surround – often even bettering it in sound quality and accuracy – are headsets. No, not those little fragile things that barely fit on your ears. I mean bulky over-ear headsets. If you go with a decent make, you pay some extra money, but you're paying for quality. Good headsets will give you the advantage of full-surround sound.

Another advantage of decent headsets is that they often come with decent microphones. If you're playing online – FPS or MMORPG – It'll be a huge advantage to be able to communicate with your teammates or clan; in-game or using Ventrillo[11] software.

Good headsets can cost you a bit of money, but it's worth looking at Logitech and SteelSeries models. I bought mine for 80 bucks, but that's a great deal more than most people pay – 30 to 50 is a very reasonable price.

[11] http://bit.ly/KAKMr

Components Reference Chart

Graphics Card

Full Name	Memory (MB)	Slot Type	(Notes)

CPU

Full Name	Clock Cycle Speed (GHz)	L1 - L2 - L3 (KB)	Slot Type	(Notes)
		- -		

Motherboard

Full Name	Graphics Card Slot	CPU Slot	(Notes)

#	PCI	PCIe x1	PCIe x16	IDE	S-ATA	USB	FireWire	Supported RAM Standards	Maximum RAM (MB)	Soundcard	Network

Apparel

RAM Type - Size	Power Supply (W)	HDD Size - Connection	DVD-RW Connection	(Notes)
-		-		

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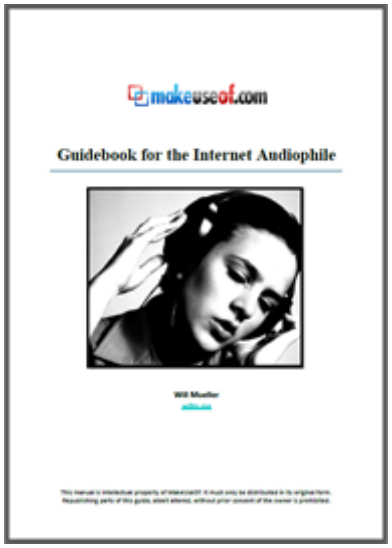

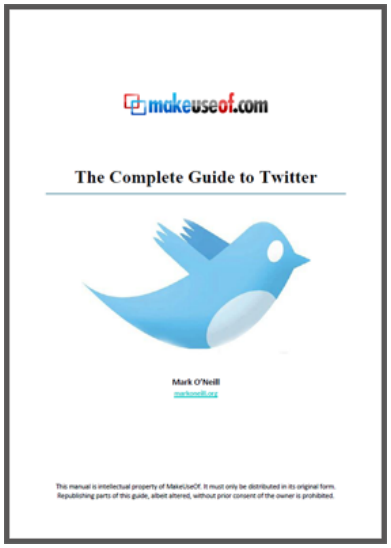

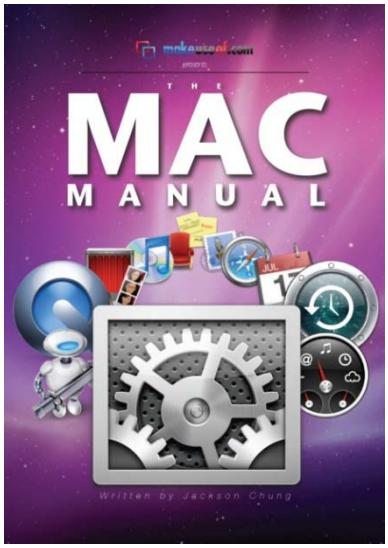

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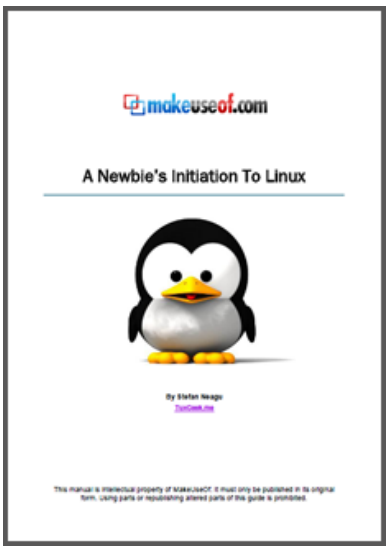
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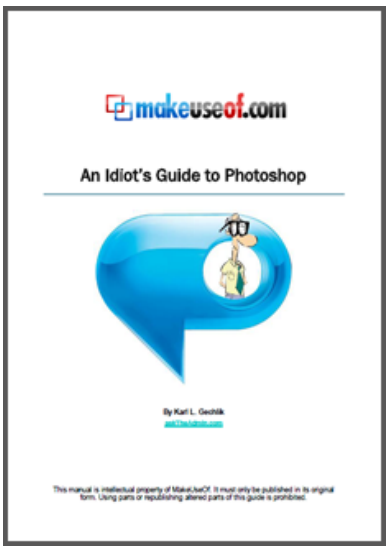
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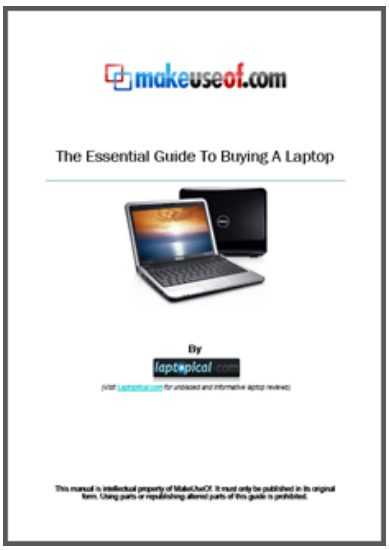
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