Protocol Design Assignment

ToDo

- Send file metadata e.g. rights, owner, creation date, ...

Important

- UDP MTU
- Don't create packages with a size of (bit-size mod 8) != 0. It makes it hard on the receiver side to interpret those!

Protocol

General field descriptions

Type [4 Bit]:
0000 => Client-Hello-Handshake
0001 => Server-Hello-Handshake
0010 => File-Creation
0011 => File-Transfer
0100 => File-Status
0101 => ACK
0110 => Ping
0111 => Transfer-Ended
1000 => Auth-Request
1001 => Auth-Result

Client ID [32 Bit]:
An unique client id generated by the client on first contact.
E.g. A random int

Checksum [32 Bit]:
CRC32 Algorithm Wiki Link

Sequence Number [32 bit]:
Like TCP.

FID Length [64 Bit]:
The length of the `FID` field in bytes.

FID [Defined in the `FID Length` filed]: The relative path to the file. Includes the file name e.g. `folder/file.txt`.

FID Part Number [32 Bit]:
The file part number.

Pub Key [32 Bit]:
The client public key for the Diffie Hellman encryption.

Client-Hello-Handshake

The initial connection message that gets send by the client.

```
0      4       8      24          56              88              120        152
+------+-------+------+-----------+---------------+-----------------+---------+
| Type | Flags | Port | Client ID | Prime Number | Primitive Root | Pub Key |
+------+-------+------+-----------+---------------+-----------------+---------+
152        184               216                 1000
+----------+-----------------+----------+--------+
| Checksum | Username Length | Username | UNUSED |
+----------+-----------------+----------+--------+
```

Flags [4 Bit]:

```
0000
||||
```

```
|||+-> Connect requested
||+--> Reconnect
|+---> *UNUSED*
+----> *UNUSED*
```

Port [16 Bit]:
The port on which the client listens to server messages.

Prime Number [32 Bit]:
The client prime number for the Diffie Hellman encryption.

Primitive Root [32 Bit]:
The client primitive root for the Diffie Hellman encryption.

Username Length [32 Bit]:
Describes how long the the following Username is in byte.

Username [X Byte]:
Defined via the `Username Length`.

UNUSED [816-X Bit]:
To "prevent" DoS attacks. Ensures the package is a least 1000 Bit long.

Server-Hello-Handshake

Once the server received a `Client-Hello-Handshake` message he should reply with this message.

```
0      4       8           40                72            88        120        152
+------+-------+-----------+-----------------+-------------+---------+----------+
| Type | Flags | Client ID | Sequence Number | Upload-port | Pub Key | Checksum |
+------+-------+-----------+-----------------+-------------+---------+----------+
```

Upload-port [16 Bit]:
The Port where the client should send all following messages to.

Flags [4 Bit]:

```
0000
||||
|||+-> Client accepted
||+--> Too many clients - connection revoked
|+---> Client ID taken - connection revoked
+----> Invalid username - connection revoked
```

File-Creation

Marks the start of a file transfer. Tells the server to create the given file with the given path. Replaces existing files.

```
0      4           36                68          72              328        360          424
+------+-----------+-----------------+-----------+---------+----------+------------+-----+
| Type | Client ID | Sequence Number | File Type | File MD5 | Checksum | FID Length | FID |
+------+-----------+-----------------+-----------+---------+----------+------------+-----+
```

