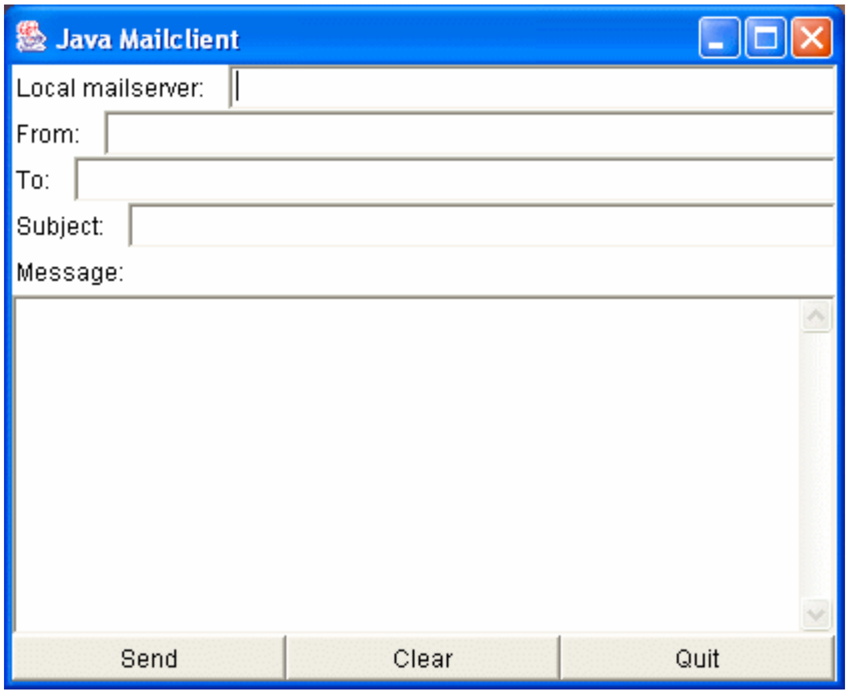
Project 2: A Mail User Agent (MUA)

Due April 8, 2014

Hand in: Electronic submission of entire project (source, compiled, excutable files, etc.) using 'Assignment' on Canvas. Please zip up your whole project directory and submit the zip file.

In this project you will implement a mail user agent that sends mail to other users. Your task is to program the SMTP interaction between the MUA and the local SMTP server. The client provides a graphical user interface containing fields for entering the sender and recipient addresses, the subject of the message and the message itself. Here's what the user interface looks like:



With this interface, when you want to send a mail, you must fill in complete addresses for both the sender and the recipient, i.e., user@someschool.edu, not just simply user. You can send mail to only one recipient. You will also need to give the name (or IP address) of your local mailserver. If you do not know the name of your local mailserver, see Querying the DNS below for more information on how to obtain the address of the local mailserver.

When you have finished composing your mail, press *Send* to send it.

The Code

The program consists of four classes:

MailClient	The user interface
Message	Mail message
Envelope	SMTP envelope around the Message
SMTPConnection	Connection to the SMTP server

You will need to complete the code in the SMTPConnection class so that in the end you will have a program that is capable of sending mail to any recipient. The code for the SMTPConnection class is at the end of this description. The code for the other three classes is provided also at the end of this description.

The places where you need to complete the code have been marked with the comments /* Fill in */. Each of the places requires one or more lines of code.

The MailClient class provides the user interface and calls the other classes as needed. When you press *Send*, the MailClient class constructs a Message class object to hold the mail message. The Message object holds the actual message headers and body. Then the MailClient object builds the SMTP envelope using the Envelope class. This class holds the SMTP sender and recipient information, the SMTP server of the recipient's domain, and the Message object. Then the MailClient object creates the SMTPConnection object which opens a connection to the SMTP server and the MailClient object sends the message over the connection. The sending of the mail happens in three phases:

1. The MailClient object creates the SMTPConnection object and opens the connection to the SMTP server.
2. The MailClient object sends the message using the function SMTPConnection.send().
3. The MailClient object closes the SMTP connection.

The Message class contains the function isValid() which is used to check the addresses of the sender and recipient to make sure that there is only one address and that the address contains the @-sign. The provided code does not do any other error checking.

