

VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ  
FAKULTA INFORMAČNÍCH TECHNOLOGIÍ

IMAP Client – Manual

# Contents

<b>1</b>	<b>Assignment</b>	<b>2</b>
<b>2</b>	<b>Implementation Details</b>	<b>2</b>
2.1	Implementation of Client . . . . .	2
2.2	Program's Features . . . . .	2
2.2.1	Usage of UIDVALIDITY Value . . . . .	2
2.2.2	Creation of Output Directory . . . . .	3
2.2.3	Store Emails From Multiple Mailboxes Into One Output Directory . . . . .	3
2.2.4	Gentle Download . . . . .	3
2.2.5	What If Server Does Sends Any Response? . . . . .	3
2.3	Known Limitations . . . . .	4
2.4	Important Definitions . . . . .	4
2.5	Program Flow . . . . .	4
2.6	Classes . . . . .	6
2.6.1	ClientConfig . . . . .	6
2.6.2	ImapClients . . . . .	7
<b>3</b>	<b>Testing</b>	<b>7</b>
3.1	Testing of Local IMAP Server . . . . .	8
3.2	Testing of Foreign IMAP Servers . . . . .	8
<b>4</b>	<b>Return Codes</b>	<b>11</b>

# 1 Assignment

The project assignment in the ISA (Network Applications and Network Administration) subject was to create IMAP4rev1 (according to RFC3501), which will be able to communicate only over TCP/IP as well as using SLL/TLS - IMAPS. The following program downloads emails from the defined server in the argument of the program call and saves them in the output directory. If the path to the output repository specified by the argument does not exist, the program creates it on this path.

## 2 Implementation Details

The principles of object-oriented programming have been applied to the program code. The program is divided into logical classes such as the `ClientConfig` class - which takes care of the configuration of the resulting IMAP client based on the input arguments of the program, which it also processes. On the result of the configuration, either an instance of the `NonSecureImapClient` class is created, which mediates communication, classically only over TCP/IP, or an instance of the `SecureImapClient` class, which also uses SSL/TLS in addition to TCP/IP. Both classes `NonSecureImapClient` and `SecureImapClient` inherit basic properties from `BaseImapClient`, which provides features that are common to both derived classes, such as generating a TAG, finding the value of the current TAG or translating a hostname to an IPv4 address.

### 2.1 Implementation of Client

The `NonSecureImapClient` and `SecureClient` classes are characterized by their very similar behavior, at the beginning when the class is instantiated they receive information like `MailBox`, `OutputDirectory`, `HeadersOnly` and `NewOnly` as input parameters. These parameters are used to define further behavior of the program and their description is given in table below.

Parameter	Description
MailBox	Mailbox from which emails will be downloaded
OutputDirectory	Specifies where downloaded emails will be stored
HeadersOnly	Only header of the emails will be downloaded
NewOnly	Only unseen emails will be downloaded

Then, from the user's point of view, the classes only need to call the `Run` method with the parameters server address, port login and password. This method interacts with the server and its behaviour is as follows.

### 2.2 Program's Features

#### 2.2.1 Usage of UIDVALIDITY Value

The program also contains some of the extra features, the first of which is that the client saves a special `.uidvalidity` file with the value `UIDVALIDITY` when downloading to a specific output directory for the first time, this value is used in case the user wants to repeatedly download files to the same output directory and have synchronized mailboxes. On each subsequent run, the `UIDVALIDITY` value is checked to see if it is the same locally (in this `.uidvalidity` file) and on the server, if the values are different, it is a sign that the structure of the mailbox on the server has changed (i.e. the emails have been removed or moved to another mailbox, etc.) and the output directory needs to be purged and the emails downloaded again. The `.uidvalidity` file is formatted according to the rule that each mailbox has its corresponding line, which contains the mailbox name followed by the equal and finally the `uidvalidity` value for the given mailbox. Note that the file is not associated with the name of the IMAP server or user account, so it is recommended

to download only emails from multiple mailboxes of one account to one output directory to maintain clarity and easy orientation in the application output.

