# ASSIGNMENT 1: ANATOMY OF A WEB CONNECTION: A BRIEF ANALYSIS

Featuring *THE HOST* (2013)

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# INTRODUCTORY NOTE

This document is the first assignment of the *Aspetos Profissionais e Sociais da Engenharia Informática* course unit and seeks to to provide a plausible identification of the technologies, processes, actors and business models involved in a web connection and identify possible social and economic implications associated with the identified technologies.

# ABSTRACT

The Internet appeared for the first time in 1969 and today it's completely embedded in our lives.

Traceroute is a command used to check network issues by sending data packets to the Internet and waiting that these will again be sent to the user network when a new hop has been discovered.

The traceroute results change for different locations.

For the same user network, if he tests the traceroute command at different hours, he will usually have similar results.

There are plenty of social and economic implications that result from a web connection, such as the concept of "global village", increase of employment and the use of online services to satisfy individual needs.

# FRAMEWORK

According to the sociologist Manuel Castells, who wrote the book *The Internet Galaxy*, the Internet appeared in 1969, during the first experience of node to node communication between two computers, through ARPANET, a computer network developed by ARPA [1]. The word sent in the experiment was "LOGIN", and although it was a failed experiment, as only the first two letters were sent to the second computer [2], this turned out to be a milestone towards the Internet as we know it today.

These days, the Internet is present in everything people do – a lot of things happen "beyond the wall", so that anyone can see their requests being solved when browsing on the Internet, such as technologies, processes and actors. All of these can lead to major changes in society.

# WHAT IS TRACEROUTE?

Traceroute is a command used to know the path of data packets sent by a local network user as they travel all over the internet, until they reach a destination. Think about the internet as a big set of networks that are interconnected with the use of multiple routers that track the packet traffic between computers and servers all over the world. With this in mind, it's pretty clear that a packet does not travel from a point to another directly, passing through different networks and, implicitly, different routers [3].

Traceroute command is more complex than the ping one – while *ping* only pings the final destination, traceroute not only pings the final destination, but it also pings each router on its way to the final destination [4]; the computer sends three data packets to all routers they pass, and they send back these packets, allowing to obtain DNS domains and measure the round trip time that these took to and from each router. Note that traceroute is based on TTL mechanism: data packets are sent with a related value, and this value is decremented when they reach a router, reaching zero when they discover a new "checkpoint" (a new router).

With all of this said, traceroute can be a great tool to help discover network issues when it is not possible to establish a communication with a given IP address or domain [5].

# TRACEROUTE COMMAND EXECUTIONS

```
C:\WINDOWS\system32>tracert thehostthefilm.com

Tracing route to thehostthefilm.com [98.153.124.3]
over a maximum of 30 hops:

  1     2 ms     2 ms     1 ms  vodafonegw [192.168.1.1]
  2     7 ms     7 ms     6 ms  2.64.54.77.rev.vodafone.pt [77.54.64.2]
  3     8 ms     7 ms    10 ms  113.41.30.213.rev.vodafone.pt [213.30.41.113]
  4     9 ms    11 ms    10 ms  195.10.48.9
  5    33 ms    35 ms    32 ms  ae18-pcr1.ptl.cw.net [195.2.21.150]
  6   117 ms   108 ms   111 ms  ae20-xcr1.ash.cw.net [195.2.9.30]
  7   109 ms   111 ms   113 ms  as7843.xcr1.ash.cw.net [195.2.14.42]
  8   183 ms   181 ms   182 ms  66.109.5.116
  9   243 ms   177 ms   177 ms  66.109.6.151
 10   175 ms   175 ms   175 ms  bu-ether12.hstqtx0209w-bcr00.tbone.rr.com [66.109.6.36]
 11   182 ms   177 ms   178 ms  107.14.19.49
 12   302 ms   201 ms   210 ms  bu-ether12.tustca4200w-bcr00.tbone.rr.com [66.109.6.0]
 13   227 ms   256 ms   201 ms  agg2.tustcaft01r.socal.rr.com [66.109.3.233]
 14   187 ms   211 ms   316 ms  agg1.chwocadq02r.socal.rr.com [72.129.25.3]
 15   222 ms   256 ms   305 ms  agg1.cnpkca2602h.socal.rr.com [72.129.27.131]
 16   269 ms   214 ms   237 ms  agg2.cnpkca2602m.socal.rr.com [76.167.30.206]
 17   248 ms   221 ms   290 ms  cpe-104-172-186-0.socal.res.rr.com [104.172.186.0]
 18     *        *        *     Request timed out.
 19  ^C
```

