ENTS 640 Networks and Protocols I

Fall 2018 Project

ACADEMIC INTEGRITY PLEDGE:
We pledge on our honor that we have not given or received any unauthorized assistance on this project

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The Problem

To design an application in Java consisting of a client and a server where client will send set of coordinates and server will compute centroid using K means clustering algorithm we used our learning about the Software development Cycle from the Software Engineering Class back in undergraduate program.

Per Software development Cycle we divided our project in four phases:

a) Planning
b) Analysis
c) Design
d) Testing & Integration /Implementation

Planning

We started our project by dividing it into small chunks as per their functions.

 Below is the division at Client's end:

a. Importing the data (coordinates) from the text file
b. Converting the data from the text file into a byte array and then Transmitting it
c. Receiving DACK , REQ functionalities and related timeouts
d. Receiving CLUS , Sending CACK
e. Converting the data from CLUS from byte to float.

Below is the division at Server's end:

a. Receiving Data from client and sending DACK
b. Converting the data from byte to float
c. Receiving REQ, Implementing K means clustering
d. Converting the data from float to byte.
e. Sending CLUS and Receiving CACK

Analysis

During analysis phase we wanted to make sure that we had complete knowledge about each functionality to be implemented at client's and server's end so that we don't get stuck in any phase while designing the code. In this phase we came up with few best practices to make our code more efficient. Below are some points on the same:

a) While importing the data from text file we didn't wanted to overwhelm the client by reading and storing all the data in an Array at once. Hence, we decided to read, and

import let's say 10-50 number of lines at a time thereafter encoding it and sending it to server.

b) Before writing the code, we drew block diagram for main functionality such as K-means clustering, byte encoding & decoding, importing data from text etc. to be implemented at client's and server's end and hence figured out the requirement of variables, loops, counters etc.

c) At last we drew a timing diagram to understand the overall program flow and timers (timeout) functionality.

Design

We divided the designing into two part. Firstly, we built the java program flow chart for each functionality and then translated the same into a code in eclipse.

Text file contained the data in a String format and the floating-point data couldn't be directly extracted using typecast. Hence, we used java.util.regex package (Matcher & Pattern class). Below is the regex expression that we have used to extract floating-point data from string.
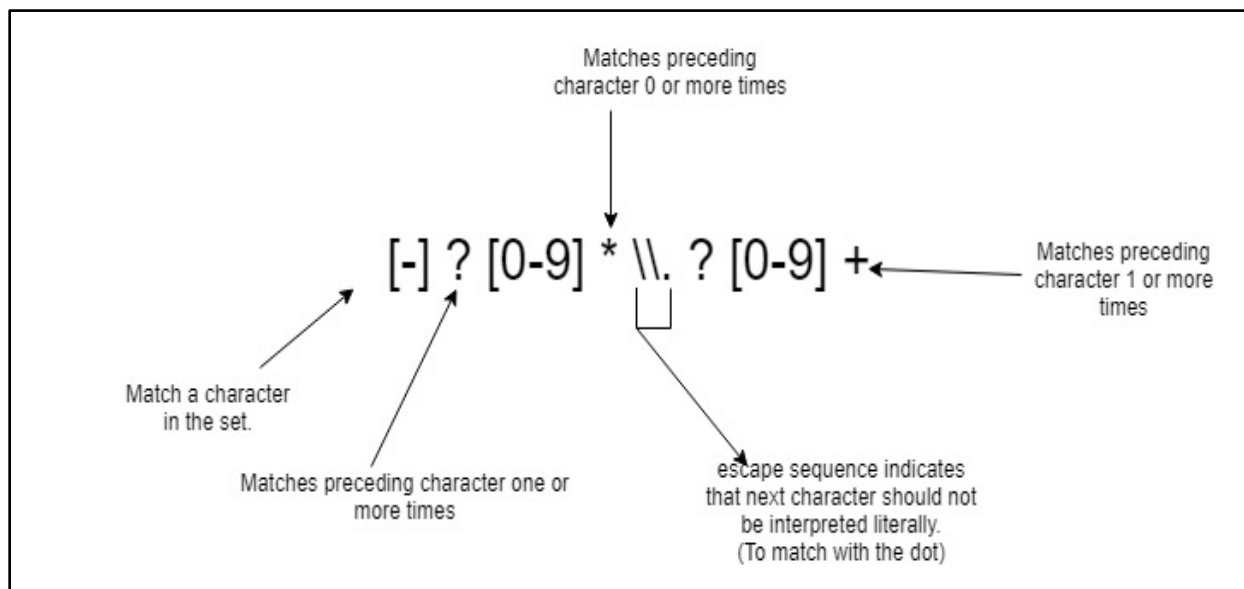

Java program flow charts & Timing Diagram

Before starting with the code in eclipse we drew following java program flow chart & Timing diagram to understand the program flow and functionality of each exchanges between client and server.

