Florida Institute of Technology

MILESTONE 5

Server and Client supporting UDP and TCP

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Introduction

This project is a simplified GOSSIP P2P system. The concurrent server and client are implemented in C and support commands from both TCP and UDP. Commands that can be handled by the concurrent server and client are:

Gossip ::= [APPLICATION 1] EXPLICIT SEQUENCE {

sha256hash OCTET STRING

timestamp GeneralizedTime

message UTF8String

}

Upon receiving this command, the server checks if it already knew it and simply discards it if it was known, while printing "DISCARDED" on the standard error. Otherwise stores it, broadcasts it to all known peers, and prints it on the standard error.

Peer ::= [APPLICATION 2] IMPLICIT SEQUENCE {

name UTF8String

port INTEGER

ip PrintableString

}

Upon receiving this command, the server stores the name and address of this peer if it is not yet known, or to updates its address.

PeersQuery ::= [APPLICATION 3] IMPLICIT NULL

Upon receiving this command, the server sends the client all the peers that it has stored until the time of the request.

PeersAnswer ::= [1] EXPLICIT SEQUENCE OF Peer

Upon receiving this command, the client receives a sequence of Peer.

```
Leave ::= [APPLICATION 4] EXPLICIT SEQUENCE {
                    name UTF8String
                    }
```

Upon receiving this command, the server has to delete the peer's data that corresponds to the peer's name in the leave command.

Technologies Used

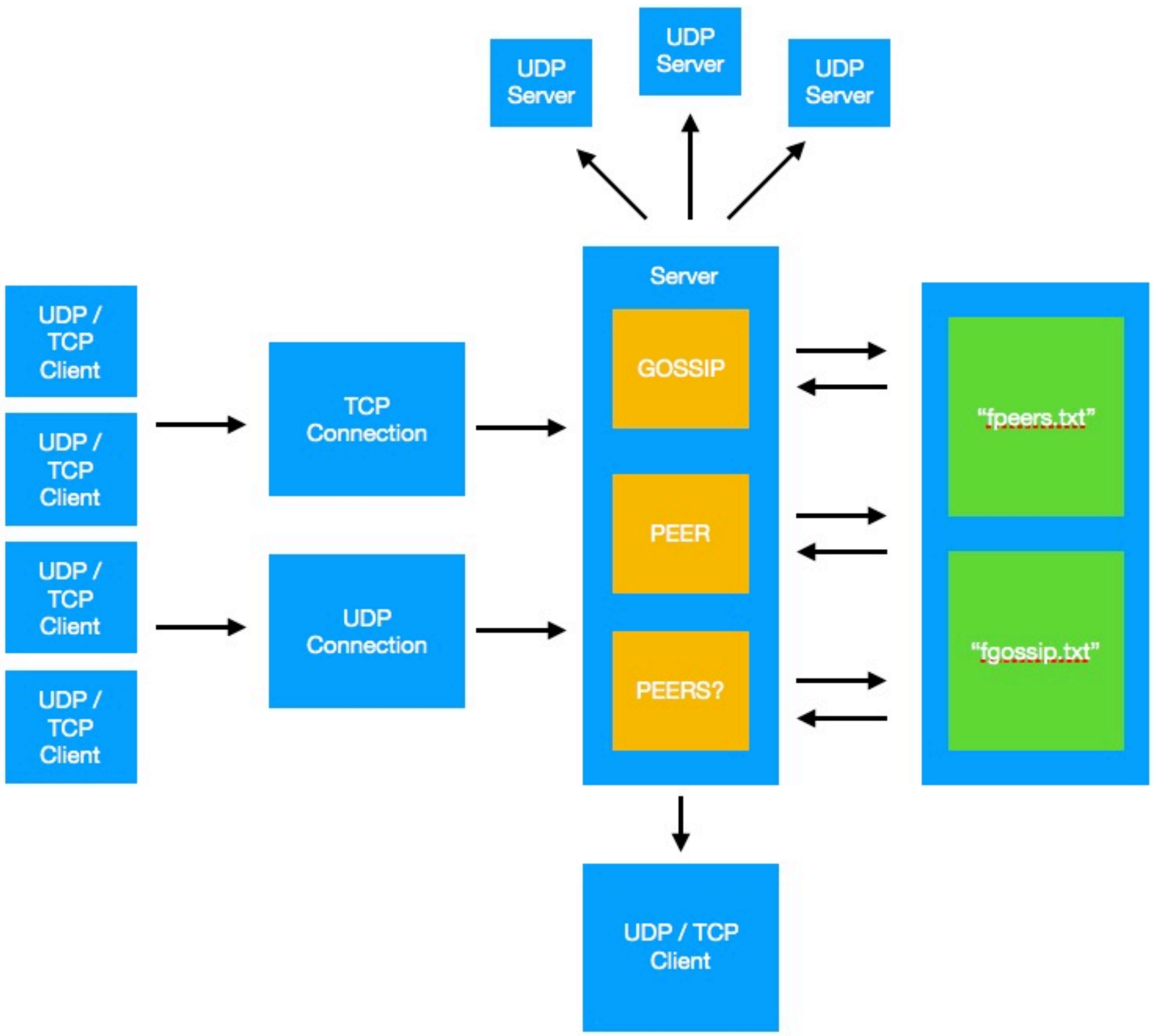
A list of all the technologies that were used to implement the iterative server and client:

- C language : Programming language used to write the server.
- Java language : Programming language used to write the client
- Vim : code editor
- Xcode : IDE used to write and compile C language.
- NotePad++ : Code editor.
- Github : Online service for collaboration in the project.
- Bash scripting : Computer language used to automate compilation, execution, and testing
- Sock : Networking tool to test the iterative server.

