Lab: HTTP Download Manager

Overview

Download managers, popularized in the mid-late 90s, have changed the way we download files from the internet. While today most of these features are integrated into modern browsers, you can still find them handy, e.g to download files faster from the command line (see: aria2 and axel).

In this lab you'll get a glance into the implementation of download managers, you'll learn how to resume broken downloads, why using multiple HTTP connections accelerate some downloads, and how to rate limit your application.

Resume Downloads

Your Download Manager needs to be able to recover from a previously stopped download (e.g. process stopped with a signal, power outage, network disconnection, etc.). Make sure to reliably store your progress to a file, and use HTTP Range request (see: https://tools.ietf.org/html/rfc7233) in order to resume broken downloads.

Concurrent Connections

You'll need to support downloading a file using multiple HTTP connection. This download acceleration method is commonly used to circumvent per-connection server side limitations. Use the multithreading Java programming techniques acquired last semester in order to manage multiple downloaders and a single disk writer threads. Use HTTP Range request to split the load between downloader threads.

Download Rate Limiting

In order to prevent your new download habits to interfere with your video streaming, use the token bucket algorithm (https://en.wikipedia.org/wiki/Token_bucket) to enforce downloading a specific amount of bytes (i.e. tokens) per second.

Usage Example

```
$ java IdcDm "https://archive.org/download/Mario1_500/Mario1_500.avi" 8 10000
Downloading using 8 connections limited to 10000 Bps...
Downloaded 0%
Downloaded 1%
^C

$ java IdcDm "https://archive.org/download/Mario1_500/Mario1_500.avi" 8
Downloading using 8 connections...
Downloaded 1%
Downloaded 2%
```

```
Downloaded 3%
Downloaded 4%
Downloaded 5%
...
Downloaded 95%
Downloaded 96%
Downloaded 97%
Downloaded 98%
Downloaded 99%
Download succeeded
```

Implementation Details

Create a command line application which accepts up to 3 parameters (in that order):

1. URL.
2. (optional) Maximum number of concurrent HTTP connections.
3. (optional) Maximum download rate in bytes-per-second.

The program will download the file specified in the URL (following redirects) into the current directory, e.g. "https://archive.org/download/Mario1_500/Mario1_500.avi" will be downloaded to "Mario1_500.avi".

The program may create additional files during download (i.e. metadata and temporary files), all of which:

- Should start with the same name as the downloaded file, e.g. "Mario1_500.avi.tmp".
- Should be deleted after a successful download.
- Should be smaller than **n/1024** in size, where **n** the size of the downloaded file.

The program should be able to properly resume download after previous invocation was terminated due to a signal (any signal) or network disconnection (you should define relevant timeouts and document that in the code).

The program can decide to use less than specified maximum number of concurrent HTTP connections, if it considered the file to be too small (you should define "too small" and document that in the code).

The program should not exceed maximum download rate in bytes-per-second, if specified, on average over 10 seconds (i.e. don't be alarmed if you exceed a little above the rate in some samples of your system monitor).

The program should print it's progress in terms of "percentage completed" similar to the example above (in case of a small file, it may print less than 100 times). A resumed download should continue from the last printed percentage. When finishing without getting a signal the program should either print "download succeeded" or "download failed".

Do's and Don'ts

1. You are **not allowed** to use Java ready made classes which implement any of the 3 core features.
2. You are **not allowed** to use any external library (e.g. apache.commons, guava, etc.)

3. You are **allowed** to use anything from the following packages:
    a. java.io.*
    b. java.net.*
    c. java.util.*
4. You are **allowed** to assume:
    a. The program input is correct.
    b. The server in the URL supports Range queries, and specifically byte ranges.
    c. The URL resource size is known to the server and is returned in HEAD requests.
5. You are **encouraged** to use the provided design proposal, to save time on architecture (or you can write your own from scratch).
6. It is OK to use constant values in your code, as long as they are **well documented**. e.g.