Timing Diagram when everything goes well i.e. no packets are lost and correct packet are sent and received
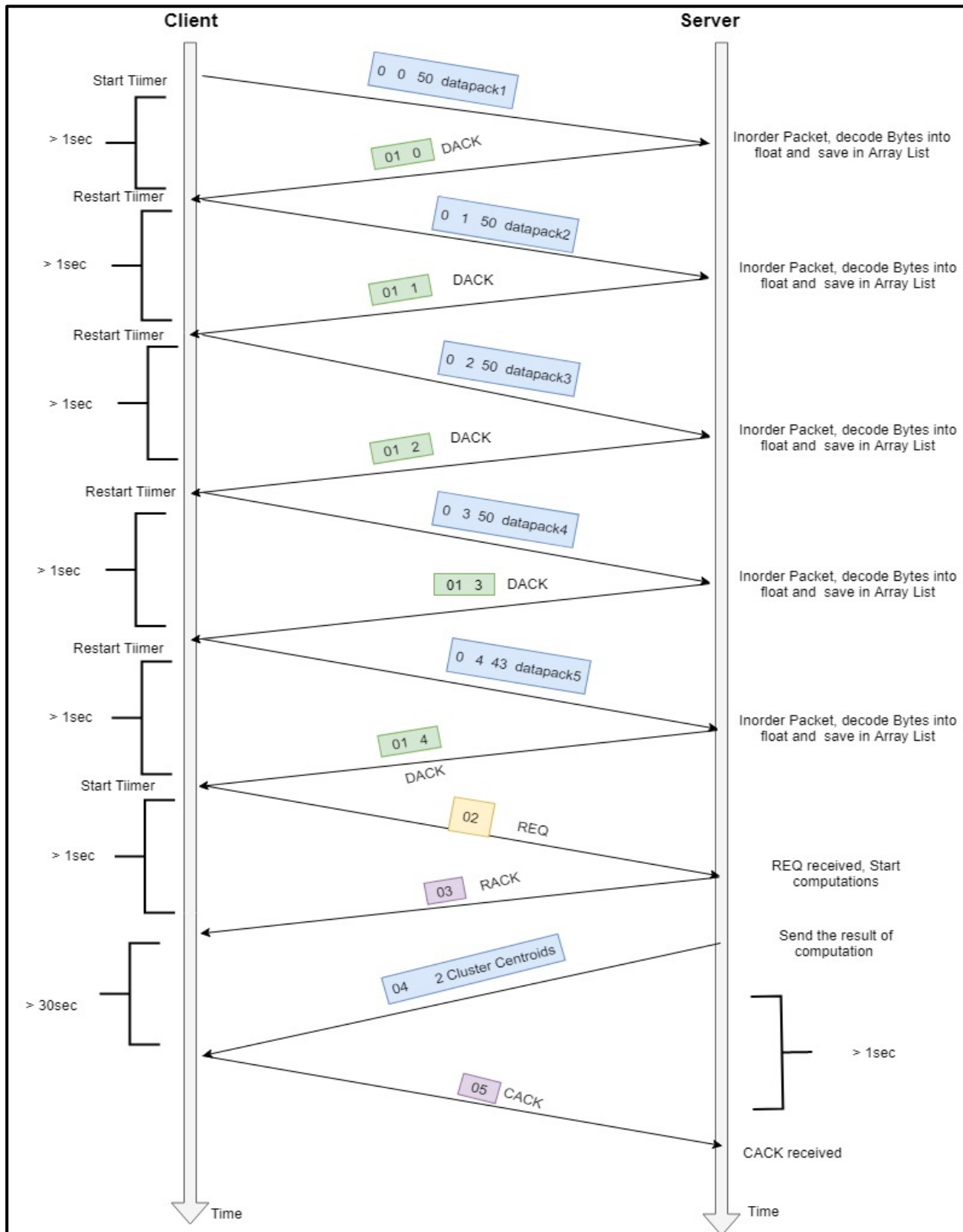