Reply Codes

For the basic interaction of sending one message, you will only need to implement a part of SMTP. In this lab you need only to implement the following SMTP commands:

Command	**Reply Code**
DATA	354
HELO	250

MAIL FROM	250
QUIT	221
RCPT TO	250

The above table also lists the accepted reply codes for each of the SMTP commands you need to implement. For simplicity, you can assume that any other reply from the server indicates a fatal error and abort the sending of the message. In reality, SMTP distinguishes between transient (reply codes 4xx) and permanent (reply codes 5xx) errors, and the sender is allowed to repeat commands that yielded in a transient error. See RFC 821 (http://www.ietf.org/rfc/rfc0821.txt?number=821) for more details.

In addition, when you open a connection to the server, it will reply with the code 220.

Note: RFC 821 allows the code 251 as a response to a RCPT TO-command to indicate that the recipient is not a local user. You may want to verify manually with the telnet command what your local SMTP server replies.

Hints

Most of the code you will need to fill in is similar to the code you wrote in the WebServer lab. You may want to use the code you have written there to help you.

To make it easier to debug your program, do not, at first, include the code that opens the socket, but use the following definitions for fromServer and toServer. This way, your program sends the commands to the terminal. Acting as the SMTP server, you will need to give the correct reply codes. When your program works, add the code to open the socket to the server.

```
fromServer = new BufferedReader(new InputStreamReader(System.in));
toServer = System.out;
```

The lines for opening and closing the socket, i.e., the lines connection = ... in the constructor and the line connection.close() in function close(), have been commented out by default.

Start by completing the function parseReply(). You will need this function in many places. In the function parseReply(), you should use the StringTokenizer-class for parsing the reply strings. You can convert a string to an integer as follows:

```
int i = Integer.parseInt(argv[0]);
```

In the function sendCommand(), you should use the function writeBytes() to write the commands to the server. The advantage of using writeBytes() instead of write() is that the former automatically converts the strings to bytes which is what the server expects. Do not forget to terminate each command with the string CRLF.

You can throw exceptions like this:

```
throw new Exception();
```

You do not need to worry about details, since the exceptions in this lab are only used to signal an error, not to give detailed information about what went wrong.

Optional Exercises

You may want to try the following optional exercises to make your program more sophisticated. For these exercises, you will need to modify also the other classes (MailClient, Message, and Envelope).

- **Verify sender address**. Java's System-class contains information about the username and the InetAddress-class contains methods for finding the name of the local host. Use these to construct the sender address for the Envelope instead of using the user-supplied value in the From-header.
- **Additional headers**. The generated mails have only four header fields, From, To, Subject, and Date. Add other header fields from RFC 822, e.g., Message-ID, Keywords. Check the RFC (http://www.faqs.org/rfcs/rfc822.html) for the definitions of the different fields.
- **Multiple recipients**. Currently the program only allows sending mail to a single recipient. Modify the user interface to include a Cc-field and modify the program to send mail to both recipients. For a more challenging exercise, modify the program to send mail to an arbitrary number of recipients.
- **More error checking**. The provided code assumes that all errors that occur during the SMTP connection are fatal. Add code to distinguish between fatal and non-fatal errors and add a mechanism for signaling them to the user. Check the RFC to see what the different reply codes mean. This exercise may require large modifications to the send(), sendCommand(), and parseReply() functions.

Querying the DNS

The Domain Name System (DNS) stores information in resource records. Normal name to IP-address mappings are stored in type A (Address) resource records. Type NS (NameServer) records hold information about nameservers and type MX (Mail eXchange) records tell which server is handling the mail delivery of the domain.

The server you need to find is the server handling the mail for your school's domain. First, you must find the nameserver of your school and then query this nameserver for the MX-host. Assuming you are at Someschool and your domain is someschool.edu, you would do the following:

1. Find the address of a nameserver for the top-level domain .edu (NS query)
2. Query the nameserver for .edu about the nameserver for the domain someschool.edu to get the address of Someschool's nameserver. (NS query)

3. Query Someschool's nameserver for MX-records for the domain someschool.edu. (MX query)

Under Unix/Windows you can query DNS manually with the nslookup-command (In fact, the nslookup command is disabled in beast.tcnj.edu. But, you always can try this command on your Windows machine). The syntax of the nslookup-command is as follows. Note that the argument host can also be a domain.

Normal query	nslookup host
Normal query using a given server	nslookup host server
NS-query	nslookup -type=NS host
MX-query	nslookup -type=MX host

The reply to the MX-query may contain multiple mail exchangers. Each of them is preceded by a number which is the preference value for this server. Lower preference values indicate preferred servers so you should use the server with the lowest preference value.

TCNJ has disabled nslookup function on beast.tcnj.edu, for safety reason, I guess. Anyway, I ran the function on a Mac machine.

