

Projektrapport
Chattapplikation
för Objektorienterad programutveckling, trådar och
datakommunikation

Rasmus Andersson
Emil Sandgren
Erik Sandgren
Jimmy Maksymiw
Lorenz Puskas
Kalle Bornemark

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1 Arbetsbeskrivning

1.1 Rasmus Andersson

Arbetade med kommunikation mellan servern och klienten med Kalle Bornemark, och Jimmy Maksymiw. Formgav projektrapporten samt skrev ImageScaleHandler.java samt Chatlog.java. Jobbade inte med UI-klasserna.

1.2 Emil Sandgren

Arbetade med UI klasserna ClientUI, StartClient och StartServer och ChatWindow. Huvudansvarig för UI. Jobbat med att koppla ihop UI:t med vad som kommer in från servern.

1.3 Erik Sandgren

Arbetade först med generell grundläggande kommunikation mellan server och klient. Jobbade sedan med UI och har även hoppat in där det behövdes på andra delar av systemet. Har ritat upp mycket av strukturen och fixat buggar.

1.4 Jimmy Maksymiw

Arbetade med planering av och struktur på hur chatten ska fungera. Vid programmeringen har han arbetat med logiken som används i både klient och server. Hur kommunikationen skall ske och vad som ska göras på de olika sidorna. Har också varit med och gjort diagrammen.

1.5 Lorenz Puskas

Arbetade främst med att designa ClientUI tillsammans med Emil.

1.6 Kalle Bornemark

Arbetade med server/klient-kommunikation, projektplanering och klasstrukturen. Skapade även diagrammen och har fungerat som projektledare till och från.

2 Instruktioner för programstart

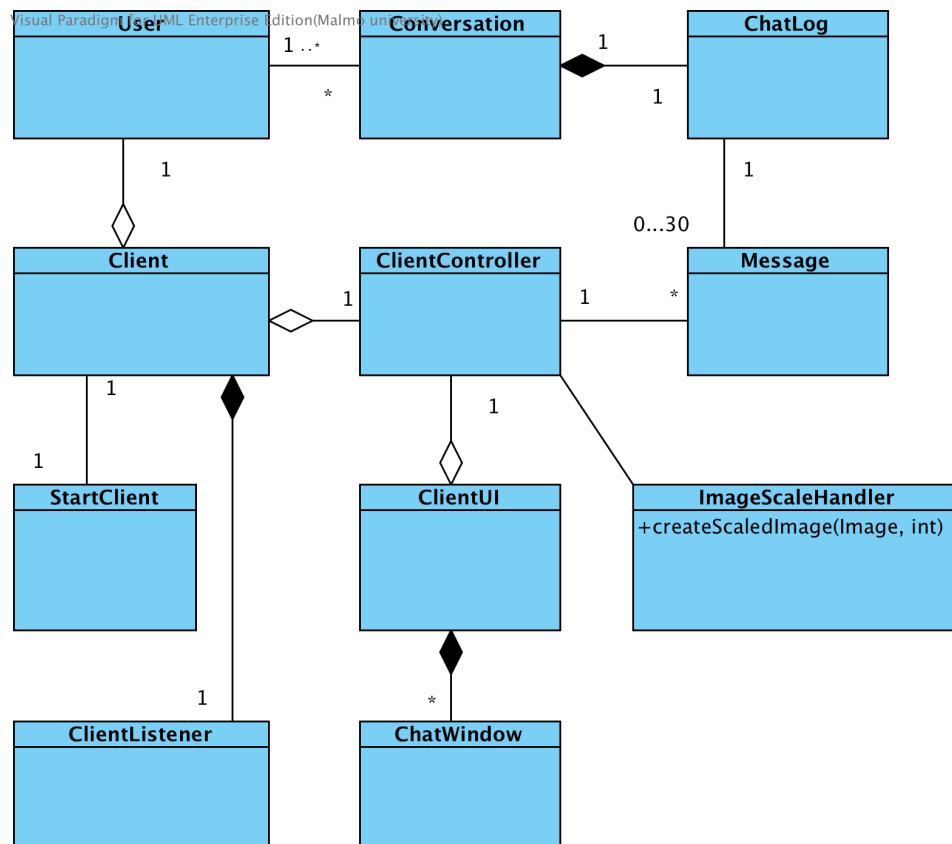
För att köra programmet krävs att man startar en server och minst en klient. Main-metoden för att starta servern finns i StartServer.java och main-metoden för att starta klienter finns i StartClient.java. Alla filvägar som används är relativa projektets workspace och behöver inte ändras.

3 Systembeskrivning

Systemet förser en Chatt-tjänst. I systemet finns det flera klienter och en server. Klienterna har ett grafiskt användargränssnitt för att skicka meddelanden till alla andra anslutna klienter, enskilda klienter, eller till en grupp av klienter. Meddelanden består av text eller av bilder. Alla dessa meddelanden går via en server som ser till att meddelanden kommer fram till rätt gruppchat eller till lobbyn. Servern lagrar alla textmeddelanden som användarna skickar och loggar även namn på de bilder som skickas via bildmeddelanden. Servern loggar även användarnamn för de klienter som ansluter och när dessa stänger ner anslutningen mot servern.