Fig.1 – Example of usage of the tracert command within Anthony's network

```
C:\Users\anth0\Desktop\LEI_Windows\2º Semestre\APSEI>tracert thehostthefilm.com

Tracing route to thehostthefilm.com [98.153.124.3]
over a maximum of 30 hops:

  1    21 ms    19 ms    17 ms  fw-vsvpn.ua.pt [193.137.173.235]
  2    25 ms    18 ms    17 ms  gt1-vrfinternet-r.core.ua.pt [193.137.173.244]
  3    23 ms    18 ms    19 ms  nx2-ibgp.core.ua.pt [10.0.34.1]
  4    22 ms    20 ms    19 ms  Router42.Porto.fccn.pt [193.136.4.26]
  5    31 ms    20 ms    21 ms  Router43.Porto.fccn.pt [193.137.4.2]
  6    26 ms    24 ms    26 ms  Router60.Backbone2.Lisboa.fccn.pt [193.136.4.1]
  7    27 ms    28 ms    37 ms  Router1.Lisboa.fccn.pt [194.210.6.203]
  8    54 ms    37 ms    45 ms  fccn-ias-geant-gw.mx2.lis.pt.geant.net [83.97.88.209]
  9  2945 ms    69 ms    70 ms  ae0.mx1.mad.es.geant.net [62.40.98.107]
 10    78 ms    72 ms    67 ms  ae3.mx1.par.fr.geant.net [62.40.98.65]
 11    78 ms    70 ms    71 ms  ae5.mx1.gen.ch.geant.net [62.40.98.182]
 12    67 ms    64 ms    75 ms  ae2.mx1.fra.de.geant.net [62.40.98.180]
 13    74 ms    69 ms    78 ms  ffm-b12-link.ip.twelve99.net [80.239.135.136]
 14   194 ms   233 ms   308 ms  ffm-bb2-link.ip.twelve99.net [62.115.142.4]
 15   425 ms   295 ms   194 ms  prs-bb2-link.ip.twelve99.net [62.115.114.98]
 16   304 ms   190 ms   314 ms  rest-bb1-link.ip.twelve99.net [62.115.122.159]
 17   197 ms   278 ms   200 ms  atl-b24-link.ip.twelve99.net [62.115.125.191]
 18   270 ms   218 ms   186 ms  dls-b23-link.ip.twelve99.net [80.91.246.75]
 19   193 ms   289 ms   200 ms  chartercommunications-ic325638-dls-b23.ip.twelve99-cust.net [62.115.156.209]
 20   229 ms   286 ms   262 ms  66.109.5.120
 21   387 ms   237 ms   230 ms  66.109.5.228
 22   231 ms   305 ms   320 ms  209-18-43-73.dfw10.tbone.rr.com [209.18.43.73]
 23   273 ms   259 ms   300 ms  agg1.chwocadq02r.socal.rr.com [72.129.25.3]
 24   335 ms   302 ms   303 ms  agg1.cnpkca2602h.socal.rr.com [72.129.27.131]
 25   310 ms   230 ms   274 ms  agg2.cnpkca2602m.socal.rr.com [76.167.30.206]
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *      ^C
```

Fig. 2 – Example of usage of the tracert command within the UA network

# Traceroute result interpretations

As shown by the screenshots above, the location of an user interferes with the traceroute results, for instance, by changing the initial IPs and domains. This happens because the user was in different networks, so the path that each data packet chose to reach its destination has changed.

It was also concluded that, for a specific location and network, the traceroute results are mostly the same (with an exception, explained in the next paragraph). This may be due to the fact that the path has the least cost for the establishment of the communication and, assuming that the Internet is redundant and that several paths will lead to the same destination, it's likely that the network is not overloaded , always privileging the same path.

Both inside and outside the network of the unniversity, it was never possible to complete the traceroute research - the last hops always have the "request timed out" message and there is no hop with the IP that's used as parameter for the traceroute command. Most of the time, the last shown IP is 76.167.30.206 (check the screenshot above), but sometimes there is a new one – 104.172.186.0. Pay attention because we'll come back to this later.

```
C:\WINDOWS\system32>tracert thehostthefilm.com

Tracing route to thehostthefilm.com [98.153.124.3]
over a maximum of 30 hops:

  1     1 ms     4 ms     3 ms  vodafonegw [192.168.1.1]
  2     8 ms     8 ms     8 ms  2.64.54.77.rev.vodafone.pt [77.54.64.2]
  3     8 ms     9 ms     6 ms  113.41.30.213.rev.vodafone.pt [213.30.41.113]
  4     6 ms     6 ms     6 ms  195.10.48.9
  5    47 ms    40 ms    34 ms  ae18-pcr1.ptl.cw.net [195.2.21.150]
  6   113 ms   108 ms   110 ms  ae20-xcr1.ash.cw.net [195.2.9.30]
  7   113 ms   109 ms   112 ms  as7843.xcr1.ash.cw.net [195.2.14.42]
  8   176 ms   181 ms   182 ms  66.109.5.116
  9   174 ms   176 ms   179 ms  66.109.6.151
 10   179 ms   174 ms   174 ms  bu-ether12.hstqtx0209w-bcr00.tbone.rr.com [66.109.6.36]
 11   174 ms   174 ms   173 ms  107.14.19.49
 12   173 ms   173 ms   173 ms  bu-ether12.tustca4200w-bcr00.tbone.rr.com [66.109.6.0]
 13   175 ms   174 ms   185 ms  agg2.tustcaft01r.socal.rr.com [66.109.3.233]
 14   184 ms   181 ms   182 ms  agg1.chwocadq02r.socal.rr.com [72.129.25.3]
 15   186 ms   189 ms   179 ms  agg1.cnpkca2602h.socal.rr.com [72.129.27.131]
 16   175 ms   189 ms   176 ms  agg2.cnpkca2602m.socal.rr.com [76.167.30.206]
 17   191 ms   196 ms   191 ms  cpe-104-172-186-0.socal.res.rr.com [104.172.186.0]
 18     *        *        *     Request timed out.
 19     *        *        *     Request timed out.
 20     *        *        *     Request timed out.
 21     *        *        *     Request timed out.
```