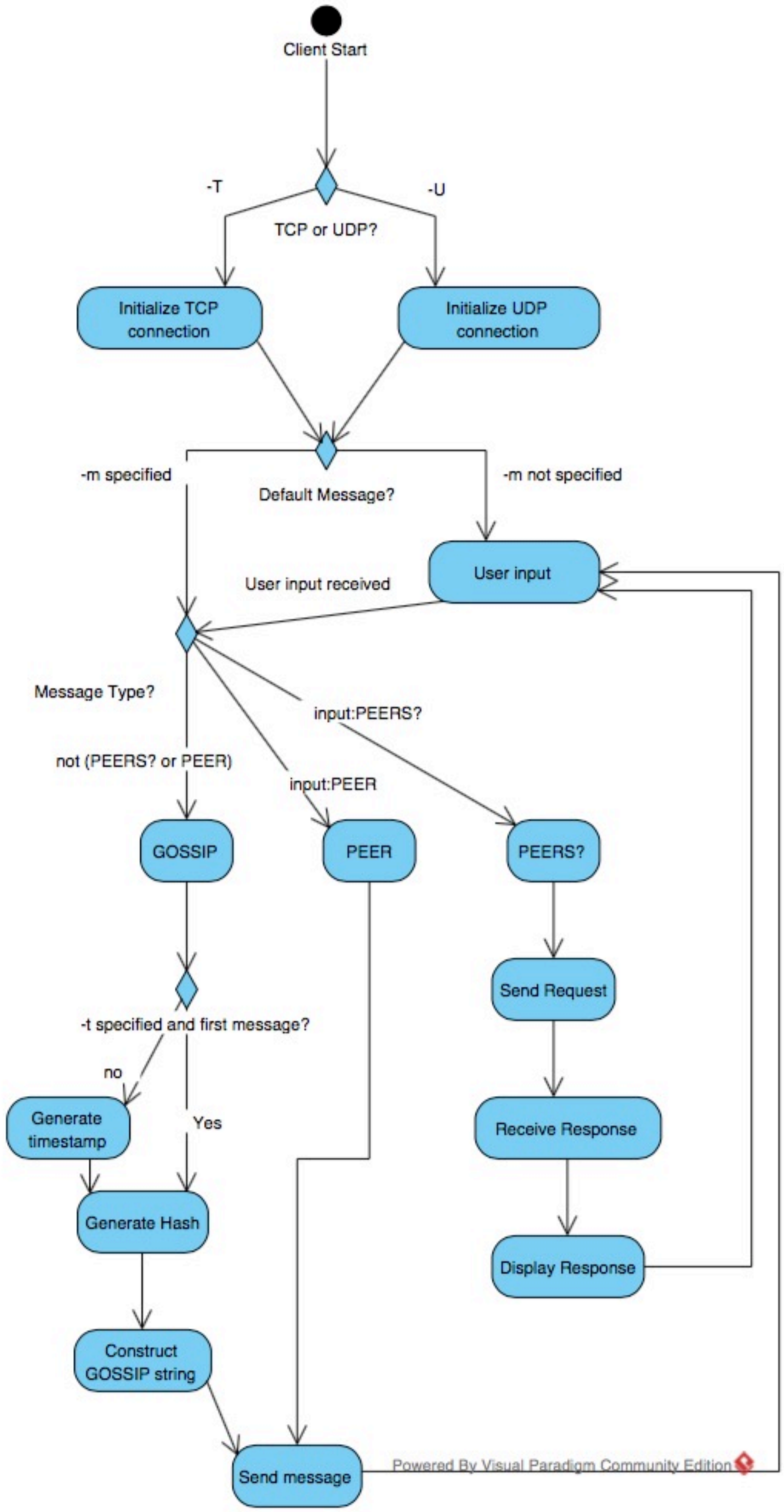
Architecture

Overall Architecture

Milestone 2



Milestone 3



Client Start
-T
-U
TCP or UDP?
Initialize TCP connection
Initialize UDP connection
-m specified
Default Message?
-m not specified
User input
User input received
Message Type?
input:PEERS?
not (PEERS? or PEER)
input:PEER
GOSSIP
PEER
PEERS?
Send Request
-t specified and first message?
no
Generate timestamp
Yes
Receive Response
Generate Hash
Display Response
Construct GOSSIP string
Send message
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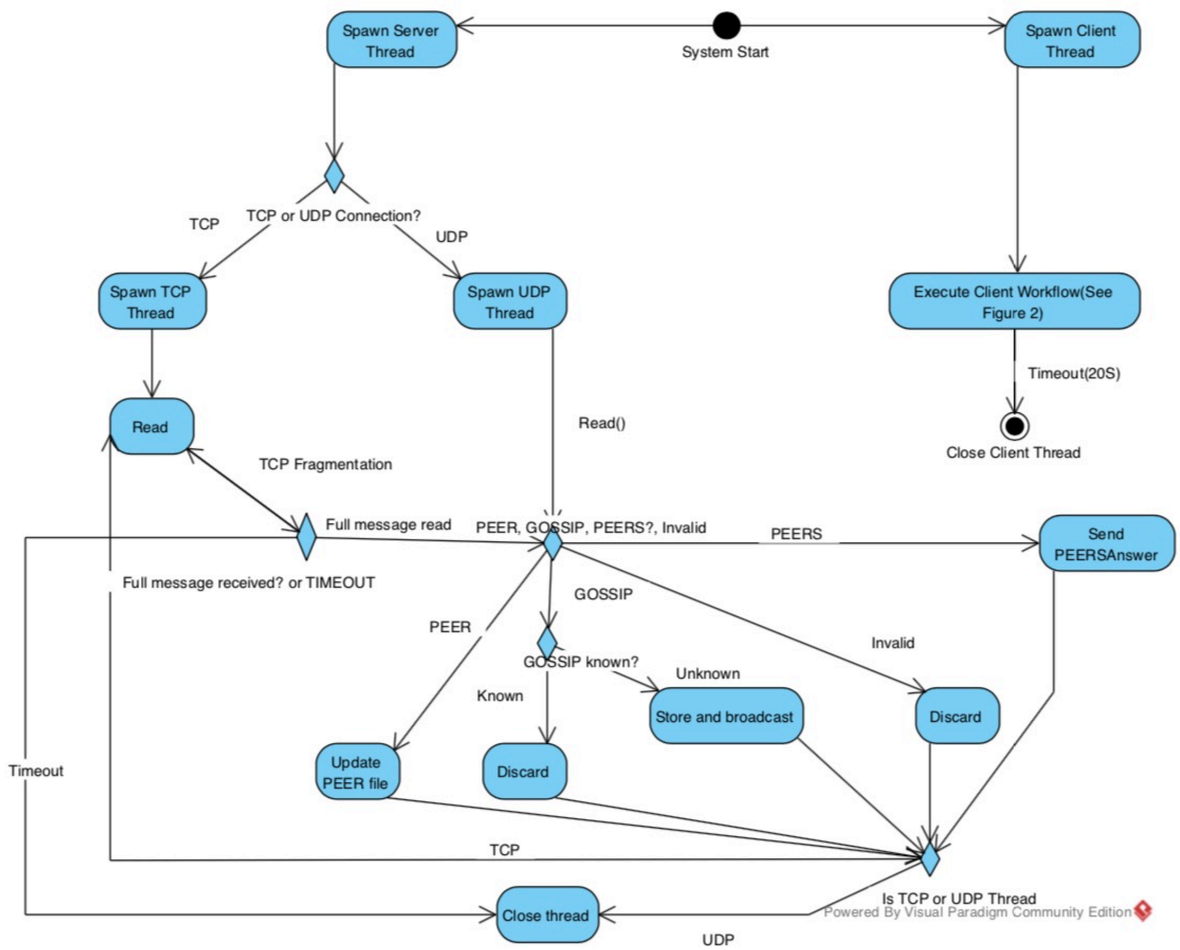
