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High-Speed Graphics Bus
AGP or PCI Express

CPU

Memory Slots

Clock Generator

Front-side bus

North Bridge (Maybe inside CPU)
Older names
Memory Controller Hub
Graphics and Memory Controller Hub

Internal bus

PCI Bus

South Bridge
Other names
Intel: I/O Controller HUB
AMD: Fusion Controller HUB

Super IO
Serial Port
Parallel Port
Keyboard/Mouse

BIOS
UEFI

Low Pin Count (LPC) Bus

Components of a Motherboard

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In this video from ITFreeTraining, I will look at the components of motherboards. In later videos I will look into motherboards in more detail. When you start configuring BIOS settings, it helps to have a basic understanding of the motherboard. Understanding the motherboard will give you a better understanding of what effect changing the BIOS settings will have.

Basic Components

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0:21 To start with, I will look at the CPU. The CPU executes the code that allows software to run. In order to achieve this, the CPU needs to communicate with other devices. In order to do this, the CPU is connected to the front side bus. The front side bus was first used in the early 90's and continues to be used in computers today.

The front side bus is traditionally connected to a chip called the North Bridge. This may also be called the Memory Controller Hub or the Graphics and Memory Controller Hub. Later in the video we will see how you can spot the North Bridge chip on a motherboard if you know what to look for.

On newer motherboards, the features of the North Bridge chip have been moved into the CPU and thus there is no North Bridge chip at all. For the purpose of studying for the CompTIA exam, the North Bridge will reference a distinct element of the motherboard that accesses memory and high-speed devices. More on that in a moment.

In order to keep the CPU in sync with the North Bridge, the motherboard has a clock generator. The clock generator produces a timing signal which is used to synchronize the computer's operations. This timing is crucial for the front side bus, but it is also used for other operations on the motherboard.

The CPU requires data in order to operate and thus the memory slots will be connected to the North Bridge or directly to the CPU. Nowadays, the video card is also a high-speed device and may be connected directly to the CPU. Newer motherboards will use PCI Express for the video card while older motherboards will use an AGP slot.

Depending on the motherboard, other devices may also be connected to the North Bridge. For example, USB 3 or SATA 3. However, lower speed devices like USB 2 and SATA will not. It is done this

way because you have limited bandwidth in the front side bus, so you essentially want the fastest devices connected directly to it.

In order to connect lower speed devices, the computer uses an internal bus that is connected to the North Bridge. This internal bus is also connected to a chip called the South Bridge. The South Bridge is connected to lower speed devices. Lower speed devices don't have the need to transfer data as quickly. Thus, there is no need for them to be directly connected to the North Bridge or the CPU.

The South Bridge will connect to devices like the PCI bus, mass storage and audio devices. Not all devices are connected to the South Bridge. There are still some devices that (when compared with everything else in the computer) are very slow.

To connect these devices, the computer uses one last bus. This bus connects the South Bridge to the last remaining devices. On older motherboards, this was achieved by a chip called the Super IO chip. The Super IO chip connects the serial port, parallel port, mouse and keyboard. In the very old days of computing, these devices had separate chips to connect them. As computers improved, all these functions were combined into the one chip called the Super IO chip. The Super IO chip was later included in the South Bridge.

The BIOS or UEFI chip is also connected to the South Bridge. Essentially, when the computer starts up, the code from the BIOS (which is not that big) is copied to memory and thus you don't need a fast connection to it.
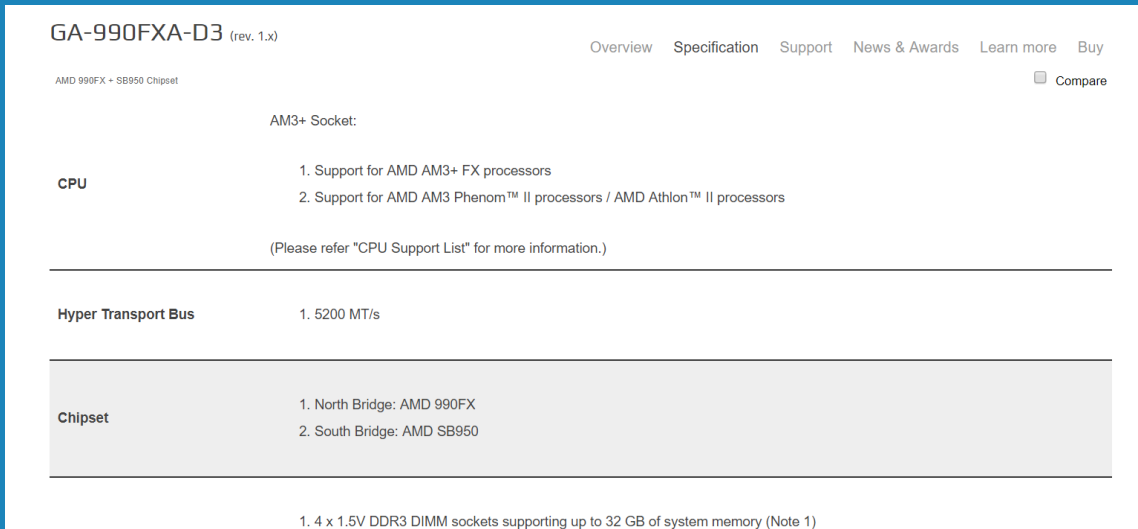
Those are all the major components of the motherboard. In later videos, when I start looking at BIOS settings, you will start to understand why certain settings are found in certain places. Also, when certain settings are configured, other settings may not be available. For example, often motherboards will have a limited number of USB 3 ports. If the USB 3 ports are connected directly to the North Bridge, you can start to understand that the limited number of USB 3 ports may be caused by a limitation of the North Bridge.

