

CS5248: Systems Support for Continuous Media Fall 2014

Project Assignment

Due: Report Draft – 12 Nov 2014 (11:59:59 pm)
Due: Code & Final Report – 19 Nov 2014 (11:59:59 pm)
Due: Presentation – 19/20 Nov 2014 (6:30 to 8:30 pm)

THIS IS A TEAM-OF-3 HOMEWORK

REMEMBER TO CHECK FOR ANNOUNCEMENTS ON THE CLASS WEB SITE:

<http://www.comp.nus.edu.sg/~cs5248/>

Project Assignment Description

In this project, your task is to build a small DASH-compliant (Dynamic Addaptive Streaming over HTTP – that is, compatible with BOTH Apple's HTTP Live Streaming (HLS) and MPEG DASH standard) client-server-based video hosting service on top of a LAMP stack (Linux, Apache, MySQL, PHP).

The DASH approach of streaming is becoming very popular. It is basically a replacement for the RTSP/RTP/RTCP based approach to streaming. With DASH, the server is a simple HTTP web server (e.g., Apache). The media (video) is divided into small individually playable video segments which are, for example, 10 seconds long. These segments are also called *streamlets*. The client media player retrieves the streamlets from the web server, one at a time, and plays them without interruption. For the client to know all the streamlet files that belong to a complete video, the server provides a *playlist* file. The playlist file has a special format; it is basically an *XML* file for the MPEG DASH standard and *M3U8* format file for HLS. To start streaming, the client player loads the playlist file and then starts to download the streamlets that are listed in this file.

You will be given a number of utilities that will help you to get the project done. Additional information will be given during the lecture on 10 September 2014 and can be found in the slides for that lecture.

The project work is divided into three tasks: (1) create a mobile application that records a video and upload its streamlets to a server, (2) create server-side utilities that prepare incoming streamlets serviceable via DASH playlist, and (3) create another mobile application that plays DASH playlists, while adaptively switching and playing video streamlets.

Task 1 (Mobile Recorder and Uploader): The mobile application, running on an ASUS Transformer or Samsung tablet computer (running the Android 4.2 *Jelly Bean* OS or the Android 4.4 *KitKat* OS), is required to provide following sub-tasks:

- 1) Record 3Mbps 720x480 MPEG-4 (MP4) videos from the camera. Record a complete file and store it on the mobile device.
- 2) Upload the recorded videos to a web server reliably.
 - a. Segment the original video into a number of self-contained 3-second-long MP4 segments before uploading on-the-fly. Segmentation can either be done first, before the upload, or in parallel, together with the upload.
 - b. Use the HTTP POST method to deliver the segmented MP4 video to the server.

For you to understand the internal structure of the MP4 format, we intentionally ask you to segment the video at the mobile client (i.e., at the tablet computer), not at the server. To segment the video, you may use third-party libraries such as MP4Parser.

To upload the segmented videos reliably, you are required to design a simple protocol on top of HTTP, such as checking the current upload status or providing segments with a sequence number.

The following are additional functionalities that the mobile app can provide, which will receive extra credits:

- 3) Provide a resumed upload when the network connection is interrupted.
- 4) Retrieve the list of the uploaded videos available from the web server.

Task 2 (Server-side DASH Preparation): The server-side utilities may be written in the PHP language and there is no restriction on the use of any other third-party software packages. The minimum requirements for the server functionality are:

- 1) Receive segmented MP4 videos from a mobile client via the HTTP POST method and store them in a video repository location (i.e., directory) which you define. To keep track of the uploading status, you may use MySQL.
 - a. Support resumed uploading.
- 2) Transcode every received MP4 video segment into the following three encoded media versions:
 - a. 720x480 3 Mbps H.264/AVC and AAC audio (High)
 - b. 480x320 768 kbps H.264/AVC and AAC audio (Medium)
 - c. 240x160 200 kbps H.264/AVC and AAC audio (Low)
- 3) Convert every version into an MPEG-2 Transport Stream.
- 4) Provide two versions of DASH playlists (M3U8 for HLS and MPD XML for MPEG DASH).
- 5) The M3U8 playlist should be playable from iOS web browsers.
- 6) The MPD XML playlist should be playable from Android MPEG-DASH player (see Task 3 below). Note that the file format for the MPD playlist does *not* have to be a MPEG-2 Transport Stream.

Task 3 (Mobile MPEG-DASH Player): The mobile application should retrieve the list of the uploaded videos available from your web server in the form of XML-formatted MPEG DASH playlist files. It should support adaptive stream switching — that means it adaptively chooses the most suitable next video streamlet based on your bandwidth estimation algorithm

and prepares it before its playback time, while receiving and playing the current streamlet. The minimum subtasks for this task are:

- 1) Retrieve a list of MPEG-DASH XML-formatted playlist files.
- 2) Read the playlist files and schedule the retrievals of individual streamlets on-the-fly.
- 3) Switches the video rendering of one video streamlet to another.

Note that this player does not have to support HLS, since it has already been a part of Android. The suggested format of video streamlets is MP4.

The following additions are given extra credits.

- 1) Implement video switching and rendering seamlessly.
- 2) Display the current network bandwidth estimation results visually.

All the above functionalities are required to run automatically, meaning that there is no manual work other than a user's upload request of a recorded video via the mobile app.