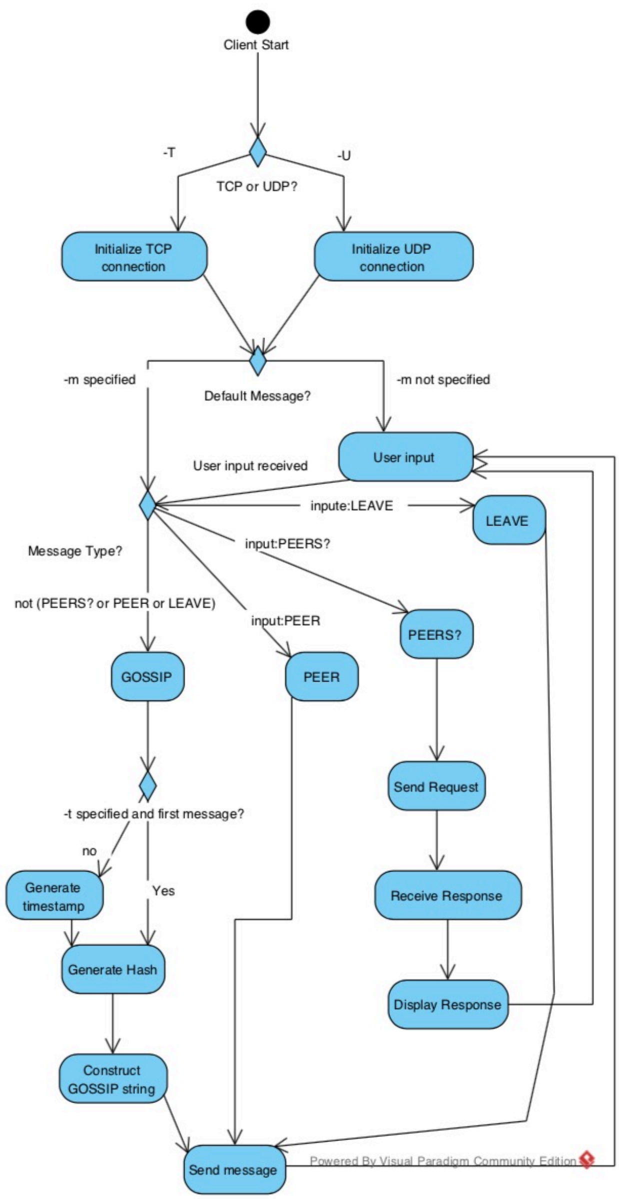
Milestone 4



Spawn Server Thread
System Start
Spawn Client Thread
TCP or UDP Connection?
TCP
UDP
Spawn TCP Thread
Spawn UDP Thread
Execute Client Workflow(See Figure 2)
Timeout(20S)
Close Client Thread
Read
Read()
TCP Fragmentation
Full message read
Full message received? or TIMEOUT
PEER, GOSSIP, PEERS?, Invalid
PEERS
Send PEERSAnswer
GOSSIP
PEER
Invalid
GOSSIP known?
Unknown
Known
Store and broadcast
Discard
Update PEER file
Discard
Timeout
TCP
Is TCP or UDP Thread
Close thread
UDP
Powered By Visual Paradigm Community Edition