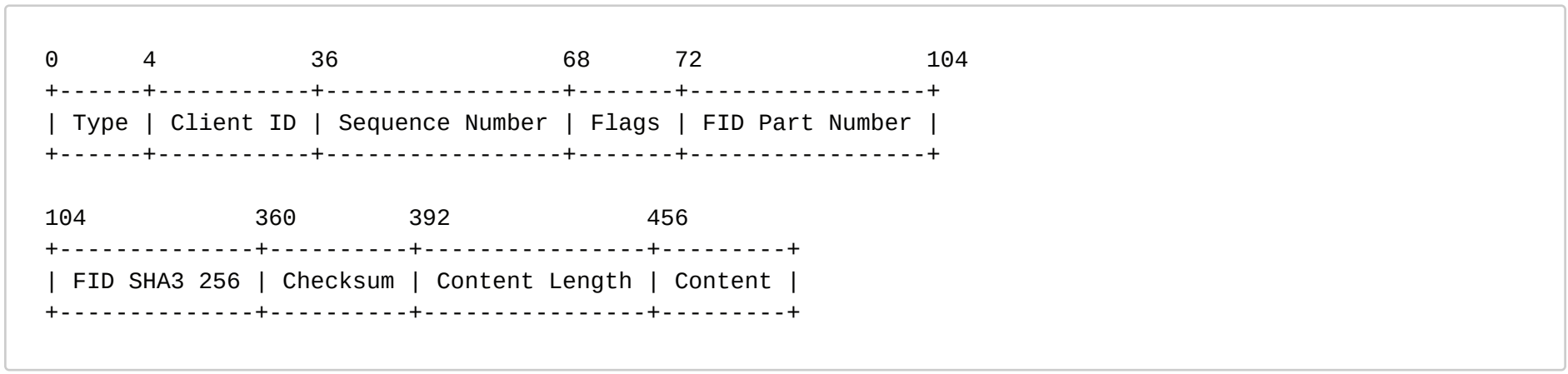
File Type [4 Bit]:

```
0000
||||
|||+-> Folder
||+--> Delete folder
|+---> File
+----> Delete file
```

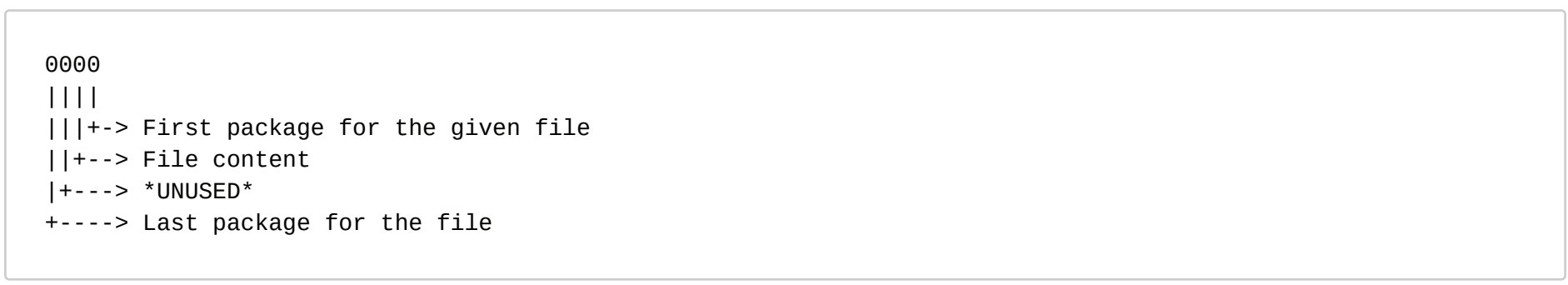
File MD5 hash [256 Bit]:
The file MD5 hash to check if the file was transmitted correctly. Unused for folders. Wiki Link

File-Transfer

The actual file transfer message containing the file content.



Flags [4 Bit]:



