What is a network?

A network is a net of devices connected to each other where a signal can travel from a place to the other, there are different types of devices that are used between the start point and the final point, and each one of them has a different functionality.

Devices:

* PC-Start
* Switch
* Router
* Firewall
* Modem
* ATT Fiber
* **Internet**

**And all the way around.**

From the PC to the ATT fiver, is the part of a network that we call the Local Area Network, or **LAN**.

Then when we get out of here to go to the Wide Area Network or **WAN** is just a bunch or other routers and devices repeating the signal and increasing it repeatedly, till it gets to its destination.

**The Bullet:**

If we take a bullet shot in Call of Duty, from someone who’s playing in a PC, against someone who’s playing in a Play Station in another City we can follow the bullet’s trajectory to find out how all this works.

The bullet, goes from the Remote or Keyboard, To the Game, To the Ethernet Card, To the Switch, to the Router, To the Firewall, To the Modem, To the ATT Fiver, Another bunch of routers and switches till the Call of Duty Server, to another bunch of routers and switches again till the other guy’s place, and from there on it does the reverse process: Internet-ATT Fiver-Modem-Firewall-Router-Switch-Play Station

The Simplest Case:

Let’s say that we are trying to connect two computers that are very close to each other, in the rank of an ethernet cable can support. I we were to connect these two devices, the only thing that we would need is an ethernet cable. Now if we want to connect more than two computers, it becomes complex, because if we send a signal, how does the cable know where to send it? :/

Here is when the **switches** come into place.

Text, whiteboard

Description automatically generated

Switch:

When we want to connect more than two computers, a switch comes very handy. Why? Because a switch solves the problem of a cable not knowing where to send the signal to. A switch is a device that receives a signal that’s able to identify which machine is the one that’s supposed to receive the data. This is done with something like a for loop. The switch takes that data and compares the hash, or the name of the machine that is supposed to receive the data, and compares it with the name in each port, if it matches, the signal is sent, if is not, goes to the next one, like a for loop.

Obviusly, there only so much a switch can support, so what happens when we want to connect more devices that the number of ports in the switch? Well, we can’t connect another switch so we have to use a router.

Now the problem with switches, is that they can only connect people that are very close, and here is when the **routers** come into place.

Router:

The router does the same exact thing as the switch, but instead of connecting two computers, a router can connect two switches, and the best is that a router is wireless.

**INTERNET:**

Text, whiteboard

Description automatically generatedText, whiteboard

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Ping and reply:

Ping is a command we use to make sure that the device at the other side of the network is up and running, and the reply is what we get in response. <ping 10.0.0.1>

Layers:

Layer one refers to the actual **electrical signals** being sent between the devices.

Layer two refers to the **MAC address**, which is a number that comes burned down with all the devices and is different for each one. This is how a **switch** identifies the devices because this data is the only one that will never change.

The switch is a layer two device, it doesn’t know anything about IP addresses or anything else.

Layer three refers to the **IP Address**

**Why can’t we just use another switch?**

Well, the answer is that we have a problem when we are going to ping, for example, someone that is not in our network, because its IP address is going to be completely different from our network, which for example, is something like 10.1.1.2, and theirs is 236.25.3.2.   
The switch can only send a ping to the IP addresses between 0/255 in the last digit of its code ( 10.1.1.0/255), and 236….. is not there. So Here a Stich can’t help because he locates the MAC address by sending a ping to all the devices in its network and only the one which IP address matches the one that we are looking for sends a response.

The problem is that the switch can only do this in its own network, when is out of here, like in the other company for example, we would use a router to access it because the routers user IP addresses instead of MAC addresses to locate the devices and ping them.

**How does the switch know who is the router?**

This is very simple, by default, the router or **GATEWAY** is in port .1, in last example that would be in 10.1.1.1. So, when ewe want to reach something outside of our network, we use the gateway, or router to get there.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Layer | Device | Language | Example | Description |
| One(Physical) | Cable | Electrical Signals | e | This is the physical part of the process, the electricity in the cables |
| Two(Data Link) | Switch | MAC Addresses | 00D0.9752.8936 | This is an Address that comes baked in with each device and is a unique number |
| Three(Network) | Router | IP Addresses | 10.1.1.1 | The IPA, or Internet Protocol Address is something that your router gives you, is how you communicate with, and ping others. |
| Four (Transport) | Port(Computer) | Ports | 433 | It refers to which port will be used for the in and out traffic |
| Seven(Application) | Device | The App language | Google Chrome | This is the final, or thr first step, which is the app that primarily, or ultimately sends or receives the message |

From here on, there are some concepts that we need to know, for example, the ARP.

