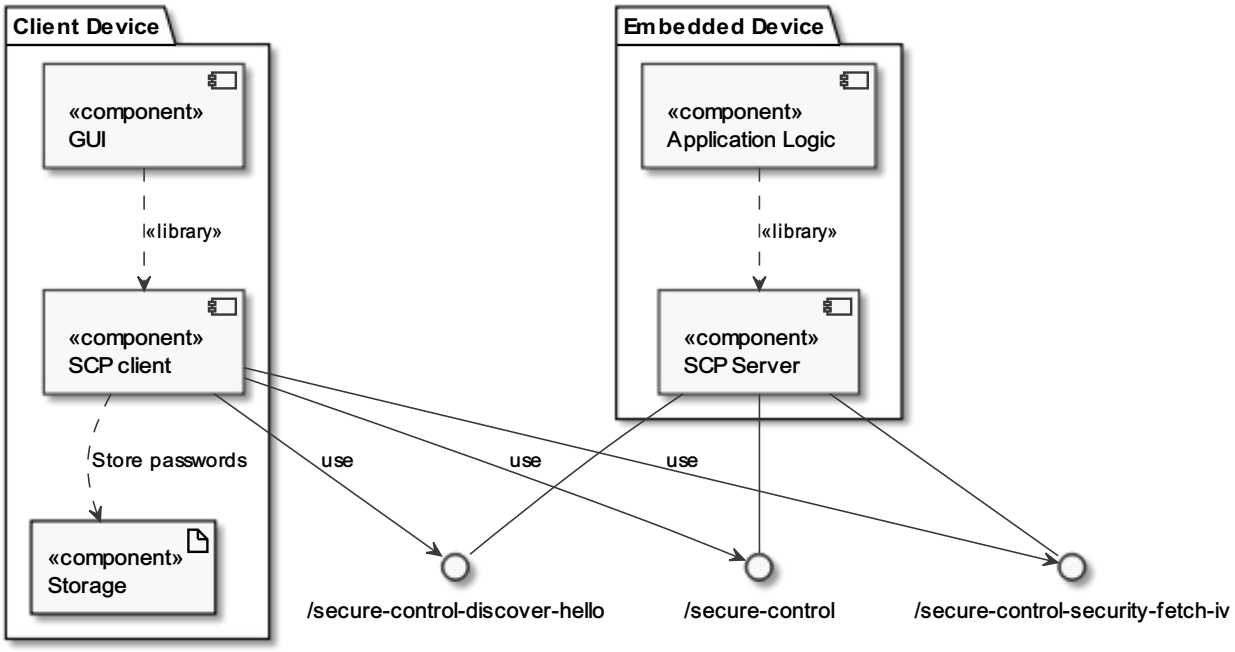
secure-control-protocol - Work in progress

Table of contents

Hint

APDF version of this README with all images is stored in the `./doc/` directory.

