



Presentation

OurTorrent

CSN-361 Project



PRESENTED TO

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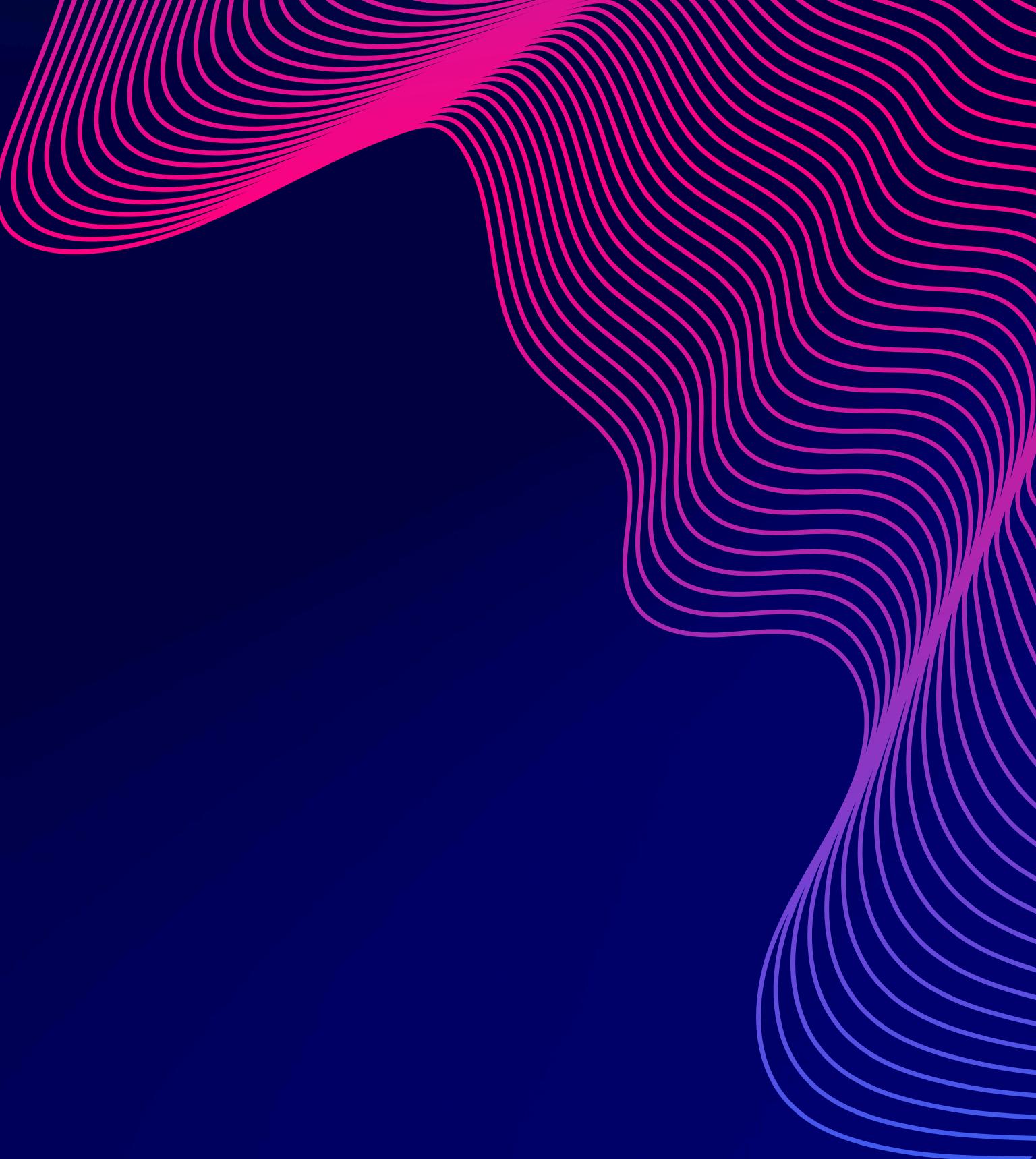
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Acknowledgement



TEAM DETAILS AND CONTRIBUTION



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Contribution:

Worked on implementation of client part of the project. Worked on establishing communications between peers and eventual downloading. Also worked on managing file pieces.