Finally, the project report should include a survey of existing streaming switching techniques (Apple's Live Streaming, Microsoft Smooth Streaming, and Adobe's HTTP Dynamic Streaming) and their comparison in terms of server software requirements, overall end-to-end delay, and network efficiency.

Reference and Software Information

All the students taking the CS5248 module are able to get an user account on our server `pilatus.dl.comp.nus.edu.sg`. The machine is running [CentOS 6.5](https://www.centos.org) Linux (<https://www.centos.org>). You will need to use `ssh` to connect to the machine. You will also write PHP code in your `pilatus your_account/public_html` directory.

When segmenting the video with the mobile application, you may use the `MP4Parser` package. When developing server utilities, you are allowed to use any useful MPEG-4 parsing and transcoding utilities such as `MP4Box` or `FFmpeg`. However, server-side segmentation is not allowed — segmentation must be done at the client side. For your convenience, you can use `ffmpeg`, `bento4`, `mp4box` commands from `/usr/local/bin` on the `pilatus` server.

Additional information and links:

- Android software packages (<http://developer.android.com/sdk/installing/index.html>)
 - Java <http://www.java.com/en/download/>
 - Eclipse IDE for Java Developers <http://www.eclipse.org/downloads/>
 - Android SDK <http://developer.android.com/sdk/index.html>
 - ADT Plugin for Eclipse IDE <http://developer.android.com/sdk/eclipse-adt.html#installing>

- Google USB Driver <http://developer.android.com/sdk/win-usb.html>
- Apple Live Streaming Internet Draft (<http://tools.ietf.org/html/draft-pantos-http-live-streaming-06>)
- Microsoft Smooth Streaming (<http://www.iis.net/downloads/microsoft/smooth-streaming>)
- Sample instruction how to build iPhone HTTP Streaming (<http://www.ioncannon.net/programming/452/iphone-http-streaming-with-ffmpeg-and-an-open-source-segmenter/>)
- MP4Parser <http://code.google.com/p/mp4parser/>
- FFmpeg <http://ffmpeg.org>
- Bento4 package <http://zebulon.bok.net/trac/Bento4>
- MP4Box <http://www.videohelp.com/tools/mp4box>
- DASH-JS http://www-itec.uni-klu.ac.at/dash/?page_id=746

If you have any questions, email either the TA or the professor!

Submission Guidelines

1. Materials which you need to submit

- (1) Your Android app source code and installable package (.apk file); your PHP or shell script code. Create a tarball (i.e., a tar file) of all your **sources** (please exclude sample videos, object files, etc.).
- (2) A detailed README.txt file, that includes
 - a) Your name(s), matriculation number(s), and your username(s) on the host pilatus.
 - b) A brief description of each file and how it works.

Please create a tarball (i.e., an archive created with the `tar` utility or the `zip` utility) that collects all your files into a package with your matriculation number. Then compress it (with `gzip`, in case you are using `tar`) before you submit the file. **Make sure that your code compiles without ANY errors!**

- (3) A project report. Your write-up should be similar to a standard research paper (see details below). Please submit a PDF file.
- (4) Submit to your report and compressed package into the course module's **IVLE Workbin** (<https://ivle.nus.edu.sg/workbin/workbin.aspx?workbinid=f5c1f929-2c17-4aee-8353-7c4560ee81fe>) to the folder called 'Student Submission' by **23:59** on **19/11/2014** (final project report) and **23:59** on **19/11/2014** (software source code).
- (5) Late submission policy for report.
 - late within 24 hours: 30% reduction in marks;
 - late within 3 days: 50% reduction in marks;
 - late within a week: 70% reduction in marks;

- after one week: zero marks.

Note that the project demonstrations will be held on 19 and 20 November 2014 during in-class time (6:30 to 8:30 pm) in the Reading Week and cannot be done later.

Grading Policy (50 full marks)

1. **Project Demonstration (30 marks)**. You will present your project in class in November 2014. You will have approximately 20 minutes to demo your project. The demo should include (1) recording a video from your mobile app (**5 marks**), (2) segmenting the video on-the-fly (**5 marks**), (3) uploading the segmented video from your mobile app (**3 marks**), (4) resuming a failed upload from the same point where the network error occurred (**2 marks**), (5) playing the playlist of your uploaded video from any mobile browser (or app) or desktop browser (**5 marks**), and (6) playing the playlist from your mobile DASH player (**10 marks**).
2. **Project Source Code (5 marks)**. We will have a look at your code. Criteria are for example, how well it is documented, how well it is understandable, how robust it is (i.e., can it process all relevant input files), etc.
3. **Project Report (15 marks)**. Your write-up should be similar to a standard research survey paper. Please include (at least) the following sections:
 - a) Abstract
 - b) Introduction and motivation for your project work (your specific design and implementation choices)
 - c) Summary of existing streaming switching techniques
 - d) Description of your implementation, i.e., details on what you did, any difficulties encountered, any special features or functionalities that you implemented, etc.
 - e) Results, comparison and discussion, i.e., what should we learn from this and what could possibly be further improved
 - f) Other research directions regarding lowering end-to-end delays for MPEG-4 streaming
 - g) Conclusions
 - h) References

Most of the marks will be given for sections b), d), and e).

Additional Notes

No plagiarism is tolerated. While you can talk to other teams and you are encouraged to use the IVLE Forum, you cannot copy source code and/or text in your report. If you are not sure whether something is permissible, either talk to the instructor or consult the university policy at http://www.usp.nus.edu.sg/acad_matters/guidelines/acad_code.html.