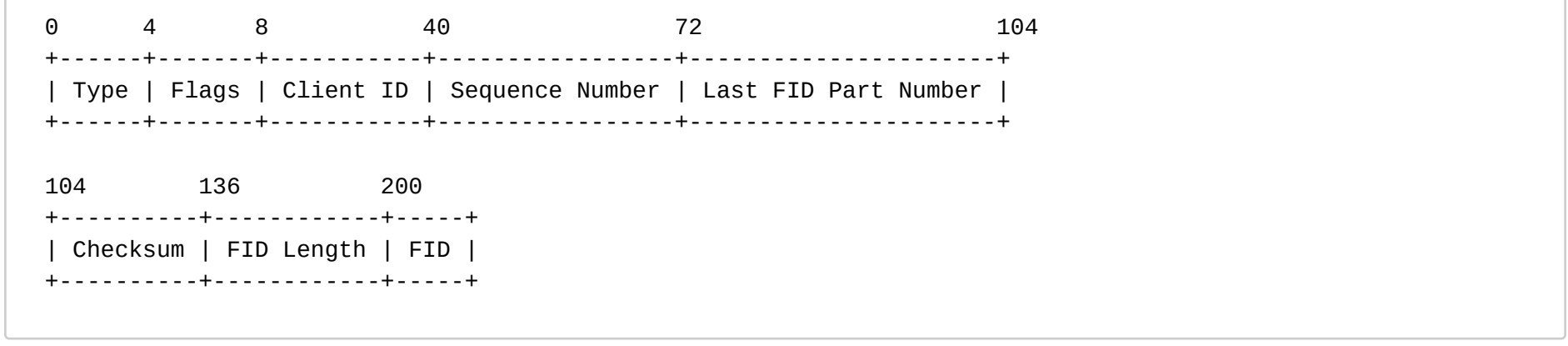
FID SHA3 256 [256 Bit]:
The SHA3 256 hash of the `FID` to identify which file gets.

Content Length [max 900 Bit]:
The length of the `Content` field.

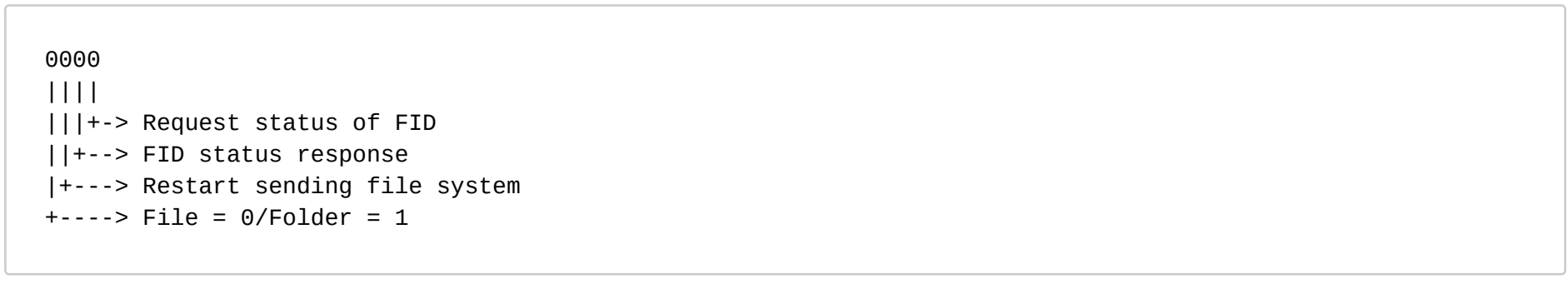
Content [defined in "Content Length" in Bit]:
The actual file content.

File-Status

Used for requesting and responding the current file status bevor a file gets transfered.



Flags [4 Bit]:



Last FID Part Number [32 Bit]: The last received `FID Part Number`. Ignored if `Request status of FID` is set.

ACK

For acknowledging `Ping`, `File-Creation` and `File-Transfer` messages.

```
0      4                     36         68      72
+------+---------------------+----------+--------+
| Type | ACK Sequence Number | Checksum | UNUSED |
+------+---------------------+----------+--------+
```

ACK Sequence Number [32 Bit]:
The acknowledged `Sequence Number` or `Ping Sequence Number`.