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Contribution:

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Contribution:

Worked on implementing UDP tracker: handling connection requests and announce requests, establishing client-tracker communication. Also, involved in overall code clarification.

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Contribution:

Worked on parsing of the torrent file using Bencoding Library. Also worked on connection of peer and tracker which included sending connect request and announce request to tracker and retrieving list of peers as response.



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Contribution:

Worked on socket utilities that are required between tracker and peer communication. Also, on setting up the UDP tracker.

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Contribution:

Implemented custom bencoding library. Also worked on implementing client part. Managed communication with multiple peers and successful downloading of files.

INTRODUCTION

Presenting **OurTorrent**- a BitTorrent inspired P2P file sharing system to share files between a set of peers without the need of any central server.

We have built this project in two phases:

1. Building a **BitTorrent client** that can read any torrent file and request the tracker to give information of peers that hold pieces of the actual file we wish to download.
2. A lightweight **UDP Tracker** to store necessary attributes of peers and dynamically updates them as they enter and exit the network.

FEATURES

P2P File Sharing

The system enables sharing files among peers over a torrent network

Bencoding Library

A small, single-header C++ serialization library for bencoded data.

Tracker

Peers can request the tracker for details of where to find required files

Client Tracker connection

Client Tracker interaction enabled using UDP protocol

CODE SNIPPETS

Client

Peer Class

Manages information about peers participating in file sharing within a BitTorrent network. It initializes peer-related attributes like IP, port, torrent instance etc

```
peer.py  X
bitTorrent > src > peer.py > peer
1  # peer.py handles all info about peers participating in file sharing
2  # and manages communication with them
3
4  import time
5  import struct
6  import hashlib
7  from threading import *
8  from copy import deepcopy
9
10 from torrent_logger import *
11 from peer_messages import *
12 from peer_socket import *
13 from peer_state import *
14
15 class peer():
16
17     def __init__(self, peer_IP, peer_port, torrent, init_peer_socket = None):
18         # peer IP, port and torrent instance
19         self.IP      = peer_IP
20         self.port    = peer_port
21         self.torrent = deepcopy(torrent)
22
23         self.state = peer_state()
24         self.unique_id = '(' + self.IP + ' : ' + str(self.port) + ')'
25         self.peer_id = None
26         self.max_block_length = torrent.block_length
27
28         # handshake flag with peer
29         self.handshake_flag = False
30
31         # bitfield representing which data file pieces peer has
32         self.bitfield_pieces = set([])
33
34         # peer socket for communication
35         self.peer_sock = peer_socket(self.IP, self.port, init_peer_socket)
36
```

Peer-to-Peer Communication

peer_wire_message class
manages the creation and
representation of peer
messages

```
peer_messages.py M X
bitTorrent > src > peer_messages.py > peer_wire_message > message
37 # class for general peer message part of peer wire protocol
38 class peer_wire_message():
39     def __init__(self, message_length, message_id, payload):
40         self.message_length = message_length
41         self.message_id = message_id
42         self.payload = payload
43
44     # returns raw bytes as peer message
45     def message(self):
46         message = struct.pack("!I", self.message_length)
47         if self.message_id != None:
48             message += struct.pack("!B", self.message_id)
49         if self.payload != None:
50             message += self.payload
51         return message
52
53     # printing the peer wire message
54     def __str__(self):
55         message = 'PEER WIRE MESSAGE : '
56         message += '(message length : ' + str(self.message_length) + '), '
57         if self.message_id is None:
58             message += '(message id : None), '
59         else:
60             message += '(message id : ' + str(self.message_id) + '), '
61         if self.payload is None:
62             message += '(protocol length : None)'
63         else:
64             message += '(payload length : ' + str(len(self.payload)) + ')'
65         return message
66
67
68
69     # class for creating handshake messages between the peers
70     class handshake():
71         # initialize the handshake with the payload
72         def __init__(self, info_hash, client_peer_id):
73             self.protocol_name = "BitTorrent protocol"
```