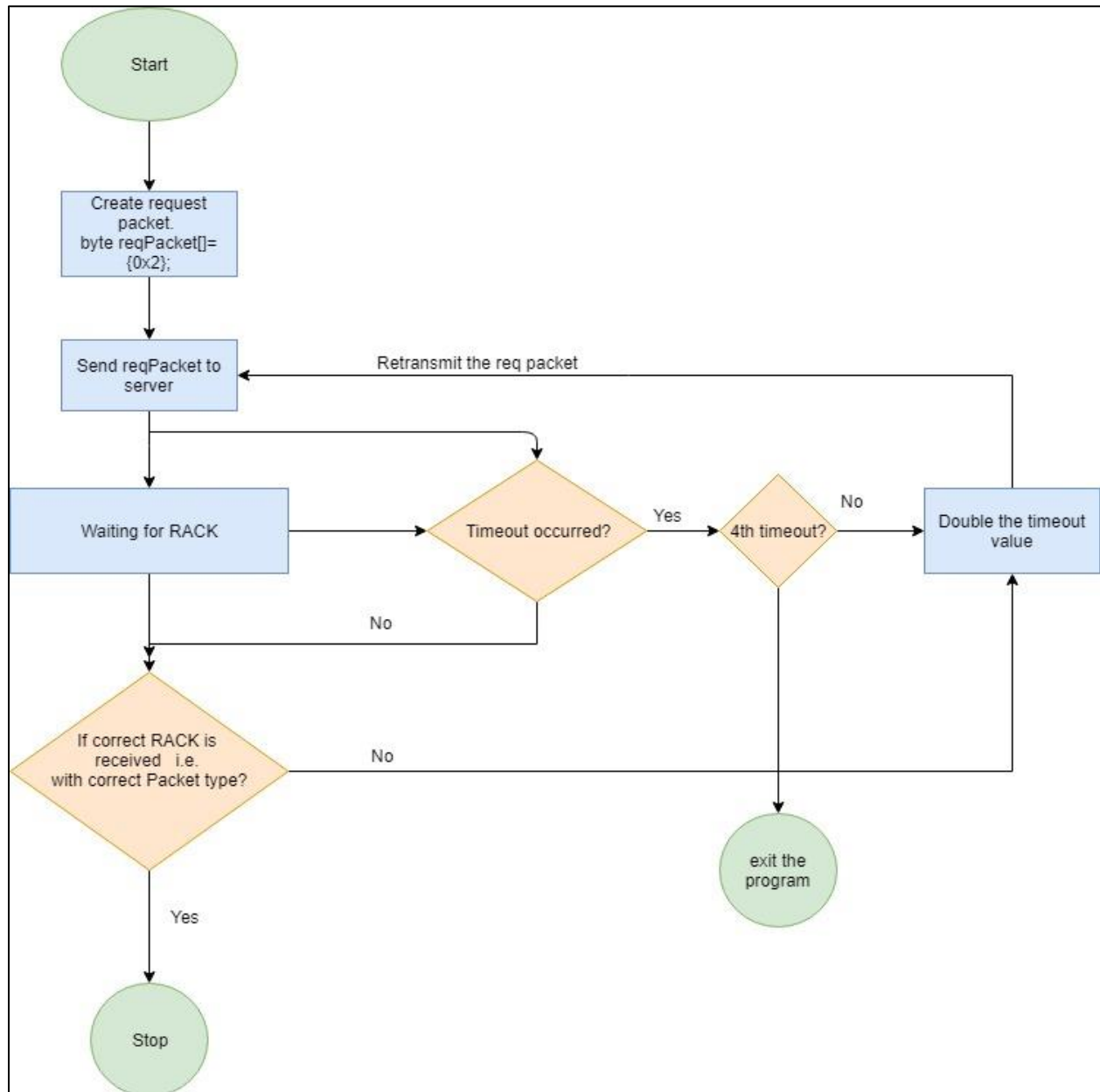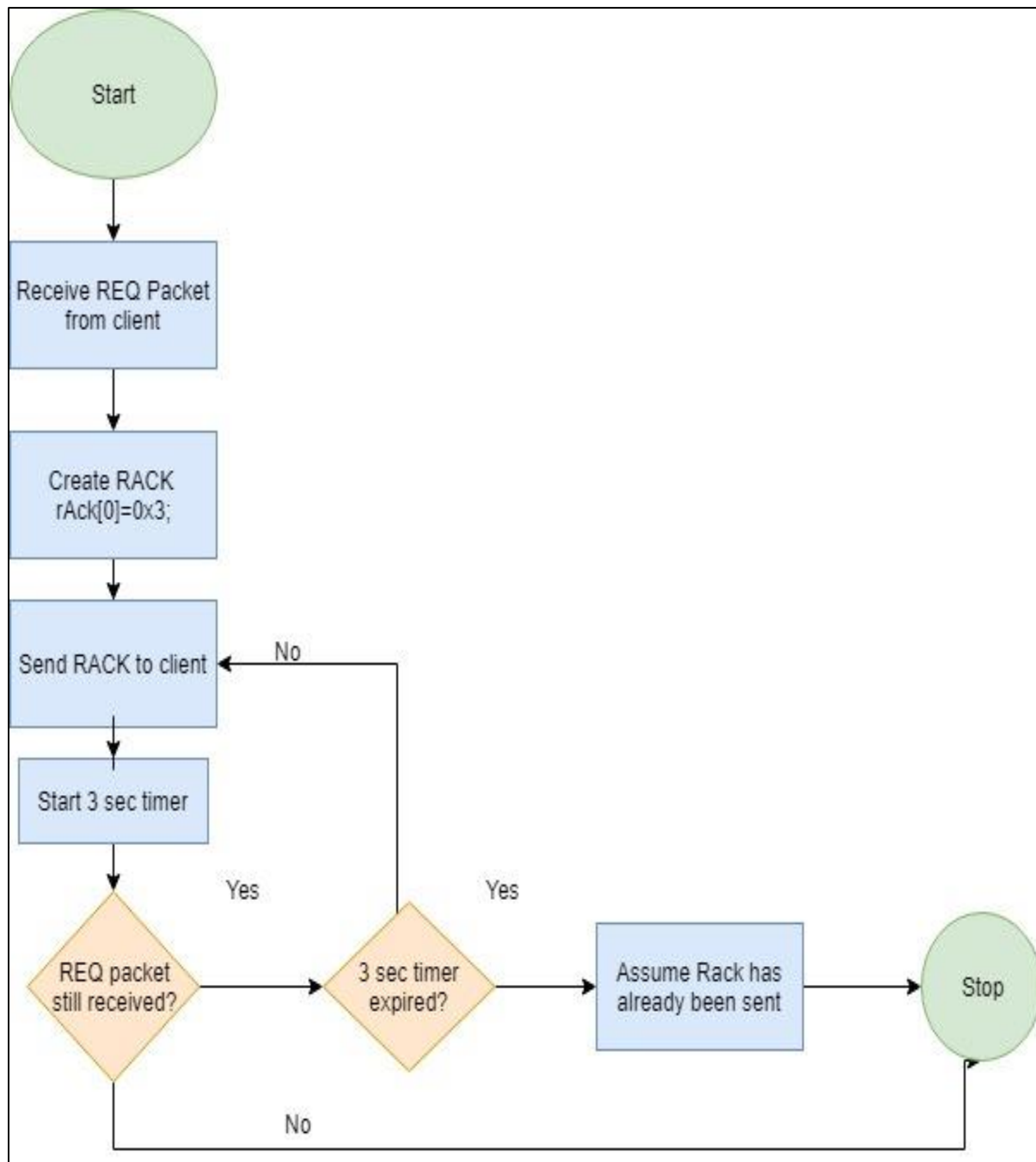**Client Side: Reading data from text, Bye encoding, Sending Data Packets, Receiving DACK**