You may also see that a certain number of SATA ports may be connected to the North Bridge while the rest are connected to the South Bridge. This will become clearer when you see that some ports support SATA 3 or certain RAID configurations. Once you start understanding how devices are connected, it starts to make sense why certain settings are available when others may not.

To get a better understanding of how these components work on the motherboard, I will have a look at a few different motherboards.

North Bridge and South Bridge Example

- ## Gigabyte GA-990FXA-D3

GA-990FXA-D3 (rev. 1.x)

AMD 990FX + SB950 Chipset

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| CPU	AM3+ Socket:
	1. Support for AMD AM3+ FX processors
	2. Support for AMD AM3 Phenom™ II processors / AMD Athlon™ II processors
	(Please refer "CPU Support List" for more information.)
Hyper Transport Bus	1. 5200 MT/s
Chipset	1. North Bridge: AMD 990FX
	2. South Bridge: AMD SB950
	1. 4 x 1.5V DDR3 DIMM sockets supporting up to 32 GB of system memory (Note 1)

4:59 The first motherboard that I will look at is a Gigabyte motherboard that contains a North Bridge and a South Bridge chip. If I have a look at the specifications for this motherboard, you will notice that the North Bridge is listed as AMD 990FX and the South Bridge as AMD SB950.

Different chipsets have different functions and support different hardware. Some chipsets have additional features like supporting different levels of RAID. When looking at different motherboards you will find that motherboards with the same chipset tend to have the same features. Thus, when looking for a motherboard, sometimes you will want to look for a motherboard that has a particular chipset to meet your needs.