1. Architecture



System Component Diagram

2. Provisioning of devices

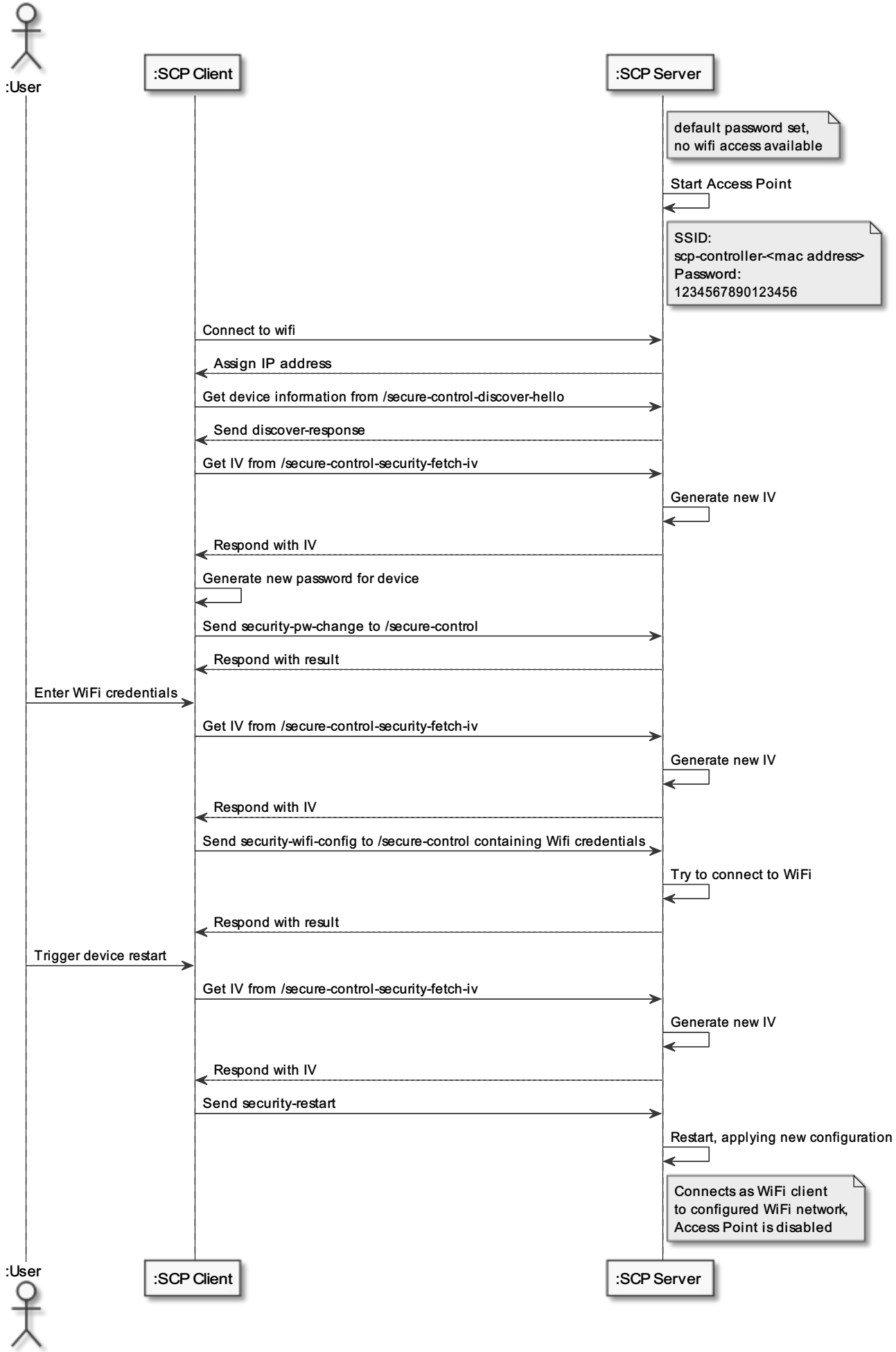
When the default password of the shutter-controller is set or no wifi credentials are provisioned the shutter-controller provides a Wifi Access Point using WPA2-PSK which can be accessed with the credentials defined in the annex.

When the Wifi Access Point is available the provisioning device connects to the wifi and the shutter-controller acts as a DHCP server and provides an IP address from a limited range to the device.

Now the device can start the discovery of shutter-controllers in the limited range and will automatically set a new device password using the security-pw-change message. Afterwards the credentials, of the wifi the shutter-controller should operate in, are being supplied by the user and sent to the shutter-controller via the security-wifi-config message.

When the shutter-controller receives a security-wifi-config message it tries to connect to the wifi and reponds with the result.

Afterwards the user triggers the security-reset message to restart the shutter-controller and thus apply the configured settings. If the default password has been changed and the wifi credentials are provisined, the shutter-controller is started as a wifi client only.