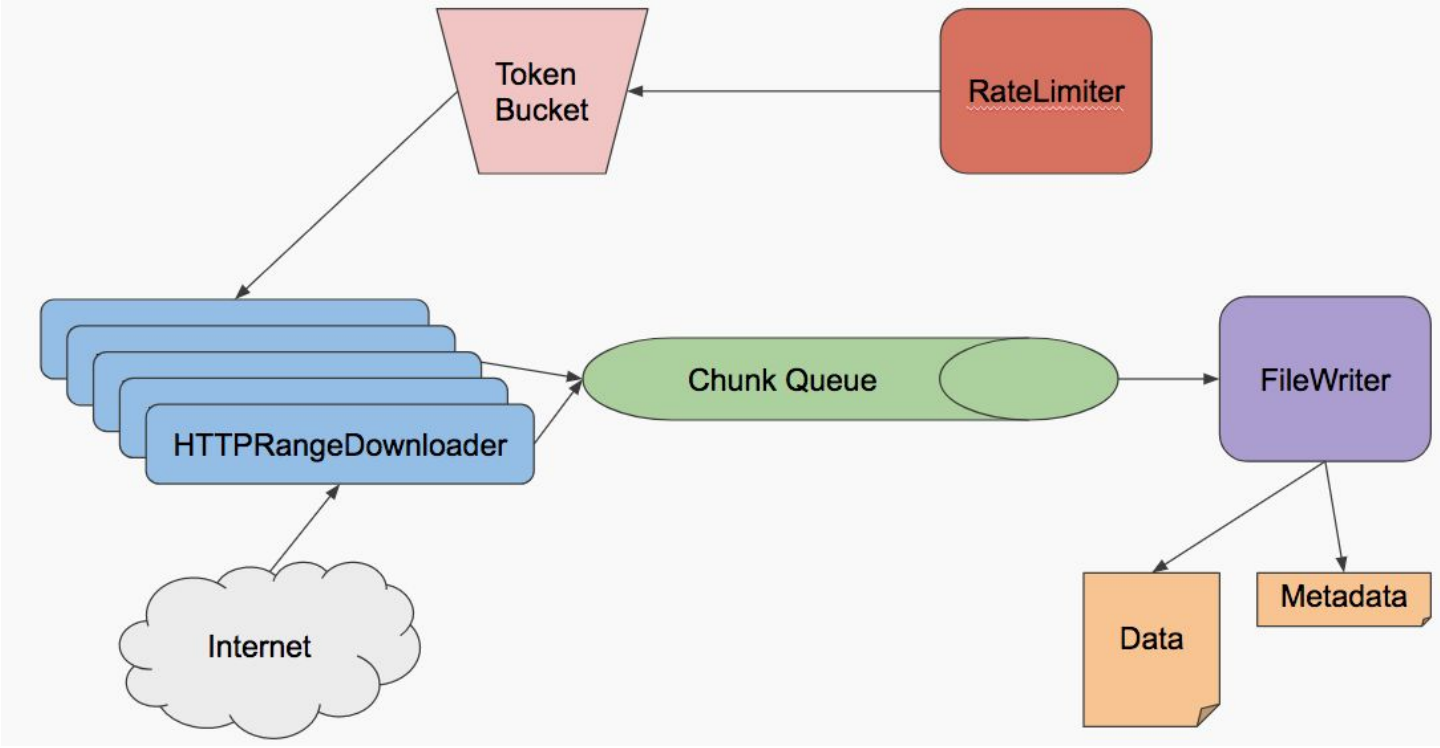
```
Thread.sleep(1000); // adding maxBps to token bucket every second
```

7. Your code will be checked with Java 8 and should compile **without warnings**!
    a. You are allowed to suppress specific warnings, in a limited scope, with proper documentation.

Error Handling

You should print only to STDERR (e.g. using `System.err.println`)
Your program shouldn't crash on exceptions, print a meaningful message, followed by "**Download failed**".

Design proposal (also see attached skeleton)



Tips, Spoilers and Common pitfalls

1. The **HttpURLConnection** instance provided by **URL**'s **openConnection()** method allows you to manipulate many aspect of your HTTP request (e.g. method, headers, etc.), and some aspects of the connection (e.g. read/connect timeouts).
2. Splitting the download into chunks will allow more efficient communication between the downloader threads and the disk writer thread.
3. When writing to disk use **RandomAccessFile** which allows you to open the output file in such a way that every change is written synchronously to disk. It also allows you to seek in the file before writing (useful when having multiple downloader threads).
4. Use Java Serialization to write your metadata to disk, but be careful- if your process gets a signal while writing a serialized object to disk you'll end up with a corrupted metadata. One way to circumvent that issue is to serialize the metadata to another temporary file and then rename it.
5. The **java.util.concurrent.atomic** package can be used to implement a thread-safe, lock-free token bucket.
6. Test your downloaded file. The quickest way is to use the md5 utility available in most Operating Systems, and compare its output for a file downloaded by your application, and the same file downloaded using the browser:
    a. **Linux**: `md5sum yourFileName`
    b. **MacOS**: `md5 yourFileName`
    c. **Windows**: `CertUtil -hashfile yourFileName MD5`

Submission guidelines

1. Submission **in pairs** by moodle by Sunday **15-01-2017**
2. File name should be lab-[student 1 id]-[student 2 id].zip (e.g. "lab-02202020-44747744.zip")
3. **Do not send any .class files in your zip**.
4. Misformatted files will not be accepted.
5. Make sure that your main function is found at the IdcDm.java file.
6. Attach a README file (in the .zip) containing
    a. The names & IDs of both students.
    b. For each file submitted: a single line describing its purpose.
7. **Use** the forum to ask any questions regarding this exercise.
    a. **Do not** upload any solution code to the forum.

Good luck!