% host tcnj.edu

An alternative way to get mail server information is to use websites, like http://mxtoolbox.com. It will show you the MX info.

In this project, you can use appropriate smtp servers, such as mailgate2.tcnj.edu or smtp.tcnj.edu. But when you use these servers, your computer must be either **on campus** or via **TCNJ VPN**. ISP usually block out of domain SMTP traffic. That means if you try to connect to mailgate2.tcnj.edu from your home **without** TCNJ VPN, your ISP probably will block it.

If you decide to use your own ISP SMTP server, make sure your ISP mail server does not require authentication. For example, if you are using Verzion FIOS, which use outgoing.verizon.net (port number 25) for outgoing email server. This mail server requires you type your Verizon username and password to authenticate yourself first. To make the implementation to be consistent among all students, your implementation should not use a mail server that requires authentication.

Once you have the mail server name, you can use **telnet** to send email to someone! The following command will establish a TCP connection to this mail server. (Notice that the port number **25** is specified on the command line.)

```
telnet mailgate2.tcnj.edu 25
```

At this point, the telnet program will allow you to enter SMTP commands, and will display the responses from the mail server. For example, the following sequence of commands would send email to bob from alice

```
HELO alice
MAIL FROM: <alice@crepes.fr>
RCPT TO: <bob@tcnj.edu>
DATA
SUBJECT: hello

Hi Bob, How's the weather? Alice.
.
QUIT
```

The SMTP protocol was originally designed to allow people to manually interact with mail servers in a conversational manner. For this reason, if you enter a command with incorrect syntax, or with unacceptable arguments, the server will return a message stating this, and will allow you to try again.

To complete this part of the lab, you should send an email message to **yourself** and verify that it was delivered.

SMTPConnection.java

This is the code for the SMTPConncetion class that you will need to complete. The code for the other three classes is provided in the following.

```
import java.net.*;
import java.io.*;
import java.util.*;

/**
 * Open an SMTP connection to a mailserver and send one mail.
 *
 */
public class SMTPConnection {
   /* The socket to the server */
   private Socket connection;

   /* Streams for reading and writing the socket */
   private BufferedReader fromServer;
   private DataOutputStream toServer;

   private static final int SMTP_PORT = 25;
   private static final String CRLF = "\r\n";

   /* Are we connected? Used in close() to determine what to do. */
   private boolean isConnected = false;

   /* Create an SMTPConnection object. Create the socket and the
   associated streams. Initialize SMTP connection. */
public SMTPConnection(Envelope envelope) throws IOException {
        // connection = /* Fill in */;
        fromServer = /* Fill in */;
        toServer =   /* Fill in */;

        /* Fill in */
        /* Read a line from server and check that the reply code is 220.
           If not, throw an IOException. */
        /* Fill in */

        /* SMTP handshake. We need the name of the local machine.
           Send the appropriate SMTP handshake command. */
        String localhost = /* Fill in */;
        sendCommand( /* Fill in */ );

        isConnected = true;
}

/* Send the message. Write the correct SMTP-commands in the
   correct order. No checking for errors, just throw them to the
   caller. */
public void send(Envelope envelope) throws IOException {
        /* Fill in */
        /* Send all the necessary commands to send a message. Call
           sendCommand() to do the dirty work. Do _not_ catch the
           exception thrown from sendCommand(). */
        /* Fill in */
}

/* Close the connection. First, terminate on SMTP level, then
   close the socket. */
public void close() {
        isConnected = false;
        try {
            sendCommand( /* Fill in */ );
            // connection.close();
        } catch (IOException e) {
            System.out.println("Unable to close connection: " + e);
            isConnected = true;
        }
}

/* Send an SMTP command to the server. Check that the reply code is
   what is is supposed to be according to RFC 821. */
private void sendCommand(String command, int rc) throws IOException {
```

```
            /* Fill in */
            /* Write command to server and read reply from server. */
            /* Fill in */

            /* Fill in */
            /* Check that the server's reply code is the same as the parameter
               rc. If not, throw an IOException. */
            /* Fill in */
    }

    /* Parse the reply line from the server. Returns the reply code. */
    private int parseReply(String reply) {
            /* Fill in */
    }

    /* Destructor. Closes the connection if something bad happens. */
    protected void finalize() throws Throwable {
            if(isConnected) {
                close();
            }
            super.finalize();
    }
}
```

Code for MailClient Lab

This page contains the code for all the other classes in the MailClient lab: `MailClient.java`, `Message.java`, and `Envelope.java`.