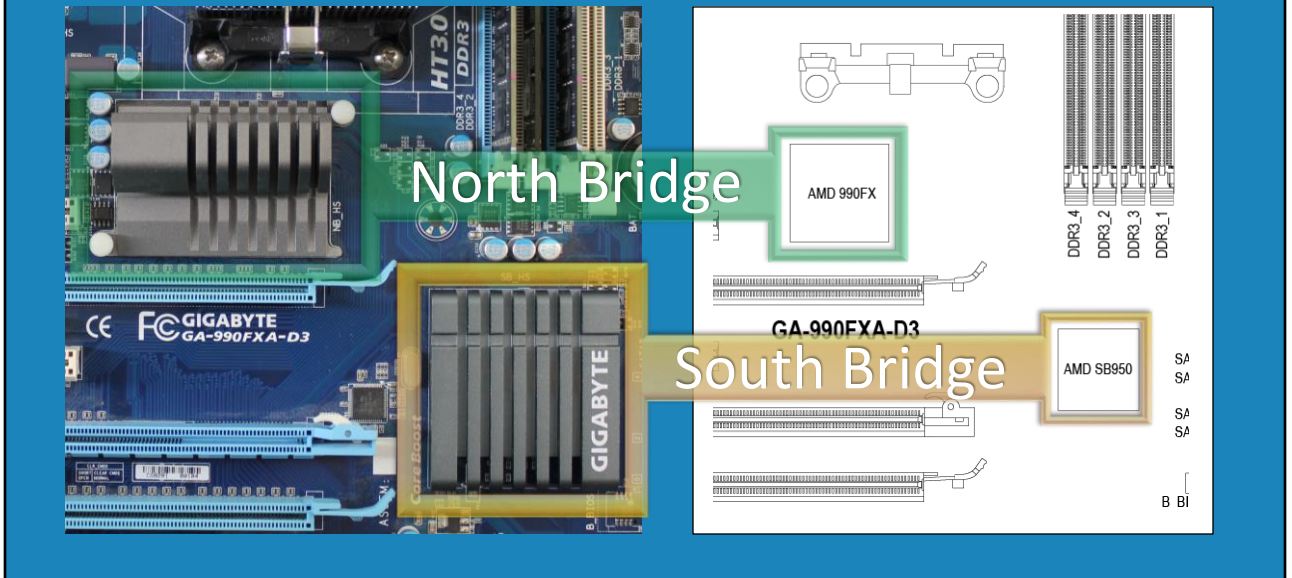# North Bridge and South Bridge Example
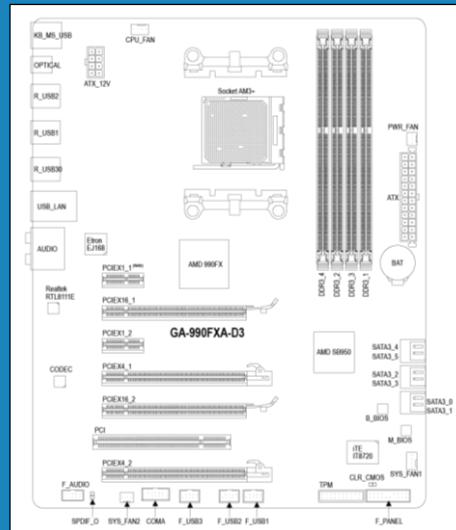
5:43 When looking at a motherboard, you should be able to identify features on the motherboard. Shown here is a photo of the motherboard. You will get used to finding particular components, connections and chips on the motherboard; however, sometimes they will be difficult to find. Particular chips like the BIOS are very small and can be difficult to spot.

If you look in the manual for the motherboard, you will often find that there will be a diagram of the motherboard called a motherboard diagram. The motherboard diagram will show where the main chip, sockets and connectors are located.

To locate the North Bridge chip on a motherboard, have a look around the CPU and the memory slots. The North Bridge chip will always be located close to the CPU and memory modules. The reason behind this is, that from an engineering prospective you want the distance between them to be as short as possible. Having them close together means shorter electrical circuits which means less problems with signal degeneration or interference. This is important for the North Bridge because it runs at very high speeds.

In contrast to this, the South Bridge will generally be found further away from the CPU. Since it does not run as fast as the North Bridge it does not need to be as close to the CPU.

# North Bridge and South Bridge Example

7:00 On this motherboard it is easy to spot the North and South Bridge due to them both having a rather large heat sync. If I zoom in I can get a better look at the North and South Bridge. If you have difficulty finding them, refer to the manual, as this will help you locate both chips.

The North and South Bridge are referred to as chipsets. Even though there is only the one chip, each chip works with other chips to manage the flow of data in a computer. In the old days, a motherboard could use both Intel and AMD chip's. However, as the CPU manufacturer added more features to their CPU this made them incompatible to be used with the one chipset. Now days, you will find that a chipset will be designed to only work with Intel or AMD CPU's.

In this particular example, notice that the North Bridge is referred to as one name and the South Bridge is given a different name. Both have different features, but need to work together. The next important point to consider is, what components are connected to the North and South Bridge?

Block Diagram
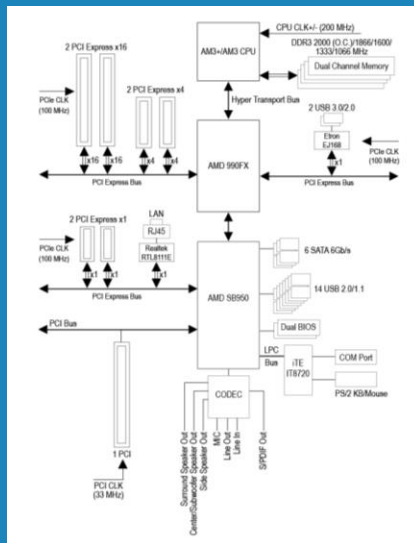
8:06 Your motherboard manual may include a block diagram. This is different from the previous diagram as it shows how the chips and connectors on the motherboard are connected together rather than the physical location of chips and connectors. Unfortunately, not all motherboard manuals include a block diagram.

On some motherboards you may find that certain components are connected to the North Bridge while others are connected to the South Bridge. You may find that certain features such as RAID functions may require certain SATA ports to be used. High-speed components will be connected to the North Bridge while slower components will be connected to the South Bridge. Looking at the block diagram will let you know which devices are connected where. Let's have a look at a different motherboard to highlight some of these points better.