An example of the `uidvalidity` file content:

```
INBOX=1662988148
SPECIFIC_MAILBOX1=1662988155
SPECIFIC_MAILBOX2=1362922155
```

In this example:

- `INBOX=1662988148` indicates that the `uidvalidity` value for the "INBOX" mailbox is 1662988148.
- `SPECIFIC_MAILBOX1=1662988155` indicates that the `uidvalidity` value for the "SPECIFIC\_MAILBOX1" mailbox is 1662988155.
- `SPECIFIC_MAILBOX2=1362922155` indicates that the `uidvalidity` value for the "SPECIFIC\_MAILBOX2" mailbox is 1362922155.

This is done to ensure that the locally downloaded emails are always synchronized with those on the server and to allow users to download emails from multiple mailboxes to a single output directory.

### 2.2.2 Creation of Output Directory

The client always needs to have a specific `output directory` to which it will download emails from the IMAP server, it can happen that the user specifies his/her own location, but the folder on the given path does not exist (for example `-o /Desktop/email/my_mailbox/`) in this case the client is able to create the folder on the given path (in this example on `/Desktop/email/my_mailbox/`) and store the emails in it.

### 2.2.3 Store Emails From Multiple Mailboxes Into One Output Directory

The user of `imapcl` has the possibility to download emails from several mailboxes into one `output directory`, the names of output files with saved emails are defined according to the `UID` value of the given email and according to the `mailbox` to which the email is saved. it is highly recommended not to mix emails e.g. from two IMAP servers into one output directory, in case of a mailbox name match the emails from the previous download will be deleted and replaced by the current download.

### 2.2.4 Gentle Download

The program also introduces a **gentle download**, i.e. emails are downloaded only if the emails are downloaded to a given output directory for the first time, or the structure of the local copy of the mailbox or the structure on the IMAP server has changed. For example, in a local folder where emails have been downloaded once before, some email(s) in the folder have been removed (perhaps by mistake) or the mailbox on the IMAP server has been modified and the `UIDVALIDITY` value has changed. The client is always in sync with the IMAP server.

### 2.2.5 What If Server Does Sends Any Response?

In order to prevent the program from freezing due to waiting for a response from the server, a timeout is set on the sockets (20 seconds for the unsecure version of the program, 30 seconds for the secure version). These values can be configured using the macros `TIMEOUT_NON_SECURE` and `TIMEOUT_SECURE` in the *definitions.hpp* file located in the *include* folder.

## 2.3 Known Limitations

A user's mailbox can often be bulky and contain a number of large emails whose size can exceed 30MB, in which case it was observed during testing that downloading the entire mailbox can take a considerable amount of time and should be taken into account.

## 2.4 Adjustable Definitions

The relevant definitions are defined in the *definitions.hpp* file in the *include* folder. Some of them can be modified according to the user's needs, here is the content of the editable definitions:

- `PORT_NON_SECURE` - Default port for non-secure mode if the client does not specify one. The default value is 143.
- `TIMEOUT_SECURE` - Timeout for receiving data from the IMAP server in secure mode, defined in seconds. The default value is 30s.
- `DEFAULT_SSL_CERT_LOC` - Default location of SSL certificates, set to `/etc/ssl/certs`.
- `DEFAULT_MAILBOX_DIR` - Default mailbox directory, set to `INBOX`.
- `UIDVALIDITY_FILE` - Filename for storing UID validity information, set to `.uidvalidity.txt`.
- `PORT_SECURE` - Default port for secure mode if the client does not specify one. The default value is 993.
- `TIMEOUT_NON_SECURE` - Timeout for receiving data from the IMAP server in non-secure mode, defined in seconds. The default value is 20s.
- `OUTPUT_FILE_FORMAT` - Format for output files, set to `.log`.