Handling Multiple Peers

Manages a group of peers in a BitTorrent network, tracking data such as seeders, leechers, and peer bitfields

```
peer_network.py M X
bitTorrent > src > peer_network.py > ...
1 import sys
2 import time
3 import random
4 from copy import deepcopy
5 from datetime import timedelta
6 from threading import *
7 from peer import peer
8 from torrent_error import *
9 from torrent_logger import *
10
11 class swarm():
12
13     def __init__(self, peers_data, torrent):
14         # initialize the peers class with peer data received
15         self.torrent = deepcopy(torrent)
16         self.interval = peers_data['interval']
17         self.seeders = peers_data['seeders']
18         self.leechers = peers_data['leechers']
19
20         # create a peer instance for all the peers received
21         self.peers_list = []
22         # used for AWS Cloud test
23         if self.torrent.client_request['AWS']:
24             self.peers_list.append(peer('34.238.166.126', 6881, torrent))
25
26         for peer_IP, peer_port in peers_data['peers']:
27             self.peers_list.append(peer(peer_IP, peer_port, torrent))
28
29         # bitfields from all peers
30         self.bitfield_pieces_count = dict()
31
32         # selecting the top N peers / pieces
33         self.top_n = self.torrent.client_request['max peers']
34
35         # peers logger object
36         self.swarm_logger = torrent_logger('swarm', SWARM_LOG_FILE, DEBUG)
37         # torrent stats logger object
```

Serialization Library

Bencoder

The serialization library is responsible for encoding metadata for torrent files

```
45  class bencode_integer : public bencode_base
46  {
47  public:
48      using value_type = int64_t;
49
50      bencode_integer() = default;
51      bencode_integer(value_type value) : integer_value_{value} {}
52
53      bencode_integer &operator=(value_type value)
54      {
55          integer_value_ = value;
56          return *this;
57      }
58      value_type get() const { return integer_value_; }
59
60      std::string encode() const override
61      {
62          return std::string(1, integer_token) + std::to_string(integer_value_) + std::string(1, end_token);
63      }
64      void encode_n_dump(std::ostream &out) const override
65      {
66          out << integer_token << integer_value_ << end_token;
67      }
68      void decode(const std::string &in, std::string::const_iterator &start) override
69      {
70          start++; // Assuming *start == 'i'
71          value_type value = 0;
72          bool neg = false;
73          if (*start == '-')
74              neg = true, start++;
75          while (start != in.end() && *start != end_token)
76              value = value * 10 + (*start - '0'), start++;
77          integer_value_ = neg ? -value : value;
78          if (start != in.end())
79              start++; // assuming it ends with 'e'
80      }
81      std::string get_as_str() const override
82      {
83          return std::to_string(integer_value_);
84      }
85  private:
86      value_type integer_value_{0};
87  };
```

```
11  namespace bencoding
12  {
13      struct string_subs
14      {
15          public:
16              std::string str;
17              std::string::const_iterator citer;
18              string_subs(std::string input) : str{input}, citer{str.begin()} {}
19              void refresh() { citer = str.begin(); }
20      };
21
22      class bencode_base
23      {
24          public:
25              static const char delimiter_token = ':';
26              static const char end_token = 'e';
27              static const char integer_token = 'i';
28              static const char list_token = 'l';
29              static const char dict_token = 'd';
30
31          bencode_base() = default;
32          bencode_base(const bencode_base &) = default;
33          bencode_base &operator=(const bencode_base &) = default;
34          bencode_base(bencode_base &&other) noexcept = default;
35          bencode_base &operator=(bencode_base &&other) noexcept = default;
36
37          virtual ~bencode_base() = default;
38
39          virtual std::string encode() const = 0;
40          virtual void encode_n_dump(std::ostream &out) const = 0;
41          virtual void decode(const std::string &in, std::string::const_iterator &start) = 0;
42          virtual std::string get_as_str() const = 0;
43      };
44  }
```

```
146     std::unique_ptr<bencode_base> make_value(const std::string &in, std::string::const_iterator &start);
147
148     template <typename T>
149     concept bencodeDerived = std::is_base_of<bencode_base, T>::value;
150
151     class bencode_list : public bencode_base
152     {
153     public:
154         using value_ptr_type = std::unique_ptr<bencode_base>;
155         using container_type = std::vector<value_ptr_type>;
156         using iterator = container_type::iterator;
157         using const_iterator = container_type::const_iterator;
158
159         bencode_list() = default;
160         bencode_list(size_t size_) : list_(size_) { list_.resize(size_); }
161
162         iterator begin() { return list_.begin(); }
163         const_iterator begin() const { return list_.begin(); }
164         const_iterator cbegin() const { return list_.cbegin(); }
165         iterator end() { return list_.end(); }
166         const_iterator end() const { return list_.end(); }
167         const_iterator cend() const { return list_.cend(); }
168
169         size_t size() const { return list_.size(); }
170         value_ptr_type &operator[](std::size_t index) { return list_[index]; }
171
172         template <bencodeDerived T, typename... Args>
173         void push_back(Args &&...args)
174         {
175             list_.emplace_back(std::make_unique<T>(std::forward<Args>(args)...));
176         }
177         void pop_back()
178         {
179             if (!list_.empty())
180                 list_.pop_back();
181         }
182
183         std::string encode() const override
184         {
185             std::string enc_str(1, list_token);
186             for (const value_ptr_type &ptr_ : list_)
187                 if (ptr_)
188                     enc_str += (ptr_->encode());
189             enc_str += end_token;