Milestone 5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-m specified
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-m not specified
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inpute:LEAVE
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Message Type?
not (PEERS? or PEER or LEAVE)
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PEERS?
GOSSIP
PEER
Send Request
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Construct GOSSIP string
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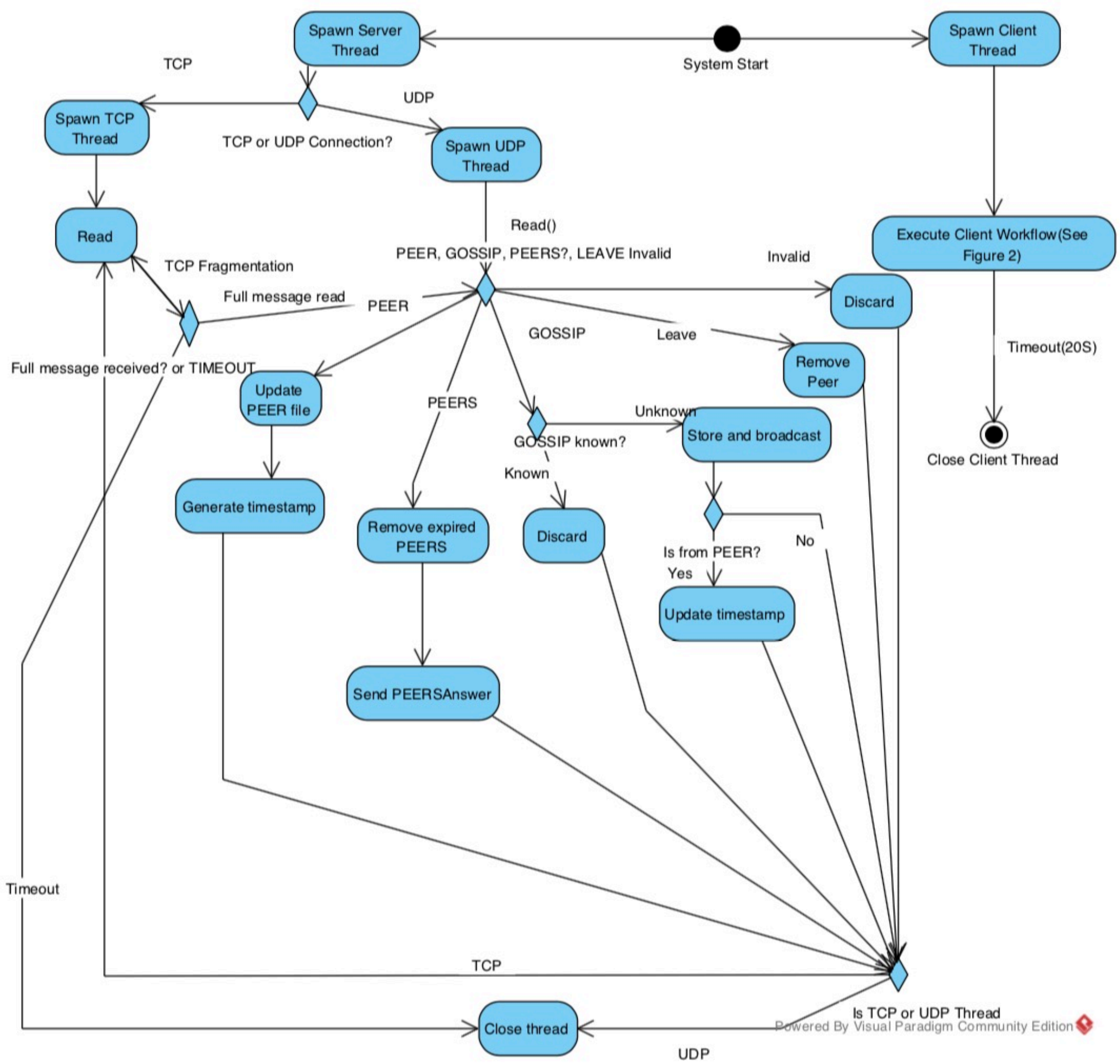
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PEER, GOSSIP, PEERS?, LEAVE Invalid
Invalid
Execute Client Workflow(See Figure 2)
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Full message read
PEER
Discard
GOSSIP
Leave
Remove Peer
Timeout(20S)
Full message received? or TIMEOUT
Update PEER file
PEERS
Unknown
Store and broadcast
GOSSIP known?
Close Client Thread
Known
Generate timestamp
Remove expired PEERS
Discard
No
Is from PEER?
Yes
Update timestamp
Send PEERSAnswer
Timeout
TCP
Is TCP or UDP Thread
Powered By Visual Paradigm Community Edition
Close thread
UDP

File Structure

Milestone 2 / 3 / 4

Files were used as a method of storing data for the server. Two files were sufficient for organizing all the data that had to be stored. One file was used to store gossip messages and the other file was used to store peers.

"FGOSSIP.TXT" FILE STRUCTURE

GOSSIPFORMAT.txt

```
This file will explain the format of our GOSSIP file structure
Each GOSSIP command has the following form :

GOSSIP:[sha256 base 64 of timestamp+message]:timestamp:message%

Our file will store each GOSSIP message with the following form:

BEGIN
1:message
2:timestamp
3:[sha256 base64]
END
BEGIN
1:message
2:timestamp
3:[sha256 base64]
END
BEGIN
...
END
...

An example file would read
BEGIN
1:Tom eats Jerry
2:2018-01-09-16-18-20-001Z
3:mBHL7IKilvdcOFKR03ASvBNX//ypQkTRUvilYmB1/OY=
END

The purpose of this form is to clearly demark where a message begins and ends. Further, the clear
BEGIN/END sentinels allow easy processing. For example, if we hit END without finding all three
components, we can log an error in the file. The error in this entry is self contained and will
not contaminate other data.
We place a 1/2/3: before the data field in case, however unlikely, any of the components could
start with "BEGIN" or "END". For example, if you gossiped the message "END" the file would read
BEGIN
[sha 256 base 64]
timestamp
END
END

While this error should not be difficult to discover while parsing and account for, we could also
have
BEGIN
[sha 256 base 64]
timestamp
BEGIN
END
and this would be fixed easily, after all all valid gossip messages were placed onto three lines,
so simply reading three lines would collect the full message, we use the 1/2/3: for the sake of
simplicity.
```

“FPEERS.TXT” FILE STRUCTURE

PEERSFORMAT.txt

```
This file will explain the format of our PEERS file. The format is similar to the format used in
the GOSSIP file. All peers will be stored with the following form:

BEGIN
1:Name
2:Port number
3:IP address
END

an example file would be

BEGIN
1:John
2:2356
3:163.118.239.68
END
BEGIN
1:Mary
2:2355
3:163.118.237.60
END

and so on. The reasoning for the format is the same as the reasoning for the GOSSIP file format.
```

Milestone 4

To provide support for ASN1 encoding and decoding, four new files were added to go along with the server and client.

Peer.h - encodes/decodes the peer command

PeersAnswer.h - encodes/decodes a sequence of peers

PeersQuery.h - encodes/decodes the peers command

Gossip.h - encodes/decodes the gossip command

Milestone 5

To provide support for leave command, two new files were added to go along with the server and client.

Leave.h - encodes/decodes the leave command

“FTIMEOUT.TXT” FILE STRUCTURE

TIMEOUTEXPLANATION.txt

```
TIMEOUT explanation:

BEGIN
4:[port]|[ip address]
5:[time]
END

Where [port] is an integer, [ip address] is a string(e.g "127.0.0.1") and [time] is the
time the peer should expire(recorded in seconds). The use of '4' and '5' as leaders
instead of '1','2','3' from GOSSIP and PEERS is for distinguishing synchronization in
generic file modification functions. The use of '|' as opposed to ':' is to retain
uniqueness inside the stored information. For example, if ':' was used instead you could
have

BEGIN
4:4:127.0.0.1
5:1524879459
END

Which would not present any great difficulty in parsing but still represents unnecessary
confusion.

An example file would be:

BEGIN
4:22222|127.0.0.1
3:1524879459
END
BEGIN
4:8227|182.91.5.100
3:1524879470
END
BEGIN
4:5005|63.5.12.1
3:1524879489
END

and so on.
```

Program Structure

Milestone 2

Section A: Implementation of command line options

Implementation of command line options is found inside of main method in server.c at lines 72-83. Options processed are -p for port and -d for path. Option -p is valid for any port from 0 to

65535. Using an invalid port will cause errors further in the program. Option -d specifies the directory for our PEER and GOSSIP files. The directory is hardcoded inside run.sh, which specifies "testFolder" as the directory (testFolder will be created if it does not already exist).