## 2.5 Program Flow

The behaviour of the program has already been mentioned, this chapter contains a more detailed description and the program flow diagram shows the behaviour of the client in graphical form.

The program parses the program arguments at the beginning - find out how the client should be configured. Next, a client is created according to the request, which establishes a connection to the IMAP server using only TCP/IP or a combination of TCP/IP with SSL/TLS. If the connection is established, it sends a LOGIN command to the server, which should log the user in. In case of successful login, the SELECT command selects the mailbox from which the user wants to download emails (note: the default is INBOX), next, the UIDVALIDITY value is verified against the local copy (if the local copy does not exist in the output directory, it is created). Then all UIDs related to the mailbox are retrieved using the FETCH command (the collection of retrieved UIDs can be influenced by this parameter if the `'-n'` argument is used). After the set of UIDs is obtained, the email download sequence starts, the emails are downloaded one by one only - if is not yet downloaded locally into this specific output directory and the rest of the communication with the IMAP client is removed. Finally, the email is stored in the output directory specified by the `'-o'` argument and the client repeats this process with the next email with a UID from the set of pending emails.

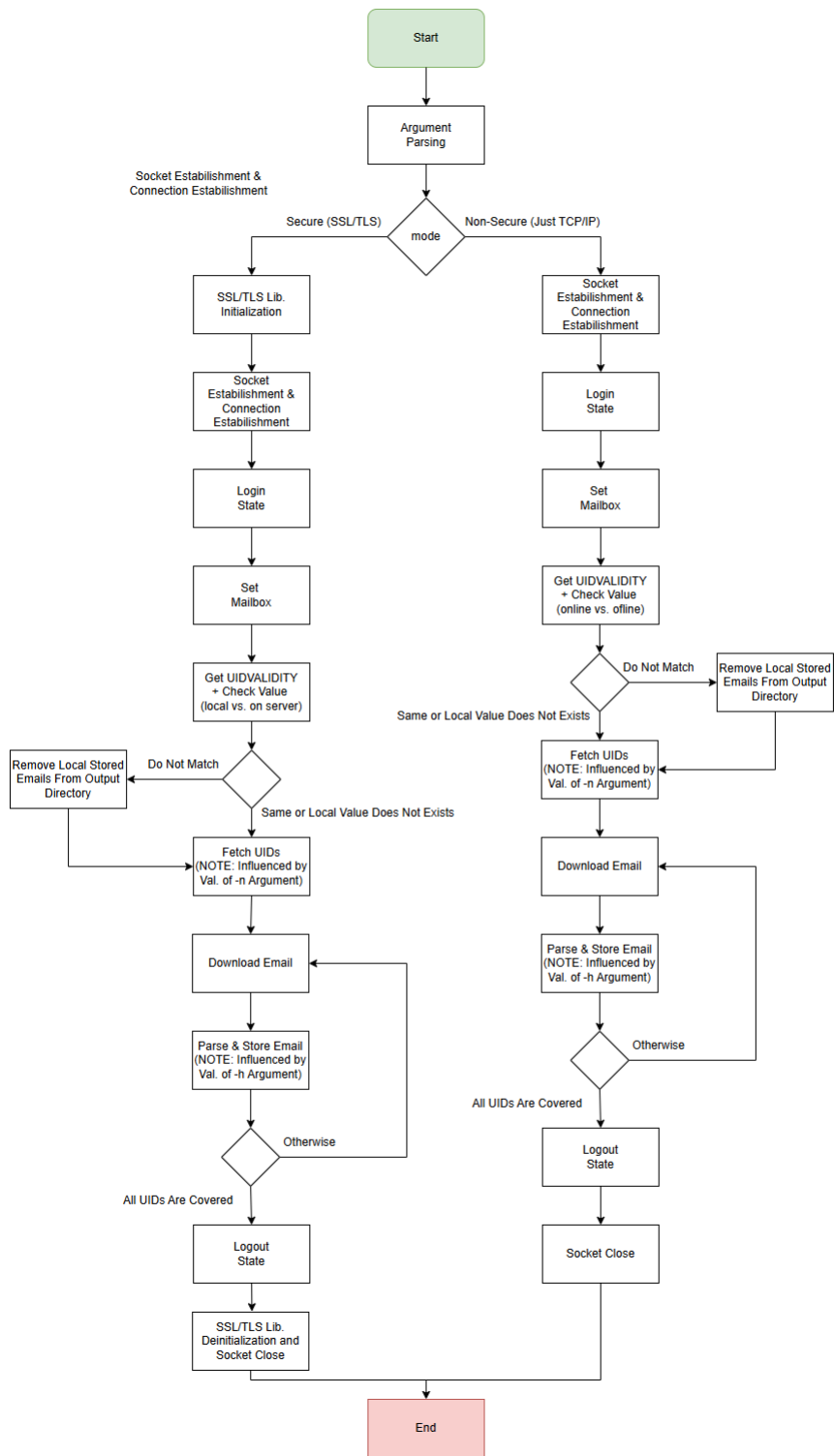


Figure 1: Program Flow Diagram

## 2.6 Classes

This section contains a visualization of the main program classes using a diagram based on the use-case diagram. The aim of these diagrams was to capture the individual classes and the methods/operations they allow.

### 2.6.1 ClientConfig

A class for processing user arguments, which is also responsible for storing the configuration of the future IMAP Client.

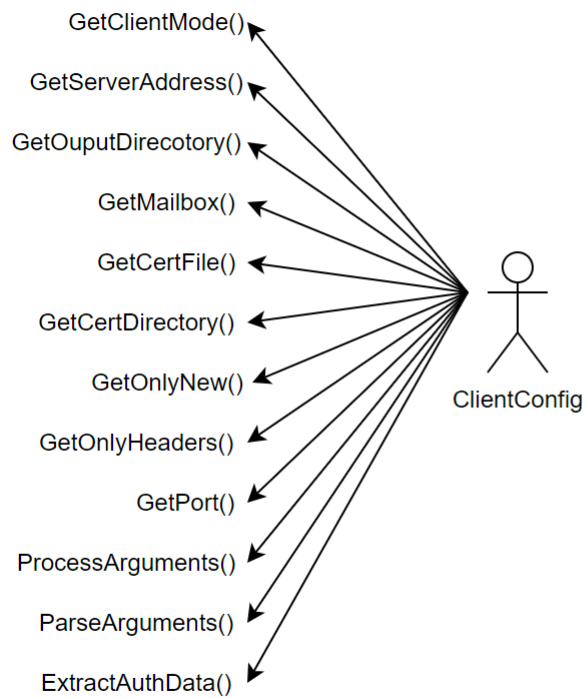


Figure 2: Class `ClientConfig` and `ClientConfig` Methods

### 2.6.2 ImapClients

Here it may be seen that both `SecureImapClient` and `NonSecureImapClient` have a common ancestor, which is `BaseImapClient` - providing common methods for both successors. On the basis of the configuration, an instance of the `SecureImapClient` or `NonSecureImapClient` class is created, it is responsible for taking care of the whole process of communication with the IMAP server and storing the results.