```

```
class bencode_string : public bencode_base
{
public:
    using string_type = std::string;
    using iterator = string_type::iterator;
    using const_iterator = string_type::const_iterator;
    using CharT = char;

    bencode_string() = default;
    bencode_string(string_type str) : str_{str} {}
    bencode_string(const CharT *cstr) : str_{cstr} {}

    iterator begin() { return str_.begin(); }
    const_iterator begin() const { return str_.begin(); }
    const_iterator cbegin() const { return str_.cbegin(); }
    iterator end() { return str_.end(); }
    const_iterator end() const { return str_.end(); }
    const_iterator cend() const { return str_.cend(); }

    bencode_string &operator=(string_type str)
    {
        str_ = str;
        return *this;
    }
    bencode_string &operator=(const CharT *cstr)
    {
        str_ = cstr;
        return *this;
    }
    size_t size() const { return str_.length(); }
    string_type get() const { return str_; }
    std::string encode() const override
    {
        return std::to_string(str_.length()) + std::string(1, delimiter_token) + str_;
    }
    void encode_n_dump(std::ostream &out) const override
    {
        out << str_.length() << delimiter_token << str_;
    }
    void decode(const std::string &in, std::string::const_iterator &start) override
    {
        size_t len = 0; // Assuming it starts with length
        while (start != in.end() && *start != delimiter_token)
```

```
class bencode_dict : public bencode_base
{
private:
    // custom comparator
    template <typename T_>
    struct lexicographical_compare
    {
        bool operator()(const T_ &lhs, const T_ &rhs) const
        {
            return std::lexicographical_compare(lhs.cbegin(), lhs.cend(), rhs.cbegin(), rhs.cend());
        }
    };

public:
    using key_type = bencode_string;
    using mapped_type = std::unique_ptr<bencode_base>;
    using value_type = std::pair<const key_type, mapped_type>;
    using comparator_type = lexicographical_compare<key_type>;
    using container_type = std::map<key_type, mapped_type, comparator_type>;
    using iterator = container_type::iterator;
    using const_iterator = container_type::const_iterator;

    bencode_dict() = default;

    iterator begin() { return dict_.begin(); }
    const_iterator begin() const { return dict_.begin(); }
    const_iterator cbegin() const { return dict_.cbegin(); }
    iterator end() { return dict_.end(); }
    const_iterator end() const { return dict_.end(); }
```

```
std::string encode() const override
{
    std::string enc_str(1, dict_token);
    for (const auto &[key_, ptr_] : dict_)
    {
        if (ptr_)
        {
            enc_str += key_.encode();
            enc_str += ptr_->encode();
        }
    }
    enc_str += end_token;
    return enc_str;
}

void encode_n_dump(std::ostream &out) const override
{
    out << dict_token;
    for (const auto &[key_, ptr_] : dict_)
    {
        if (ptr_)
        {
            key_.encode_n_dump(out);
            ptr_->encode_n_dump(out);
        }
    }
    out << end_token;
}

void decode(const std::string &in, std::string::const_iterator &start) override
{
    dict_.clear();
    start++; // assuming *start = 'd'
    while (start != in.end() && *start != end_token)
    {
        key_type key_;
        key_.decode(in, start);
        dict_[key_] = make_value(in, start);
    }
    start++; // assuming *start = 'e'
}

std::string get_as_str() const override
{
    return this->encode();
}
```

Tracker

UDP Tracker

The code initialises UDP server, listening for incoming client messages on a specified port, handling connection and announcement requests, and logging client messages in hexadecimal format.