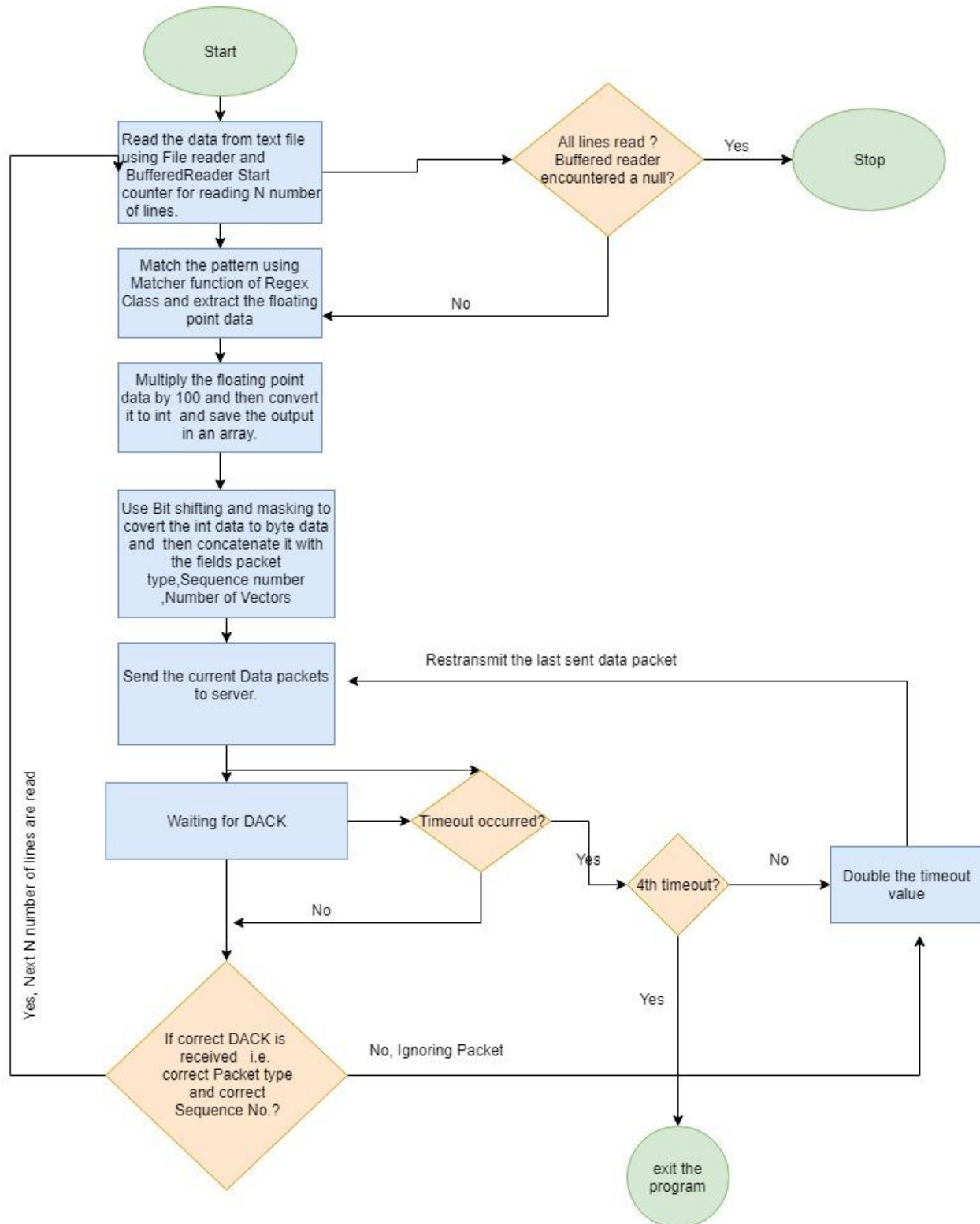
Server Side: Receiving Data packets and Sending DACK
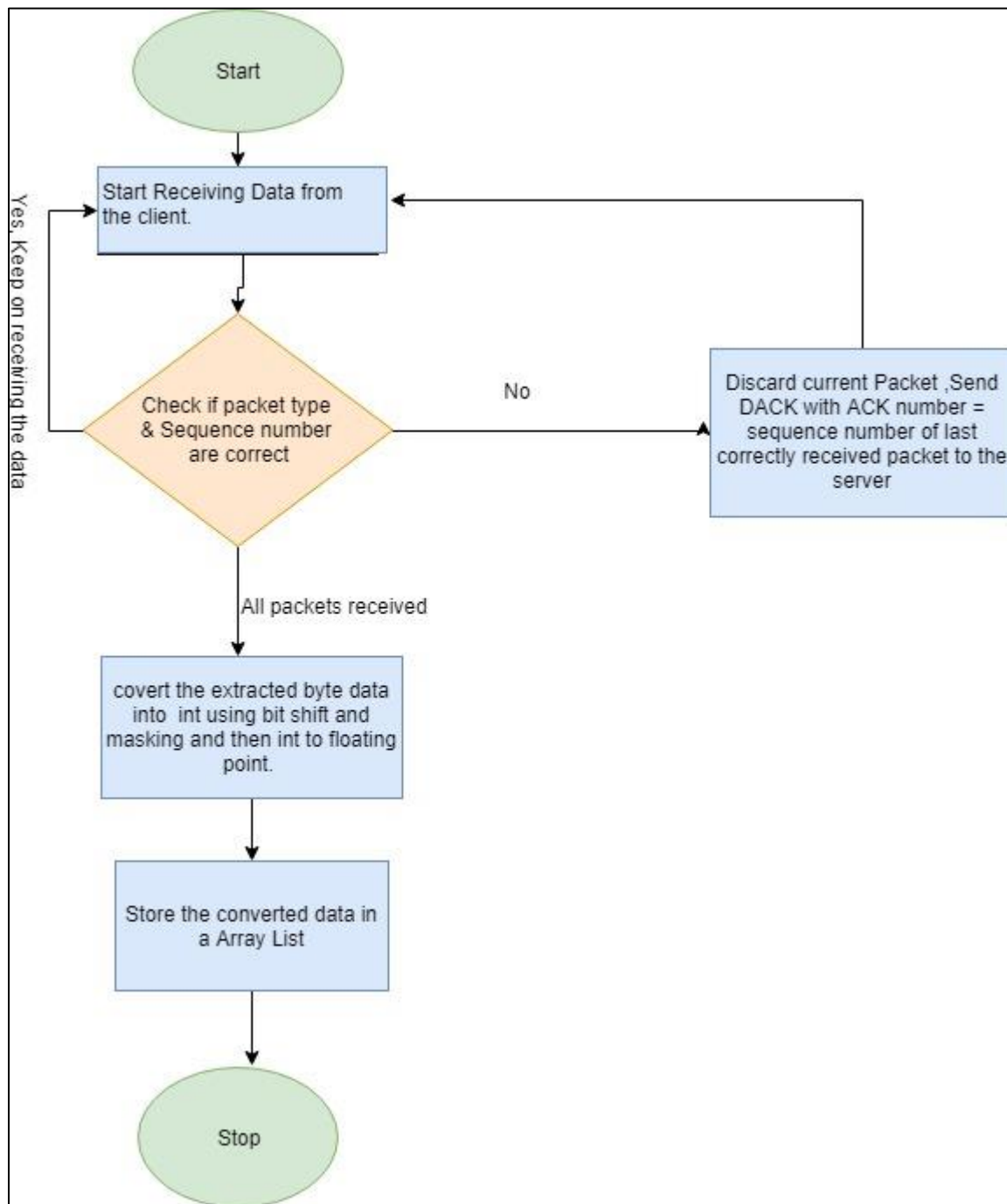
Client Side :Create REQ, Send REQ & Receive RACK