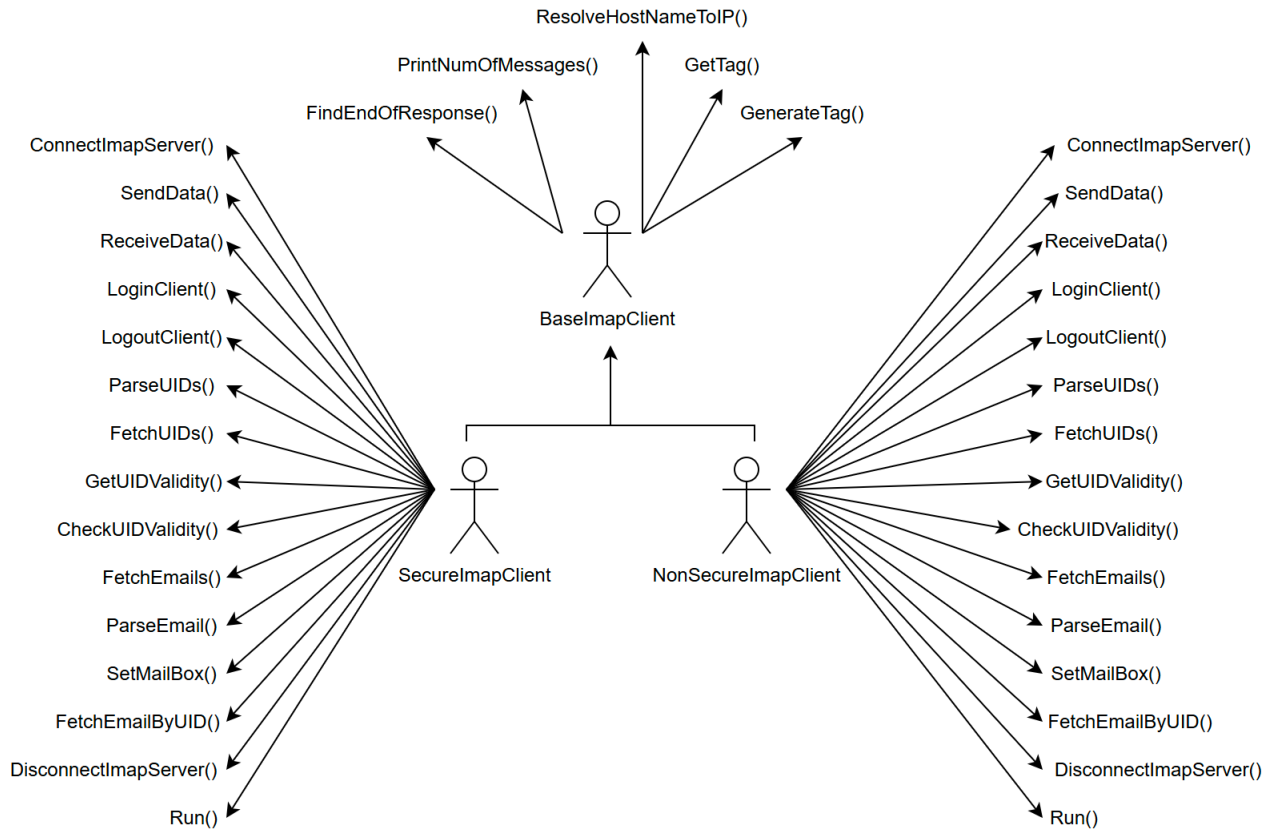


Figure 3: ImapClient's Classes and Methods

## 3 Testing

The `imapcl` program has also been tested. The testing was performed in two ways, the first one was tested using the local implementation of the IMAP server, the second way was chosen to test on foreign IMAP servers provided by the school such as `eva` or `merlin`.



### 3.1 Testing of Local IMAP Server

To ensure the correct operation of the program, `imapcl` was tested using a local implementation of the IMAP server. The local IMAP server is available in the repository in the tests folder under the name `imap_server.py`. The server is implemented in Python using the `os`, `socket`, `threading`, `subprocess`, `time`, and `signal` libraries and handles all requests from the client implementation such as `LOGIN`, `FETCH` (fetch support involves responding to specific requests such as `'tag' UID 'x' FETCH BODY[HEADER]` or `'tag' UID 'x' FETCH BODY[TEXT]` where `'tag'` is specific tag of the request and `'x'` is UID of the email), `SELECT`, and `LOGOUT`.

The tests folder also contains the `test_emails` folder with sample emails that are sent to the IMAP client, at the same time these emails are used to compare what was sent with what was received on the IMAP client, the contents should be the same - the result of the comparison is displayed in the output of the script `imap_server.py`.

