ASSIGNMENT 1

DEVELOP A NETWORK APPLICATION

COURSE: COMPUTER NETWORKS, SEMESTER 1, 2023-2024

OBJECTIVES

Build a **Simple Like-torrent application** with application protocols defined by each group, using the TCP/IP protocol stack.

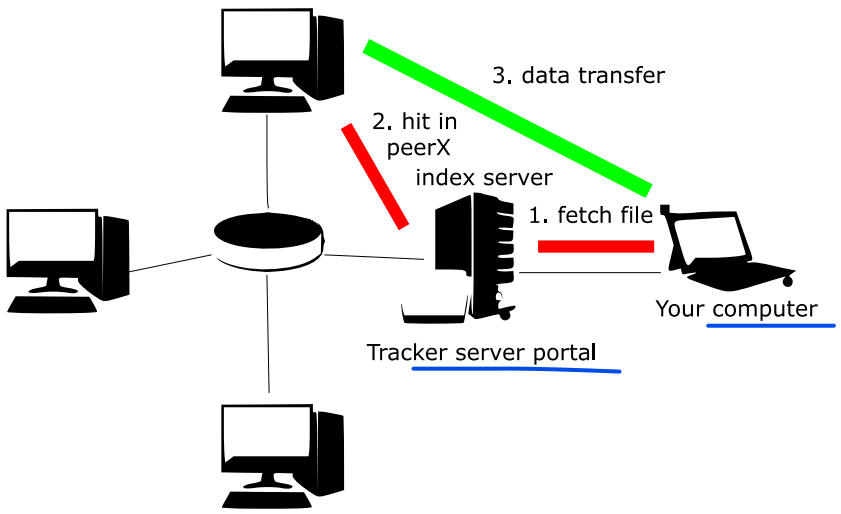
APPLICATION DESCRIPTION

Application overview

- A centralized server keeps track of which clients are connected and storing what pieces of files.
- Through tracker protocol, a client informs the server as to what files are contained in its local repository but does not actually transmit file data to the server.
- When a client requires a file that does not belong to its repository, a request is sent to the server.
- Multiple clients could be downloading different files from a target client at a given point in time. This requires the client code to be multithreaded

tracker client

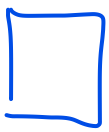
Figure 1. Illustration of file-sharing system.



client

The simple Like-torrent essential components

Before starting with the network transmission, you need to know something about all these small crucial components



Magnet text: is simple text that contains all of the necessary information to metainfo file, for minimum requirement is a hash code point to metainfo file on your centralized tracker portal (aka your-tracker-portal.local).
Metainfo File:(also known as .torrent file) holds all the details about your torrent, including where the tracker address (IP address) is, what is the piece length, piece-count.
Pieces: are specified in the Metainfo File. Pieces are equally-sized parts of the download. The usual size of piece is around 512KB.
Files: are also specified in the Metainfo File. There can be more than one file in a torrent. This implies that you may need to map the piece address space to the file address space if you have N parts and M files. Simple math mistakes are very likely possible here, but you MUST carry out all of the address mapping by hand and by yourself definition for later referring. For starting point, you can implement one file per torrent as a minimum score but stopping at this stage could result in a lower scoring evaluation.

Tracker HTTP protocol

Tracker request parameters: at start up, you are required to contact the tracker server (the global centralized tracker portal), submit all the appropriate fields. You should include the compact flag or metainfo in your request, a bare minimum requirement is a magnet text of your torrent that be able to parse.
Lastly, you have to submit started, stopped and completed requests to the tracker server when appropriate. When you send the started request, you need to include how many bytes you have downloaded already (at the piece level detail).
Tracker response: we determine a limited subset of the specification for bittorrent (in https://wiki.theory.org/BitTorrentSpecification). The tracker responds with "text/plain" document consisting of a dictionary with the following keys:
Failure reason: If present, then no other keys may be present. The value is a human-readable error message as to why the request failed (string).
Warning message: (new, optional) Similar to failure reason, but the response still gets processed normally. The warning message is shown just like an error.
Tracker id: A string that the client should send back on its next announcements. If absent and a previous announce sent a tracker id, do not discard the old value; keep using it.
Peers: (dictionary model) the value is a list of dictionaries, each with the following keys:

- peer id: peer's self-selected ID, as described above for the tracker request (string)
- ip: peer's IP address either IPv6 (hexed) or IPv4 (dotted quad) or DNS name (string)
- port: peer's port number (integer)

PEER- Downloading

After you get the list of peers from the Tracker, you now must connect to as many of them as you can and start downloading from them.
These are simple TCP connections with a 2-way handshake to enter the established state.
After you receive an establish command from the peer, you can start downloading pieces. You download pieces by requesting blocks.
The last requirement for downloading is that you send has messages each time you finish downloading a piece to close the connection.
For advanced development:
To maximally utilize network bandwidth, you want to have a request queue, which keeps a list of all blocks you have sent a request message to the peer for.
Since you will have multiple peers for the same torrent, you will need some way to keep track of which blocks have been requested to all the peers, so you don't send requests for the same block to multiple peers.

You algorithm for choosing which blocks to request from which peer is completely up to you, with the minimum requirements that you don't send a request for a piece the peer does not have, and *you don't send a request for a piece you already have*.