Section B: Initialization of TCP and UDP servers

(all line numbers in this section refer to server.c unless otherwise mentioned)

Initialization of TCP and UDP servers is found inside of main in server.c at lines 86-95 for the TCP server and at lines 98-105 for the UDP server. All connections are handled by a polling mechanism inside of main in server.c, lines 108-140. The TCP server will spawn a new process (see: tcpConnection(int, char *) in next section) to handle the client (lines 122-135). The UDP server will not spawn a new process and will directly handle the connection within the same process (see: udpConnection(int, sockaddr_in, char *) in next section) in lines 137-139. A failure of either server to bind is not a fatal error and a warning will be written to STDERR informing that BIND failed.

Section C: Where messages are read from sockets

(all line numbers in this section refer to server.c unless otherwise mentioned)

Whenever the server receives a message the polling mechanism will trigger the proper connection function as defined in Section B.

tcpConnection(int, char *): implemented in lines 264-326, tcpConnection is run by a child process to handle the TCP sockets interactions. A child process is used due to the stream nature of TCP. In tcpConnection we must account for message fragmentation and message concatenation. To accomplish this we define one buffer, here after referred to as BUF_LARGE, to hold the total read messages, and one buffer, here after referred to as BUF_SMALL, to hold each individual read from the socket. Each read is placed into BUF_SMALL and then appended(see bufAppend(char *, char *, int, int)) to BUF_LARGE. This is to handle message fragmentation(lines 274-275). The result of this operation is that a socket receiving:

Read 1: PE

Read 2: ER:Name:port:IP

Read 3:%

will assemble into BUF_LARGE: PEER:Name:port:IP%. The appending operation also allows for message concatenation, a TCP socket receiving:

Read 1: PEER:Name:port:

Read 2: IP%PEERS?

Will result in BUF_LARGE containing PEER:Name:port:IP%PEERS?. After each command is executed it is cleared from the buffer(see Section D, clearBuffer(char *, int, int)).

udpConnection(int, sockaddr_in, char *): implemented in lines 399-416, the UDP connection does not spawn a child process. This is because each UDP packet is the full set of data, there does not exist a stream to account for unlike with TCP. The message is read in line 405. Again, because UDP is not a stream there does not exist any need to handle message fragmentation or concatenation. It is assumed that each UDP packet contains one and only one command.

Section D: Where messages are parsed

(all line numbers in this section refer to server.c unless otherwise mentioned)

Before messages are pared, the server does a validity test before sending the command into the appropriate methode. That is, all messages sent to the server obey the form

GOSSIP:[sha]:[time]:[message]%

PEER:[name]:PORT=[port]:IP=[ip]%

PEERS?\n

Each message must be parsed in its appropriate protocol handler to determine which helper function to call. After input validation the program determines which function to call. The function isValidForm(char *), described in more detail in the appendix, affirms the message is a valid command string and passes it to the appropriate function GOSSIP(), PEER() or PEERS(). In tcpConnection() this is in lines: 295, 308, 315. In udpConnection this is in lines: 409, 411, 413 Both tcpConnection() and udpConnection() call the same helper functions which handle the message parsing and execution.

GOSSIP(char * char *): first allocates buffers for each of the three GOSSIP string components([sha], [time],[message])(lines 432-437). Then we place the parts of the GOSSIP string into the appropriate buffers in lines 440-448 knowing that ':' divides them. The actual execution of GOSSIP is described in the methods section.

PEER(char *, char *): first allocates room for each of the three PEER string components([name],[port],[ip])(lines 671-677). The parsing of the message occurs in lines 686-696, recognizing it follows the same delimiters as GOSSIP with only a need to account for PORT=, IP= in the last parts of the command. The actual execution of PEER is described in the methods section.

PEERS(int, sockaddr_in, char *, int): does not parse any string, it only reads from our PEER file and writes it to the querying client. The execution of PEERS is described in the methods section.

Section E: Where messages are saved in database

(all line numbers in this section refer to server.c unless otherwise mentioned)

Instead of using a sql server we use fpeers.txt and fgossip.txt (file structure is described above).

Only GOSSIP and PEER strings must be saved, so this section will only discuss these two.

GOSSIP:

All GOSSIP strings are composed of [sha], [time], and [message]. Each GOSSIP string is appended to fgossip.txt in lines 454-460, such that the components are saved in the file in [message], [time], [sha] order.

PEER:

All PEER strings are composed of [name], [port], and [ip]. Each PEER string is appended to fpeers.txt in lines 702-708, such that the components are saved in the file in [name], [port], [ip] order.

Section F: Where messages are forwarded futher

(all line numbers in this section refer to server.c unless otherwise mentioned)

Only GOSSIP strings are forwarded further, so this section will only discuss GOSSIP strings. For a message to be forwarded further GOSSIP must connect to each known peer and send the GOSSIP string. This is handled in lines 464-467 and the helper function broadcastToPeers(char *, int, char *). Lines 464-467 are a loop to execute broadcastToPeers() for each peer.

Milestone 3

Section A: Reading user input

(All line numbers referred to are in Client.java)

The client has three functions to fulfill, as outlined in the activity diagram. It must collect user input, send it forward, and receive a response(if appropriate). To do this we first handle reading user input, which is done in lines 228-244. Trivially we collect whatever the user typed, excluding the '\n' character sent by the system, and send it for further processing inside messageHandler(lines 79-86). The message is of one of three forms: GOSSIP, PEER or PEERS?.

The message type is determined as follows

PEERS? - Only the string "PEERS?"

PEER... - Any string that begins with "PEER". The validity of the form is confirmed by the server.