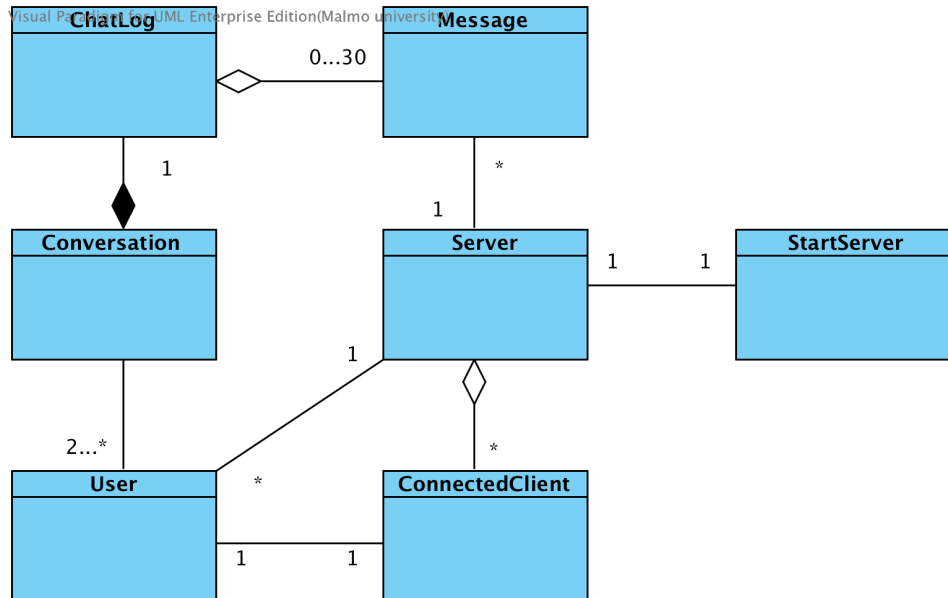
4 Klassdiagram

4.1 Klient



Figur 1: Klient

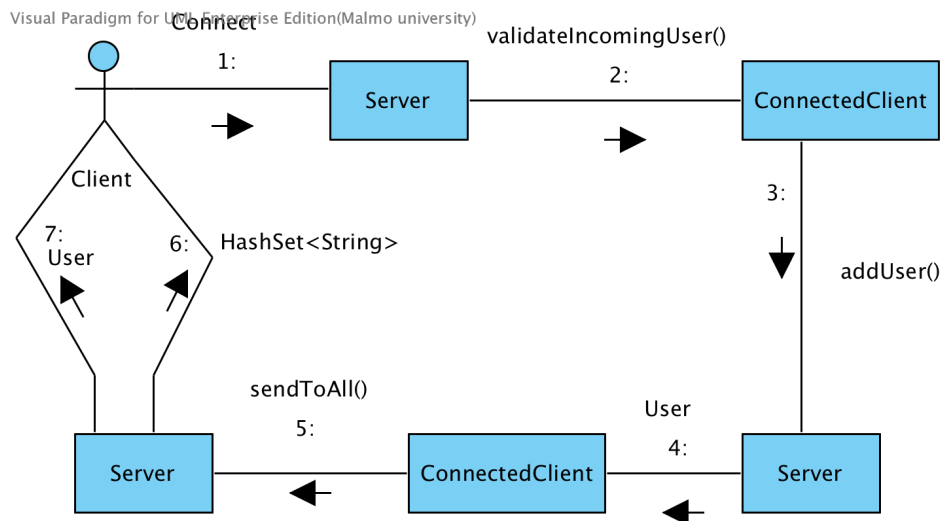
4.2 Server



Figur 2: Server

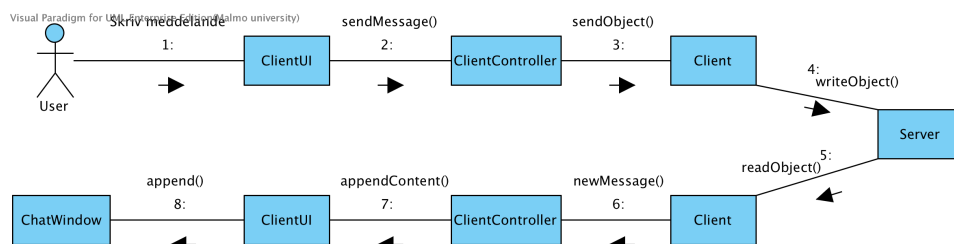
5 Kommunikationsdiagram

5.1 Connect and login



Figur 3: Client connecting and logging in

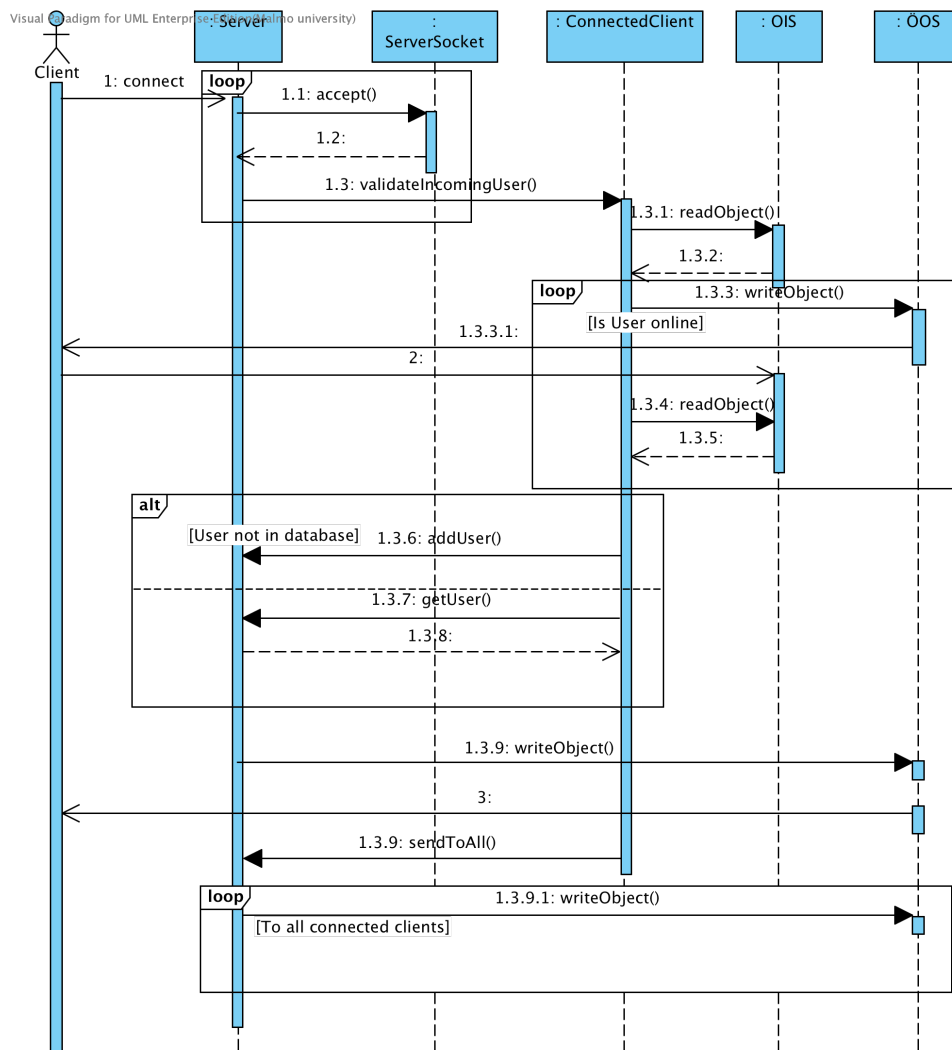
5.2 Client send Message



Figur 4: Client sending a message

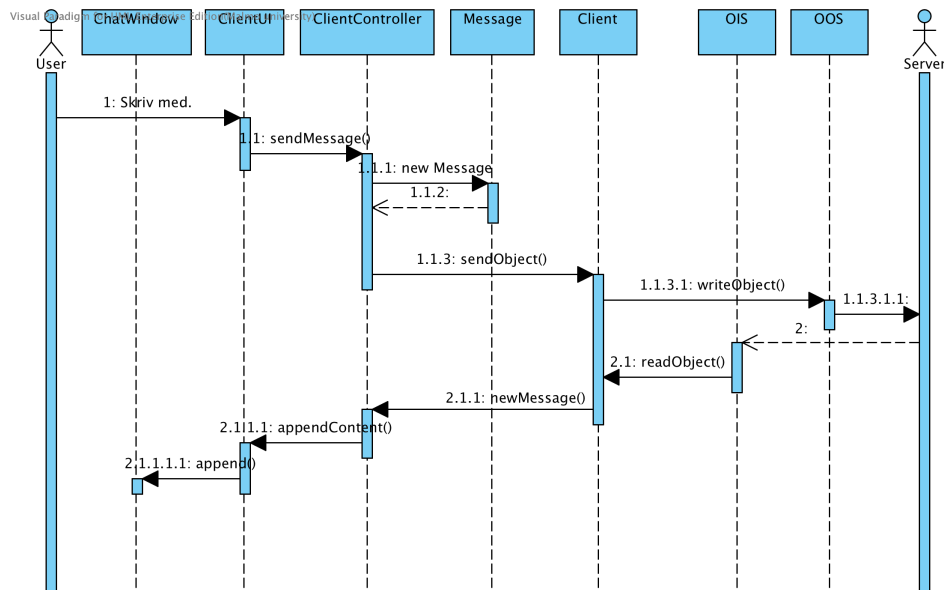
6 Sekvensdiagram

6.1 Connect and login



Figur 5: Client connecting and logging in

6.2 Send message



Figur 6: Client sending a message

7 Källkod

7.1 Server

7.1.1 Server.java, Server.ConnectedClient.java

```

1 package chat;
2
3 import java.io.IOException;
4 import java.io.ObjectInputStream;
5 import java.io.ObjectOutputStream;
6 import java.net.ServerSocket;
7 import java.net.Socket;
8 import java.util.ArrayList;
9 import java.util.HashSet;
10 import java.util.logging.*;
11
12 /**
13  * Model class for the server.
14  *
15  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
16  * @author Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
17  */
18 public class Server implements Runnable {
19     private ServerSocket serverSocket;
20     private ArrayList<ConnectedClient> connectedClients;

```



```
21     private ArrayList<User> registeredUsers;  
22     private static final Logger LOGGER = Logger.getLogger(Server  
23         .class.getName());  
24  
25     public Server(int port) {  
26         initLogger();  
27         registeredUsers = new ArrayList<>();  
28         connectedClients = new ArrayList<>();  
29         try {  
30             serverSocket = new ServerSocket(port);  
31             new Thread(this).start();  
32         } catch (IOException e) {  
33             e.printStackTrace();  
34         }  
35     }  
36  
37     /**  
38     * Initiates the Logger  
39     */  
40     private void initLogger() {  
41         Handler fh;  
42         try {  
43             fh = new FileHandler("./src/log/Server.log");  
44             LOGGER.addHandler(fh);  
45             SimpleFormatter formatter = new SimpleFormatter();  
46             fh.setFormatter(formatter);  
47             LOGGER.setLevel(Level.FINE);  
48         } catch (IOException e) {}  
49     }  
50  
51     /**  
52     * Returns the User which ID matches the given ID.  
53     * Returns null if it doesn't exist.  
54     *  
55     * @param id The ID of the User that is to be found.  
56     * @return The matching User object, or null.  
57     */  
58     public User getUser(String id) {  
59         for (User user : registeredUsers) {  
60             if (user.getId().equals(id)) {  
61                 return user;  
62             }  
63         }  
64         return null;  
65     }  
66  
67     /**  
68     * Sends an object to all currently connected clients.  
69     *  
70     * @param object The object to be sent.  
71     */  
72     public synchronized void sendObjectToAll(Object object) {  
73         for (ConnectedClient client : connectedClients) {  
74             client.sendObject(object);  
75         }  
76     }  
77 }
```

```
74     }
75 }
76
77 /**
78  * Checks who the message shall be sent to, then sends it.
79  *
80  * @param message The message to be sent.
81  */
82 public void sendMessage(Message message) {
83     Conversation conversation = null;
84     String to = "";
85
86     // Lobby message
87     if (message.getConversationID() == -1) {
88         sendObjectToAll(message);
89         to += "lobby";
90     } else {
91         User senderUser = null;
92
93         // Finds the sender user
94         for (ConnectedClient cClient : connectedClients) {
95             if (cClient.getUser().getId().equals(message.
96                 getFromUserID())) {
97                 senderUser = cClient.getUser();
98
99                 // Finds the conversation the message shall
100                 // be sent to
101                 for (Conversation con : senderUser.
102                     getConversations()) {
103                     if (con.getId() == message.
104                         getConversationID()) {
105                         conversation = con;
106                         to += conversation.getInvolvedUsers
107                             ().toString();
108
109                         // Finds the message's recipient
110                         // users, then sends the message
111                         for (String s : con.getInvolvedUsers
112                             ()) {
113                             for (ConnectedClient conClient :
114                                 connectedClients) {
115                                 if (conClient.getUser().
116                                     getId().equals(s)) {
117                                     conClient.sendObject(
118                                         message);
119                                 }
120                             }
121                         }
122                     }
123                 }
124                 conversation.addMessage(message);
125             }
126         }
127     }
128 }
```

```
118         LOGGER.info("— NEW MESSAGE SENT —\n" +
119                     "From: " + message.getFromUserID() + "\n" +
120                     "To: " + to + "\n" +
121                     "Message: " + message.getContent().toString());
122     }
123
124     /**
125     * Sends a Conversation object to its involved users
126     *
127     * @param conversation The Conversation object to be sent.
128     */
129     public void sendConversation(Conversation conversation) {
130         HashSet<String> users = conversation.getInvolvedUsers();
131         for (String s : users) {
132             for (ConnectedClient c : connectedClients) {
133                 if (c.getUser().getId().equals(s)) {
134                     c.sendObject(conversation);
135                 }
136             }
137         }
138     }
139
140     /**
141     * Sends an ArrayList with all connected user's IDs.
142     */
143     public void sendConnectedClients() {
144         ArrayList<String> connectedUsers = new ArrayList<>();
145         for (ConnectedClient client : connectedClients) {
146             connectedUsers.add(client.getUser().getId());
147         }
148         sendObjectToAll(connectedUsers);
149     }
150
151     /**
152     * Waits for client to connect.
153     * Creates a new instance of ConnectedClient upon client
154     * connection.
155     * Adds client to list of connected clients.
156     */
157     public void run() {
158         LOGGER.info("Server started.");
159         while (true) {
160             try {
161                 Socket socket = serverSocket.accept();
162                 ConnectedClient client = new ConnectedClient(
163                     socket, this);
164                 connectedClients.add(client);
165             } catch (IOException e) {
166                 e.printStackTrace();
167             }
168         }
169     }
170
171     /**
```

```
170     * Class to handle the communication between server and
171     * connected clients.
172     */
173     private class ConnectedClient implements Runnable {
174         private Thread client = new Thread(this);
175         private ObjectOutputStream oos;
176         private ObjectInputStream ois;
177         private Server server;
178         private User user;
179         private Socket socket;
180
181         public ConnectedClient(Socket socket, Server server) {
182             LOGGER.info("Client connected: " + socket.
183                 getInetAddress());
184             this.socket = socket;
185             this.server = server;
186             try {
187                 oos = new ObjectOutputStream(socket.
188                     getOutputStream());
189                 ois = new ObjectInputStream(socket.
190                     getInputStream());
191             } catch (IOException e) {
192                 e.printStackTrace();
193             }
194             client.start();
195         }
196
197         /**
198          * Returns the connected clients current User.
199          *
200          * @return The connected clients current User
201          */
202         public User getUser() {
203             return user;
204         }
205
206         /**
207          * Sends an object to the client.
208          *
209          * @param object The object to be sent.
210          */
211         public synchronized void sendObject(Object object) {
212             try {
213                 oos.writeObject(object);
214             } catch (IOException e) {
215                 e.printStackTrace();
216             }
217         }
218
219         /**
220          * Removes the user from the list of connected clients.
221          */
222         public void removeConnectedClient() {
223             for (int i = 0; i < connectedClients.size(); i++) {
```

```
220         if (connectedClients.get(i).getUser().getId().
221             equals(this.getUser().getId())) {
222             connectedClients.remove(i);
223             System.out.println("Client removed from
224                                 connectedClients");
225         }
226     }
227
228     /**
229     * Removes the connected client,
230     * sends an updated list of connected clients to other
231     * connected clients,
232     * sends a server message with information of who
233     * disconnected
234     * and closes the client's socket.
235     */
236     public void disconnectClient() {
237         removeConnectedClient();
238         sendConnectedClients();
239         sendObjectToAll("Client disconnected: " + user.getId
240                         ());
241         LOGGER.info("Client disconnected: " + user.getId());
242         try {
243             socket.close();
244         } catch (Exception e) {
245             e.printStackTrace();
246         }
247     }
248
249     /**
250     * Checks if given user exists among already registered
251     * users.
252     *
253     * @return Whether given user already exists or not.
254     */
255     public boolean isUserInDatabase(User user) {
256         for (User u : registeredUsers) {
257             if (u.getId().equals(user.getId())) {
258                 return true;
259             }
260         }
261         return false;
262     }
263
264     public User getUser(String ID) {
265         for (User user : registeredUsers) {
266             if (user.getId().equals(ID)) {
267                 return user;
268             }
269         }
270         return null;
271     }
272 }
```

```
268      /**
269       * Compare given user ID with connected client's IDs and
          check if the user is online.
270       *
271       * @param id User ID to check online status.
272       * @return Whether given user is online or not.
273       */
274     public boolean isUserOnline(String id) {
275         for (ConnectedClient client : connectedClients) {
276
277             if (client.getUser().getId().equals(id) &&
                client != this) {
278                 return true;
279             }
280         }
281         return false;
282     }
283
284     /**
285      * Checks if given set of User IDs already has an open
          conversation.
286      * If it does, it sends the conversation to its
          participants.
287      * If it doesn't, it creates a new conversation, adds it
          to the current users
288      * conversation list, and sends the conversation to its
          participants.
289      *
290      * @param participants A HashSet of user-IDs.
291      */
292     public void updateConversation(HashSet<String>
          participants) {
293         boolean exists = false;
294         Conversation conversation = null;
295         for (Conversation con : user.getConversations()) {
296             if (con.getInvolvedUsers().equals(participants))
297             {
298                 conversation = con;
299                 exists = true;
300             }
301         }
302         if (!exists) {
303             conversation = new Conversation(participants);
304             addConversation(conversation);
305         }
306         sendConversation(conversation);
307     }
308
309     /**
310      * Adds given conversation to all its participants' User
          objects.
311      *
312      * @param con The conversation to be added.
```

```
313     */
314     public void addConversation(Conversation con) {
315         for (User user : registeredUsers) {
316             for (String ID : con.getInvolvedUsers()) {
317                 if (ID.equals(user.getId())) {
318                     user.addConversation(con);
319                 }
320             }
321         }
322     }
323
324     /**
325     * Check if given message is part of an already existing
326     * conversation.
327     *
328     * @param message The message to be checked.
329     * @return Whether given message is part of a
330     *         conversation or not.
331     */
332     public Conversation isPartOfConversation(Message message) {
333         for (Conversation con : user.getConversations()) {
334             if (con.getId() == message.getConversationID()) {
335                 return con;
336             }
337         }
338         return null;
339     }
340
341     /**
342     * Forces connecting users to pick a user that's not
343     * already logged in,
344     * and updates user database if needed.
345     * Announces connected to other connected users.
346     */
347     public void validateIncomingUser() {
348         Object object;
349         try {
350             object = ois.readObject();
351             user = (User) object;
352             LOGGER.info("Checking online status for user: "
353                 + user.getId());
354             while (isUserOnline(user.getId())) {
355                 LOGGER.info("User " + user.getId() + "
356                     already connected. Asking for new name.");
357                 ;
358                 sendObject("Client named " + user.getId() + "
359                     already connected, try again!");
360                 // Wait for new user
361                 object = ois.readObject();
362                 user = (User) object;
363                 LOGGER.info("Checking online status for user
364                     : " + user.getId());
```

```
357         }
358         if (!isUserInDatabase(user)) {
359             registeredUsers.add(user);
360         } else {
361             user = getUser(user.getId());
362         }
363         oos.writeObject(user);
364         server.sendObjectToAll("Client connected: " +
365             user.getId());
366         LOGGER.info("Client connected: " + user.getId());
367         ;
368         sendConnectedClients();
369     } catch (Exception e) {
370         e.printStackTrace();
371     }
372 }
373
374 /**
375  * Listens to incoming Messages, Conversations, HashSets
376  * of User IDs or server messages.
377  */
378 public void startCommunication() {
379     Object object;
380     Message message;
381     try {
382         while (!Thread.interrupted()) {
383             object = ois.readObject();
384             if (object instanceof Message) {
385                 message = (Message) object;
386                 server.sendMessage(message);
387             } else if (object instanceof Conversation) {
388                 Conversation con = (Conversation) object
389                 ;
390                 oos.writeObject(con);
391             } else if (object instanceof HashSet) {
392                 @SuppressWarnings("unchecked")
393                 HashSet<String> participants = (HashSet<
394                     String>) object;
395                 updateConversation(participants);
396             } else {
397                 server.sendObjectToAll(object);
398             }
399         }
400     } catch (IOException e) {
401         disconnectClient();
402         e.printStackTrace();
403     } catch (ClassNotFoundException e2) {
404         e2.printStackTrace();
405     }
406 }
407
408 public void run() {
409     validateIncomingUser();
410     startCommunication();
411 }
```



```
406     }  
407 }  
408 }
```