Transfer-Ended

Gets send by the client once he wants to end the transfer/close the connection.

```
0      4       8           40         72
+------+-------+-----------+----------+
| Type | Flags | Client ID | Checksum |
+------+-------+-----------+----------+
```

Flags [4 Bit]:

```
0000
||||
|||+-> Transfer finished
||+--> Cancelled by user
|+---> Error
+----> *UNUSED*
```

Ping

This message is used for ensuring the opponent is still there. The opponent should acknowledge each received `Ping` message with an `Server-ACK`.Should get send by each side if there was no message exchange for more than 2 seconds.
It also can be used for package loss and throughput tests with a modified `Payload Length`.

```
0      4                      36         68          100      104              136
+------+----------------------+----------+----------+--------+----------------+---------+
| Type | Ping Sequence Number | Client ID | Checksum | Unused | Payload Length | Payload |
+------+----------------------+----------+----------+--------+----------------+---------+
```

Ping Sequence Number [32 Bit]
An unique number for identifying each ping.

Payload Length [32 Bit]:
Describes how long the the following payload is in byte.

Payload [X Byte]:
Defined via the `Payload Length`.

Auth-Request

Send by the client to authentificate at the server.

```
0      4        8           40                                          72         104
+------+--------+-----------+-------------------------------------------+----------+
| Type | UNUSED | Client ID | Server-Hello-Handshake Sequence Number | Checksum |
+------+--------+-----------+-------------------------------------------+----------+
104               136
+-----------------+----------+
| Password Length | Password |
+-----------------+----------+
```

Server-Hello-Handshake Sequence Number [32 Bit]:
The sequence number of the `Server-Hello-Handshake` message.

Password Length [32 Bit]:
Describes how long the the following password is in byte.

Password [X Byte]:
Defined via the `Password Length`.

Auth-Result

Send by the server with the authentification result.

```
0      4       8           40                              72         104
+------+-------+-----------+-------------------------------+----------+
| Type | Flags | Client ID | Auth-Request Sequence Number | Checksum |
+------+-------+-----------+-------------------------------+----------+
```

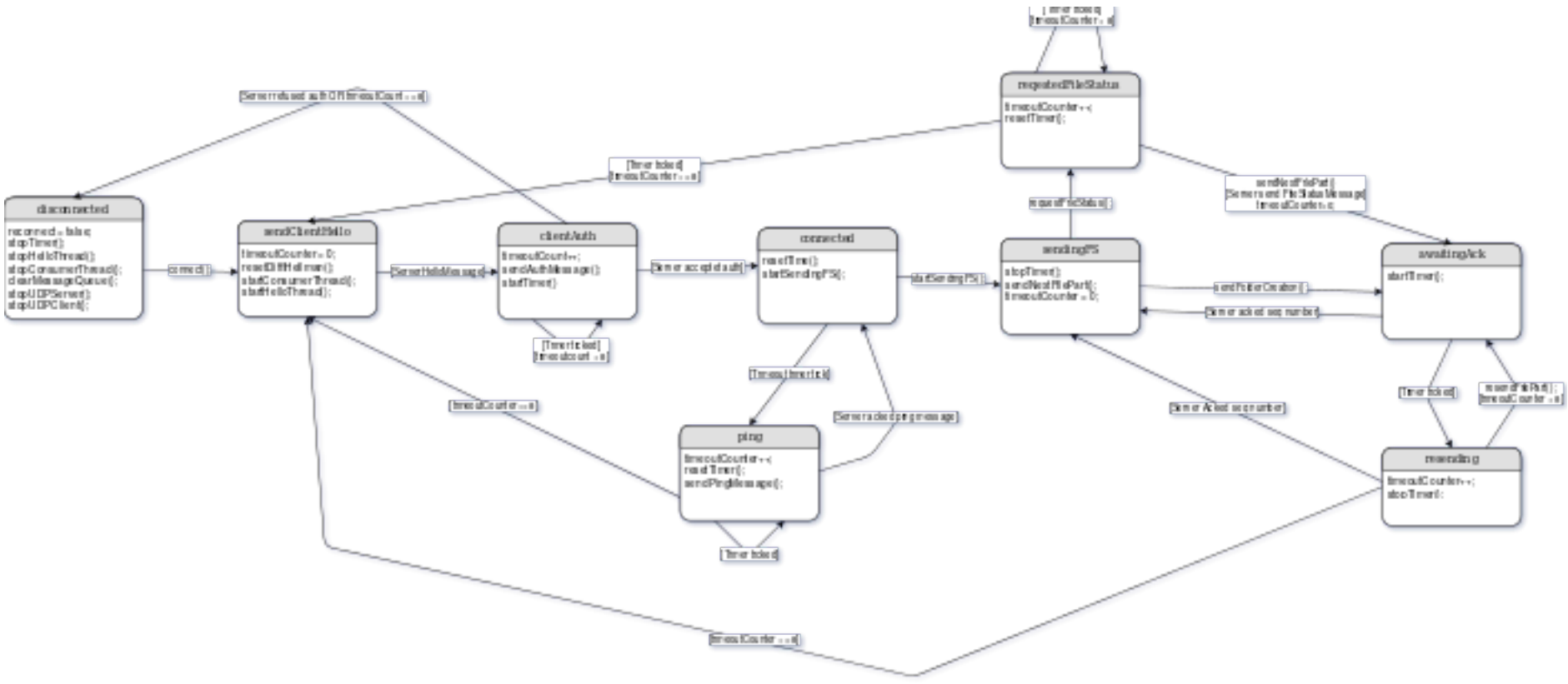
Flags [4 Bit]:

```
0000
||||
|||+-> Authentification successfull
||+--> *UNUSED*
|+---> *UNUSED*
+----> *UNUSED*
```