Fig.3 – Traceroute with a new last shown IP.

To help the process of interpeting the results obtained while testing the traceroute command, an IP geolocation API was used – ipinfo.io. Using the curl command together with ipconfig and the IP to be analyzed, it was possible to retrieve a json with additional information related to that IP:

```
C:\Users\anth0\Desktop\LEI_Windows\2º Semestre\APSEI>curl ipinfo.io/193.137.173.235
{
  "ip": "193.137.173.235",
  "city": "Aveiro",
  "region": "Aveiro",
  "country": "PT",
  "loc": "40.6443,-8.6455",
  "org": "AS1930 Fundacao para a Ciencia e a Tecnologia, I.P.",
  "postal": "3800-000",
  "timezone": "Europe/Lisbon",
  "readme": "https://ipinfo.io/missingauth"
}
```

Fig.4 – Example of usage of the IP geolocation API ipinfo.io [6]

With this in mind, a python program was made to help to save the traceroute command results and get all the jsons for each of the IPs obtained – this program accepts two arguments, the website that's being inspected and a VPN UA password:

```
getJsonsIpInfo.py
import subprocess
import sys
import schedule
import time
from datetime import datetime
from pynput.keyboard import Key, Controller
import os
import pyautogui

running = True
now = datetime.now()
now = now.strftime("%d-%m-%Y--%H-%M-%S")
# Author: Anth0nyPereira

def tracert(ip, fileName):
    global now
    f = open(fileName, "w")
    proc = subprocess.Popen("tracert " + str(ip), stdout=subprocess.PIPE, stderr=subprocess.STDOUT)
    output = proc.stdout.read()
    output = output.decode("utf-8")
    f.write(output)
    f.close()
```

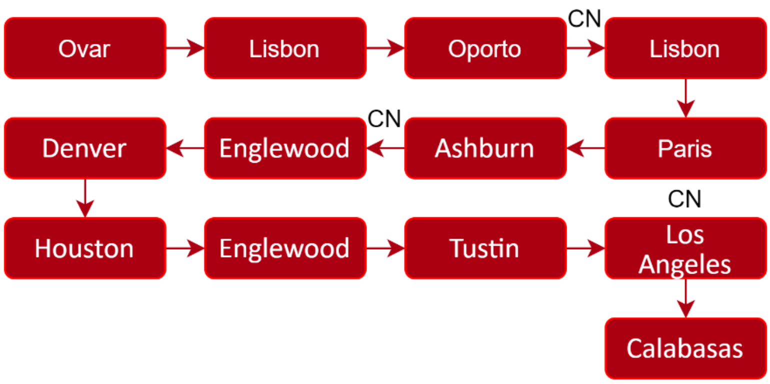
```
def turnOnVPN(password):
    keyboard = Controller()
    time.sleep(2)
    pyautogui.click(x=1707, y=1048)
    pyautogui.click(x=1707, y=1048)
    time.sleep(2)
    keyboard.type(password)
    keyboard.press(Key.enter)
    keyboard.release(Key.enter)
    time.sleep(5)


def turnOffVPN():
    keyboard = Controller()
    time.sleep(2)
    pyautogui.click(x=1707, y=1048)
    pyautogui.click(x=1707, y=1048)
    time.sleep(2)
    pyautogui.click(x=435, y=590)
    time.sleep(2)
    keyboard.press(Key.enter)
    keyboard.release(Key.enter)
    time.sleep(5)
```

```python
def openTracertFile(fileName):
    ips = []
    f = open(fileName, "r")
    for line in f:
        if not line.split():
            continue
        array = line.split()
        lastElement = array[len(array)-1]
        removingChars = [ "[", "]", "*" ]
        for char in removingChars:
            if char in lastElement:
                lastElement = lastElement.replace(char, "")
        if lastElement != "" and "out" not in lastElement and "complete" not in lastElement and "hop" not in lastElement:
            ips.append(lastElement)
    f.close()
    return ips

def getIpLocation(fileName, lst):
    f = open(fileName, "w")
    for ip in lst:
        proc = subprocess.Popen('curl ipinfo.io/' + str(ip), stdout=subprocess.PIPE, stderr=subprocess.STDOUT)
        output = proc.stdout.read()
        output = output.decode("utf-8")
        f.write(output)
    f.close()
```