Listing 1: Server

7.1.2 Startserver.java

```
1 package chat;  
2  
3 import java.awt.BorderLayout;  
4 import java.awt.Color;  
5 import java.awt.Dimension;  
6 import java.awt.FlowLayout;  
7 import java.awt.Font;  
8 import java.awt.GridLayout;  
9 import java.awt.event.ActionEvent;  
10 import java.awt.event.ActionListener;  
11 import java.awt.event.KeyEvent;  
12 import java.awt.event.KeyListener;  
13 import java.net.InetAddress;  
14 import java.net.UnknownHostException;  
15  
16 import javax.swing.JButton;  
17 import javax.swing.JFrame;  
18 import javax.swing.JLabel;  
19 import javax.swing.JOptionPane;  
20 import javax.swing.JPanel;  
21 import javax.swing.JTextField;  
22 import javax.swing.UIManager;  
23 import javax.swing.UnsupportedLookAndFeelException;  
24  
25 /**  
26  * Create an server-panel class.  
27  */  
28 public class StartServer extends JPanel{  
29     private JPanel pnlServerCenterFlow = new JPanel(new  
30         FlowLayout());  
31     private JPanel pnlServerCenterGrid = new JPanel(new  
32         GridLayout(1,2,5,5));  
33     private JPanel pnlServerGrid = new JPanel(new GridLayout  
34         (2,1,5,5));  
35     private JPanel pnlServerRunning = new JPanel(new  
36         BorderLayout());  
37  
38     private JTextField txtServerPort = new JTextField("3450");  
39     private JLabel lblServerPort = new JLabel("Port:");  
40     private JLabel lblServerShowServerIp = new JLabel();  
41     private JLabel lblWelcome = new JLabel("Create a blRC server  
42         ");  
43     private JLabel lblServerRunning = new JLabel("Server is  
44         running...");
```

```
39     private JButton btnServerCreateServer = new JButton("Create
        Server");
40
41     private Font fontIpPort = new Font("Sans-Serif",Font.PLAIN
        ,17);
42     private Font fontInfo = new Font("Sans-Serif",Font.BOLD|Font
        .ITALIC,20);
43     private Font fontWelcome = new Font("Sans-Serif", Font.BOLD
        ,25);
44     private Font fontButton = new Font("Sans-Serif", Font.BOLD
        ,18);
45     private Server server;
46
47     private BorderLayout br = new BorderLayout();
48
49     public StartServer() {
50         lookAndFeel();
51         initPanels();
52         initLabels();
53         setlblServerShowServerIp();
54         initListeners();
55     }
56
57     /**
58      * Initiate Server-Panels.
59      */
60     public void initPanels() {
61         setPreferredSize(new Dimension(350,150));
62         setOpaque(true);
63         setLayout(br);
64         setBackground(Color.WHITE);
65         add(pnlServerGrid, BorderLayout.CENTER);
66         pnlServerGrid.add(pnlServerCenterGrid);
67         add(lblServerShowServerIp, BorderLayout.SOUTH);
68
69         pnlServerCenterFlow.setOpaque(true);
70         pnlServerCenterFlow.setBackground(Color.WHITE);
71         pnlServerCenterGrid.setOpaque(true);
72         pnlServerCenterGrid.setBackground(Color.WHITE);
73         pnlServerGrid.setOpaque(true);
74         pnlServerGrid.setBackground(Color.WHITE);
75
76         pnlServerCenterGrid.add(lblServerPort);
77         pnlServerCenterGrid.add(txtServerPort);
78         btnServerCreateServer.setFont(fontButton);
79         pnlServerGrid.add(btnServerCreateServer);
80         pnlServerRunning.add(lblServerRunning, BorderLayout.
            CENTER);
81     }
82
83     /**
84      * Initiate Server-Labels.
85      */
86     public void initLabels() {
```

```
87         lblServerPort.setHorizontalAlignment(JLabel.CENTER);
88         lblWelcome.setHorizontalAlignment(JLabel.CENTER);
89         lblServerShowServerIp.setFont(fontInfo);
90         lblServerShowServerIp.setForeground(new Color(146,1,1));
91         lblServerShowServerIp.setHorizontalAlignment(JLabel.
92             CENTER);
93         lblServerPort.setFont(fontIpPort);
94         lblServerPort.setOpaque(true);
95         lblServerPort.setBackground(Color.WHITE);
96         lblWelcome.setFont(fontWelcome);
97         add(lblWelcome, BorderLayout.NORTH);
98         txtServerPort.setFont(fontIpPort);
99         lblServerRunning.setFont(fontInfo);
100     }
101     /**
102      * Method that shows the user that the server is running.
103      */
104     public void setServerRunning() {
105         remove(br.getLayoutComponent(BorderLayout.CENTER));
106         add(lblServerRunning, BorderLayout.CENTER);
107         lblServerRunning.setHorizontalAlignment(JLabel.CENTER);
108         validate();
109         repaint();
110     }
111     /**
112      * Initiate Listeners.
113      */
114     public void initListeners() {
115         CreateStopServerListener create = new
116             CreateStopServerListener();
117         EnterListener enter = new EnterListener();
118         btnServerCreateServer.addActionListener(create);
119         txtServerPort.addKeyListener(enter);
120     }
121     /**
122      * Sets the ip-label to the local ip of your own computer.
123      */
124     public void setlblServerShowServerIp() {
125         try {
126             String message = ""+ InetAddress.getLocalHost();
127             String realmessage[] = message.split("/");
128             lblServerShowServerIp.setText("Server ip is: " +
129                 realmessage[1]);
130         } catch (UnknownHostException e) {
131             JOptionPane.showMessageDialog(null, "An error
132                 occurred.");
133         }
134     }
135     /**
136      * Main method for create a server-frame.
```

```
137     * @param args
138     */
139     public static void main(String[] args) {
140         StartServer server = new StartServer();
141         JFrame frame = new JFrame("bIRC Server");
142         frame.setDefaultCloseOperation(JFrame.DISPOSE_ON_CLOSE);
143         frame.add(server);
144         frame.pack();
145         frame.setVisible(true);
146         frame.setLocationRelativeTo(null);
147         frame.setResizable(false);
148     }
149
150     /**
151     * Returns the port from the textfield.
152     *
153     * @return Port for creating a server.
154     */
155     public int getPort() {
156         return Integer.parseInt(this.txtServerPort.getText());
157     }
158
159     /**
160     * Set the "Look and Feel".
161     */
162     public void lookAndFeel() {
163         try {
164             UIManager.setLookAndFeel(UIManager.
165                 getSystemLookAndFeelClassName());
166         } catch (ClassNotFoundException e) {
167             e.printStackTrace();
168         } catch (InstantiationException e) {
169             e.printStackTrace();
170         } catch (IllegalAccessException e) {
171             e.printStackTrace();
172         } catch (UnsupportedLookAndFeelException e) {
173             e.printStackTrace();
174         }
175     }
176
177     /**
178     * Listener for create server. Starts a new server with the
179     * port of the textfield.
180     */
181     private class CreateStopServerListener implements
182         ActionListener {
183         public void actionPerformed(ActionEvent e) {
184             if (btnServerCreateServer==e.getSource()) {
185                 server = new Server(getPort());
186                 setServerRunning();
187             }
188         }
189     }
```

```
188     /**
189      * Enter Listener for creating a server.
190      */
191     private class EnterListener implements KeyListener {
192         public void keyPressed(KeyEvent e) {
193             if (e.getKeyCode() == KeyEvent.VK_ENTER) {
194                 server = new Server(getPort());
195                 setServerRunning();
196             }
197         }
198
199         public void keyReleased(KeyEvent arg0) {}
200
201         public void keyTyped(KeyEvent arg0) {}
202     }
203 }
```