The local IMAP server was used for basic testing of the application functionality, and at a later stage of development it was used to simulate errors and unusual conditions that can occur during communication between client and server.

Testcase	Expected Output	Program Output
Server does not responds to <code>LOGIN</code> command.	Program should exit with <code>BAD_RESPONSE</code> error code.	Program ends with <code>BAD_RESPONSE</code> error code.
Server sends different end of response string (e.g. not <code>TAG OK FETCH Completed</code> but <code>TAG OK fetch</code> ).	Client should handle this kind change and continue.	Client successfully proceeds and completes its download.
Server sends different <code>.uidvalidity</code> value for mailbox.	Output directory should be cleared and emails should be downloaded again.	Output directory is cleared and emails are downloaded again.
Server does not respond at all.	Client should successfully end and print error message on <code>stderr</code> .	Client successfully ends and prints error message on <code>stderr</code> .
Stress test, sending three emails, size of each of them 33MB.	Emails successfully downloaded.	Emails were successfully downloaded. Note: Speed was not great.

### 3.2 Testing of Foreign IMAP Servers

As a complementary method, testing on foreign IMAP servers provided by the school, such as `eva` or `merlin`, was chosen to ensure compatibility outside the local environment and to demonstrate the usability of the program.

Testcase	Server	Expected Output	Program Output
Compilation	eva	Successful compilation.	Successful compilation.
Auth. file parsing	eva	Auth. file successfully parsed	Auth. file successfully parsed.
Calling ./imapcl outlook.office365.com -p 143 -a PATH/auth_file.txt -b INBOX -o PATH/output/	eva	Downloaded whole emails (including header and body), note: number emails on server was 1739.	Downloaded 1739 from server with headers and bodies.
Calling ./imapcl outlook.office365.com -p 143 -a PATH/auth_file.txt -b INBOX -o PATH/output/ with changed value of .uidvalidity file	eva	Downloaded whole emails (including header and body) and updated value in .uidvalidity file, note: number emails on server was 1739	Downloaded 1739 from server with headers and bodies. Updated value of .uidvalidity file.
Calling ./imapcl outlook.office365.com -p 143 -a PATH/auth_file.txt -b INBOX -o PATH/output/ and path PATH/output/ does not exists	eva	Downloaded whole emails (including header and body) and created output directory in PATH/output/ file, note: number emails on server was 1739	Downloaded 1739 from server with headers and bodies. in output directory PATH/output/.
Calling ./imapcl outlook.office365.com -T -a PATH/auth_file.txt -b INBOX -o PATH/output/ with changed value of .uidvalidity file	eva	Downloaded whole emails (including header and body) and updated value in .uidvalidity file thru SSL/TLS on port 993, note: number emails on server was 1739	Downloaded 1739 from server with headers and bodies. Updated value of .uidvalidity file. Used SSL/TLS on default port 993.
Compilation	merlin	Successful Compilation	Successful Compilation
Auth. file parsing	merlin	Auth. file successfully parsed	Auth. file successfully parsed.
Calling ./imapcl eva.fit.vutbr.cz -p 143 -a PATH/auth_file.txt -b INBOX -o PATH/output/	merlin	Downloaded whole emails (including header and body), note: number emails on server was 2349.	Downloaded 2349 from server with headers and bodies.
Calling ./imapcl eva.fit.vutbr.cz -p 143 -h -a PATH/auth_file.txt -b INBOX -o PATH/output/	merlin	Downloaded email only headers, note: number emails on server was 2349.	Downloaded 2349 email headers from server.