Server Side: Receiver REQ & Send RACK

K means Clustering
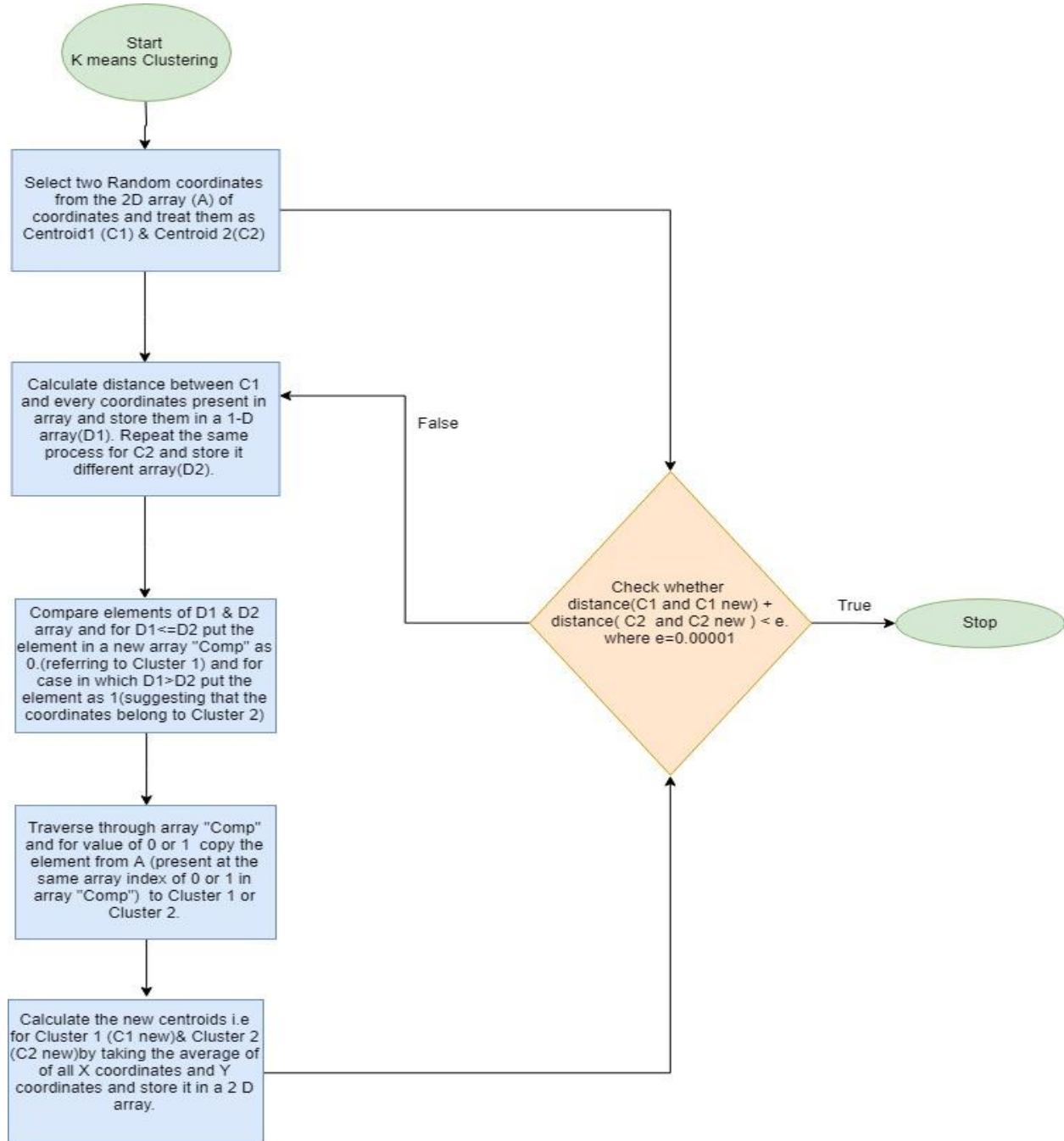
K-means Clustering java program flow graph