Listing 2: StartServer

7.2 Klient

7.2.1 ChatWindow.java

```
1 package chat;
2
3 import java.awt.BorderLayout;
4 import java.awt.Color;
5
6 import javax.swing.*;
7 import javax.swing.text.*;
8
9 /**
10  * Class used to present content in the main window.
11  *
12  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
13  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
14  */
15 public class ChatWindow extends JPanel {
16     private int ID;
17     private JScrollPane scrollPane;
18     private JTextPane textPane;
19
20     private SimpleAttributeSet chatFont = new SimpleAttributeSet
21         ();
22     private SimpleAttributeSet nameFont = new SimpleAttributeSet
23         ();
24
25     /**
26      * Constructor that takes an ID from a Conversation, and
27      * creates a window to display it.
28      *
29      * @param ID The Conversation object's ID.
30      */
31 }
```

```
28 public ChatWindow(int ID) {
29     setLayout(new BorderLayout());
30     this.ID = ID;
31     textPane = new JTextPane();
32     scrollPane = new JScrollPane(textPane);
33
34     scrollPane.setVerticalScrollBarPolicy(JScrollPane.
35         VERTICAL_SCROLLBAR_AS_NEEDED);
36     scrollPane.setHorizontalScrollBarPolicy(JScrollPane.
37         HORIZONTAL_SCROLLBAR_NEVER);
38
39     StyleConstants.setForeground(chatFont, Color.BLACK);
40     StyleConstants.setFontSize(chatFont, 20);
41
42     StyleConstants.setForeground(nameFont, Color.BLACK);
43     StyleConstants.setFontSize(nameFont, 20);
44     StyleConstants.setBold(nameFont, true);
45
46     add(scrollPane, BorderLayout.CENTER);
47     textPane.setEditable(false);
48 }
49
50 /**
51  * Appends a new message into the panel window.
52  * The message can either contain a String or an ImageIcon.
53  *
54  * @param message The message object which content will be
55  * displayed.
56  */
57 public void append(final Message message) {
58     SwingUtilities.invokeLater(new Runnable() {
59         @Override
60         public void run() {
61             StyledDocument doc = textPane.getStyledDocument
62             ();
63             try {
64                 doc.insertString(doc.getLength(), message.
65                     getTimestamp() + " - ", chatFont);
66                 doc.insertString(doc.getLength(), message.
67                     getFromUserID() + ": ", nameFont);
68                 if (message.getContent() instanceof String)
69                 {
70                     doc.insertString(doc.getLength(), (
71                         String)message.getContent(), chatFont
72                     );
73                 } else {
74                     ImageIcon icon = (ImageIcon)message.
75                         getContent();
76                     StyleContext context = new StyleContext
77                     ();
78                     Style labelStyle = context.getStyle(
79                         StyleContext.DEFAULT_STYLE);
80                     JLabel label = new JLabel(icon);
```

```

69         StyleConstants.setComponent(labelStyle ,
70             label);
71         doc.insertString(doc.getLength(), "
72             Ignored", labelStyle);
73     }
74     doc.insertString(doc.getLength(), "\n",
75         chatFont);
76     textPane.setCaretPosition(textPane.
77         getDocument().getLength());
78     } catch (BadLocationException e) {
79         e.printStackTrace();
80     }
81 }
82
83 /**
84  * Appends a string into the panel window.
85  *
86  * @param stringMessage The string to be appended.
87  */
88 public void append(String stringMessage) {
89     StyledDocument doc = textPane.getStyledDocument();
90     try {
91         doc.insertString(doc.getLength(), "[Server: " +
92             stringMessage + "\n", chatFont);
93     } catch (BadLocationException e) {
94         e.printStackTrace();
95     }
96 }
97
98 /**
99  * Returns the ChatWindow's ID.
100  *
101  * @return The ChatWindow's ID.
102  */
103 public int getID() {
104     return ID;
105 }

```

Listing 3: ChatWindow

7.2.2 Client.java

```

1 package chat;
2
3 import java.io.IOException;
4 import java.io.ObjectInputStream;
5 import java.io.ObjectOutputStream;
6 import java.net.Socket;

```

```
7 import java.net.SocketTimeoutException;
8 import java.util.ArrayList;
9
10 import javax.swing.JOptionPane;
11
12 /**
13  * Model class for the client.
14  *
15  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
16  * @author Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
17  */
18
19 public class Client {
20     private Socket socket;
21     private ClientController controller;
22     private ObjectInputStream ois;
23     private ObjectOutputStream oos;
24     private User user;
25     private String name;
26
27
28     /**
29      * Constructor that creates a new Client with given ip, port
30      * and user name.
31      *
32      * @param ip The IP address to connect to.
33      * @param port Port used in the connection.
34      * @param name The user name to connect with.
35      */
36     public Client(String ip, int port, String name) {
37         this.name = name;
38         try {
39             socket = new Socket(ip, port);
40             ois = new ObjectInputStream(socket.getInputStream());
41             ;
42             oos = new ObjectOutputStream(socket.getOutputStream());
43             controller = new ClientController(this);
44             new ClientListener().start();
45         } catch (IOException e) {
46             System.err.println(e);
47             if (e.getCause() instanceof SocketTimeoutException)
48                 {
49
50                 }
51         }
52     }
53
54     /**
55      * Sends an object object to the server.
56      *
57      * @param object The object that should be sent to the
58      * server.
59      */
60 }
```



```
56     public void sendObject(Object object) {
57         try {
58             oos.writeObject(object);
59             oos.flush();
60         } catch (IOException e) {}
61     }
62
63     /**
64      * Sets the client user by creating a new User object with
65      * given name.
66      *
67      * @param name The name of the user to be created.
68      */
69     public void setName(String name) {
70         user = new User(name);
71     }
72
73     /**
74      * Returns the clients User object.
75      *
76      * @return The clients User object.
77      */
78     public User getUser() {
79         return user;
80     }
81
82     /**
83      * Closes the clients socket.
84      */
85     public void disconnectClient() {
86         try {
87             socket.close();
88         } catch (Exception e) {}
89     }
90
91     /**
92      * Sends the users conversations to the controller to be
93      * displayed in the UI.
94      */
95     public void initConversations() {
96         for (Conversation con : user.getConversations()) {
97             controller.newConversation(con);
98         }
99     }
100
101     /**
102      * Asks for a username, creates a User object with given
103      * name and sends it to the server.
104      * The server then either accepts or denies the User object.
105      * If successful, sets the received User object as current
106      * user and announces login in chat.
107      * If not, notifies in chat and requests a new name.
108      */
109     public synchronized void setUser() {
```

```
106     Object object = null;
107     setName(this.name);
108     while (!(object instanceof User)) {
109         try {
110             sendObject(user);
111             object = ois.readObject();
112             if (object instanceof User) {
113                 user = (User) object;
114                 controller.newMessage("You logged in as " +
115                                     user.getId());
116                 initConversations();
117             } else {
118                 controller.newMessage(object);
119                 this.name = JOptionPane.showInputDialog("
120                                                         Pick a name: ");
121                 setName(this.name);
122             }
123         } catch (IOException e) {
124             e.printStackTrace();
125         } catch (ClassNotFoundException e2) {
126             e2.printStackTrace();
127         }
128     }
129 }
130
131 /**
132  * Listens to incoming Messages, user lists, Conversations
133  * or server messages, and deal with them accordingly.
134  */
135 public void startCommunication() {
136     Object object;
137     try {
138         while (!Thread.interrupted()) {
139             object = ois.readObject();
140             if (object instanceof Message) {
141                 controller.newMessage(object);
142             } else if (object instanceof ArrayList) {
143                 ArrayList<String> userList = (ArrayList<
144                                     String>) object;
145                 controller.setConnectedUsers(userList);
146             } else if (object instanceof Conversation) {
147                 Conversation con = (Conversation) object;
148                 user.addConversation(con);
149                 controller.newConversation(con);
150             } else {
151                 controller.newMessage(object);
152             }
153         }
154     } catch (IOException e) {
155         e.printStackTrace();
156     } catch (ClassNotFoundException e2) {
```

```
156         e2.printStackTrace();
157     }
158 }
159
160 /**
161  * Class to handle communication between client and server.
162  */
163 private class ClientListener extends Thread {
164     public void run() {
165         setUser();
166         startCommunication();
167     }
168 }
169 }
```