PEER- Uploading

It wouldn't be possible to download files with your client without seeders. Therefore, your application has to begin seeding the file to other peers who are also interested in downloading it after you download it.

For advanced development:

The "tit-for-tat" theory underlies peer-to-peer file sharing, implying that the more you share, the more files will be shared with you. This project is a chance to apply your learned theory.

The currently deployed peer selecting algorithm prevents free-rider by only changing peer selecting decision once every ten seconds.

User Interface

This part of the assignment allows for a large room for creativity: you can ultilize and implement any style of client you want, as long as it satisfies the minimum requirements of downloading and seeding a single torrent to multiple peers, and provides us ability to see all the upload/download statistics.

In general, http://www.transmissionbt.com/has a complete description. You can support some fundamental parameters and options of the transmission-client command lines. We keep an in-depth description for your comprehensive reference in future research if needed.

- **transmission-cli** - a bittorrent clienthttps://linux.die.net/man/1/transmission-cli
  - E.g: transmission-cli <<*torrent-file*>>
- transmission-create: https://linux.die.net/man/1/transmission-create
- transmission-daemon: https://linux.die.net/man/1/transmission-daemon
- transmission-edit: https://linux.die.net/man/1/transmission-edit
- transmission-remote: https://linux.die.net/man/1/transmission-remote
- transmission-show: https://linux.die.net/man/1/transmission-show

You could even develop a GUI if you have a lot of extra time. Although you probably won't get extra credit for this, you might earn some Github stars instead.

Extra credit:

You may choose to implement any or all of the following items (or something event not in this list but it is relevant to bittorrent and networking)

Distributed hash table (DHT): transmit your torrent file without the centralized tracker. Typically, this is a better source to find more peers here than by using the torrent's centralized tracker.

Simultaneous torrents: require your client show how to download and upload several torrents simultaneously (at the same time), as well as access the statistics through your user interface.

Tracker scrape: https://en.wikipedia.org/wiki/Tracker_scrape is the exchange to obtain the metainfo on behalf of the client. It should be mentioned that a peer's involvement in a data transmission is unaffected by scrape exchanges.

Download/Seeding strategies: a simple download strategy is required for your client, but if you choose to apply something fancier (like Super Seeding, Rarest-First, End Game), you need to document it and provide supplemental materials.

Optimizing peer selection: a simple peer selection strategy is required for your client, meaning you can just response to all your peers. If you want to use the wiki's actual standards (of only 4+1 peers at a time), please make sure you document it

Grading

The main requirements for this assignment are:

- Download a multi-file torrent from multiple peers concurrently
- Upload a multi-file torrent to multiple peers concurrently
- Show useful statistics of download/upload statistics, that allow us to inspect peer information, currently used torrents.

You grade breakdown will be as follows:
Tracker Protocol - 15% successfully parse the metainfo, send a request to the tracker, obtain its response with the list of corresponding peers, and parse the list of peers into useful 'ip' and 'port' pairs.
Torrent Download - 30% establish connection to serveral peers, download the torrent from all of them simultaneously, and appropriately use the mapping to determine which blocks to request. You must not send requests for pieces you have stored on disk and you must handle multi-file downloads correctly.
Torrent Upload - 15% allow several peers to connect to you so that you can serve multiple request streams simultaneously.
User Interface - 5% it is possible to define which torrent to download, where to store it, and how to view statistics for the current torrents by implementing appropriate command line interface or GUI.
Readme - 5% document your design, as well as any errors or features.
Provide documentation on your design, as well as any bugs or features.
Extra Credit - up to 10% check over the list above for some suggestions. Keep in mind that whatever you submit for additional credit needs to have something related to bittorrent and networks.
Cross team assessment – up to 20% In a cross-assessment, students are required to respond to an assignment individually or in groups, and then to assess or complement each other's work according to criteria set. The critical assessment set includes (i) students receive personalized feedback on their work with different approaches from other teams (ii) putting work (student work) into perspective with that of other (comparing the outputs of works) (iii) enhancing anchoring through evaluating each other's work (using teacher-established criteria that are deployed/spread to all student to focus on the key points and determine the correct way to solve the assignment project)

WORKING PLAN

- Work in a team.
- Each group has up to 4 members.

Phase 1 (First 2 weeks):

- Define specific functions of the file-sharing application
- Define the communication protocols used for each function

Phase 2 (Next 2 weeks)

- Implement and refine the application according to the functions and protocols defined in Phase 1

Phase 1 (softcopy):

- Submit the report file of the first phase to BKeL in the predefined section as announced on BKeL.
- File format (pdf): **ASS1_P1_<<Group_Name>>.pdf**

This report includes:

- Define and describe the functions of the application
- Define the protocols used for each function

Phase 2 (hard and softcopy):

- Submit the report file of the assignment to BKeL
- File format (.rar): ASS1_**<<Group_name>>**.rar

This report includes:

- Phase 1 content
- Describe each specific function of the application
- Detailed application design (architecture, class diagrams, main classes ...)
- Validation (sanity test) and evaluation of actual result (performance)
- Extension functions of the system in addition to the requirements specified in section 2
- Participants' roles and responsibilities
- Manual document
- Source code (softcopy)
- Application file (softcopy) compiled from source code

EVALUATION

Assignment 1 is worth 15% of the course grade.

DEADLINE FOR SUBMISSION

4 weeks from the assignment announcement.