Server Side: Create CLUS, Send CLUS & Receive CACK
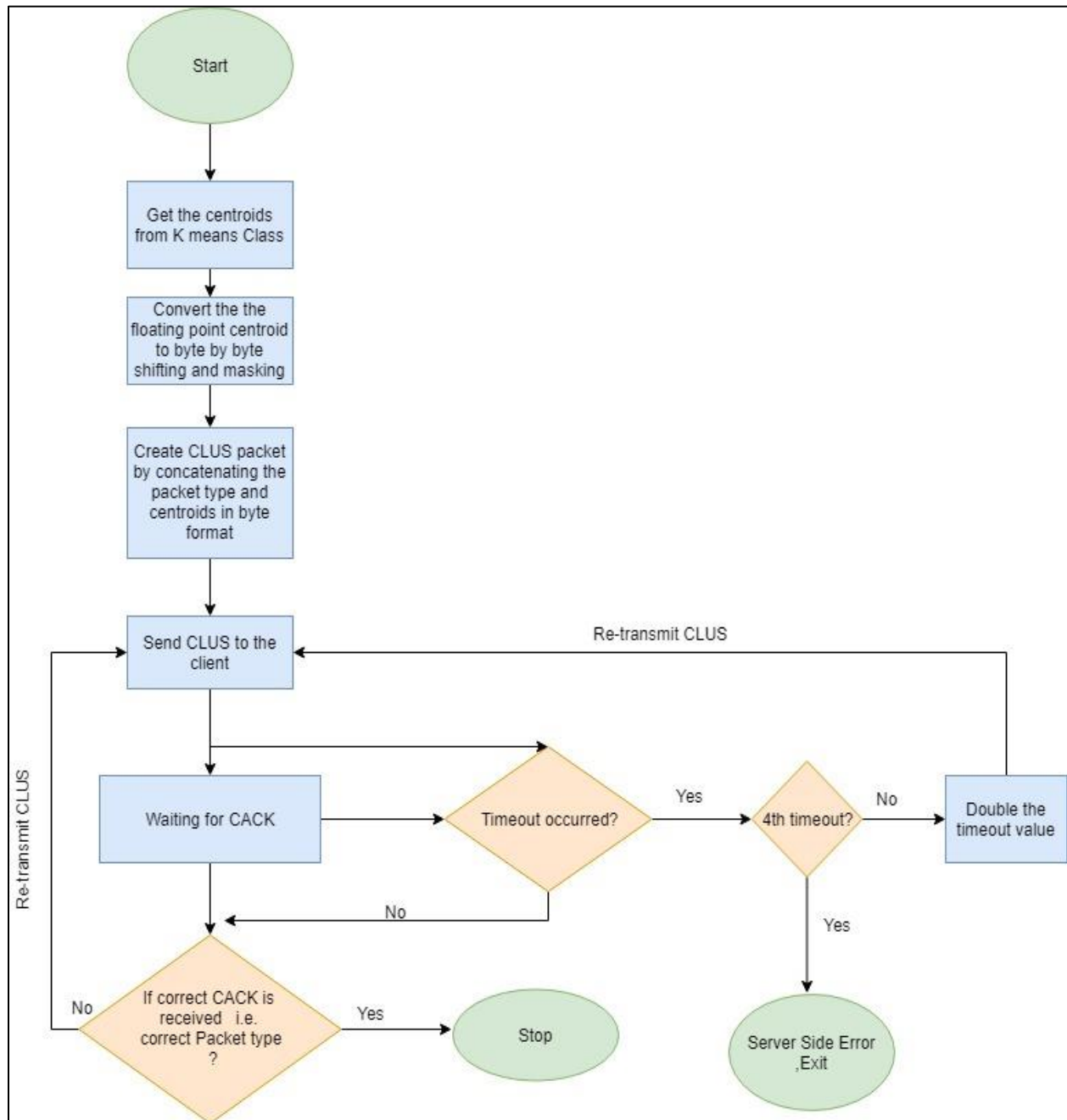
Client Side: Receive CLUS & Send CACK
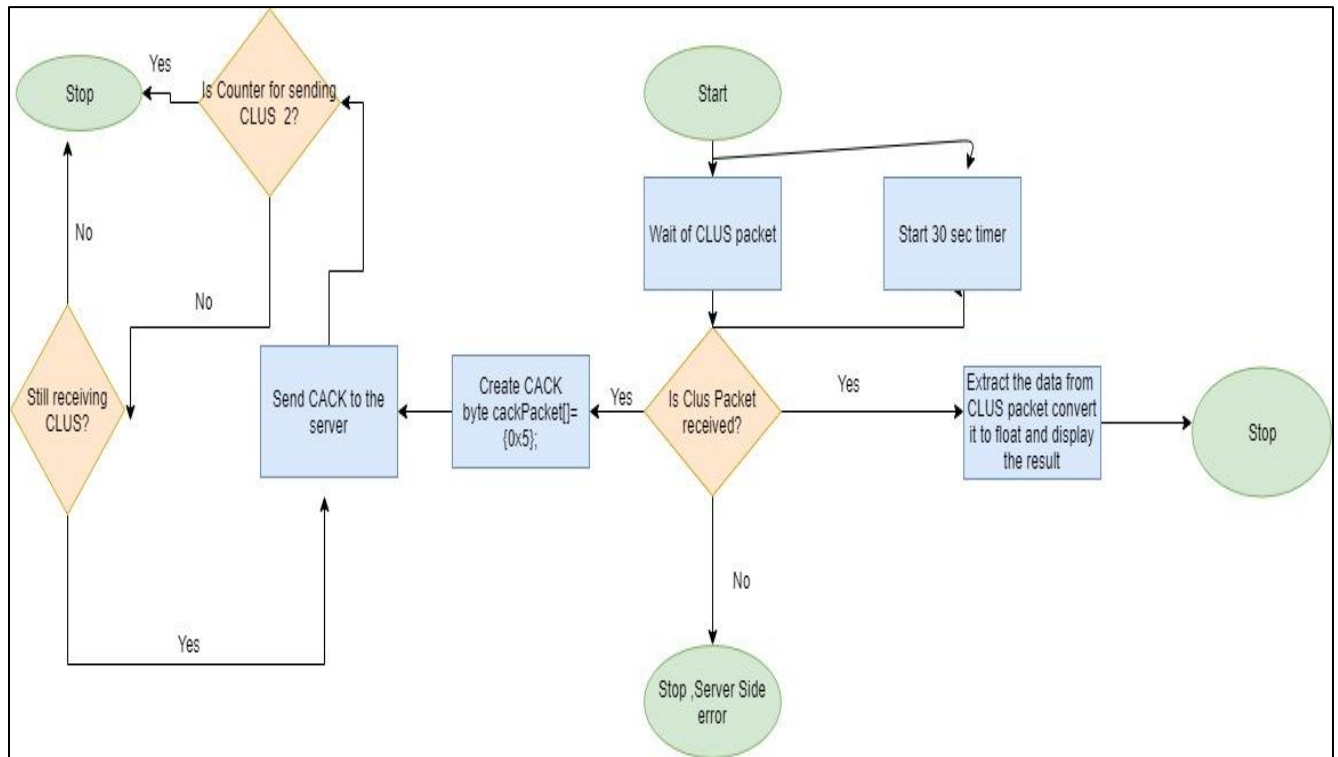
After drawing all the above flow diagram, we started with the coding in Java using eclipse. We divided our overall code in four classes namely:

- ➢ FinalClient: Communicates with server.
- ➢ FinalServer: Communicates with client and see if
- ➢ ReadTextEncodeByte: Reads the text file and convert the data into Byte format
- ➢ ComputeKmeans: Computes centroid and return its value.