Testcase	Server	Expected Output	Program Output
Calling ./imapcl eva.fit.vutbr.cz -p 143 -n -a PATH/auth_file.txt -b INBOX -o PATH/output/	merlin	Downloaded email only new emails (headers + bodies), note: number emails on server was 56.	Downloaded 56 new emails from server with headers and bodies.
Calling ./imapcl eva.fit.vutbr.cz -p 143 -n -a PATH/auth_file.txt -b BOX1 -o PATH/output/	merlin	Two emails should be downloaded and UIDVALIDITY of BOX1 should be stored into .uidvalidity.txt	Two emails were downloaded and UIDVALIDITY of BOX1 were saved into .uidvalidity.txt
Calling ./imapcl eva.fit.vutbr.cz -T -p 993 -n -a PATH/auth_file.txt -b INBOX -o PATH/output/	merlin	For SSL cetificates should be used default location - /etc/ssl/certs.	Used default location for SSL certificates, /etc/ssl/certs.
Calling ./imapcl eva.fit.vutbr.cz -T -p 993 -n -a PATH/auth_file.txt -b BOX1 -o PATH/output/ with stored all emails from mailbox and right value of UIDVALIDITY	merlin	Zero emails should be downloaded	Zero emails downloaded.
Calling ./imapcl eva.fit.vutbr.cz -p 143 -h -n -a PATH/auth_file.txt -b INBOX -o PATH/output/	merlin	Downloaded email only new emails (only headers), note: number emails on server was 56.	Downloaded 56 headers of new emails from server.
Calling ./imapcl eva.fit.vutbr.cz -g 143 -h -n -a PATH/auth_file.txt -b INBOX -o PATH/output/	merlin	Wrong argument -g, help on terminal should be printed.	Printed help to the user on terminal.
Calling ./imapcl eva.fit.vutbr.cz -p 143	merlin	A small number of arguments for calling the program. The error message should be displayed to the user.	Displayed the error message that informs user a small number of arguments for calling the program that were used.

## 4 Return Codes

The program is designed in such a way that in case of an error or failure, the user is always informed about the situation that has occurred. In case of success the program always returns the return value 0 (respectively SUCCESS), in other cases the program gives the return values according to the table below.

Name	Data Type	Value	Description
OUTPUT_DIR_NOT_CREATED	int	-7	Output Directory Could Not Be Created
UIDVALIDITY_FILE_NOT_FOUND	int	-6	.uidvalidity File Not Found
UIDVALIDITY_FILE_ERROR	int	-5	Error With .uidvalidity File (Invalid Format, Out of Range)
CREATE_CONNECTION_FAILED	int	-4	Failed to Create Connection With IMAP Server
SSL_CERT_VERIFICATION_FAILED	int	-3	SSL Certificate Verification Failed
FETCH_EMAIL_FAILED	int	-2	Fetching Email By UID Failed
SUCCESS	int	0	Operation Was Successful
NO_IP_ADDR_FOUND	int	1	No IPv4 Address Was Found
PARSE_ARGUMENTS_FAILED	int	2	Parsing Program's Arguments Failed
PARSE_CREDENTIALS_FAILED	int	3	Parsing Credentials Failed
SERVER_UNKNOWN_RESPONSE	int	4	Server Sent an Unknown Response
TRANSMIT_DATA_FAILED	int	5	Transmission of Data Failed
RECEIVE_DATA_FAILED	int	6	Reception of Data Failed
RESPONSE_NOT_FOUND	int	7	Expected Server's Response Was Not Found
PARSE_BY_REGEX_FAILED	int	8	Parsing of Regular Expression Failed
NON_UIDS_RECEIVED	int	9	No UIDs Were Received From The IMAP Server
CONTINUE_IN_RECEIVING	int	10	Continue Receiving More Data
UNDEFINED_STATE	int	11	Undefined State Encountered
UID_VALIDITY_ERROR_IN_RECV	int	14	Unable to Receive UIDVALIDITY From The Server
REMOVAL_OF_EMAILS_FAILED	int	15	Failed to Remove Emails When UIDVALIDITY Does Not Match
BAD_RESPONSE	string	"Bad Response :("	Error During Receiving of Server's Response