Auth-Request Sequence Number [32 Bit]:
The Sequence number of the received ````Auth-Request``` message.

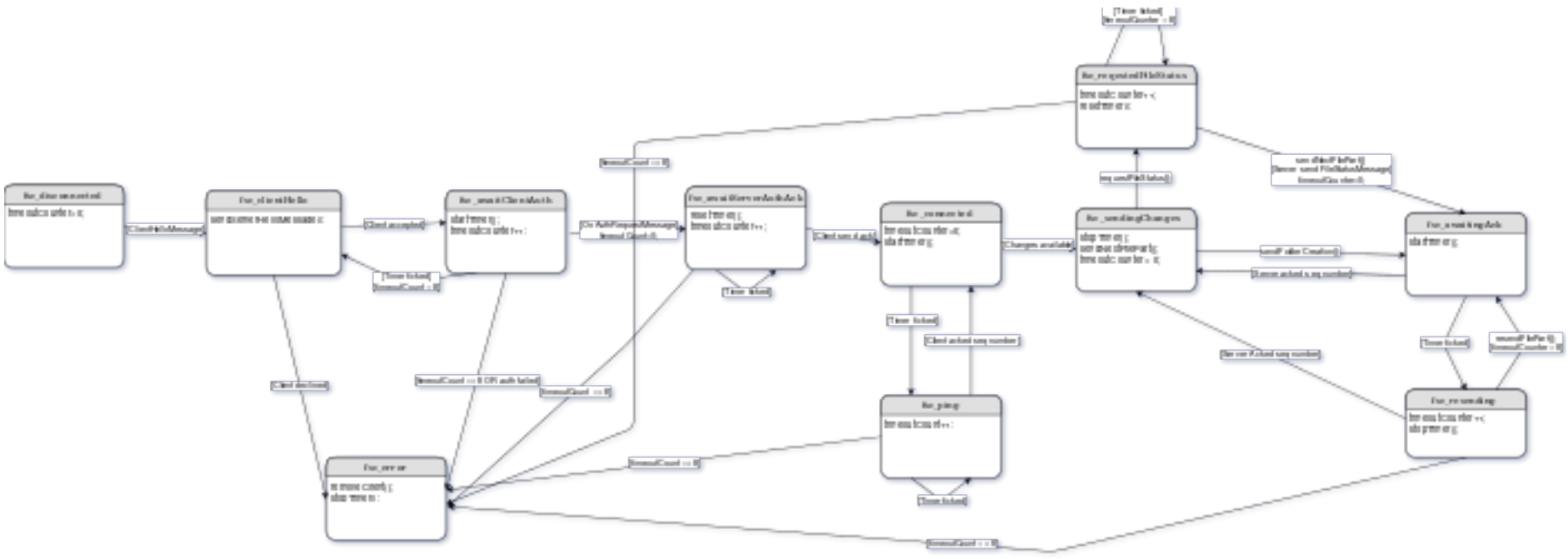
State charts

FileClient



FileServer

The server it selfe is stateless but it has `FileServerClient` objects with the following state chart:



Process example

```
Client                                  Server
  |     Client-Hello-Handshake          |
  | ------------------------------> | The clients starts the connection on the default port
  |                                 | and tells the server the port on which he listens for answers.
  |                                 | It also contains ```ClientStartConnection``` key exchange data.
  |     Server-Hello-Handshake      |
  | <------------------------------ | The server responds with an upload port and the
  |                                 | ```onServerReceive``` key exchange data.
  |     Auth-Request                |
  | ------------------------------> | If the client got accepted he sends his password via the
  |                                 | now encrypted connection.
  |     Auth-Result                 |
  | <------------------------------ | The server answers with the result of the authentification.
  |                                 | Now the connection is established.
  |     File-Status                 |
  | ------------------------------> | The client requests the file status.
  |                                 |
  |     Auth-Result                 |
  | <------------------------------ | The server responds with the current file status.
  |                                 |
  |     File-Creation               |
  | ------------------------------> | The client sends this message if the server does not has
  |                                 | the file yet.
  |     Server-ACK                  |
  | <------------------------------ | The server acks the ```File-Creation```.
  |                                 |
  |     File-Transfer               |
  | ------------------------------> | The client starts sending the file in chunks.
  |                                 |
  |     Server-ACK                  |
  | <------------------------------ | The server sends an ACK message for each message
  |                                 | it received from the client
  |     File-Transfer               |
  | ------------------------------> | The client sets the ```Last package for the file``` flag
  |                                 | to inform the server, it is the last file part.
  |     Server-ACK                  |
  | <------------------------------ |
  |                                 |
  |     Transfer-Ended              |
  | ------------------------------> | The client tells the server that he liks to close the connection.
```

Key Exhange

```
Client                              Server
  |     ClientStartConnection       |
  | ------------------------------> | Client calculates and sends P, G to the server.
  |                                 |
  |     onServerReceive             |
```

```
| <------------------------------ | Server calculates it's shared key, public key and sends it's
|                                  | public key to client.
|                                  | Sets secureConnection to true.
|     onClientReceive              |
| ------------------------------> | Client calculates it's shared key.
|                                  | Sets secure connection to true.
```

Diffie-Hellman algorithm relies on *discrete logarithm problem.* It is very hard for computers to solve discrete logarithm thus it is a good candidate against brute force attacks. This implementation works like this:

- Client and server have to have the common values `P` and `G`. P is a prime number and G is the primitive root of that number. As connections are initiated by client, both P and G is calculated by client. Before sending P and G, client generates a private key and calculates it's public key. `P , G and client's public key` are sent to server by the client at the beginning of the connection.
- Server receives P , G , and client's public key. It selects a private key for itself and calculates it own public key. At this calculation, server also successfully calculates the `shared key` that the encryption will be based on.
- Client receives server's public key and calculates the `shared key`. At this point both server and the client have the same shared key which has never transmitted through insecure channels.
- Exposed API of Encrypt and Decrypt uses that shared key to encrypt and decrypt messages.

More info can be found at: Wiki Link

File syncronisation

In order to do file sync we check periodically if there were files changed (It's planned to switch to Filsystem watcher to monitor for changes). To detect which files were changed we compare the MD5's of the files to internally saved hashes of them on the last run.

- *If the files weren't there in the prior* run, they get marked for complete transmission.
- *If the hash changed* we chunk the data into 900 Byte blocks. For each block we will calculate the CRC32. Afterward's it all CRC32 will get compared to the corresponding CRC32 of the previous run. If a CRC32 changed, it replaces the old CRC32 and the Part get's marked for transmission.
- *If nothing changed*, nothing will be send.