Below is the UML Diagram for above mentioned Classes

UML diagram from FinalClient
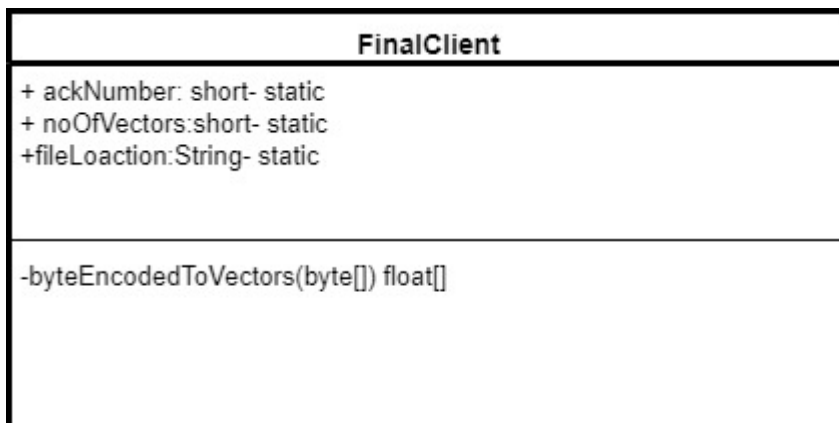
UML diagram for FinalServer

FinalServer
-main ()
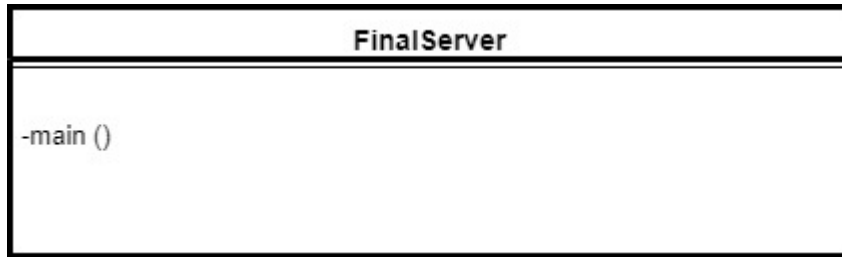
UML diagram for ReadTextEncodeByte

ReadTextEncodeByte
- getDocToArray(int,int,String): int[] - getPacketStructure(int[],short,short)
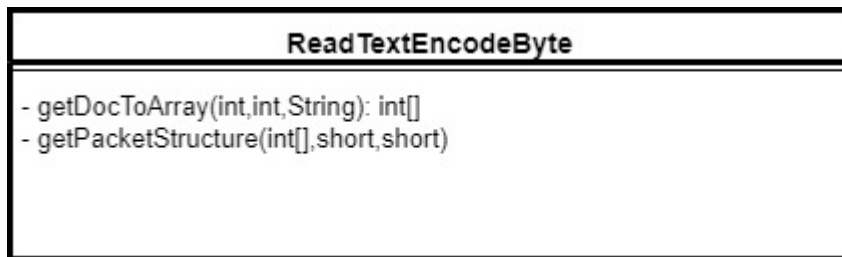
UML diagram for Class ComputeKmeans

ComputeKmeans
-getCentroid(float [] []) float[] []
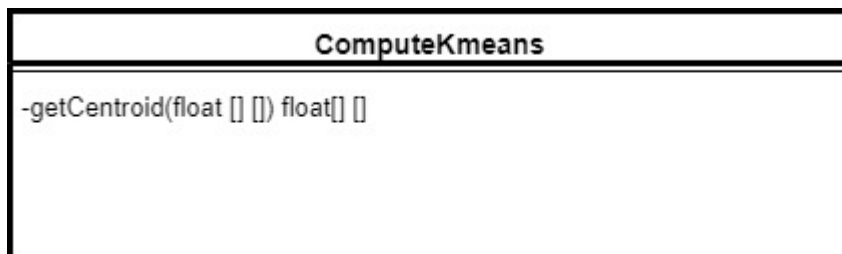
Testing & Integration /Implementation

During this phase we tested each code block one by one and debug whenever there was an error.

After the successful implementation of each code block we integrated them and tested the whole code. Below is the output for every possible timeouts and incorrect packet/data received.

OUTPUT:

NO ERROR:

📺 Console ⊠ 👤 Problems 🔟 Debug Shell

\<terminated\> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 10:52:36 AM)

```
Number of data vectors per DATA paket: 50
sending 0 DATA packet
        DACK 0 received, correct
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
sending 3 DATA packet
        DACK 3 received, correct
sending 4 DATA packet
        DACK 4 received, correct
Sending REQ packet
        RACK received
        CLUS Rxed
Centroids for two Clusters are
m1= (-1.18,-1.02)
m2= (1.1,1.08)

Sending CACK
CLUS Timeout
        No dupicate CLUS received
```

📺 Console ⊠ 👤 Problems 🔟 Debug Shell

FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 10:52:31 AM)

```
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
DATA 3 received
        Sending 3 DACKto the client.....
DATA 4 received
        Sending 4 DACKto the client.....
REQ received
        Sending the RACKto the client.....
        no duplicate REQ received..continue....
        Sending CLUS packet
Cack received
```

SERVER NOT RUNNING:

```
Console ⊠  Problems  Debug Shell
<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 10:49:37 AM)
Number of data vectors per DATA paket: 50
sending 0 DATA packet
Client DACK timeout!
sending 0 DATA packet
Client DACK timeout!
sending 0 DATA packet
Client DACK timeout!
Communication failure
```

INCORRECT DATA RECEIVED:

```
Console ⊠  Problems  Debug Shell
<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:03:49 AM)
Number of data vectors per DATA paket: 50
sending 0 DATA packet
        DACK 0 received, correct
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
sending 3 DATA packet
        Incorrct DACK received
Client DACK timeout!
sending 2 DATA packet
        Incorrct DACK received
Client DACK timeout!
sending 2 DATA packet
        Incorrct DACK received
Client DACK timeout!
Communication failure
```

```
Console ⊠  Problems  Debug Shell
FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:03:47 AM)
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
Invalid DATA received
        Sending 2 DACKto the client.....
Invalid DATA received
        Sending 2 DACKto the client.....
Invalid DATA received
        Sending 2 DACKto the client.....
```

