TECHNISCHE UNIVERSITÄT BERLIN

Fakultät IV – Elektrotechnik und Informatik
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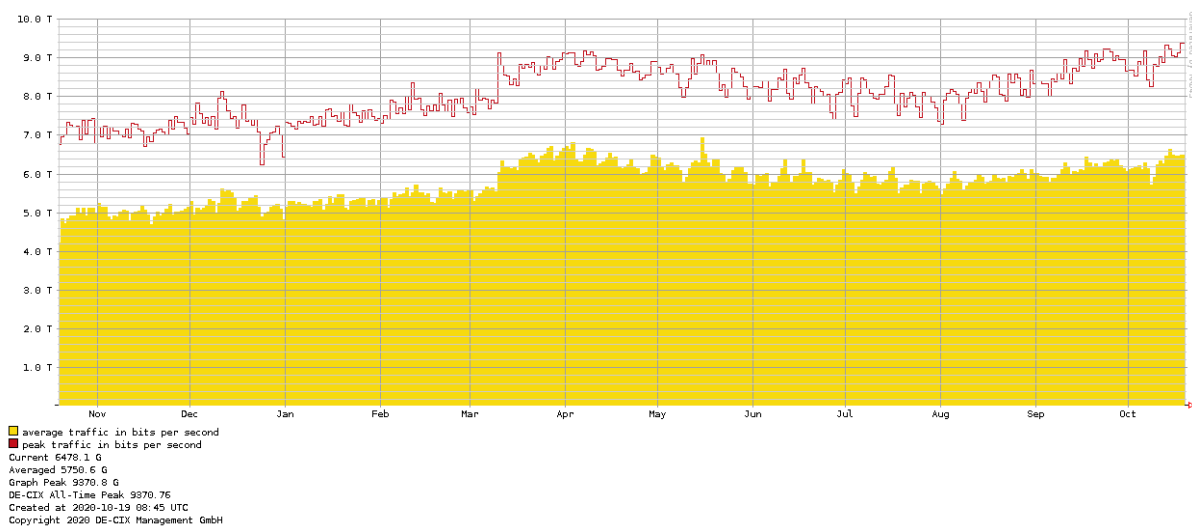
1st Assignment   Network Protocols and Architectures, WS 20/21

Figure 1: DE-CIX Frankfurt one-year statistics[1]

Question 1: $(10 + 5 + 5 = 20$ points) *Circuit Switching vs. Packet Switching*

(a) Compare the **delays** in **circuit switching** and **packet switching**: Which delays occur and which do not occur in circuit switching? Which delays occur and which do not occur in packet switching? Which delays occur in both? **Please provide definitions and explanations.**

(b) A link with a bandwidth of 45 MBit/s is to be used by several users. Each user needs 1.5 MBit/s to send, but is only active 20 % of the time. **How many users** can be connected if **circuit switching** is used? **Justify your answer briefly.**

(c) Could the link from (b) support more users when **packet switching** is used? **Justify your answer briefly.**

Please turn over!

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[1]Source of graphic: https://www.de-cix.net/en/locations/germany/frankfurt/statistics

Question 2: $(6 + 5 + 5 + 4 = 20$ points) *Outlook on the Internet*

After the outbreak of the COVID-19 pandemic, media started reporting a significant increase in the volume of internet traffic. You are tasked with evaluating these reports for their accuracy.

Figure 1 shows traffic statistics from the last 12 months for one of the largest internet exchange points (IXPs) in Germany, the DE-CIX. Based on this figure and your general knowledge answer the following questions:

(a) Consider Figure 1 carefully. What statistics are provided in the figure? **Please name these statistics and briefly (one sentence) explanin each.**

(b) Evaluate the period between **March** and **April** of this year. Briefly describe the changes in internet traffic for that period. What do you think is the reason for the major changes in traffic volume during that period? **Justify your answer briefly.**

(c) Look at the periods before and after March of this year. Can you see an increase in the average volume of traffic routed by the IXP? If so, provide a rough estimation of that increase.

(d) Second part of December can be considered a holiday season in Germany. Are there any particular traffic changes present in this period? What events could these correspond with?