Listing 4: Client

7.2.3 ClientController.java

```
1 package chat;
2
3 import javax.swing.*;
4 import java.awt.*;
5 import java.awt.image.BufferedImage;
6 import java.util.ArrayList;
7 import java.util.HashSet;
8
9 /**
10  * Controller class to handle system logic between client and
11  * GUI.
12  *
13  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
14  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
15  */
16 public class ClientController {
17     private ClientUI ui = new ClientUI(this);
18     private Client client;
19
20     /**
21      * Creates a new Controller (with given Client).
22      * Also creates a new UI, and displays it in a JFrame.
23      *
24      * @param client
25      */
26     public ClientController(Client client) {
27         this.client = client;
28         SwingUtilities.invokeLater(new Runnable() {
29             public void run() {
30                 JFrame frame = new JFrame("bIRC");
31                 frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
32                 frame.add(ui);
```

```
32         frame.pack();
33         frame.setLocationRelativeTo(null);
34         frame.setVisible(true);
35         ui.focusTextField();
36     }
37     });
38 }
39
40 /**
41  * Receives an object that's either a Message object or a
42  * String
43  * and sends it to the UI.
44  * @param object A Message object or a String
45  */
46 public void newMessage(Object object) {
47     if (object instanceof Message) {
48         Message message = (Message) object;
49         ui.appendContent(message);
50     } else {
51         ui.appendServerMessage((String) object);
52     }
53 }
54
55 /**
56  * Returns the current user's ID.
57  *
58  * @return A string containing the current user's ID.
59  */
60 public String getUserID () {
61     return client.getUser().getId();
62 }
63
64 /**
65  * Creates a new message containing given ID and content,
66  * then sends it to the client.
67  *
68  * @param conID Conversation-ID of the message.
69  * @param content The message's content.
70  */
71 public void sendMessage(int conID, Object content) {
72     Message message = new Message(conID, client.getUser().
73         getId(), content);
74     client.sendObject(message);
75 }
76
77 /**
78  * Takes a conversation ID and String with URL to image,
79  * scales the image and sends it to the client.
80  *
81  * @param conID Conversation-ID of the image.
82  * @param url A string containing the URL to the image to be
83  * sent.
84  */
```

```
81     public void sendImage(int conID, String url) {
82         ImageIcon icon = new ImageIcon(url);
83         Image img = icon.getImage();
84         BufferedImage scaledImage = ImageScaleHandler.
            createScaledImage(img, 250);
85         icon = new ImageIcon(scaledImage);
86         sendMessage(conID, icon);
87     }
88
89
90     /**
91      * Creates a HashSet of given String array with participants
92      * , and sends it to the client.
93      *
94      * @param conversationParticipants A string array with
95      *   conversaion participants.
96      */
97     public void sendParticipants(String []
98         conversationParticipants) {
99         HashSet<String> setParticipants = new HashSet<>();
100         for(String participant: conversationParticipants) {
101             setParticipants.add(participant);
102         }
103         client.sendObject(setParticipants);
104     }
105
106     /**
107      * Sends the ArrayList with connected users to the UI.
108      *
109      * @param userList The ArrayList with connected users.
110      */
111     public void setConnectedUsers(ArrayList<String> userList) {
112         ui.setConnectedUsers(userList);
113     }
114
115     /**
116      * Presents a Conversation in the UI.
117      *
118      * @param con The Conversation object to be presented in the
119      *   UI.
120      */
121     public void newConversation(Conversation con) {
122         HashSet<String> users = con.getInvolvedUsers();
123         String [] usersHashToStringArray = users.toArray(new
124             String[users.size()]);
125         int conId = con.getId();
126         ui.createConversation(usersHashToStringArray, conId);
127         for (Message message : con.getConversationLog()) {
128             ui.appendContent(message);
129         }
130     }
131 }
```

Listing 5: ClientController

7.2.4 ClientUI.java

```
1 package chat;
2
3 import java.awt.BorderLayout;
4 import java.awt.Color;
5 import java.awt.Dimension;
6 import java.awt.FlowLayout;
7 import java.awt.Font;
8 import java.awt.GridLayout;
9 import java.awt.event.ActionEvent;
10 import java.awt.event.ActionListener;
11 import java.awt.event.KeyEvent;
12 import java.awt.event.KeyListener;
13 import java.io.File;
14 import java.util.ArrayList;
15
16 import javax.swing.ImageIcon;
17 import javax.swing.JButton;
18 import javax.swing.JCheckBox;
19 import javax.swing.JFileChooser;
20 import javax.swing.JFrame;
21 import javax.swing.JLabel;
22 import javax.swing.JOptionPane;
23 import javax.swing.JPanel;
24 import javax.swing.JScrollPane;
25 import javax.swing.JTextField;
26 import javax.swing.JTextPane;
27 import javax.swing.UIManager;
28 import javax.swing.UnsupportedLookAndFeelException;
29 import javax.swing.text.BadLocationException;
30 import javax.swing.text.DefaultCaret;
31 import javax.swing.text.SimpleAttributeSet;
32 import javax.swing.text.StyleConstants;
33 import javax.swing.text.StyledDocument;
34
35 /**
36  * Viewer class to handle the GUI.
37  *
38  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
39  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
40  */
41
42 public class ClientUI extends JPanel {
43     private JPanel southPanel = new JPanel();
44     private JPanel eastPanel = new JPanel();
45     private JPanel eastPanelCenter = new JPanel(new BorderLayout
46         ());
47     private JPanel eastPanelCenterNorth = new JPanel(new
48         FlowLayout());
49     private JPanel pnlGroupSend = new JPanel(new GridLayout
50         (1,2,8,8));
51     private JPanel pnlFileSend = new JPanel(new BorderLayout
52         (5,5));
```

```

49
50     private String userString = "";
51     private int activeChatWindow = -1;
52     private boolean createdGroup = false;
53
54     private JLabel lblUser = new JLabel();
55     private JButton btnSend = new JButton("Send");
56     private JButton btnNewGroupChat = new JButton();
57     private JButton btnLobby = new JButton("Lobby");
58     private JButton btnCreateGroup = new JButton("");
59     private JButton btnFileChooser = new JButton();
60
61     private JTextPane tpConnectedUsers = new JTextPane();
62     private ChatWindow cwLobby = new ChatWindow(-1);
63     private ClientController clientController;
64     private GroupPanel groupPanel;
65
66     private JTextField tfMessageWindow = new JTextField();
67     private BorderLayout bL = new BorderLayout();
68
69     private JScrollPane scrollConnectedUsers = new JScrollPane(
70         tpConnectedUsers);
71     private JScrollPane scrollChatWindow = new JScrollPane(
72         cwLobby);
73     private JScrollPane scrollGroupRooms = new JScrollPane(
74         eastPanelCenterNorth);
75
76     private JButton[] groupChatList = new JButton[20];
77     private ArrayList<JCheckBox> arrayListCheckBox = new
78         ArrayList<JCheckBox>();
79     private ArrayList<ChatWindow> arrayListChatWindows = new
80         ArrayList<ChatWindow>();
81
82     private Font txtFont = new Font("Sans-Serif", Font.BOLD ,
83         20);
84     private Font fontGroupButton = new Font("Sans-Serif",Font.
85         PLAIN, 12);
86     private Font fontButtons = new Font("Sans-Serif", Font.BOLD
87         ,15);
88     private SimpleAttributeSet chatFont = new SimpleAttributeSet
89         ();
90
91     public ClientUI(ClientController clientController) {
92         this.clientController = clientController;
93         arrayListChatWindows.add(cwLobby);
94         groupPanel = new GroupPanel();
95         groupPanel.start();
96         lookAndFeel();
97         initGraphics();
98         initListeners();
99     }
100
101     /**
102      * Initiates graphics and design.