MailClient.java

```
import java.io.*;
import java.net.*;
import java.awt.*;
import java.awt.event.*;


public class MailClient extends Frame {
    /* The stuff for the GUI. */
    private Button btSend = new Button("Send");
    private Button btClear = new Button("Clear");
    private Button btQuit = new Button("Quit");
private Label serverLabel = new Label("Local mailserver:");
private TextField serverField = new TextField("", 40);
private Label fromLabel = new Label("From:");
private TextField fromField = new TextField("", 40);
private Label toLabel = new Label("To:");
private TextField toField = new TextField("", 40);
private Label subjectLabel = new Label("Subject:");
private TextField subjectField = new TextField("", 40);
private Label messageLabel = new Label("Message:");
private TextArea messageText = new TextArea(10, 40);

/**
 * Create a new MailClient window with fields for entering all
 * the relevant information (From, To, Subject, and message).
 */
public MailClient() {
    super("Java Mailclient");

    /* Create panels for holding the fields. To make it look nice,
       create an extra panel for holding all the child panels. */
    Panel serverPanel = new Panel(new BorderLayout());
    Panel fromPanel = new Panel(new BorderLayout());
    Panel toPanel = new Panel(new BorderLayout());
    Panel subjectPanel = new Panel(new BorderLayout());
    Panel messagePanel = new Panel(new BorderLayout());
    serverPanel.add(serverLabel, BorderLayout.WEST);
    serverPanel.add(serverField, BorderLayout.CENTER);
    fromPanel.add(fromLabel, BorderLayout.WEST);
    fromPanel.add(fromField, BorderLayout.CENTER);
    toPanel.add(toLabel, BorderLayout.WEST);
    toPanel.add(toField, BorderLayout.CENTER);
    subjectPanel.add(subjectLabel, BorderLayout.WEST);
    subjectPanel.add(subjectField, BorderLayout.CENTER);
    messagePanel.add(messageLabel, BorderLayout.NORTH);
    messagePanel.add(messageText, BorderLayout.CENTER);
    Panel fieldPanel = new Panel(new GridLayout(0, 1));
    fieldPanel.add(serverPanel);
    fieldPanel.add(fromPanel);
    fieldPanel.add(toPanel);
    fieldPanel.add(subjectPanel);

    /* Create a panel for the buttons and add listeners to the
       buttons. */
    Panel buttonPanel = new Panel(new GridLayout(1, 0));
    btSend.addActionListener(new SendListener());
    btClear.addActionListener(new ClearListener());
    btQuit.addActionListener(new QuitListener());
    buttonPanel.add(btSend);
    buttonPanel.add(btClear);
    buttonPanel.add(btQuit);

    /* Add, pack, and show. */
    add(fieldPanel, BorderLayout.NORTH);
    add(messagePanel, BorderLayout.CENTER);
    add(buttonPanel, BorderLayout.SOUTH);
    pack();
    show();
```

```
}

static public void main(String argv[]) {
    new MailClient();
}

/* Handler for the Send-button. */
class SendListener implements ActionListener {
    public void actionPerformed(ActionEvent event) {
        System.out.println("Sending mail");

        /* Check that we have the local mailserver */
        if ((serverField.getText()).equals("")) {
            System.out.println("Need name of local mailserver!");
            return;
        }

        /* Check that we have the sender and recipient. */
        if((fromField.getText()).equals("")) {
            System.out.println("Need sender!");
            return;
        }
        if((toField.getText()).equals("")) {
            System.out.println("Need recipient!");
            return;
        }

        /* Create the message */
        Message mailMessage = new Message(fromField.getText(),
                                        toField.getText(),
                                        subjectField.getText(),
                                        messageText.getText());

        /* Check that the message is valid, i.e., sender and
           recipient addresses look ok. */
        if(!mailMessage.isValid()) {
            return;
        }

        /* Create the envelope, open the connection and try to send
           the message. */
        try {
            Envelope envelope = new Envelope(mailMessage,
                                           serverField.getText());
        } catch (UnknownHostException e) {
            /* If there is an error, do not go further */
            return;
        }
        try {
          SMTPConnection connection = new SMTPConnection(envelope);
            connection.send(envelope);
            connection.close();
        } catch (IOException error) {
            System.out.println("Sending failed: " + error);
            return;
        }
        System.out.println("Mail sent succesfully!");
        }
    }

    /* Clear the fields on the GUI. */
    class ClearListener implements ActionListener {
        public void actionPerformed(ActionEvent e) {
            System.out.println("Clearing fields");
            fromField.setText("");
            toField.setText("");
            subjectField.setText("");
            messageText.setText("");
        }
    }

    /* Quit. */
    class QuitListener implements ActionListener {
        public void actionPerformed(ActionEvent e) {
            System.exit(0);
        }
    }
}
```