INCORRECT DACK RECEIVED:

```
Console ⊠   Problems   Debug Shell
<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 10:57:35 AM)
Number of data vectors per DATA paket: 50
sending 0 DATA packet
        Incorrct DACK received
Client DACK timeout!
sending 0 DATA packet
        Incorrct DACK received
Client DACK timeout!
sending 0 DATA packet
        Incorrct DACK received
Client DACK timeout!
Communication failure
```

```
Console ⊠   Problems   Debug Shell
FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 10:57:32 AM)
DATA 0 received
        Sending 0 DACKto the client.....
Invalid DATA received
        Sending 0 DACKto the client.....
Invalid DATA received
        Sending 0 DACKto the client.....
```

INCORRECT REQ RECEIVED:

```
Console ⊠  Problems  Debug Shell
<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:07:44 AM)
Number of data vectors per DATA paket: 50
sending 0 DATA packet
        DACK 0 received, correct
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
sending 3 DATA packet
        DACK 3 received, correct
sending 4 DATA packet
        DACK 4 received, correct
Sending REQ packet
        Incorrct RACK received
Client RACK timeout!
Sending REQ packet
        Incorrct RACK received
Client RACK timeout!
Sending REQ packet
        Incorrct RACK received
Client RACK timeout!
communication failure
```

```
Console ⊠  Problems  Debug Shell
FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:07:42 AM)
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
DATA 3 received
        Sending 3 DACKto the client.....
DATA 4 received
        Sending 4 DACKto the client.....
Invalid DATA received
        Sending 4 DACKto the client.....
Invalid DATA received
        Sending 4 DACKto the client.....
Invalid DATA received
        Sending 4 DACKto the client.....
```

INCORRECT RACK RECEIVED ONCE:

Console ⊠ | Problems | Debug Shell

<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:21:49 AM)

```
sending 3 DATA packet
        DACK 3 received, correct
sending 4 DATA packet
        DACK 4 received, correct
Sending REQ packet
        Incorrct RACK received
Client RACK timeout!
Sending REQ packet
        RACK received
        CLUS Rxed
Centroids for two Clusters are
m1= (1.1,1.08)
m2= (-1.18,-1.02)

Sending CACK
CLUS Timeout
        No dupicate CLUS received
```

Console ⊠ | Problems | Debug Shell

FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:21:47 AM)

```
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
DATA 3 received
        Sending 3 DACKto the client.....
DATA 4 received
        Sending 4 DACKto the client.....
REQ received
        Sending the RACKto the client.....
REQ received again
        Sending the RACKto the client.....
        no duplicate REQ received..continue....
        Sending CLUS packet
Cack received
```

RECEIVED INVAILD CLUS PACKET ONCE:

```
Console ⊠   Problems   Debug Shell
<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:46:11 AM)
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
sending 3 DATA packet
        DACK 3 received, correct
sending 4 DATA packet
        DACK 4 received, correct
Sending REQ packet
        RACK received
        received invalid CLUS packet
        CLUS Rxed
Centroids for two Clusters are
m1= (1.1,1.08)
m2= (-1.18,-1.02)

Sending CACK
```

```
Console ⊠   Problems   Debug Shell
FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:46:08 AM)
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
DATA 3 received
        Sending 3 DACKto the client.....
DATA 4 received
        Sending 4 DACKto the client.....
REQ received
        Sending the RACKto the client.....
        no duplicate REQ received..continue....
        Sending CLUS packet
Cack Timeout
        Sending CLUS packet
Cack received
```

INCORRECT CACK RECEIVED:

Console ⌧ Problems Debug Shell

\<terminated\> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:50:37 AM)

```
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
sending 3 DATA packet
        DACK 3 received, correct
sending 4 DATA packet
        DACK 4 received, correct
Sending REQ packet
        RACK received
        CLUS Rxed
Centroids for two Clusters are
m1= (-1.18,-1.02)
m2= (1.1,1.08)

Sending CACK
Sending CACK
```

Console ⌧ Problems Debug Shell

FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:50:34 AM)

```
        Sending 2 DACKto the client.....
DATA 3 received
        Sending 3 DACKto the client.....
DATA 4 received
        Sending 4 DACKto the client.....|
REQ received
        Sending the RACKto the client.....
        no duplicate REQ received..continue....
        Sending CLUS packet
Invalid Cack received
Cack Timeout
        Sending CLUS packet
Invalid Cack received
Cack Timeout
        Sending CLUS packet
Cack Timeout
Communication failure
```

RECEIVED TWO DATA FILES ONE AFTER OTHER:

Console ✕ � 🔧 Problems 🗗 Debug Shell

<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:53:21 AM)

```
Number of data vectors per DATA paket: 50
sending 0 DATA packet
        DACK 0 received, correct
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
sending 3 DATA packet
        DACK 3 received, correct
sending 4 DATA packet
        DACK 4 received, correct
Sending REQ packet
        RACK received
        CLUS Rxed
Centroids for two Clusters are
m1= (1.1,1.08)
m2= (-1.18,-1.02)

Sending CACK
CLUS Timeout
        No dupicate CLUS received
```

Console ✕ 🗗 Problems 🗗 Debug Shell

<terminated> FinalClient [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:55:17 AM)

```
Number of data vectors per DATA paket: 50
sending 0 DATA packet
        DACK 0 received, correct
sending 1 DATA packet
        DACK 1 received, correct
sending 2 DATA packet
        DACK 2 received, correct
Sending REQ packet
        RACK received
        CLUS Rxed
Centroids for two Clusters are
m1= (-1.21,-1.2)
m2= (0.85,1.21)

Sending CACK
CLUS Timeout
        No dupicate CLUS received
```

Console ⊠ Problems Debug Shell

FinalServer [Java Application] C:\Program Files\Java\jre-10.0.2\bin\javaw.exe (05-Dec-2018, 11:53:11 AM)

```
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
DATA 3 received
        Sending 3 DACKto the client.....
DATA 4 received
        Sending 4 DACKto the client.....
REQ received
        Sending the RACKto the client.....
        no duplicate REQ received..continue....
        Sending CLUS packet
Cack received
DATA 0 received
        Sending 0 DACKto the client.....
DATA 1 received
        Sending 1 DACKto the client.....
DATA 2 received
        Sending 2 DACKto the client.....
REQ received
        Sending the RACKto the client.....
        no duplicate REQ received..continue....
        Sending CLUS packet
Cack received
```