```

```
94      * Also initiates the panels and buttons.
95      */
96      public void initGraphics() {
97          setLayout(bL);
98          setPreferredSize(new Dimension(900,600));
99          eastPanelCenterNorth.setPreferredSize(new Dimension
100              (130,260));
101          initScroll();
102          initButtons();
103          add(scrollChatWindow, BorderLayout.CENTER);
104          southPanel();
105          eastPanel();
106      }
107      /**
108       * Initiates the buttons.
109       * Also sets the icons and the design of the buttons.
110       */
111      public void initButtons() {
112          btnNewGroupChat.setIcon(new ImageIcon("src/resources/
113              newGroup.png"));
114          btnNewGroupChat.setBorder(null);
115          btnNewGroupChat.setPreferredSize(new Dimension(64,64));
116
117          btnFileChooser.setIcon(new ImageIcon("src/resources/
118              newImage.png"));
119          btnFileChooser.setBorder(null);
120          btnFileChooser.setPreferredSize(new Dimension(64, 64));
121
122          btnLobby.setFont(fontButtons);
123          btnLobby.setForeground(new Color(1,48,69));
124          btnLobby.setBackground(new Color(201,201,201));
125          btnLobby.setOpaque(true);
126          btnLobby.setBorderPainted(false);
127
128          btnCreateGroup.setFont(fontButtons);
129          btnCreateGroup.setForeground(new Color(1,48,69));
130      }
131      /**
132       * Initiates the scrollpanes and styleconstants.
133       */
134      public void initScroll() {
135          scrollChatWindow.setVerticalScrollBarPolicy(JScrollPane.
136              VERTICAL_SCROLLBAR_AS_NEEDED);
137          scrollChatWindow.setHorizontalScrollBarPolicy(
138              JScrollPane.HORIZONTAL_SCROLLBAR_NEVER);
139          scrollConnectedUsers.setVerticalScrollBarPolicy(
140              JScrollPane.VERTICAL_SCROLLBAR_AS_NEEDED);
141          scrollConnectedUsers.setHorizontalScrollBarPolicy(
142              JScrollPane.HORIZONTAL_SCROLLBAR_NEVER);
143          DefaultCaret caretConnected = (DefaultCaret)
144              tpConnectedUsers.getCaret();
```



```
139         caretConnected.setUpdatePolicy(DefaultCaret.  
140             ALWAYS_UPDATE);  
141         tpConnectedUsers.setEditable(false);  
142  
143         tfMessageWindow.setFont(txtFont);  
144         StyleConstants.setForeground(chatFont, Color.BLACK);  
145         StyleConstants.setBold(chatFont, true);  
146     }  
147  
148     /**  
149     * Requests that tfMessageWindow gets focus.  
150     */  
151     public void focusTextField() {  
152         tfMessageWindow.requestFocusInWindow();  
153     }  
154  
155     /**  
156     * Initialises listeners.  
157     */  
158     public void initListeners() {  
159         tfMessageWindow.addKeyListener(new EnterListener());  
160         GroupListener groupListener = new GroupListener();  
161         SendListener sendListener = new SendListener();  
162         LobbyListener disconnectListener = new LobbyListener();  
163         btnNewGroupChat.addActionListener(groupListener);  
164         btnCreateGroup.addActionListener(groupListener);  
165         btnLobby.addActionListener(disconnectListener);  
166         btnFileChooser.addActionListener(new FileChooserListener  
167             ());  
168         btnSend.addActionListener(sendListener);  
169     }  
170  
171     /**  
172     * The method takes a ArrayList of the connected users and  
173     * sets the user-checkboxes and  
174     * the connected user textpane based on the users in the  
175     * ArrayList.  
176     *  
177     * @param connectedUsers The ArrayList of the connected  
178     * users.  
179     */  
180     public void setConnectedUsers(ArrayList<String>  
181         connectedUsers) {  
182         setUserText();  
183         tpConnectedUsers.setText("");  
184         updateCheckBoxes(connectedUsers);  
185         for (String ID : connectedUsers) {  
186             appendConnectedUsers(ID);  
187         }  
188     }  
189  
190     /**  
191     * Sets the usertext in the labels to the connected user.  
192     */
```

```
187     public void setUserText() {
188         lblUser.setText(clientController.getUserID());
189         lblUser.setFont(txtFont);
190     }
191
192     /**
193      * The south panel in the ClientUI BorderLayout.SOUTH.
194      */
195     public void southPanel() {
196         southPanel.setLayout(new BorderLayout());
197         southPanel.add(tfMessageWindow, BorderLayout.CENTER);
198         southPanel.setPreferredSize(new Dimension(600, 50));
199
200         btnSend.setPreferredSize(new Dimension(134, 40));
201         btnSend.setFont(fontButtons);
202         btnSend.setForeground(new Color(1, 48, 69));
203         southPanel.add(pnlFileSend, BorderLayout.EAST);
204
205         pnlFileSend.add(btnFileChooser, BorderLayout.WEST);
206         pnlFileSend.add(btnSend, BorderLayout.CENTER);
207
208         add(southPanel, BorderLayout.SOUTH);
209     }
210
211     /**
212      * The east panel in ClientUI BorderLayout.EAST.
213      */
214     public void eastPanel() {
215         eastPanel.setLayout(new BorderLayout());
216         eastPanel.add(lblUser, BorderLayout.NORTH);
217         eastPanel.add(eastPanelCenter, BorderLayout.CENTER);
218         eastPanelCenterNorth.add(pnlGroupSend);
219         eastPanelCenter.add(scrollGroupRooms, BorderLayout.NORTH);
220         eastPanelCenter.add(scrollConnectedUsers, BorderLayout.CENTER);
221
222         pnlGroupSend.add(btnNewGroupChat);
223
224         eastPanel.add(btnLobby, BorderLayout.SOUTH);
225         add(eastPanel, BorderLayout.EAST);
226     }
227
228     /**
229      * Appends the message to the chatwindow object with the ID
230      * of the message object.
231      *
232      * @param message The message object with an ID and a
233      * message.
234      */
235     public void appendContent(Message message) {
236
```

```
237         getChatWindow(message.getConversationID()).append(  
238             message);  
239         if(activeChatWindow != message.getConversationID()) {  
240             highlightGroup(message.getConversationID());  
241         }  
242     }  
243     /**  
244     * The method handles notice.  
245     *  
246     * @param ID The ID of the group.  
247     */  
248     public void highlightGroup(int ID) {  
249         if(ID != -1)  
250             groupChatList[ID].setBackground(Color.PINK);  
251     }  
252     /**  
253     * Appends the string content in the chatwindow-lobby.  
254     *  
255     * @param content Is a server message  
256     */  
257     public void appendServerMessage(String content) {  
258         cwLobby.append(content.toString());  
259     }  
260     /**  
261     * The method updates the ArrayList of checkboxes and add  
262     * the checkboxes to the panel.  
263     * Also checks if the ID is your own ID and doesn't add a  
264     * checkbox of yourself.  
265     * Updates the UI.  
266     *  
267     * @param checkBoxUserIDs ArrayList of UserID's.  
268     */  
269     public void updateCheckBoxes(ArrayList<String>  
270         checkBoxUserIDs) {  
271         arrayListCheckBox.clear();  
272         groupPanel.pnlNewGroup.removeAll();  
273         for (String ID : checkBoxUserIDs) {  
274             if (!ID.equals(clientController.getUserID())) {  
275                 arrayListCheckBox.add(new JCheckBox(ID));  
276             }  
277         }  
278         for (JCheckBox box: arrayListCheckBox) {  
279             groupPanel.pnlNewGroup.add(box);  
280         }  
281         groupPanel.pnlOuterBorderLayout.revalidate();  
282     }  
283     /**  
284     * The method appends the text in the textpane of the  
285     * connected users.  
286     */
```

```

286     * @param message Is a username.
287     */
288     public void appendConnectedUsers(String message){
289         StyledDocument doc = tpConnectedUsers.getStyledDocument
290             ();
291         try {
292             doc.insertString(doc.getLength(), message + "\n",
293                 chatFont);
294         } catch (BadLocationException e) {
295             e.printStackTrace();
296         }
297     }
298
299     /**
300     * Sets the text on the groupbuttons to the users you check
301     * in the checkbox.
302     * Adds the new group chat connected with a button and a
303     * ChatWindow.
304     * Enables you to change rooms.
305     * Updates UI.
306     *
307     * @param participants String-Array of the participants of
308     * the new groupchat.
309     * @param ID The ID of the participants of the new groupchat
310     * .
311     */
312     public void createConversation(String[] participants, int ID
313     ) {
314         GroupButtonListener gbListener = new GroupButtonListener
315         ();
316         for (int i = 0; i < participants.length; i++) {
317             if (!(participants[i].equals(clientController.
318                 getUserID()))) {
319                 if (i == participants.length - 1) {
320                     userString += participants[i];
321                 } else {
322                     userString += participants[i] + " ";
323                 }
324             }
325         }
326         if (ID < groupChatList.length && groupChatList[ID] ==
327             null) {
328             groupChatList[ID] = (new JButton(userString));
329             groupChatList[ID].setPreferredSize(new Dimension
330                 (120,30));
331             groupChatList[ID].setOpaque(true);
332             groupChatList[ID].setBorderPainted(false);
333             groupChatList[ID].setFont(fontGroupButton);
334             groupChatList[ID].setForeground(new Color(93,0,0));
335             groupChatList[ID].addActionListener(gbListener);
336
337             eastPanelCenterNorth.add(groupChatList[ID]);
338
339             if (getChatWindow(ID)==null) {

```

```

329         arrayListChatWindows.add(new ChatWindow(ID));
330     }
331
332     eastPanelCenterNorth.revalidate();
333     if (createdGroup) {
334         if (activeChatWindow == -1) {
335             btnLobby.setBackground(null);
336         }
337         else {
338             groupChatList[activeChatWindow].
                setBackground(null);
339         }
340
341         groupChatList[ID].setBackground(new Color
            (201,201,201));
342         remove(bL.getLayoutComponent(BorderLayout.CENTER
            ));
343         add(getChatWindow(ID), BorderLayout.CENTER);
344         activeChatWindow = ID;
345         validate();
346         repaint();
347         createdGroup = false;
348     }
349 }
350 this.userString = "";
351 }
352
353 /**
354  * Sets the "Look and Feel" of the panels.
355  */
356 public void lookAndFeel() {
357     try {
358         UIManager.setLookAndFeel(UIManager.
            getSystemLookAndFeelClassName());
359     } catch (ClassNotFoundException e) {
360         e.printStackTrace();
361     } catch (InstantiationException e) {
362         e.printStackTrace();
363     } catch (IllegalAccessException e) {
364         e.printStackTrace();
365     } catch (UnsupportedLookAndFeelException e) {
366         e.printStackTrace();
367     }
368 }
369
370 /**
371  * The method goes through the ArrayList of chatwindow
372  * object and
373  * returns the correct one based on the ID.
374  *
375  * @param ID The ID of the user.
376  * @return ChatWindow A ChatWindow object with the correct
377  * ID.
378  */