GOSSIP - Any string which does not match either of the previous forms.

For a **PEERS?** command we must perform three steps defined in lines 156-159:

Send the request to the server(Implemented in lines 133-140)

Receive the response string from the server(Implemented in lines 165-177)

Display the response to the user(Implemented in lines 179)

We block the user from entering further commands until the server has responded. This was done to prevent odd text buffering on the command line experienced during early testing.

For a **PEER** command we need only perform a single step, to send the string to the server. This is again implemented in lines 148-150.

A GOSSIP command has more work put into it. The steps of a GOSSIP command are to take the message, generate a timestring, generate a hash and send this string off. However, the existence of initial messages and timestamps slightly complicates the process.

Generating a timestring(Lines 113-118) is accomplished with a little trick. The process is as follows:

1: Generate a timestamp regardless

2: If the initial timestamp exists(non-null), replace the generated timestamp with the initial timestamp

3: null out the initial timestamp

The nulling of the initial timestamp is because it can only be used once, further messages are obviously generated at a different time.

Following this, we need to generate a hash. This is handled in lines 124-127. The Base64 hash is simply the SHA256 digest of [timestamp]:[message] encoded into base64.

Finally, we assemble and send off the complete string in lines 105-106, and 134-140.

Section B: Generating the hash

Generation of the hash is handled in lines 124-127. The Base64 hash is simply the SHA256 digest of [timestamp]:[message] encoded into base64.

Section C: Server threads starting point

(All line numbers past this point are in server.c)

Threads are created at line 138-139 with the pthread_create() function which calls function tcpConnection(), located at line 269. Programs that use threads have synchronization issues because two threads can access the same data at the same time, so in the server we used a pair of semaphores initialized in lines 90-91. The only parts of the program that require synchronization are the parts that deal with accessing the fpeers and fgossip files. To keep thread safety while maintaining simplicity we only allow one thread to write to the files at a time (Line pairs (459,469), (743,757)) .

Milestone 4

Section A: ASN1 Encoding and Decoding

All functions use the contentLength(byte*)(Lines 647- 682)function to determine if the full message has arrived.

For PEERSQUERY: Encoded in lines 226,227. Decoded in the same function.

For PEER: Encoded in lines 327-343(mostly extracting information from user string), decoded in lines 805-806 for TCP, 1059-1060 for UDP

For GOSSIP: Encoded in lines 353-355, decoded in lines:723-724 for TCP, 977-978 for UDP.

Section B: Read from socket, assembled and segmented

TCP: Lines 700-866: Segmented in line 710 for fragmentation/concatenation. Specific message types mentioned in ASN1 Encoding and Decoding.

UDP: Lines 958-1095. Specific message types mentioned in ASN1 Encoding and Decoding.

Section C: Timeouts implemented

TCP: Lines 517-523. The server closing a socket will close it for the client.

UDP does not use timeouts since it is not a stream

Section D: Client and Server started

Master Server: Line 142, function serverThread(void *), lines 448-531.

Client: Line 144, function clientThread(void*), lines 152-196.

Milestone 5

Section A: Synchronization for database access

A set of general functions(isKnown, updateFile, removeEntries) are each synchronized on semaphores for the file it is called for. Beyond that, each commands relevant functions may interact with the files. These are:

fgossip: (1380,1390)

fpeers: (774, 776), (1557, 1570), (1587, 1632), (1674, 1676), (1751, 1765), (1857, 1876), (1900, 1993)

ftime: (737, 771), (777, 779), (1677, 1679), (1737, 1749).

Section B: Option -D

-D for timeout is parsed in line 145 of server.cpp, all arguments are parsed in lines 118-150.

Section C: Forgetting

Each PEER command stores a [port]|[ip] pair along with an accompanying timestamp for deletion in ftimestamp.txt beyond storing the regular information in fpeers.txt.

Each connection has its port and IP stored for comparison(lines 573-576)(UDP directly passes this information without auxiliary struct in line 583).

Whenever a gossip is called, this information is checked. If a timestamp exists, the timestamp is updated(line 858-860). Note that we store the time the peer will expire for simplicity.

Whenever a PEERS request is sent, we check this file to see if any peers have expired, and if they have, we remove them from fpeers.txt as well as ftimeout.txt(LEAVE function at line 1636).

Section D: LEAVE implementation

Leave is handled in the LEAVE function(Line 1636). This is called from the TCP/UDP connection functions in lines 1086(TCP) and line 1337(UDP).

The function essentially creates a bitmap for peers, with 0 representing a safe peer and 1 representing the peer to be removed. The removeEntries function will read this bitmap, writing to a swap file all peers representing 0 on the bitmap, then deleting the old file and renaming the swap file to the original. This updating must be done for both fpeers.txt and ftimeout.txt.

Method Description

Milestone 2

(Meaning of variable names are specified in the header every method in server.c)

i**nt isValidForm(char *);** takes a string to parse. The function will determine if it fits the form of a GOSSIP, PEER or PEERS command. A string is said to have the form of a GOSSIP command if it obeys the structure GOSSIP:[sha]:[time]:[message]% such that [sha] is 44 characters long, [time] is 24 characters with 6 ‘-’ characters, and [message] is an arbitrary string. A string is said to have the form of a PEER command if it obeys the structure PEER:

[name]:PORT=[port]:IP=[ip]% such that [name] is an arbitrary string, [port] is any number

having at most 5 digits, and [ip] obeys the form: [a].[b].[c].[d] where a,b,c,d are any numbers having at most 3 digits. A string is said to have the form of a PEERS command if the string is "PEERS?" exactly. Any string which does not obey one of the above forms is rejected as malformed.

void tcpConnection(int, char*); Discussed in details in SECTION C.

int bufAppend(char*, char*, int, int); A wrapper for strcat that ensures the source buffer will fit into the destination buffer before execution, otherwise it will return -1. This was primarily used during early testing, however the return value is no longer relevant as of submission build.

void clearBuffer(char*, int, int); clearBuffer removes all content up to howFar, shifting down all content past that point. All memory that is shifted down has its original location in the buffer overwritten with '\0' to ensure memory safety and avoid potential errors while processing the buffer in the future.