**What is ARP?**

The ARP, or Address Resolution Protocol, is how we can find out who in our network has come IP address, since the switch doesn’t store that info, he only store who has which MAC address, or which MAC address lives in which port.

The ARP is the protocol the switch will use to learn a MAC address for the first time and know which MAC address belongs to which IP address because remember, we can only ping IP addresses.

The ARP is a message with the information on the IP address we are requesting and is sent to all the available ports to discover who has it. Depending on if the device has this IP address or not, the device will answer or not.

If it matches, the device will return a response and the switch will learn whose MAC address is in which port and use it to make forwarding decision.

More than just Ping:

When we want to visit a website, we obviously don’t use the exact IP address to get it, we just type something like <http://www.google.com>. But if the switch understands MAC addresses, and the router IP addresses, WHO deals with the urls?

Short answer is no one. Your computer must know what IP address corresponds to this url, and it does it by using something called the **DNS**.

**What is DNS?**

DNS stands for Domain Name Service. Is a server and we can configure it in the settings giving it an IP address to get there, like 10.1.1.50 for this example.

Protocols:

**TCP/IP and OSI:**

The TCP, or how we know it today, the IP or Internet Protocol is the Protocol we use to connect between devices. It refers to how is the bullet going to get from point A, to point B. In other words, it describes which Layers will be used to get there.

The OSI is another protocol, is not used these days but is worth to be learned, AND, is still considered when networking. This is what I mean:

We saw earlier that we have Layers from one to seven, but layers **five and six** are missing. This is because we refer to the OSI protocol which use to have two more layers, a **Session Layer** and a **Presentation Layer**. That’s why we jump from layer four to layer seven, because is a reference to the old OSI Protocol.

**About Layer four (Transportation):**

In this layer is when the actual transport of information occurs. We have two main options when comes to transport methods, **TCP** and **UDP**. We usually use TCP because is more reliable and can automatically re-send it if the message didn’t make it. UDP on the other hand, is seen as a more fast transportation method, but less reliable.

Encapsulation and Transportation:

We can imagine that moving data across layers means to add and eliminate some information from this data since we will need to know for example the IP address once we are in the Layer three so the router can send it to the right switch. So, what happens here, and how does it happen.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Layers** | **Data Visualization** | **Added Info** |
| 7 | Application | Data | Data |
| 6 | Presentation |  |  |
| 5 | Session |  |  |
| 4 | Traffic | Data + L4 Header = Segment | Ports, Method |
| 3 | Network | Segment + L3 Header = Paquet | IP Address |
| 2 | Data Link | L2 Trailer + Paquet + L2 Header = Frame | MAC Address |
| 1 | Physical | Frame | Electrons |

Visual Encapsulation:

This is what a switch, for example can see when he gets the info that he receives:

**Switch:** **This is what is really happening:**

|  |
| --- |
| Layer 2: Ethernet II Header  00D0.9752.8936>>0002.17EB.1D01 |
| Layer 1: Port(s): FastEthernet 0/6 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Layer 2: Ethernet II Header  00D0.9752.8936>>0002.17EB.1D01 | | | | | | |
| Layer 1: Port(s): FastEthernet 0/6 | | | | | | |
|  | Layer3 Info-Paquet | | | | |  |
|  | Layer4 Info-Segment | | |  |
|  | Layer5 Info |  |
| Layer6 Info |
| Layer7 Info-Data |
|  | | | | |

**De- capsulation:**

The de-encapsulation process is really simple, as we move trough the layers, we remove the headers, and the one trailer, in the Layer two to layer three case. We can see this process as if we are trying to get a letter by ripping of it envelops, The only difference is that to get to that letter(DATA) we need the help of 4 or 5 people and each one of them can only break one envelope.

IMPORTANT: **ONCE AND AGAIN**

This process of Encapsulating and de-capsulating a **packet** ( Layer3 ) to a **frame** ( Layer 2 ) happens every time we get across with a switch router-like structure. Here the message for the Header must change because if it didn’t id go back to the person who sent it instead of a different direction.