The System Clock also controls memory
A quick look at memory

Memory works like a big shelf. You can put stuff there and – of you remember where you put it – you can get stuff back.

- Memory can be read and written during each processing cycle.
A quick look at memory

You might buy a computer with 8GB RAM.

RAM stands for Random Access Memory, meaning we don't need to seek data like we would on a magnetic tape or hard drive. We can get to any random address in the same period of time.
The Operating System

When you use a computer, you typically don't interact with any of the internal hardware.

There is something between you and all those chips and electrons (let's just ignore dust bunnies for now).
The Operating System

Because you don't really want to have to tell the CPU exactly what to do all the time.

And you also don't want to deal with any of the other components and peripherals either.
The Operating System

You just want to say "Get this web site and print it for me"

And the rest should work like magic
The Operating System

The Operating System (OS for short) provides a large number of services for programs and applications.

As a programmer you can talk to the OS instead of the hardware and save yourself a lot of trouble.
The Operating System

OS are very complex animals

But for now you can think of an OS as the general manager of your computer – it talks to clients (users), employees (hardware), delivery drivers (output devices), etc.... It just keeps things running for you
Which OS is the Best?

No surprise .... It depends.

Some OS are ideally suited for particular devices – like Android for mobile devices

And for each device there are usually a few different OS choices
So which is best for a Laptop?

Popular OS for laptops include:

- Windows
- macOS
- Linux
Why is Linux green?

Unlike Windows or macOS, Linux is an open source operating system.

This means that you can obtain the code and rewrite it any way you like.

And most open source products are available for free.
Other Open Source Examples

Windows
MS Office
PhotoShop
IE / Edge
AutoCAD
so many more

Linux
OpenOffice etc.
GIMP
Firefox
FreeCAD
just google "open source .........."
Let's Recall

We have seen how a computer works, how it stores data, how it is able to understand numbers and strings, perform calculations and interact with peripherals and users.

Now we'll let it talk to other machines.
Networks

Some networks have been around for a very long time.

Social Networks, for example
Networks

Others are a bit newer

Phone Networks

TV Networks

Computer Networks
Networks

Networks connect nodes

Social networks connect people

Phone networks connect phones

Computer networks connect computers
Networks

Let's look at a very simple network

Somehow these machines must be connected

And they must know how to communicate
Network Topologies

There are a few different ways in which we can connect computers

Here we have a classic bus topology
Network Topologies

There are a few different ways in which we can connect computers.

In this example we use a token ring topology.

Source: http://www.fiber-optics.info/articles/fiber_optic_network_topologies_for_its_and_other_systems
Network Topologies

Most of the networks you use are configured as start topology networks.
Networks

Some networks are very small

some are pretty big
The Internet

Basically the Internet is a network of networks

One that you can be a part of as well

All you need is an ISP
The Internet

What does the Internet do?

Nothing exciting, really

It just moves little packages of data from one place to another

Everything else is up to servers
Servers and Clients

When you use the Internet (or pretty much any network), your computer is a "client".

It will ask another computer to send it a piece of data or to perform a particular task.

That other computer is known as a "server".
Sometimes the same computer can be both a server and a client.

The same machine can even run multiple servers and provide various services.
Network Services

There are many types of servers:

File Servers
Print Servers
Web Servers
Mail Servers

and many more....
Services on the Internet

The Internet provides many services:

Cloud Storage
Could Computing
Voice Over IP
World Wide Web

and many more....
Internet vs. WWW

The Internet provides many services:

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and many more....
Internet vs. WWW

Many people say "Internet" when they actually mean the World Wide Web.

Actually the WWW is only a small part of the Internet. Essentially the WWW runs on the Internet.

But we can use the WWW as an example to understand how the Internet works.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

And what does that even mean?
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

http stands for Hypertext Transfer Protocol

We need a protocol to make sure that the machines understand each other
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

There are many top level domains. Usually you cannot own your own TLD.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

Just about anybody can get a second level domain – although some TLDs are pretty restrictive.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

Within your domain you can define subdomains any which way you like. It is, however, a good idea to follow a few rules.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

As you know, computers only understand numbers. While we can use numbers to represent strings, that takes a lot of time.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

So nodes on the Internet don't actually answer to names – they answer to numbers. IP numbers. IP stands for Internet Protocol.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

192.168.12.14

A0F7:B8A8:0A4E:FFD3
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

You first need to translate "illinois.edu" into an IP number. For that you need a "phonebook" – your Domain Name Server (DNS). Your computer will know the DNS's IP address.
The Web

What happens when you open a browser and type in the URL http://www.illinois.edu

nsllookup illinois.edu

Name: illinois.edu
Address: 192.17.13.36
Just like a house or business can have multiple entrances, each computer can have many "ports". Each port may lead to a different server running on the physical machine. Some people like to think of ports as suites in a strip mall.
"A-Record" request for illinois.edu
10.1.117.1:80
10.1.117.2:80
10.1.117.3:80
10.1.117.4:80
10.1.117.5:80
10.1.117.6:80
10.1.117.7:80
10.1.117.8:80
192.17.13.136:80
192.17.13.136:80
130.126.2.131:53
HTTP GET Request for "index.html"
HTTP GET Request for "index.html" (may assign request to an available machine)

10.1.117.1:80
10.1.117.2:80
10.1.117.3:80
10.1.117.4:80
10.1.117.5:80
10.1.117.6:80
10.1.117.7:80
10.1.117.8:80

192.17.13.136:80
HTTP GET Request for "does.not.exist"
Technically

Each one of those requests and responses is broken down into nice, small packages.

Each package may be routed independently and the receiver will reassemble them.

It's like shipping a large LEGO building in individual pieces.
Protocol Matters

Some protocols require that all packages arrive correctly. Others are perfectly happy when a few go missing.

And for some order matters more than completeness.
Protocol Matters

Our sore and seen years ago our fath brought forth, upon his content, ane nation, conceived in liety, and dicated to the proposition that "all men are creed equ
Protocol Matters

Four score and seven years ago our father brought forth, upon this continent, a new nation, conceived in liberty, and dedicated to the proposition that “all men are created equal.”
Protocol Matters

Four score and seven years ago our fathers brought forth, upon this continent, a new nation, conceived in liberty, and dedicated to the proposition that “all men are created equal.”
Protocol Matters

yowur so tre an seee, niyears avo vur fia. thrs orought fo rh, mcupn tqeis coniFnent anoe nain, cone ceied in libert, ahd dedi ated to tne prtopositioncthat “all gen abre crated udalh”
Protocol Matters
Protocol Matters

20% of data missing
Protocol Matters

75% of data missing!
Protocol Matters

TCP requires that all packages arrive correctly. It is hence useful for any application where accuracy matters most.

UDP cares more about speed. Packages must be assembled in order, but missing data will be ignored (and can be interpolated).
The Takeaway

The Internet is made up of billions of nodes (or devices).

Protocols are used to easily communicate across this vast global network and across all borders.

Many nodes provide services. You can reach these servers on various different ports.
The Takeaway

The Web is only one of the many services available on the Internet.

When you access a web site, your computer first talks to a Domain Name Server (DNS, listening on port 53) to find the numerical address for the machine that hosts the HTTP service for that address.
The Takeaway

Your computer then sends a HTTP request to that machine's port 80.

The server will respond with an OK (code 200) and the desired data or an error (code 404, for example).
The Takeaway

All transmissions are broken down into easily manageable packages that are sent independently and reassembled at their destination.

Many services such as VOIP and video streaming use UDP, a protocol that accepts a certain amount of missing data and prioritizes speed.
That's It, Folks