```

```
377     public ChatWindow getChatWindow(int ID) {
378         for(ChatWindow cw : arrayListChatWindows) {
379             if(cw.getID() == ID) {
380                 return cw;
381             }
382         }
383         return null;
384     }
385
386     /**
387      * The class extends Thread and handles the Create a group
388      * panel.
389      */
390     private class GroupPanel extends Thread {
391         private JFrame groupFrame;
392         private JPanel pnlOuterBorderLayout = new JPanel(new
393             BorderLayout());
394         private JPanel pnlNewGroup = new JPanel();
395         private JScrollPane scrollCheckConnectedUsers = new
396             JScrollPane(pnlNewGroup);
397
398         /**
399          * The metod returns the JFrame groupFrame.
400          * @return groupFrame
401          */
402         public JFrame getFrame() {
403             return groupFrame;
404         }
405
406         /**
407          * Runs the frames of the groupPanes.
408          */
409         public void run() {
410             panelBuilder();
411             groupFrame = new JFrame();
412             groupFrame.setDefaultCloseOperation(JFrame.
413                 DISPOSE_ON_CLOSE);
414             groupFrame.add(pnlOuterBorderLayout);
415             groupFrame.pack();
416             groupFrame.setVisible(false);
417             groupFrame.setLocationRelativeTo(null);
418         }
419
420         /**
421          * Initiates the scrollpanels and the panels of the
422          * groupPanel.
423          */
424         public void panelBuilder() {
425             scrollCheckConnectedUsers.setVerticalScrollBarPolicy
426                 (JScrollPane.VERTICAL_SCROLLBAR_AS_NEEDED);
427             scrollCheckConnectedUsers.
428                 setHorizontalScrollBarPolicy(JScrollPane.
429                     HORIZONTAL_SCROLLBAR_NEVER);
```

```
423         btnCreateGroup.setText("New Conversation");
424         pnlOuterBorderLayout.add(btnCreateGroup,
425             BorderLayout.SOUTH);
426         pnlOuterBorderLayout.add(scrollCheckConnectedUsers,
427             BorderLayout.CENTER);
428         scrollCheckConnectedUsers.setPreferredSize(new
429             Dimension(200,500));
430         pnlNewGroup.setLayout(new GridLayout(100,1,5,5));
431     }
432 }
433
434 /**
435  * KeyListener for the messagewindow.
436  * Enables you to send a message with enter.
437  */
438 private class EnterListener implements KeyListener {
439     public void keyPressed(KeyEvent e) {
440         if (e.getKeyCode() == KeyEvent.VK_ENTER && !(
441             tfMessageWindow.getText().isEmpty())) {
442             clientController.sendMessage(
443                 activeChatWindow, tfMessageWindow.getText(
444                     ));
445             tfMessageWindow.setText("");
446         }
447     }
448     public void keyReleased(KeyEvent e) {}
449     public void keyTyped(KeyEvent e) {}
450 }
451
452 /**
453  * Listener that listens to New Group Chat-button and the
454  * Create Group Chat-button.
455  * If create group is pressed, a new button will be created
456  * with the right name,
457  * the right participants.
458  * The method use alot of ArrayLists of checkboxes,
459  * participants and strings.
460  * Also some error-handling with empty buttons.
461  */
462 private class GroupListener implements ActionListener {
463     private ArrayList<String> participants = new ArrayList<
464         String>();
465     private String[] temp;
466     public void actionPerformed(ActionEvent e) {
467         if (btnNewGroupChat == e.getSource() &&
468             arrayListCheckBox.size() > 0) {
469             groupPanel.getFrame().setVisible(true);
470         }
471         if (btnCreateGroup == e.getSource()) {
472             participants.clear();
473             temp = null;
474         }
475     }
476 }
```

```

465         for (int i = 0; i < arrayListCheckBox.size(); i
466             ++ ) {
467             if (arrayListCheckBox.get(i).isSelected()) {
468                 participants.add(arrayListCheckBox.get(i)
469                     .getText());
470             }
471         }
472
473         temp = new String[participants.size() + 1];
474         temp[0] = clientController.getUserID();
475         for (int i = 1; i <= participants.size(); i++) {
476             temp[i] = participants.get(i-1);
477         }
478         if (temp.length > 1) {
479             clientController.sendParticipants(temp);
480             groupPanel.getFrame().dispose();
481             createdGroup = true;
482         } else {
483             JOptionPane.showMessageDialog(null, "You
484                 have to choose atleast one person!");
485         }
486     }
487 }
488
489 /**
490  * Listener that connects the right GroupChatButton in an
491  * ArrayList to the right
492  * active chat window.
493  * Updates the UI.
494  */
495 private class GroupButtonListener implements ActionListener
496 {
497     public void actionPerformed(ActionEvent e) {
498         for (int i = 0; i < groupChatList.length; i++) {
499             if (groupChatList[i] == e.getSource()) {
500                 if (activeChatWindow == -1) {
501                     btnLobby.setBackground(null);
502                 }
503                 else {
504                     groupChatList[activeChatWindow].
505                         setBackground(null);
506                 }
507                 groupChatList[i].setBackground(new Color
508                     (201,201,201));
509                 remove(bL.getLayoutComponent(BorderLayout.
510                     CENTER));
511                 add(getChatWindow(i), BorderLayout.CENTER);
512                 activeChatWindow = i;
513                 validate();
514                 repaint();
515             }
516         }
517     }
518 }

```



```
511     }
512
513     /**
514     * Listener that connects the user with the lobby chatWindow
515     * through the Lobby button.
516     * Updates UI.
517     */
518     private class LobbyListener implements ActionListener {
519         public void actionPerformed(ActionEvent e) {
520             if (btnLobby==e.getSource()) {
521                 btnLobby.setBackground(new Color(201,201,201));
522                 if(activeChatWindow != -1)
523                     groupChatList[activeChatWindow].
524                         setBackground(null);
525                 remove(bL.getLayoutComponent(BorderLayout.CENTER
526                     ));
527                 add(getChatWindow(-1), BorderLayout.CENTER);
528                 activeChatWindow = -1;
529                 invalidate();
530                 repaint();
531             }
532         }
533     }
534
535     /**
536     * Listener that creates a JFileChooser when the button
537     * btnFileChooser is pressed.
538     * The JFileChooser is for images in the chat and it calls
539     * the method sendImage in the controller.
540     */
541     private class FileChooserListener implements ActionListener
542     {
543         public void actionPerformed(ActionEvent e) {
544             if (btnFileChooser==e.getSource()) {
545                 JFileChooser fileChooser = new JFileChooser();
546                 int returnValue = fileChooser.showOpenDialog(
547                     null);
548                 if (returnValue == JFileChooser.APPROVE_OPTION)
549                 {
550                     File selectedFile = fileChooser.
551                         getSelectedFile();
552                     String fullPath = selectedFile.
553                         getAbsolutePath();
554                     clientController.sendImage(activeChatWindow ,
555                         fullPath);
556                 }
557             }
558         }
559     }
560
561     /**
562     * Listener for the send message button.
563     * Resets the message textfield text.
564     */
```

```
554     private class SendListener implements ActionListener {
555         public void actionPerformed(ActionEvent e) {
556             if (btnSend==e.getSource() && !(tfMessageWindow.
                    getText().isEmpty())) {
557
558                 clientController.sendMessage(
                    activeChatWindow, tfMessageWindow.getText
                    ());
559                 tfMessageWindow.setText("");
560             }
561         }
562     }
563 }
```

Listing 6: ClientUI

7.2.5 ImageScaleHandler.java

```
1 package chat;
2
3 import java.awt.Graphics2D;
4 import java.awt.Image;
5 import java.awt.image.BufferedImage;
6
7 import javax.swing.ImageIcon;
8 import javax.swing.JFrame;
9 import javax.swing.JLabel;
10 import javax.swing.JPanel;
11
12 import org.imgscalr.Scalr;
13 import org.imgscalr.Scalr.Method;
14
15 /**
16  * Scales down images to preferred size.
17  *
18  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
19  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
20  */
21 public class ImageScaleHandler {
22
23     private static BufferedImage toBufferedImage(Image img) {
24         if (img instanceof BufferedImage) {
25             return (BufferedImage) img;
26         }
27         BufferedImage bimage = new BufferedImage(img.getWidth(
28             null),
29             img.getHeight(null), BufferedImage.TYPE_INT_ARGB
30             );
31         Graphics2D bGr = bimage.createGraphics();
32         bGr.drawImage(img, 0, 0, null);
33         bGr.dispose();
34         return bimage;
35     }
36 }
```

```
33     }
34
35     public static BufferedImage createScaledImage(Image img, int
        height) {
36         BufferedImage bimage = toBufferedImage(img);
37         bimage = Scalr.resize(bimage, Method.ULTRA_QUALITY,
38             Scalr.Mode.FIT_TO_HEIGHT, 0, height);
39         return bimage;
40     }
41
42     // Example
43     public static void main(String[] args) {
44         ImageIcon icon = new ImageIcon("src/filer/new1.jpg");
45         Image img = icon.getImage();
46
47         // Use this to scale images
48         BufferedImage scaledImage = ImageScaleHandler.
            createScaledImage(img, 75);
49         icon = new ImageIcon(scaledImage);
50
51         JLabel lbl = new JLabel();
52         lbl.setIcon(icon);
53         JPanel panel = new JPanel();
54         panel.add(lbl);
55         JFrame frame = new JFrame();
56         frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
57         frame.add(panel);
58         frame.pack();
59         frame.setVisible(true);
60     }
61 }
```

Listing 7: ImageScaleHandler

7.2.6 StartClient.java

```
1 package chat;
2
3 import java.awt.BorderLayout;
4 import java.awt.Color;
5 import java.awt.Dimension;
6 import java.awt.FlowLayout;
7 import java.awt.Font;
8 import java.awt.GridLayout;
9 import java.awt.event.ActionEvent;
10 import java.awt.event.ActionListener;
11
12 import javax.swing.*;
13
14 /**
15  * Log in UI and start-class for the chat.
16  */
```

```
17  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
18  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson.
19  */
20  public class StartClient extends JPanel {
21      private JLabel lblIp = new JLabel("IP:");
22      private JLabel lblPort = new JLabel("Port:");
23      private JLabel lblWelcomeText = new JLabel("Log in to bIRC")
24      ;
25      private JLabel lblUserName = new JLabel("Username:");
26
27      private JTextField txtIp = new JTextField("localhost");
28      private JTextField txtPort = new JTextField("3450");
29      private JTextField txtUserName = new JTextField();
30
31      private JButton btnLogIn = new JButton("Login");
32      private JButton btnCancel = new JButton("Cancel");
33
34      private Font fontWelcome = new Font("Sans-Serif",Font.BOLD
35      ,25);
36      private Font fontIpPort = new Font("Sans-Serif",Font.PLAIN
37      ,17);
38      private Font fontButtons = new Font("Sans-Serif",Font.BOLD
39      ,15);
40      private Font fontUserName = new Font("Sans-Serif",Font.BOLD
41      ,17);
42
43      private JPanel pnlCenterGrid = new JPanel(new GridLayout
44      (3,2,5,5));
45      private JPanel pnlCenterFlow = new JPanel(new FlowLayout());
46      private JPanel pnlNorthGrid = new JPanel(new GridLayout
47      (2,1,5,5));
48      private JPanel pnlNorthGridGrid = new JPanel(new GridLayout
49      (1,2,5,5));
50
51      private JFrame frame;
52
53      public StartClient() {
54          setLayout(new BorderLayout());
55          initPanels();
56          lookAndFeel();
57          initGraphics();
58          initButtons();
59          initListeners();
60          frame = new JFrame("bIRC Login");
61          frame.setDefaultCloseOperation(JFrame.DISPOSE_ON_CLOSE);
62          frame.add(this);
63          frame.pack();
64          frame.setVisible(true);
65          frame.setLocationRelativeTo(null);
66          frame.setResizable(false);
67      }
68
69      /**
70       * Initiates the listeners.
```

```
63      */
64      public void initListeners() {
65          LogInMenuListener log = new LogInMenuListener();
66          btnLogIn.addActionListener(log);
67          txtUserName.addActionListener(new EnterListener());
68          btnCancel.addActionListener(log);
69      }
70
71      /**
72       * Initiates the panels.
73       */
74      public void initPanels(){
75          setPreferredSize(new Dimension(400, 180));
76          pnlCenterGrid.setBounds(100, 200, 200, 50);
77          add(pnlCenterFlow, BorderLayout.CENTER);
78          pnlCenterFlow.add(pnlCenterGrid);
79
80          add(pnlNorthGrid, BorderLayout.NORTH);
81          pnlNorthGrid.add(lblWelcomeText);
82          pnlNorthGrid.add(pnlNorthGridGrid);
83          pnlNorthGridGrid.add(lblUserName);
84          pnlNorthGridGrid.add(txtUserName);
85
86          lblUserName.setHorizontalAlignment(JLabel.CENTER);
87          lblUserName.setFont(fontIpPort);
88          lblWelcomeText.setHorizontalAlignment(JLabel.CENTER);
89          lblWelcomeText.setFont(fontWelcome);
90          lblIp.setFont(fontIpPort);
91          lblPort.setFont(fontIpPort);
92      }
93
94      /**
95       * Initiates the buttons.
96       */
97      public void initButtons() {
98          btnCancel.setFont(fontButtons);
99          btnLogIn.setFont(fontButtons);
100
101          pnlCenterGrid.add(lblIp);
102          pnlCenterGrid.add(txtIp);
103          pnlCenterGrid.add(lblPort);
104          pnlCenterGrid.add(txtPort);
105          pnlCenterGrid.add(btnLogIn);
106          pnlCenterGrid.add(btnCancel);
107      }
108
109      /**
110       * Initiates the graphics and some design.
111       */
112      public void initGraphics() {
113          pnlCenterGrid.setOpaque(false);
114          pnlCenterFlow.setOpaque(false);
115          pnlNorthGridGrid.setOpaque(false);
116          pnlNorthGrid.setOpaque(false);
```

```

117         setBackground( Color .WHITE);
118         lblUserName.setBackground( Color .WHITE);
119         lblUserName.setOpaque( false );
120
121         btnLogIn.setForeground( new Color (41,1,129));
122         btnCancel.setForeground( new Color (41,1,129));
123
124         txtIp.setFont( fontIpPort );
125         txtPort.setFont( fontIpPort );
126         txtUserName.setFont( fontUserName );
127     }
128
129     /**
130     * Sets the "Look and Feel" of the JComponents.
131     */
132     public void lookAndFeel() {
133         try {
134             UIManager.setLookAndFeel( UIManager.
135                                     getSystemLookAndFeelClassName());
136         } catch (ClassNotFoundException e) {
137             e.printStackTrace();
138         } catch (InstantiationException e) {
139             e.printStackTrace();
140         } catch (IllegalAccessException e) {
141             e.printStackTrace();
142         } catch (UnsupportedLookAndFeelException e) {
143             e.printStackTrace();
144         }
145     }
146
147     /**
148     * Main method for the login-frame.
149     */
150     public static void main(String[] args) {
151         SwingUtilities.invokeLater( new Runnable() {
152             @Override
153             public void run() {
154                 StartClient ui = new StartClient();
155             }
156         });
157     }
158
159     /**
160     * Listener for login-button, create server-button and for
161     * the cancel-button.
162     * Also limits the username to a 10 char max.
163     */
164     private class LogInMenuListener implements ActionListener {
165         public void actionPerformed( ActionEvent e ) {
166             if ( btnLogIn == e.getSource() ) {
167                 if ( txtUserName.getText().length() <= 10 ) {
168                     new Client( txtIp.getText(), Integer.
169                             parseInt( txtPort.getText() ),