int removeNewLines(char*); is a function that is used by udpConnection and tcpConnection to remove all newline characters '\n' of a given string. Basically, removeNewLines every time it finds a newline character '\n' shifts to the left the entire content of the string after that '\n'. Returns the number of '\n' found in the string.

int commandCount(char*); is a function used by tcpConnection to determine how many commands are in a given buffer (char * buf). Tcp connection might concatenate two commands together, so this function is used to make sure that every command in the buffer is executed. Returns the number of commands found in the given buffer.

void udpConnection(int, struct sockaddr_in, char*); Discussed in details in SECTION C.

int GOSSIP(char*, char*); After stripping the relevant parts of the GOSSIP string(already covered) GOSSIP() must determine if a given message is already known. This is done by scanning fgossip.txt for a matching [sha] entry. If this is found we discard the message, otherwise we write it to fgossip.txt and broadcast it to all peers.

int isKnown(char*, char*, char); is a function used by GOSSIP and PEER to determine if a given command or peer does already exist in "fgossip.txt" or "fpeers.txt". IsKnown opens the file specified in the parameters, scans the entire file and returns the line number where the match was found or -1 if any error occurred during execution (i.e. if a file is not properly closed).

void broadcastToPeersTCP(char*, int, char*); has the same functionality as broadcastToPeersUDP, but uses TCP instead.

void broadcastToPeersUDP(char*, int, char*); is a function use by GOSSIP to send all its peers, using UDP protocol, the gossip that the server received. Inside this function, the server acts as a UDP client and sends a message to the port and ip retired by peerInfo() function. UDP was chosen over TCP as the best alternative for broadcasting because with UDP the server did not had to connect with the servers before sending the message. On the other side, TCP had to connect with the other server before sending the message and when TCP tried to connect with servers that were not available for the moment, it would hang the server for a few of minutes and block other operations.

int peerInfo(int, char*, char*); is a function used by broadcastToPeersUDP to retrieve the IP and PORT of a specific peer that is found in the peer file. PeerInfo opens the peer file, finds the port and ip of the desired peer, returns the port, and passes ip by reference. If any error occurs during the execution of the function, it returns -1.

int peerNumber(char*); is a function used by GOSSIP to determine the number of peers the peer file. Returns the number of peers in the peer file.

int PEER(char *, char *); is a function used by tcpConnection and udpConnection to handle the PEER command. First, this function parses the peer command into three fields: peer's name, peer's port, and peer's address. Then, checks if the peer that was fed to the function was known or not using isKnown() function. If the peer is known to the server, updateFile() function updates peer's address. If the peer is not known to the server, PEER appends peer's information into the peer file. Returns 0 if the update or appending was successful or -1 if any error occurred.

int updateFile(char*, int, char* ,char*); is a function used by PEER to update a peer's ip address. Basically, updateFile takes the line number that has to be changed in the peer file, creates a new file named "output.txt", copies every line of the "fpeers.txt" to the new file until it is at the line that has to be updated, writes the new line in the new file, copies the rest of "fpeers.txt" to "output.txt", deletes the old file ("fpeers.txt"), and renames "output.txt" to "fpeers.txt". Returns 1 if the update was successful or -1 if it was not successful.

int PEERS(int, struct sockaddr_in, char *, int); The goal of peers is to respond to a query for the known peers of this server. The response has the form PEERS|#peers|PEER:[name]:PORT=[port]:IP=[ip]|… To accomplish this we must collect the number of known peers. Following that is a formula for determining the size of the message. It is easy to discover by counting houw many characters exist inside the file, accounting for additional characters(BEGIN,END,1:,2:,3: = 14 per peer) and the need for an additional (PORT=,IP=, :,:,:,|) in the response. Parses the file, collecting the relevant information from within each BEGIN/

END block and put it into the string. Afterwards the function recognizes if the UDP or TCP server called this, and sends a reply appropriately.

int countDigit(int); is a function used by PEERS to count the numbers of digit in an integer. Returns the number of digits.

char* itoa(int, char*, int); is a function used to convert an integer into a string. Returns the number that is passed in a string form.

void error(char*); is a function used to print to standard error.

void sig_chld(int); is a function that is used to handle signals by child processes.

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public Client(String host, int port, String initialTimestamp, boolean TCP); is the constructor of the class Client that establishes a connection with either UDP or TCP depending on the user input. Host and port are specified by the user and are used to created the sockets.

void messageHandler(String input); is a function used my the main function that feeds the command written by the user in the standard input into one of the three functions that handle commands known by the server.

void GOSSIP(String s); takes the message typed by the user, generates a timestamp that fits the format of the server, generates the hash of the timestamp and the message, and send the command to the server using sendMessage() function.

String generateTimestamp(); is a function used by GOSSIP to generate the timestamp in a specific format. Returns a string containing the timestamp.

String generateHash(String message, String timestamp); is a function used by GOSSIP to generate the hash of the message and timestamp provided. Returns a string that contains the hash.

void sendMessage(String s); is a function used by GOSSIP, PEER, and PEERS that sends the command (s) provided through TCP or UDP.

void PEER(String s); is a function that sends the PEER command by calling the sendMessage() function.

void PEERS(String s); is a function that sends the PEERS command by calling the sendMessage() function, and receives the server response with the reciveResponse() function. The server sends a string containing the peers that that server knows about.

void receiveResponse(); is a function that is used by PEERS function to listen to TCP or UDP sockets to retrieve data from the server, and then display the response of the server.

displayResponse(String response); is a function used by reciveResponse() function to display the response of the server in the standard output (terminal).