Header files socket_util.h is used for implementation of Tracker

```
#include "socket_util.h"
#include "peer_manager.h"
using namespace std;

void startUDPServer()
{
    srand(time(0));
    cout << "Server" << endl;
    int listenSocket=createUDPIPv4Socket();
    if (listenSocket < 0) {
        cout << "Socket creation failed" << endl;
        return ;
    }
    sockaddr_in trackeraddr=createIPv4Address("0.0.0.0",PORT);

    if (bind(listenSocket, reinterpret_cast<sockaddr*>(&trackeraddr), sizeof(trackeraddr)) < 0) {
        cout << "Bind error" << endl;
        close(listenSocket);
        return;
    }

    char buffer[4096];
    sockaddr_in clientAddr;
    socklen_t addrLen=sizeof(clientAddr);
    while (true) {
        int bytesRcvd = recvfrom(listenSocket, buffer, sizeof(buffer), 0,(sockaddr*)&clientAddr,&addrLen);

        cout << "Message from client: " << endl;
        for(size_t i=0; i<bytesRcvd;i++)
        {
            printf("%02x", (unsigned char)buffer[i]);
        }
    }
}
```

BEP-15

The following reference has been used for the format of connect request and response

Connect

Before announcing or scraping, you have to obtain a connection ID.

1. Choose a random transaction ID.
2. Fill the connect request structure.
3. Send the packet.

connect request:

Offset	Size	Name	Value
0	64-bit integer	protocol_id	0x41727101980 // magic constant
8	32-bit integer	action	0 // connect
12	32-bit integer	transaction_id	
16			

1. Receive the packet.
2. Check whether the packet is at least 16 bytes.
3. Check whether the transaction ID is equal to the one you chose.
4. Check whether the action is connect.
5. Store the connection ID for future use.

connect response:

Offset	Size	Name	Value
0	32-bit integer	action	0 // connect
4	32-bit integer	transaction_id	
8	64-bit integer	connection_id	
16			

Announce request

This is Bittorrent Extension proposal and is made for UDP tracker. It can also be updated to IPv6

Announce

1. Choose a random transaction ID.
2. Fill the announce request structure.
3. Send the packet.

IPv4 announce request:

Offset	Size	Name	Value
0	64-bit integer	connection_id	
8	32-bit integer	action	1 // announce
12	32-bit integer	transaction_id	
16	20-byte string	info_hash	
36	20-byte string	peer_id	
56	64-bit integer	downloaded	
64	64-bit integer	left	
72	64-bit integer	uploaded	
80	32-bit integer	event	0 // 0: none; 1: completed; 2: started; 3: stopped
84	32-bit integer	IP address	0 // default
88	32-bit integer	key	
92	32-bit integer	num_want	-1 // default
96	16-bit integer	port	
98			

1. Receive the packet.
2. Check whether the packet is at least 20 bytes.
3. Check whether the transaction ID is equal to the one you chose.
4. Check whether the action is announce.
5. Do not announce again until interval seconds have passed or an event has occurred.

Do note that most trackers will only honor the IP address field under limited circumstances.

Retrieving peers from database

sqlite3 library of C++ is utilised to achieve this functionality

```
std::vector<Peer> retrievePeersFromDatabase(const std::string &infoHash)
{
    std::vector<Peer> peers;

    const char *selectSQL = "SELECT peer_id, ip, port FROM peers WHERE info_hash = ?";
    sqlite3_stmt *stmt;

    if (sqlite3_prepare_v2(db, selectSQL, -1, &stmt, 0) != SQLITE_OK)
    {
        std::cerr << "Failed to prepare statement: " << sqlite3_errmsg(db) << std::endl;
        return peers;
    }

    sqlite3_bind_text(stmt, 1, infoHash.c_str(), -1, SQLITE_STATIC);

    while (sqlite3_step(stmt) == SQLITE_ROW)
    {
        Peer peer;
        peer.peer_id = reinterpret_cast<const char *>(sqlite3_column_text(stmt, 0));
        peer.ip = reinterpret_cast<const char *>(sqlite3_column_text(stmt, 1));
        peer.port = sqlite3_column_int(stmt, 2);
        peers.push_back(peer);
    }

    sqlite3_finalize(stmt);
    return peers;
}
```