Single Chipset Example

- MSI X79A-GD45 (8D)

X79A-GD45 (8D)

PRODUCT SPECIFICATIONS	DETAIL	DATASHEET

SOCKET	2011
CPU (MAX SUPPORT)	i7
BASECLOCK/HYPER TRANSPORT	100MHz
CHIPSET	Intel® X79
DDR3 MEMORY	DDR3 1066/1333/1600/1800*/2133*/2400*(OC)

8:46 The next motherboard that I will look at is the MSI motherboard that has a single chipset. This motherboard only has the X79 chipset. The CompTIA exam will refer to the North Bridge and South Bridge, however this motherboard has only the one dedicated chip, so is this the North or South Bridge?

CPU North Bridge Functions

- North Bridge functions moved into CPU
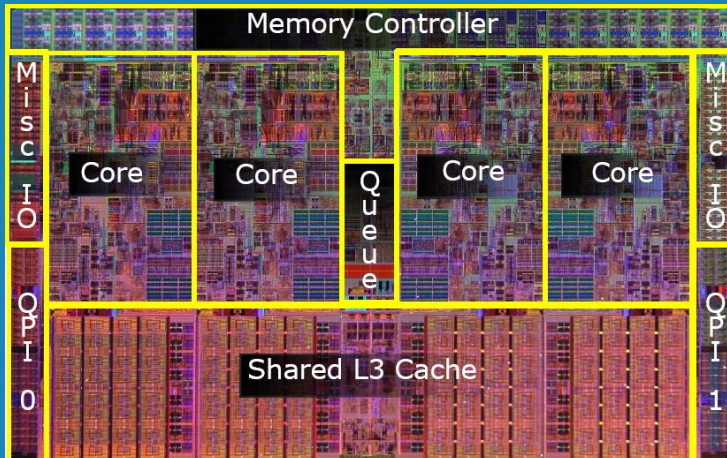
9:08 In order to achieve better performance, you will find that the traditional functions performed by the North Bridge have been moved into the CPU. In this example, you will notice (at the top) the section for the memory controller. Traditionally, the North Bridge chip performed the role of accessing memory in the computer. If the CPU handles this function, there is no need to have a North Bridge chip on the motherboard. Let's have a look at the motherboard to see what effect this has.

Single Chipset Motherboard

North Bridge Example
By contrast North Bridge
close to Memory/CPU/PCIe

South Bridge

9:36 On this motherboard there is only the one chipset. As before, it is easy to spot as it has a heat sync on it. Since the North Bridge functions are performed by the CPU this chip is essentially the South Bridge.

On this particular motherboard, there is also a heat sync at the top of the motherboard with "MILITARY CLASS" written on it. This may lead you to think that this is the North Bridge. Remember, the North Bridge connects high-speed devices. This includes memory, video cards or other high-speed devices. For this reason, the North Bridge will often be placed in close proximity to memory, the CPU and the video card. In this case, it is in close proximity to the memory and the CPU, but not the video card. I also had a look under the heat sync and there are a number of components for regulating power rather than being on a single chip. Thus, there is not a North Bridge under this heat sync. Once you start looking at more and more motherboards you will get better at quickly spotting the North Bridge and South Bridge chipsets.

The next point to consider is the location of the South Bridge. You can see that even though it is close to half of the memory slots it is a fair distance from the others. Also, it is a reasonable distance from the CPU, but is still close to the PCI Express slots.

If I have a look at the North Bridge example, you can see the North Bridge is quite close to the CPU, memory and the PCI Express slots. It is done this way because it runs at such a high speed there are increased transmission errors the further the components are away from each other.

You should now be able to spot the North Bridge and South Bridge on a motherboard or to note the absence of a North Bridge. All modern motherboards use this design. The CompTIA exam will make reference to the North and South Bridge. Try to think of it more as the functions each provides rather than them being on specific chips. This is because some CPUs will perform all of the functions of a traditional North Bridge. If this is the case, there will be no North Bridge chip on the computer.

This video has looked at the basic components that make a motherboard work. I hope you have found this helpful. In later videos, I will have a closer look at the chips on the motherboard and what they do. Until those videos, I would like to thank you for watching.

References
"Northbridge (computing)" https://en.wikipedia.org/wiki/Northbridge_(computing)

Credits
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Voice Talent: HP Lewis http://hplewis.com
Quality Assurance: Brett Batson http://www.pbb-proofreading.uk