TECHNISCHE UNIVERSITÄT BERLIN
Fakultät IV – Elektrotechnik und Informatik
Fachgebiet Internet Network Architectures

IP Multimedia Lab WS 2018/19
Homework 4
Due: 05.02.2019, 11.55 PM

You can upload your submission to the ISIS online course (`https://isis.tu-berlin.de/mod/folder/view.php?id=628432`). Please submit your results as an archive, including your code and any scripts that you wrote to solve the assignments. Prepare a PDF file, in which you write down your results and answers to the questions. For your submission, please consider the following points:

- Please name your archive *worksheet_⟨ws_number⟩_group_⟨group_number⟩*
- Add a cover page to the PDF including your group number and all group members
- Describe all relevant steps you performed
- Add all relevant log files to your
- Make your plots easily understandable, this is supported by
  - labeling your x-axis and y-axis
  - using informative captions
  - setting an appropriate font size
  - adding legends when needed
- Write down which libraries/tools you used
- Describe your results and denote to which (sub-)task they belong
- All code must be properly documented using inline comments
- All files that belong to a specific question must have the question/subquestion in their filenames
- When you are asked to visualize results, you are expected to provide a plot, i.e. visualizing using a table is not sufficient!
- When using ffmpeg, please shortly refer to all flags used, what they do, and why you use them (it is sufficient to do so once for a flag, i.e. when you apply a certain paramter a second time, you do not again need to describe it)

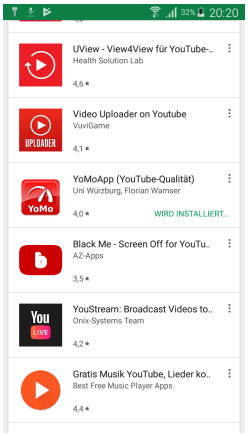

Figure 1: YoMoApp in Google's playstore

Question 1: (25 Points) *Monitoring YouTube's Streaming Quality with YoMoApp*

You need the *YoMoApp* for the following tasks (see Figure 1). You can find the App in Google's playstore, there is no support for iOS.

(a) Start the app and watch a video in three different different scenarios:

- **Scenario 1:** You are connected to WIFI
- **Scenario 2:** You are using your smartphone's mobile access, but not considerably moving
- **Scenario 3:** You are connected to a WIFI or use mobile access and traverse any location, where connection might be critical (e.g. using the elevator, passing through an underground tunnel)

For each of the scenarios, use the parameters logged in the App to analyze

- the duration of the initial delay
- how often the video paused during play black
- the number of quality switches
- the average and maximum buffered play time

Please note! The statistics are only available as long as the app is running. This means that you will not be able to analyze your results after restarting the app.

(b) In the app's statistic section, you can also find charts illustrating the buffer and throughput. Make a screenshot of both of them for all three scenarios and interpret the results!

(c) When you are asked to rate the video's quality, you are also asked how much you liked the video's content. Why might this be of interest for the app developers?

(d) How is the concept called that YoMoApp is using for monitoring YouTube streaming quality? Shortly describe the concept. In this context, also name some possible benefits and drawbacks.

Question 2: (35 Points) *Evaluating the Impact of Using Video Segments of Variable Duration*

For this task, you need the Big Buck Bunny full movie, provided here: `https://service.inet.tu-berlin.de/owncloud/index.php/s/h6DvYK8tmBTBQCi`. Consider for all tasks variable bitrate encoding with a CRF of 30.

(a) Use ffmpeg to encode and segment the video. Let the encoder freely choose the segment duration within a range of 0 to 10 seconds (e.g. segment_1 has a duration of 6 seconds, segment_2 has a duration of 3 seconds, etc.)

(b) Analyze

- the average segment duration
- the standard deviation of segment duration
- the segment durations along the video
- the segment durations using a box plot

(c) Encode and segment the video so to obtain the same average segment duration as resulting from subtask a). Thereby, you can floor or ceil to the nearest half second (e.g. 4.5s if your average from a) is 4.37s)

(d) Encode and segment the video so to obtain a segment duration of 10 seconds.

(e) Compare your results from a) with b) and c) in terms of

- total video size
- number of I-frames
- average segment size.

Finally, use box plots to visualize the segment sizes resulting from a) and b)

(f) Considering your findings above, what would be possible benefits and drawbacks of using variable segment durations?

Question 3: (45 Points) *Analyzing the Impact of Network Characteristics and Concurrent Flows on Video Streaming Performance*

For this tasks, you need a (virtual) testbed consisting of server, a client, and the possibility to shape traffic. You can either setup your own environment or use the existing Vagrant machine from the previous sheet.

(a) In order to emulate real world network characteristics, network traces are often used in research. Download the three provided network traces from `https://service.inet.tu-berlin.de/owncloud/index.php/s/TuiDICsuKTrwjEA`, `https://service.inet.tu-berlin.de/owncloud/index.php/s/hXmZsjG66QomZdc`, and `https://service.inet.tu-berlin.de/owncloud/index.php/s/WcnOjIcYFK5XkHV`. Implement, e.g. using a bash script, the network traces into your testbed. In case you use Linux namespaces, the following command is helpful:

```
sudo ip netns exec ns_srv0 tc class change dev ns_srv0_veth0 parent 1:
classid 1:1 htb rate 10000Kbit
```

Each line in the trace file represents the throughput in kbps on a per-second scale.

(b) Download the provided videos `https://service.inet.tu-berlin.de/owncloud/index.php/s/orDS1ZclGdegAxT`. Perform at least five measurement runs for the following configurations:

- static bandwidth of 0.5 Mbps
- static bandwidth of 1 Mbps
- static bandwidth of 2 Mbps
- network_trace0
- network_trace1
- network_trace2

Analyze the Quality of Experience-relevant metrics (initial delay, average quality, number of quality switches, stalling number and duration) for all configurations.

(c) Use network_trace1 to evaluate the impact of packet loss values of $p_{pl} = \{2, 4, 10, 20\}\%$ on the QoE-relevant metrics.

(d) Use network_trace1 to evaluate the impact of delays of $delay = \{25, 50, 100, 200\}$ms on the QoE-relevant metrics.

(e) Set a bandwidth of 3 Mbps and start three video clients simultaneously. Plot the estimated throughput over time for all clients. What is the average estimated throughput for each client? Corresponds the result your expectations? Please explain!

Question 4: (30 Points) *Design your own HAS Heuristic*

(a) Implement and test your own HAS heuristic. We advise you to use Tapas player, as it is designed for easily integrating new heuristics and already implements the heuristic *Conventional*, which serves as a reference to evaluate the performance of your implementation. For the following tasks, perform at least five runs with the following network configurations:

- static bandwidth of 0.5 Mbps
- static bandwidth of 1 Mbps
- static bandwidth of 2 Mbps
- network_trace0
- network_trace1
- network_trace2

In order to compare your heuristic to *Conventional* in a fair manner, set the maximum buffer threshold to the same value, and always play out the complete video. Furthermore, use again the video representations provided here: `https://service.inet.tu-berlin.de/owncloud/index.php/s/orDS1ZclGdegAxT`. For grading this task, we will consider the performance of your algorithm compared to *Conventional* in all network scenarios and in terms of the following metrics:

- initial delay
- average quality
- number of video interruptions
- total duration of video interruptions

Try to optimize your algorithm as good as possible!

(b) Give your algorithm a meaningful and creative acronym.