Announce Request

The peer generates an announce request and registers its presence with the tracker

```
#include <iostream>
#include <cstring>
#include <vector>
#include <arpa/inet.h> // For inet_addr

// Define htonl if not available
#ifndef htonl
uint64_t htonl(uint64_t value) { ...
#endif

#include <cstdint>      // For fixed-width integer types like uint32_t, uint16_t

// Function to create an announce request
std::vector<uint8_t> createAnnounceRequest() {
    std::vector<uint8_t> request;

    // 8-byte Connection ID (for example, using a known constant)
    uint64_t connection_id = htonl(0x41727101980); // For a real tracker
    request.insert(request.end(), reinterpret_cast<uint8_t*>(&connection_id),
                  reinterpret_cast<uint8_t*>(&connection_id) + sizeof(connection_id));

    // 4-byte Action (1 for announce)
    uint32_t action = htonl(1);
    request.insert(request.end(), reinterpret_cast<uint8_t*>(&action),
                  reinterpret_cast<uint8_t*>(&action) + sizeof(action));

    // 4-byte Transaction ID (example value)
    uint32_t transaction_id = htonl(123456); // Arbitrary transaction ID
    request.insert(request.end(), reinterpret_cast<uint8_t*>(&transaction_id),
                  reinterpret_cast<uint8_t*>(&transaction_id) + sizeof(transaction_id));
}
```

socket_util.cpp

The file contains important functions that deal with creation of socket and IPV4 addresses

```
#include "socket_util.h"

int createUDPIPv4Socket()
{
    int s=socket(AF_INET,SOCK_DGRAM,0);
    return s;
}
int createTCPIPv4Socket()
{
    int s=socket(AF_INET,SOCK_STREAM,0);
    return s;
}
sockaddr_in createIPv4Address(const char* ip, int port) {
    sockaddr_in address;
    address.sin_family = AF_INET;
    address.sin_port = htons(port);

    if (strlen(ip) == 0) {
        address.sin_addr.s_addr = INADDR_ANY;
    } else {
        inet_pton(AF_INET, ip, &address.sin_addr);
    }

    return address;
}

> uint64_t ntohll(uint64_t value) ...

> uint64_t htonll(uint64_t value) { ...
```

db_manager.cpp

The file is responsible for maintaining peers' information in the database using functions such as store peer in database. It can also count number of seeders and leechers.

```
std::vector<Peer> retrievePeersFromDatabase(const std::string& infoHash) { ... }

void initializeDatabase() {
    if (sqlite3_open("tracker.db", &db)) {
        std::cerr << "Can't open database: " << sqlite3_errmsg(db) << std::endl;
        exit(1);
    }

    const char* createTableSQL = R"(CREATE TABLE IF NOT EXISTS peers (
        info_hash TEXT NOT NULL,
        peer_id TEXT NOT NULL,
        ip TEXT NOT NULL,
        port INTEGER NOT NULL,
        uploaded INTEGER,
        downloaded INTEGER,
        left INTEGER
    );
)";

    char* errMsg = 0;
    if (sqlite3_exec(db, createTableSQL, NULL, 0, &errMsg)) {
        std::cerr << "SQL error: " << errMsg << std::endl;
        sqlite3_free(errMsg);
    }
}

void storePeerInDatabase(const std::string& infoHash, const std::string& peerId, const std::string& ip, int
port, int uploaded, int downloaded, int left) { ... }

void countLeechersAndSeeders(const std::string& infoHash, int& leechers, int& seeders) { ... }
```

peer_manager.cpp

Important functions:

- generateConnectionID()
- handleConnectRequest()
- processAnnounceRequest()

```
#include "peer_manager.h"
#include "db_manager.h"

using namespace std;
set<uint64_t> valid_connection_ids;

uint64_t generateConnectionID() ...
void handleConnectRequest(char *buffer, int bytesRcvd, int listenSocket, sockaddr_in &clientAddr,
addrLen) ...
void processAnnounceRequest(char *buffer, int length, int sockfd, sockaddr_in &clientAddr)
{
    try
    {
        // Check if buffer length matches the expected size
        if (length < sizeof(AnnounceRequest))
        {
            throw std::runtime_error("Invalid announce request length");
        }

        AnnounceRequest req;
        memcpy(&req, buffer, sizeof(AnnounceRequest));
        // sample Announcement:<8-byte Connection ID><4-byte Action (1 for announce)><4-byte Trans
        ID><20-byte Info_hash><20-byte Peer ID><8-byte Downloaded><8-byte Left><8-byte Uploaded><4
        Event><4-byte IP address><4-byte Key><4-byte Num Want><2-byte Port>
        // Convert network byte order to host byte order where necessary
        req.connection_id = ntohl(req.connection_id);

        if (valid_connection_ids.find(req.connection_id) == valid_connection_ids.end())
    }
```

Application Snapshot



Peer file download interface

The screenshot shows interface of how Torrent file, trackers list and other data is provided to the client

```
(myenv) meet3112@LAPTOP-SC19U0FB:/mnt/e/proj/bittorrent/src$ python3 main.py -d .../downloads/ ..../data/ubuntu.torrent
MainThread - DEBUG - bittorrent
Reading ..../data/ubuntu.torrent file ...

TORRENT FILE DATA


| TORRENT FILE DATA | DATA VALUE                                                                      |
|-------------------|---------------------------------------------------------------------------------|
| Tracker List      | https://torrent.ubuntu.com/announce<br>https://ipv6.torrent.ubuntu.com/announce |
| File name         | ubuntu-24.10-desktop-amd64.iso                                                  |
| File size         | 5665497088 B                                                                    |
| Piece length      | 262144 B                                                                        |
| Info Hash         | 20 Bytes file info hash value                                                   |
| Files             | None                                                                            |



FILE INFO


| CLIENT TORRENT DATA<br>(client state = downloading) | DATA VALUE                     |
|-----------------------------------------------------|--------------------------------|
| File name                                           | ubuntu-24.10-desktop-amd64.iso |
| File size                                           | 5403.04 MB                     |
| Piece length                                        | 262144                         |
| Info hash                                           | 20 Bytes file info hash value  |
| Files                                               | None                           |
| Number of Pieces                                    | 21613                          |
| Client port                                         | 6881                           |
| Client peer ID                                      | b'PC0001-046209116452'         |



MainThread - DEBUG - bittorrent
<rich.table.Table object at 0x7f6cc24039e0>

MainThread - DEBUG - bittorrent
Connecting to Trackers ...
TRACKERS LIST


| TRACKERS LIST                                                                   | CONNECTION STATUS                                                                     |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| https://torrent.ubuntu.com/announce<br>https://ipv6.torrent.ubuntu.com/announce | successful connection <input checked="" type="checkbox"/><br>not attempted connection |



HTTP TRACKER RESPONSE DATA


| HTTP TRACKER RESPONSE DATA | DATA VALUE                                  |
|----------------------------|---------------------------------------------|
| HTTP tracker URL           | https://torrent.ubuntu.com/announce         |
| Interval                   | 1800                                        |
| Number of leechers         | 82                                          |
| Number of seeders          | 853                                         |
| Peers in swarm             | (185.125.190.59 : 6894)<br>... 0 more peers |



MainThread - DEBUG - bittorrent
<rich.table.Table object at 0x7f6cc254fc80>

MainThread - DEBUG - bittorrent
Initializing the swarm of peers ...

MainThread - DEBUG - bittorrent
Initializing the file handler for peers in swarm ...

MainThread - DEBUG - bittorrent
Client started downloading (check torrent statistics) ...
```

Tester's Terminal

The following is the screenshot of tester's terminal output and the details of the requests it sent and responses it received.

```
Transaction ID: 1714636915
Sent connect request to tracker.
Got packet from tracker
Packet is 16 bytes long
Received valid connection ID: 5278119872812102796
Sent announce request to tracker.
Received packets from tracker
Packet is 158 bytes long

Peers list is as follows:
IP: 10.81.71.27, Port: 6881
IP: 192.168.12.4, Port: 48967
IP: 192.168.31.8, Port: 6969
IP: 10.81.72.3, Port: 32428
nayan@nayan-Inspiron-3501:~/Desktop/BitTorrent$ █
```

Tracker's interface

The screenshot below shows the handling of requests and responses by the tracker

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Thank You

Thank You