Question 3: $(10 + 8 + 8 + 4 = 30$ points) *Impact of COVID-19 on European Internet*

The COVID-19 pandemic impacted the internet usage patterns, especially during the the initial lockdown, as well as in the following months. Researchers have analysed these changes and summarized their findings in a paper titled "The Lockdown Effect: Implications of the COVID-19 Pandemic on Internet Traffic"[2] by Feldmann, et. al. **Please read this paper and familiarize yourself with its contents.**

(a) Take a look at Figure 2 (a) of the aforementioned paper that shows the normalized ISP internet traffic on three different days. **Briefly (1-2 sentences each) describe the daily internet traffic patterns for:**

- Workday before lockdown
- Weekend before lockdown
- Workday after lockdown

How did the workday internet traffic pattern change during lockdown when compared to pre-lockdown times? **Briefly compare the traffic patterns before and during lockown.**

(b) Now consider Figure 2 (b) from the same paper that shows the normalized traffic volume for January 1st to June 24th observed at a central-european ISP. The figure also distinguishes between a workday-like and weekend-like traffic patterns for each of the shown days.

What changes in traffic patterns can you observe between before the lockdown (until roughly the middle of March) and during lockdown (from middle of Mach until middle of May)? How did the volume of traffic change during the lockdown? **Justify your answers briefly**

(c) Analyse Figure 2 (c) from the paper that shows the normalized daily traffic volume as well as distinguishes between workday-like and weekend-like patterns for each day between January 1st and June 24th. Can you observe anything out-of-the-ordinary in the beginning of January? **Briefly justify your answer.**

Consider the pre-lockdown and post-lockdown traffic patterns. What differences between the two time periods did you observe? Did the traffic volume increase during the lockdown? What could be **two of the possible reasons for this increase?** **Briefly justify your answer.**

(d) Compare the traffic observed at a regional ISP (Figure 2 (b) from the paper) and regional IXP (Figure 2 (c) from the paper) after the lockdown (i.e. beginning middle of March). What differences in traffic patterns can you observe between the two? **Justify your answer briefly**

Please turn over!

Question 4: $(10 + 10 + 10 = 30$ points) *Hands-on Experiments with* `ping` *and* `traceroute`

The tool `ping` can be used to check whether a given host in the Internet is reachable and how long it takes to get an answer back from this host. The tool `traceroute` can be used to find out about devices on the path.

Familiarize yourself with both tools. You can invoke them from the command line. Note that `traceroute` is called `tracert` on Windows.

(a) Select three DNS resolvers within Germany, five DNS resolvers in other European countries (each in different country), and five DNS resolvers outside of Europe (each in different country)[3]. We will call these DNS resolvers "targets" in the remainder of this question. Ensure that you can ping these targets. For each of the resolvers gather its **IP address**, **location**, and record the **average time in milliseconds** it takes to get a reply back from the target as Round Trip Time (RTT) in ms.

(b) Determine the **geographic distance (in meters) of the target** to the location where you perform the experiment (e. g., use some Internet service[4]) and note it. Can you find targets that have a **smaller RTT** but a higher distance than other targets? **Why can this happen?**

Hint: **You can present your measurements from (a) and (b) in a single table.**

(c) Try a `traceroute` to each target. You can see intermediate devices on the path and their ping response times. Seeing stars (* * *) means that no reply was received. Often, ping works, but traceroute does not provide answers for all devices along the path.

From each category (targets in Germany, in Europe, and outside of Europe), pick the traceroute attempt where you see the most devices on the path, and paste it to your solution. **Describe what you see, and why.**

Bonus Question: (Bonus: 10 points) *Layering*

The textbook by Kurose and Ross compares layers in networks to actions when taking an airplane trip. Read the analogy in the first chapter and **come up with another human analogy** similar to the airport example to discuss layered architectures. If you do not have a hardcopy of the textbook, you can use the online version[5] **Please describe and explain your analogy.**

Due Date: Wednesday, 18.11.2020 11.59 pm (end of day)

- **As PDF files (no MS Office or OpenOffice files)**, uploaded via ISIS:
  `https://isis.tu-berlin.de/course/view.php?id=21979`
- Put the names and Student ID numbers (Matrikelnummer) of **all** your group members **and** the tutorial slot on your solution!

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[3] Check out `https://public-dns.info` if you have problems finding DNS resolvers

[4] The following sites should yield useable information: `http://www.timeanddate.com/worldclock/distance.html`, `http://www.geobytes.com/CityDistanceTool.htm`

[5] `http://www.net.t-labs.tu-berlin.de/teaching/computer_networking/01.07.htm`