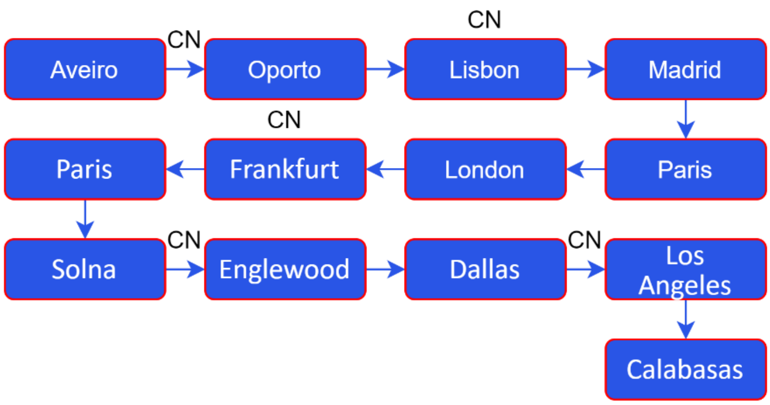
```python
def program():
    global running
    global now

    site = sys.argv[1]
    fileName = "tracert-" + site + "-" + now + ".txt"

    tracert(site, fileName)
    ipsList = openTracertFile(fileName)
    resultsFileName = "results-" + fileName
    getIpLocation(resultsFileName, ipsList)
    time.sleep(5)

    #VPN
    passArgument = sys.argv[2]
    turnOnVPN(passArgument)
    time.sleep(3)

    fileNameVPN = "tracert-VPN-" + site + "-" + now + ".txt"
    tracert(site, fileNameVPN)
    ipsVPNList = openTracertFile(fileNameVPN)
    resultsVPNFileName = "results-" + fileNameVPN
    getIpLocation(resultsVPNFileName, ipsVPNList)
    turnOffVPN()

def main():
    program()

if __name__ == "__main__":
    main()
```

Fig.5 – Python program to obtain a sequence of JSONs using an IP geolocation API

With the results that were achieved, two diagrams were made for helping to visualize the way that these data packets perform during the traceroute command (CN means "changed network"):




Diag.1 – Path traced with VPN switched off




Diag.2 – Path traced with VPN switched on

Some cities are out of place or have changed (check Tustin and Dallas, for example), so, it's reliable to say (again) that the path changed in these two different situations. Checking the two tables (see the appendix), it can be observed that even the networks (organizations) have changed too, even after the UA network. So, we can assume that the tracert path is not always the same and that it's dependent on the location where the user is, leading to a possible mid-different path/networks – not only the user's network can (obviously) change, everything can change.

Now that the location of the IPs were recorded, let's go back a little bit and check the location of both IPs 76.167.30.206 and 104.172.186.0:

```
C:\WINDOWS\system32>curl ipinfo.io/76.167.30.206
{
  "ip": "76.167.30.206",
  "hostname": "agg2.cnpkca2602m.socal.rr.com",
  "city": "Los Angeles",
  "region": "California",
  "country": "US",
  "loc": "34.0522,-118.2437",
  "org": "AS20001 Charter Communications Inc",
  "postal": "90009",
  "timezone": "America/Los_Angeles",
  "readme": "https://ipinfo.io/missingauth"
}
```

```
C:\WINDOWS\system32>curl ipinfo.io/104.172.186.0
{
  "ip": "104.172.186.0",
  "hostname": "cpe-104-172-186-0.socal.res.rr.com",
  "city": "Calabasas",
  "region": "California",
  "country": "US",
  "loc": "34.1993,-118.5983",
  "org": "AS20001 Charter Communications Inc",
  "postal": "91303",
  "timezone": "America/Los_Angeles",
  "readme": "https://ipinfo.io/missingauth"
}
```

Figs.6 & 7 – Results of the consultation of the geolocation API for two specific IPs

The target IP 98.153.124.3 was also inspected:

```
C:\WINDOWS\system32>curl ipinfo.io/98.153.124.3
{
  "ip": "98.153.124.3",
  "hostname": "rrcs-98-153-124-3.west.biz.rr.com",
  "city": "Calabasas",
  "region": "California",
  "country": "US",
  "loc": "34.1993,-118.5983",
  "org": "AS20001 Charter Communications Inc",
  "postal": "91303",
  "timezone": "America/Los_Angeles",
  "readme": "https://ipinfo.io/missingauth"
}
```

Fig.8 – Result of the consultation of the geolocation API for the target IP

All three IPs are from the same organization and region – California. 104.172.186.0 and 98.153.124.3 (the IP that sometimes appears in the trace and the initial IP, respectively) are from the same city – Calabasas!