```

```
168         txtUserName.getText());
169     } else {
170         JOptionPane.showMessageDialog(null, "Namnet
171         får max vara 10 karaktärer!");
172         txtUserName.setText("");
173     }
174     if (btnCancel==e.getSource()) {
175         System.exit(0);
176     }
177 }
178
179 /**
180  * Listener for the textField. Enables you to press enter
181  * instead of login.
182  * Also limits the username to 10 chars.
183  */
184 private class EnterListener implements ActionListener {
185     public void actionPerformed(ActionEvent e) {
186         if (txtUserName.getText().length() <= 10) {
187             new Client(txtIp.getText(), Integer.parseInt(
188                 txtPort.getText()), txtUserName.getText());
189             frame.dispose();
190         } else {
191             JOptionPane.showMessageDialog(null, "Namnet får
192             max vara 10 karaktärer!");
193             txtUserName.setText("");
194         }
195     }
196 }
```

Listing 8: LoginUI

7.3 Delade klasser

7.3.1 ChatLog

```
1 package chat;
2 import java.io.Serializable;
3 import java.util.Iterator;
4 import java.util.LinkedList;
5
6 /**
7  * Class to hold logged messages.
8  *
9  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
10  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
11  */
12
13 public class ChatLog implements Iterable<Message>, Serializable
14 {
```

```
14     private LinkedList<Message> list = new LinkedList<Message>()  
15     ;  
16     private static int MESSAGE_LIMIT = 30;  
17     private static final long serialVersionUID =  
18         13371337133732526L;  
19  
20     /**  
21     * Adds a new message to the chat log.  
22     *  
23     * @param message The message to be added.  
24     */  
25     public void add(Message message) {  
26         if(list.size() >= MESSAGE_LIMIT) {  
27             list.removeLast();  
28         }  
29         list.add(message);  
30     }  
31  
32     public Iterator<Message> iterator(){  
33         return list.iterator();  
34     }  
35 }
```

Listing 9: ChatLog

7.3.2 Message

```
1 package chat;  
2  
3 import java.io.Serializable;  
4 import java.text.SimpleDateFormat;  
5 import java.util.Date;  
6  
7 /**  
8  * Model class to handle messages  
9  *  
10  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,  
11  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson  
12  */  
13 public class Message implements Serializable {  
14     private String fromUserID;  
15     private Object content;  
16     private String timestamp;  
17     private int conversationID = -1;    /* -1 means it's a lobby  
18         message */  
19     private static final long serialVersionUID = 133713371337L;  
20  
21     /**  
22     * Constructor that creates a new message with given  
23     * conversation ID, String with information who sent it,  
24     * and its content.  
25     */  
26     public Message(int conversationID, String fromUserID, String content, String timestamp) {  
27         this.conversationID = conversationID;  
28         this.fromUserID = fromUserID;  
29         this.content = content;  
30         this.timestamp = timestamp;  
31     }  
32  
33     /**  
34     * Get the conversation ID  
35     */  
36     public int getConversationID() {  
37         return conversationID;  
38     }  
39  
40     /**  
41     * Get the fromUserID  
42     */  
43     public String getFromUserID() {  
44         return fromUserID;  
45     }  
46  
47     /**  
48     * Get the content  
49     */  
50     public Object getContent() {  
51         return content;  
52     }  
53  
54     /**  
55     * Get the timestamp  
56     */  
57     public String getTimestamp() {  
58         return timestamp;  
59     }  
60  
61     /**  
62     * Set the conversation ID  
63     */  
64     public void setConversationID(int conversationID) {  
65         this.conversationID = conversationID;  
66     }  
67  
68     /**  
69     * Set the fromUserID  
70     */  
71     public void setFromUserID(String fromUserID) {  
72         this.fromUserID = fromUserID;  
73     }  
74  
75     /**  
76     * Set the content  
77     */  
78     public void setContent(Object content) {  
79         this.content = content;  
80     }  
81  
82     /**  
83     * Set the timestamp  
84     */  
85     public void setTimestamp(String timestamp) {  
86         this.timestamp = timestamp;  
87     }  
88 }
```



```
22      *
23      * @param conversationID The conversation ID.
24      * @param fromUserID A string with information who sent the
25      *   message.
26      * @param content The message's content.
27      */
28      public Message(int conversationID, String fromUserID, Object
29      content) {
30          this.conversationID = conversationID;
31          this.fromUserID = fromUserID;
32          this.content = content;
33          newTime();
34      }
35
36      /**
37       * Creates a new timestamp for the message.
38       */
39      private void newTime() {
40          Date time = new Date();
41          SimpleDateFormat ft = new SimpleDateFormat("HH:mm:ss");
42          this.timestamp = ft.format(time);
43      }
44
45      /**
46       * Returns a string containing sender ID.
47       *
48       * @return A string with the sender ID.
49       */
50      public String getFromUserID() {
51          return fromUserID;
52      }
53
54      /**
55       * Returns an int with the conversation ID.
56       *
57       * @return An int with the conversation ID.
58       */
59      public int getConversationID() {
60          return conversationID;
61      }
62
63      /**
64       * Returns the message's timestamp.
65       *
66       * @return The message's timestamp.
67       */
68      public String getTimestamp() {
69          return this.timestamp;
70      }
71
72      /**
73       * Returns the message's content.
74       *
75       * @return The message's content.
```

```
74     */
75     public Object getContent() {
76         return content;
77     }
78 }
```

Listing 10: Message

7.3.3 User

```
1 package chat;
2
3 import java.io.Serializable;
4 import java.util.ArrayList;
5
6 /**
7  * Class to hold information of a user.
8  *
9  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
10  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
11  */
12 public class User implements Serializable {
13     private static final long serialVersionUID = 1273274782824L;
14     private ArrayList<Conversation> conversations;
15     private String id;
16
17     /**
18      * Constructor to create a User with given ID.
19      *
20      * @param id A string with the user ID.
21      */
22     public User(String id) {
23         this.id = id;
24         conversations = new ArrayList<>();
25     }
26
27     /**
28      * Returns an ArrayList with the user's conversations
29      *
30      * @return The user's conversations.
31      */
32     public ArrayList<Conversation> getConversations() {
33         return conversations;
34     }
35
36     /**
37      * Adds a new conversation to the user.
38      *
39      * @param conversation The conversation to be added.
40      */
41     public void addConversation(Conversation conversation) {
42         conversations.add(conversation);
43     }
44 }
```

```
43     }
44
45     /**
46      * Returns the user's ID.
47      *
48      * @return The user's ID.
49      */
50     public String getId() {
51         return id;
52     }
53 }
```

Listing 11: User

7.3.4 Conversation

```
1 package chat;
2
3 import java.io.Serializable;
4 import java.util.HashSet;
5
6 /**
7  * Class to hold information of a conversation.
8  *
9  * @author Emil Sandgren, Kalle Bornemark, Erik Sandgren,
10  * Jimmy Maksymiw, Lorenz Puskas & Rasmus Andersson
11  */
12 public class Conversation implements Serializable {
13     private HashSet<String> involvedUsers;
14     private ChatLog conversationLog;
15     private int id;
16     private static int numberOfConversations = 0;
17
18     /**
19      * Constructor that takes a HashSet of involved users.
20      *
21      * @param involvedUsersID The user ID's to be added to the
22      * conversation.
23      */
24     public Conversation(HashSet<String> involvedUsersID) {
25         this.involvedUsers = involvedUsersID;
26         this.conversationLog = new ChatLog();
27         id = ++numberOfConversations;
28     }
29
30     /**
31      * Returns a HashSet of the conversation's involved users.
32      *
33      * @return A hashSet of the conversation's involved users.
34      */
35     public HashSet<String> getInvolvedUsers() {
36         return involvedUsers;
37     }
38 }
```

```
36     }
37
38     /**
39      * Returns the conversation's ChatLog.
40      *
41      * @return The conversation's ChatLog.
42      */
43     public ChatLog getConversationLog() {
44         return conversationLog;
45     }
46
47     /**
48      * Adds a message to the conversation.
49      *
50      * @param message The message to be added.
51      */
52     public void addMessage(Message message) {
53         conversationLog.add(message);
54     }
55 }
56
57 /**
58  * Return the conversation's ID.
59  *
60  * @return The conversation's ID.
61  */
62     public int getId() {
63         return id;
64     }
65
66 }
```

Listing 12: Conversation