Milestone 4

void* serverThread(void*); is the function used to handle the server thread. serverThread() establishes a connection over TCP and UDP in the same port and handles both the connections with tcpConnection() and udpConnection() functions discussed above.

void* clientThread(void*); is the function used to handle the client thread. clientThread() establishes a connection over TCP or UDP, depending on options set by the user, and provides an interface for sending commands to the server.

void clientPEER(char*); is a function that is used by clientThread() to handle the peer command. clientPEER() parses user input, encodes it in ASN1 format and sends it to the server using sendMessage() function.

void clientPEERS(); is a function that is used by clientThread() to handle the peers command. clientPEERS encodes the peers command in ASN1, sends the command to the server, waits to receive the sequence of peers from the server, decodes the answer from the ASN1 format, and displays the answer.

void clientGOSSIP(char*); is a function that is used by clientThread() to handle the gossip command. clientGOSSIP() produces the sha256 base64 of the message entered by the user and the timestamp, encodes it in the ASN1 format, and sends it over to the server.

void constructPeers(PeerAnswer); is a function used by clientPEERS() to decode the ASN1 format and display it to console.

void produceHash(char*, char);** is a function used by clientGOSSIP to produce the hash.

void sendMessage(unsigned char*, int); is a function used by clientGOSSIP(), clientPEERS(), and clientPEER() to send commands to the server over TCP and UDP depending on the setting set by user.

int bufAppendByte(unsigned char*, unsigned char*, int, int, int, int); A wrapper for strcat that ensures the source buffer will fit into the destination buffer before execution, otherwise it will return -1. This was primarily used during early testing, however the return value is no longer relevant as of submission build.

int contentLength(byte * buf); is a function used by tcpConnection() in the server thread to find and return the length of the first ASN1 element that was send by the client. This function is used to handle TCP fragmentation and concatenation.

Milestone 5

void clientLEAVE(char*); is a function used by the clientThread to handle the leave commands. clientLEAVE() checks if the leave command that it received is valid, extracts the name of the peer from the command, encodes it into ASN1 DER format and sends it over to the port and ip that the client is connected to with the help of the sendMessage() function described previously.

int LEAVE(char*, char*); is a function used by tcpConnection and Udpconnection to handle the leave command in the server side of the program. It receives the decoded leave command, finds the position of the peer, whose name is provided in the leave command, in the peer file, and then removes that peer from the peer and timeout files with the help of the removeEntries function.

int removeEntries(char* , char* , int, int* , int); is a function that is used by LEAVE() and checkIfExpired to remove from peer and timeout files. It receives the directory of the file, a bitmap of the peers and the timestamps that has to remove (i.e. 010 meaning that the second peer has to be removed), how many peers does the file have, and how many lines does each peer occupies. removeEntries() copies every peer except the ones that are going to be removed into a new file, change the name of the new file, removes the old one.

int checkIfExipired(char* path); is a function used by PEERS and GOSSIP to check if any of the peers that are in the database has expired. It first scans the peer file, creates a bitmap of the peer file, and if any peer has expired uses removeEntries to remove them and their timestamp from the timeout file.

int addPeerLeave(char * portAndIP, char * path); is a function used by the GOSSIP function to update the timestamp of a peer.

User Manual

Milestone 3

Compile: To compile the server in terminal use ./compileServer.sh

To compile the client in terminal use ./compileCient.sh

Execute: To run the server in terminal use ./runServer.sh <port number>.

NOTE: RunServer script will also compile the server.

NOTE: Run script will create a folder testFolder (if does not exist) to place "fgossip.txt" and "fpeers.txt".

To run the client in terminal use ./runClient.sh <port> <ip> [<message> <timestamp>]

NOTE: <message> and <timestamp> are optional

NOTE: RunClient script will also compile the client.

Test: To test the server use ./script1.sh in another terminal.

NOTE: Test script assumes that server is connected in port 12345.

To test the client and the server follow these steps:

1. Open 3 terminals

2. Run ./scriptServer1.sh in the first terminal
3. Run ./scriptServerPeerWitness.sh in the second terminal
4. Run ./scriptClientTCP.sh in the third terminal to connect through TCP
5. [optional] Run ./scriptClientUDP.sh in the third terminal to connect through UDP

Milestone 4

Compile: To compile the server and client in terminal use ./compileSC.sh

Execute: To run a client test in terminal over TCP use ./scrpitClientTCP.sh

To run a client test in terminal over UDP use ./scrpitClientUDP.sh

NOTE: Client will connect to port 23232

To run a server in terminal use ./scriptServer1.sh

NOTE: Server will be listening to port 23232

NOTE: Client of the same server program will connect to 23232

NOTE: Script will create a testFolder to save all the files of the server

Test: To test the client and the server follow these steps:

1. Open 3 terminals
2. Run ./scriptServer1.sh in the first terminal
3. Run ./scriptServerPeerWitness.sh in the second terminal
4. Run ./scriptClientTCP.sh in the third terminal to connect through TCP
5. [optional] Run ./scriptClientUDP.sh in the third terminal to connect through UDP

Milestone 5

Compile: To compile sever-client program use ./compileSC.sh

Test: To test the new leave command follow these steps:

1. Open 3 terminals
2. Run ./scriptServer1.sh in the first terminal
3. Run ./scriptServerPeerWitness.sh in the second terminal
4. Run ./checkLeave.sh in the third terminal

NOTE: Test folder will be created by one of the scripts to simulate a different directory environment between the two servers.

NOTE: If any ERROR on binding comes up, change the ports inside the scripts.

NOTE: All the scripts compile the server.cpp file.

Conclusion

Milestone 2

The work done by the server can be summarized as Read, Store, Broadcast, Reply. The work done by the milestones functionality did not benefit greatly from the reliability of TCP ,and especially with broadcasting the simplicity of UDP made it the more favored protocol. Development took longer than expected, and this can be attributed to inexperience in the material and a poorly coordinated development process. In future milestones we will define more of the structure of the result from the start rather than evolve into the structure of the submission build.

Milestone 3

Implementing milestone 3 required less work than the server. While the server has much more to do and so this is expected, we also believe that greater familiarity with networking concepts and a thorough planning process helped cut down on development time greatly. In the future we will keep a planning stage before implementing features. We still need to communicate better when implementing details, however we have made significant improvements in this area.

Milestone 4

Problems with learning and utilizing ASN1 prevented us from making our initial timetable. While this was fixed and we quickly made up for the lost time, this was still a problem. A poor understanding of the technology prevented us from noticing the encoding issue in a prompt manner. Additionally we failed to properly plan the progress of this milestone before hand, so many things came up that wasted development time that would not have come up if we had started this milestone with a proper plan.

Milestone 5

More frequent group meetings helped in making sure we knew what we each needed to do. As tasks became less trivial and more interconnected it became more necessary to ensure we developed with a mutual understanding of not just what the problem was, but how to solve it.

References

http://www.strudel.org.uk/itoa/