Now, let's check the distance between Los Angeles and Calabasas:

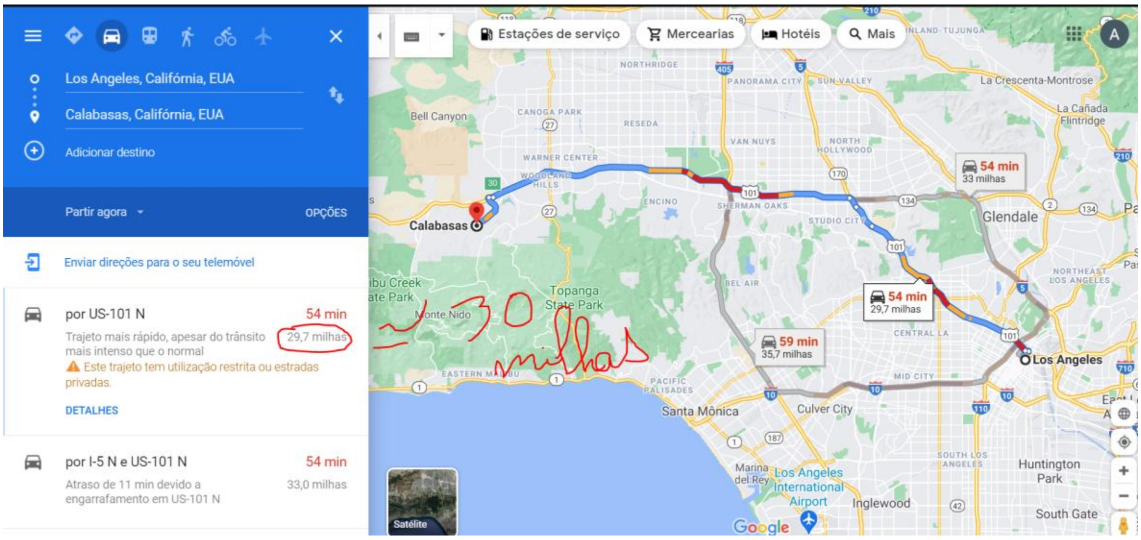



Fig. 9 – Distance between Los Angeles and Calabasas, using Google Maps

Time to make a conversion:

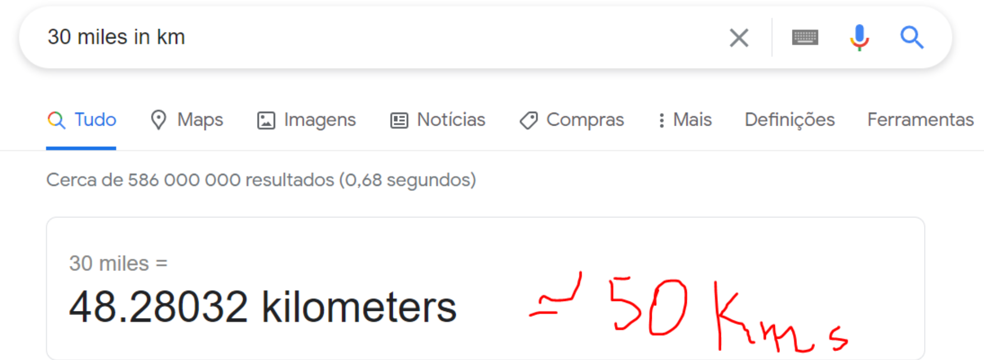



Fig.10 – Conversion between miles and kilometers, using Google

With all of this shown, it can be deduced that the server where the website that is being targeted by traceroute is located is probably denying any interaction with the user, that is, it is not responding with the traceroute packages that were sent to it. Both possible last IPs are close to the real location of the server - either they are from the same city or are 50 km apart from each other - so it's safe to discard the possibility of 98.153.124.3 being too far away from 76.167.30.206 that they are not able to connect to each other. Another thing is that all three IPs are from the same network, so, we can surely say that the problem is not that it's not possible to move from a previous network to the last one.