Message.java

```
import java.util.*;
import java.text.*;


public class Message {
    /* The headers and the body of the message. */
    public String Headers;
    public String Body;

    /* Sender and recipient. With these, we don't need to extract them
       from the headers. */
    private String From;
    private String To;

    /* To make it look nicer */
    private static final String CRLF = "\r\n";

    /* Create the message object by inserting the required headers from
       RFC 822 (From, To, Date). */
    public Message(String from, String to, String subject, String text)
{
        /* Remove whitespace */
        From = from.trim();
        To = to.trim();
        Headers = "From: " + From + CRLF;
        Headers += "To: " + To + CRLF;
        Headers += "Subject: " + subject.trim() + CRLF;

        /* A close approximation of the required format. Unfortunately
           only GMT. */
        SimpleDateFormat format =
            new SimpleDateFormat("EEE, dd MMM yyyy HH:mm:ss 'GMT'");
        String dateString = format.format(new Date());
        Headers += "Date: " + dateString + CRLF;
        Body = text;
    }

    /* Two functions to access the sender and recipient. */
    public String getFrom() {
        return From;
    }

    public String getTo() {
        return To;
    }

    /* Check whether the message is valid. In other words, check that
       both sender and recipient contain only one @-sign. */
    public boolean isValid() {
        int fromat = From.indexOf('@');
        int toat = To.indexOf('@');

        if(fromat < 1 || (From.length() - fromat) <= 1) {
            System.out.println("Sender address is invalid");
            return false;
        }
        if(toat < 1 || (To.length() - toat) <= 1) {
            System.out.println("Recipient address is invalid");
            return false;
        }
        if(fromat != From.lastIndexOf('@')) {
            System.out.println("Sender address is invalid");
            return false;
        }
        if(toat != To.lastIndexOf('@')) {
            System.out.println("Recipient address is invalid");
            return false;
        }
        return true;
    }

    /* For printing the message. */
    public String toString() {
        String res;

        res = Headers + CRLF;
        res += Body;
        return res;
    }
}
```

Envelope.java

```
import java.io.*;
import java.net.*;
import java.util.*;
```

```
/**
 * SMTP envelope for one mail message.
 *
 * @author Jussi Kangasharju
 */
public class Envelope {
    /* SMTP-sender of the message (in this case, contents of From-
header. */
    public String Sender;

    /* SMTP-recipient, or contents of To-header. */
    public String Recipient;

    /* Target MX-host */
    public String DestHost;
    public InetAddress DestAddr;

    /* The actual message */
    public Message Message;

    /* Create the envelope. */
    public Envelope(Message message, String localServer) throws
UnknownHostException {
        /* Get sender and recipient. */
        Sender = message.getFrom();
        Recipient = message.getTo();

        /* Get message. We must escape the message to make sure that
           there are no single periods on a line. This would mess up
           sending the mail. */
        Message = escapeMessage(message);

        /* Take the name of the local mailserver and map it into an
         * InetAddress */
        DestHost = localServer;
        try {
            DestAddr = InetAddress.getByName(DestHost);
        } catch (UnknownHostException e) {
            System.out.println("Unknown host: " + DestHost);
            System.out.println(e);
            throw e;
        }
        return;
    }

    /* Escape the message by doubling all periods at the beginning of
       a line. */
    private Message escapeMessage(Message message) {
        String escapedBody = "";
        String token;
        StringTokenizer parser = new StringTokenizer(message.Body, "\n",
true);

        while(parser.hasMoreTokens()) {
            token = parser.nextToken();
            if(token.startsWith(".")) {
                token = "." + token;
            }
            escapedBody += token;
        }
        message.Body = escapedBody;
        return message;
    }

    /* For printing the envelope. Only for debug. */
    public String toString() {
        String res = "Sender: " + Sender + '\n';
        res += "Recipient: " + Recipient + '\n';
        res += "MX-host: " + DestHost + ", address: " + DestAddr + '\n';
        res += "Message:" + '\n';
        res += Message.toString();

        return res;
    }
}
```