Computer Performance
At the heart of all modern personal computers is one, or more, microprocessors.

The microprocessor is the chip that contains the CPU, Cache Memory (RAM), and connects to all of the other components on the computer.

Several aspects of computer speed are linked to the microprocessor.
The most basic measure of computer performance is the speed of the microprocessor.

Measured in kilohertz (kHz), megahertz (MHz), and now gigahertz (GHz), the clock speed determines the rate at which instructions are processed.

1 GHz = 1 billion clock ticks per second
1 MHz = 1 million clock ticks per second
1 kHz = 1 thousand clock ticks per second
The clock is a timing mechanism inside the computer that controls how quickly actions happen.

In the microprocessor, a faster clock means that the CPU can be asked to process more instructions in less time. In theory, this should make the computer “think” faster.
Microprocessor – Number of CPUs

Clock speeds are increasing more slowly than they used to. Instead, gains in speed are coming from changes to the layout of microprocessors.

Rather than a single CPU, many processors now have two or even four “cores” (CPUs + extras).

By dividing the work to be done, processing tasks can be completed more quickly. It takes work to divide a task, so two CPUs do not double the speed.
Microprocessor – Cache Memory

Each microprocessor has a small amount of RAM built right into the chip. This memory is used to store short-term data, and is known as cache.

There are different types of cache, but it is enough to know that cache RAM is very fast and very expensive.

The cache RAM is on the microprocessor, right next to the CPUs, which also improves the speed at which data is exchanged by minimizing the distance the signal has to travel.
Motherboard Bus Speed

The microprocessor must talk to the other components on the computer. It does this using the data bus.

No matter how fast any component is on the computer, no two components can talk faster than the speed limit of the bus.

This is why many components, such as the microprocessor and video cards, are as self-contained as possible, to avoid using the bus.
Main Memory (RAM) – Speed

Computer memory (RAM) is composed of integrated circuit chips (ICs), just like a microprocessor. It also has a speed limit.

In addition to the speed limit of the RAM chips, the data to/from the RAM is limited by the data bus.

System RAM is much slower than cache RAM, but still faster than most other hardware on the computer.
Main Memory (RAM) – Size

System memory (RAM) is measured in megabytes (MB) or gigabytes (GB). The amount of system memory defines how much information can be stored on the relatively fast memory chips.

As the microprocessor works, it stores and retrieves data. Any data that cannot be kept in RAM (fast) must be kept on the hard drive (slow).

Increasing the amount of RAM is often considered to be the easiest and least expensive way to improve computer performance.
Extra Processors

The microprocessor contains the primary processing for the computer. Many computers have only this single chip for processing information.

It is also possible to add processing for specialized tasks, such as video and audio.

These extra processors reduce the workload of the main processor. They are also often optimized for their task, making them particularly fast for that application (e.g., video & graphics).
Hard Drive – Speed

In terms of the other computer hardware, moving data to or from the hard drive is slow.

The speed of a hard drive is generally measured in terms of the number of revolutions the drive makes per minute (higher is faster).

Current drives spin at 5400 rpm (laptops, low power), 7200 rpm (desktops), or even 10,000 rpm (expensive, high-performance drives).
Hard Drive – Solid State Technology

Traditional hard drives are made up of one or more metal disks spinning at high speed.

Newer and faster hard drives are emerging that use no moving parts, and are similar to flash memory (e.g., usb memory sticks, digital cameras).

They currently have less capacity, but higher speed, than traditional spinning platter drives.
Hard Drive – File Organization

Hard drives are so slow in comparison to other computer hardware that even the location of files on the drive can make a speed difference.

Data is stored in files wherever there is space on a drive. If there isn't room for each file to be continuous, the file is broken into two, or thousands, of pieces.

As a drive fills with data, more and more data files will become fragmented.
Hard Drive – File Organization

In order to access a fragmented file, the reading sensor must physically move from place-to-place over the drive surface, which takes time (and also places physical strain on the parts).

It is possible to use special software to perform a defragmentation of a hard drives. Data is rearranged to make files continuous, which can yield noticeable improvements to computer performance if the drive is heavily fragmented.

Discussion Questions

What performance considerations do you think are the most important for the following users/applications? Why?

* word processing & internet browsing
* computer gaming
* mathematical modeling & simulation
* online database service (e.g., YouTube)
* digital media (photos, sound, video)