A quick search was performed and a curious result was gotten:

- *One or two asterisks for a hop do not necessarily indicate packet loss at the final destination.* Many Internet routers *intentionally discard ping or traceroute packets*, but this has no bearing on applications that use these routers. This practice is called ICMP Rate Limiting and is used to prevent routers from being impacted by denial-of-service attacks.

Fig.11 – Paragraph from the website Xfinity.com

It seems that some routers can intentionally discard traceroute packets because of security reasons, such as preventing DoS attacks [7] using a firewall. This could be what's happening in this case. Let's check the *ping* command:

```
C:\WINDOWS\system32>ping thehostthefilm.com

Pinging thehostthefilm.com [98.153.124.3] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 98.153.124.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Fig.12 – Result of a *ping* command to the same destination IP, confirming the previous hypothesis

Another reason that sustains this assumption is the fact that the website seems forgotten by everyone:

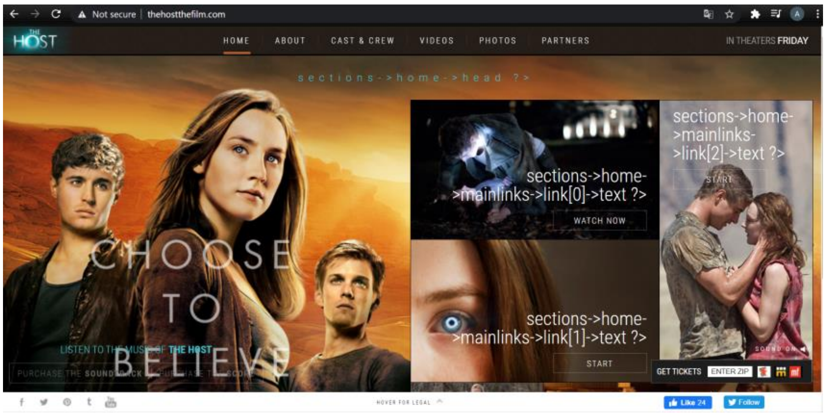



Fig.13 – Homepage of the website The Host, a movie from the year 2013

As we can clearly see from the screenshot taken, some things seem misconfigured (some raw code appears) and even if we check some features that it offers (or that it once offered), we can see that there are some bugs or some features that no longer exist. Thus, it's possible to assume that this website is no longer maintained – which can lead to security problems. So, the owners could probably block some ways to communicate with the internet – to protect what's left.

# SOCIAL IMPLICATIONS OF THE INTERNET

It’s clear that the ability to connect to a large universe of interconnected networks, which we call the Internet, has allowed us to feel “less alone” - it is easier to communicate with a family member who is far away, you’re able to watch in real time a ceremony in a country thousands of kilometers away without having to be there physically and can learn about news or events from countries on the other side of the world. We are increasingly becoming a “global village” - a concept introduced by canadian Herbert Marshall McLuhan that seeks to explain the relationship between new communication technologies and the idea that by shortening figuratively the distance between all human beings that inhabit, we are all in a village in which we know each other and know everything that goes on all over the world. Just think about it: how could we send an e-mail to our boss or a message via Messenger or WhatsApp to a friend without a web connection?

The access to the internet also allowed public figures to show their authority beyond television, using social media or blogs, or to become public figures through their constant presence in these same social networks and / or blogs: let’s remember Kim Kardashian, who after having participated in a reality show about her family, started to publish her personal life experiences on her social networks, taking the opportunity to advertise her own brands of perfumes, makeup, partnerships with magazines and clothing brands, etc [8]. Now, let’s talk about Ana Garcia Martins, better known as “A Pipoca Mais Doce” – she is the owner of a blog with the same name that was created in 2004 and a pioneer in this type of technologies, which made her famous by having the most visited blog ever in Portugal [9]. A better known example - Justin Bieber, singer, composer and actor quite acclaimed nowadays that started posting covers on Youtube in 2007 and then he was found by Scooter Braun, becoming his agent, and signed a professional contract with Island Records two years later, beginning his artistic career [10]. To finish this topic, another example: Mário Daniel, the famous Portuguese illusionist who was also presenter on the SIC television program, “Minutos Mágicos”, is a recurring presence on Facebook, in which he shares articles and gives his opinion about covid-19 - recommending what people should and shouldn't do.

However, the access to the internet has also created even more social inequalities, as not everyone has the chance to access this service equally - in third world countries, this is still not a very common reality. Thus, it can be said that this social inequality is also related to the existing economic inequalities, in the country and in the world. If there are no resources to end hunger in Africa, if there are no resources to end all homeless people who roam the cities and suburbs of Oporto and Lisbon, how would it be possible to guarantee equal access to the internet?

Another negative implication inherent in the possibility of a web is how quick online news are spread. We live in an era in which it’s increasingly common to view fake news on current topics that are not yet consensual (unfortunately) and that incite to violence and hatred. This is the case with issues related to the LGBTQ + community and covid-19. The internet also promotes the spread of catastrophic news, such as accidents, homicides, bombings, wars, promoting a feeling of insecurity and creating the idea that the world was once safer. My grandmother says that "when I was little, we could leave the door open that no one would bother us". This thought may be slightly distorted from reality – it’s possible that the rate of incidents has not changed significantly over time, but taking into account that it’s possible for us to know more quickly and more often what's happening in the world, this can create a false sense of insecurity and panic.

## ECONOMIC IMPLICATIONS OF THE INTERNET

There would be no Internet without hardware and it's constant maintenance and improvement of the communications and materials for transporting the data packets such as optical fibers, or even without the implementation of security mechanisms, among others. Therefore, it's clear that the existence of the internet has created more jobs associated to areas of computer engineering as networks, electronics and security, as well as engineering in general.

But in addition to the job offer and growth of companies provided by the existence and maintenance of the Internet, it also allowed the emergence of telework, currently so important in times of a pandemic - this is the case of companies like Ubiwhere and clothing stores that, today, advertise their products in lives on the Internet.

The Internet also brought a new set of features, providing goods and services without the customer having to leave home. This is the case with online stores, such as Fnac, Amazon and Continente that allow a quick purchase of goods, health services such as online consultations in general medicine or psychology, bank transfers through services such as Paypal and MB WAY, streaming services such as Netflix, YouTube and Spotify, allowing to watch movies without having to go to a cinema and listen to music without having to attend a concert. Regarding streaming services, there are even partnerships with companies to display advertisements, as is the case with YouTube and the free version of Spotify (in which every five songs heard, an ad is shown), emerging new forms of income. And talking about forms of income, thanks to these platforms youtubers and streamers came up – people who create content and publish on YouTube, being paid for it, and who create content about video games and show live matches, being equally paid, respectively. Again, the appearance of the Internet and the employment creation.

On the other hand, all these automated services present on the Internet can cause problems: one of them is to increase economic inequalities between companies - let's assume a local grocery store and a large supermarket; if this last one creates an online platform to provide its services and reach a wider segment of customers, it will increasingly gain consumers who, satisfied with their value proposition and the ease in buying the goods they provide, they become regular customers, creating long-term revenue streams. And the grocery store? Most likely it'll lose clients. Another possibility is that, when creating a digital platform, work post will decrease - assuming that a company that had a physical store with 100 employees creates an online store that, requiring less labour, it passes needing only 20 employees. This will increase the unemployment rate.

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# APENDIX 1. TRACEROUTE WITHIN MY NETWORK

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 0 | My Computer (192.168.1.131) | Ovar | AS12353 Vodafone Portugal - Communicacoes Pessoais S.A. | HTTP, SOAP, DHCP, DNS | 7 - Application |
| | | | | TLS, SSL | 6 - Presentation |
| | | | | RTCP | 5 – Session |
| | | | | TCP | 4 – Transport |
| | | | | IP | 3 - Network |
| | | | | Wi-Fi IEEE802.11x | 2 – Data Link |
| | | | | Free-Space radio | 1 - Physical |
| 1 | My local network router (192.168.1.1) | Ovar | AS12353 Vodafone Portugal - Communicacoes Pessoais S.A. | IP | 3 - Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 2 | Router (77.54.64.2) | Lisbon | AS12353 Vodafone Portugal - Communicacoes Pessoais S.A. | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 3 | Router (213.30.41.113) | Oporto | AS12353 Vodafone Portugal - Communicacoes Pessoais S.A. | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| CHANGED NETWORK | | | | | |

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 4 | Router (195.10.48.9) | Lisbon | AS1273 Vodafone Group PLC | IP, RIP | 3 - Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 5 | Router (195.2.21.150) | Paris | AS1273 Vodafone Group PLC | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 6 | Router (195.2.9.30) | Ashburn | AS1273 Vodafone Group PLC | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 7 | Router (195.2.14.42) | Ashburn | AS1273 Vodafone Group PLC | IP, RIP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| CHANGED NETWORK | | | | | |
| 8 | Router (66.109.5.116) | Englewood | AS7843 Charter Communications Inc | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 9 | Router (66.109.6.151) | Denver | AS7843 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 10 | Router (66.109.6.36) | Houston | AS7843 Charter Communications Inc | IP | 3 - Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 11 | Router (107.14.19.49) | Englewood | AS7843 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 12 | Router (66.109.6.0) | Tustin | AS7843 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 13 | Router (66.109.3.233) | Los Angeles | AS7843 Charter Communications Inc | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| CHANGED NETWORK | | | | | |
| 14 | Router (72.129.25.3) | Los Angeles | AS20001 Charter Communications Inc | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 15 | Router (72.129.27.131) | Los Angeles | AS20001 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 16 | Router (76.167.30.206) | Los Angeles | AS20001 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 17 | Router (104.172.186.0) | Calabasas | AS20001 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| REQUEST TIMED OUT… | | | | | |

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| * | Apache HTTP Server by CentOS (98.153.124.3) | Calabasas | AS20001 Charter Communications Inc | HTTP, SOAP, DHCP, DNS | 7 - Application |
| | | | | TLS, SSL, FTP | 6 - Presentation |
| | | | | RTCP | 5 – Session |
| | | | | TCP | 4 – Transport |
| | | | | IP | 3 – Network |
| | | | | Fast Ethernet | 2 – Data Link |
| | | | | 10GBASE | 1 - Physical |

# APENDIX 2. TRACEROUTE WITHIN UA NETWORK

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 0 | My Computer (192.168.1.131) | Aveiro | UA VPN | HTTP, SOAP, DHCP, DNS | 7 - Application |
| | | | | TLS, SSL | 6 - Presentation |
| | | | | RTCP | 5 – Session |
| | | | | TCP | 4 – Transport |
| | | | | IPv4 | 3 – Network |
| | | | | Wi-Fi IEEE802.11x | 2 – Data Link |
| | | | | Free-Space radio | 1 - Physical |
| 1 | Router (193.137.173.235) | Aveiro | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP | 3 - Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 2 | Router (193.137.173.244) | Aveiro | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 3 | Router (10.0.34.1) Bogon / Endereço privado da network da UA | Aveiro | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP, RIP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 – Physical |
| CHANGED NETWORK | | | | | |
| 4 | Router de Porto Campanhã (193.136.4.26) | Oporto | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP, RIP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 5 | Router (193.137.4.2) | Oporto | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP | 3 - Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 6 | Router (193.136.4.1) | Lisbon | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 7 | Router (194.210.6.203) | Lisbon | AS1930 Fundacao para a Ciencia e a Tecnologia, I.P. | IP, RIP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| CHANGED NETWORK | | | | | |
| 8 | Router (83.97.88.209) | Lisbon | AS21320 GEANT Vereniging | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 9 | Router (62.40.98.107) | Madrid | AS20965 GEANT Vereniging | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 10 | Router (62.40.98.65) | Paris | AS20965 GEANT Vereniging | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 11 | Router (62.40.98.182) | London | AS20965 GEANT Vereniging | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 12 | Router (62.40.98.180) | Frankfurt am Main | AS20965 GEANT Vereniging | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| CHANGED NETWORK | | | | | |

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 13 | Router (80.239.135.136) | Frankfurt am Main | AS1299 Telia Company AB | IP, RIP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 14 | Router (62.115.142.4) | Frankfurt am Main | AS1299 Telia Company AB | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 – Physical |
| 15 | Router (62.115.114.98) | Paris | AS1299 Telia Company AB | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 16 | Router (62.115.122.159) | Solna | AS1299 Telia Company AB | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 – Physical |
| 17 | Router (62.115.125.191) | Solna | AS1299 Telia Company AB | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 – Physical |
| 18 | Router (80.91.246.75) | Solna | AS1299 Telia Company AB | IP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |
| 19 | Router (62.115.156.209) | Solna | AS1299 Telia Company AB | IP, RIP | 3 – Network |
| | | | | Ethernet | 2 – Data link |
| | | | | Ethernet physical layer | 1 - Physical |

CHANGED NETWORK

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| 20 | Router (66.109.5.120) | Englewood | AS7843 Charter Communications Inc | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 21 | Router (66.109.5.228) | Englewood | AS7843 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 22 | Router (209.18.43.73) | Dallas | AS7843 Charter Communications Inc | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| CHANGED NETWORK | | | | | |
| 23 | Router (72.129.25.3) | Los Angeles | AS20001 Charter Communications Inc | IP, RIP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |
| 24 | Router (72.129.27.131) | Los Angeles | AS20001 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 – Physical |
| 25 | Router (76.167.30.206) | Los Angeles | AS20001 Charter Communications Inc | IP | 3 – Network |
| | | | | PPPoE | 2 – Data link |
| | | | | OTN, SDH, SONET | 1 - Physical |

REQUEST TIMED OUT...

| Hop | Device | Local | Network/Organization | Techs & Protocols | OSI Layer |
|---|---|---|---|---|---|
| * | Apache HTTP Server by CentOS (98.153.124.3) | Calabasas | AS20001 Charter Communications Inc | HTTP, SOAP, DHCP, DNS | 7 - Application |
| | | | | TLS, SSL, FTP | 6 - Presentation |
| | | | | RTCP | 5 – Session |
| | | | | TCP | 4 – Transport |
| | | | | IP | 3 – Network |
| | | | | Fast Ethernet | 2 – Data Link |
| | | | | 10GBASE | 1 - Physical |