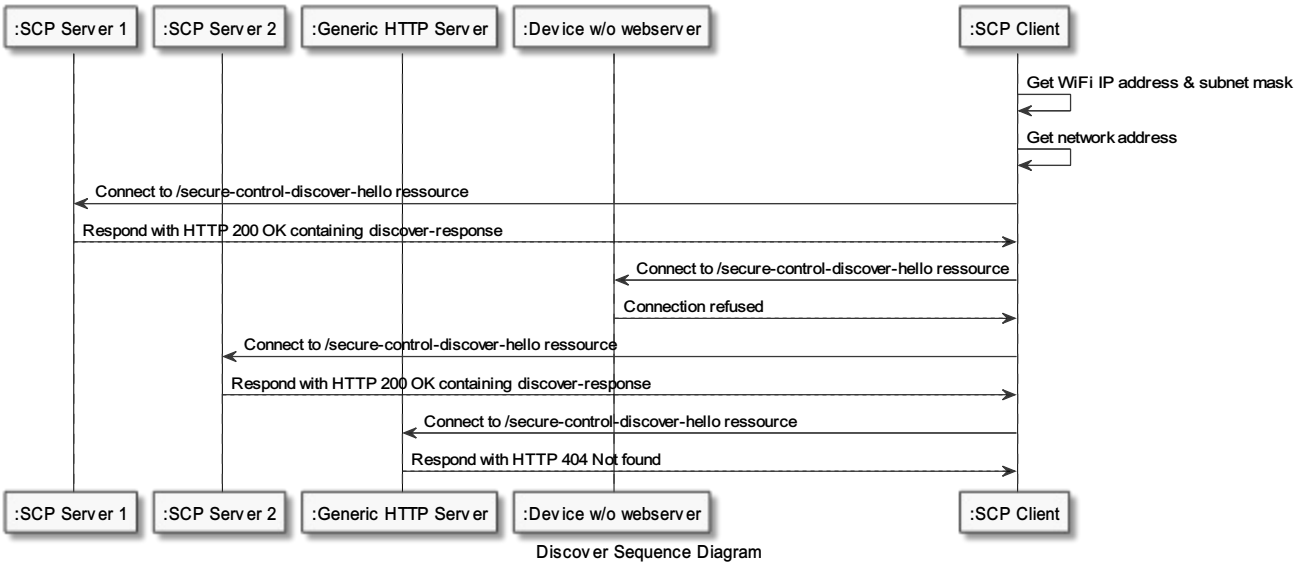
Provisioning Sequence Diagram

3. Discovery of devices

The Android app is capable of discovering devices in a configurable network range.

To do this the app connects to the secure-control-discover-hello ressource of each IP addresses of the configured IP address range.

The app stores the IP addresses of all devices which respond with a HTTP response 200 OK with information in the body.



Discover Sequence Diagram

4. Security

The security is based on pre-shared secrets.

Each SCP server has a preconfigured password which has to be changed when the first connection is established.

The SCP server does not accept control messages if the configured password matches the preconfigured one.

Additionally the password has the be 16 characters long.

The messages are encrypted using AES-128-CBC with the shared secret and an IV which has to be fetched from the device before encypting the message.

Nounce?

Currently not covered:

- Hardware attacks (Read flash to get password)

5. HTTP Ressources

The device exposes the following HTTP ressources:

```
http://device-ip/secure-control
```

```
http://device-ip/secure-control/discover-hello
```

```
http://device-ip/secure-control/security-fetch-iv
```

6. REST Message Types

The devices waits for HTTP-GET messages with the Content-Type application/x-www-form-urlencoded.

Except for the discover messages all payloads are encrypted with the configured password for the device using AES-128-CBC with PKCS5 Padding.

The initialization vector (henceforth IV) used for the encryption is being generated on start-up by the device.
It is being fetched from the client by using the security-fetch-iv message before sending the first message and incremented by the device afterwards.
By this replay attacks are being avoided.

For all encrypted messages the following HTTP ressource is used:

```
http://device-ip/secure-control
```

The data that shall be send to the device is send in the payload parameter.

```
http://device-ip/secure-control?payload=payload
```

The payload consists of the base64 and afterwards urlencoded encrypted message.

```
payload = urlencode(base64(encrypted message))
```

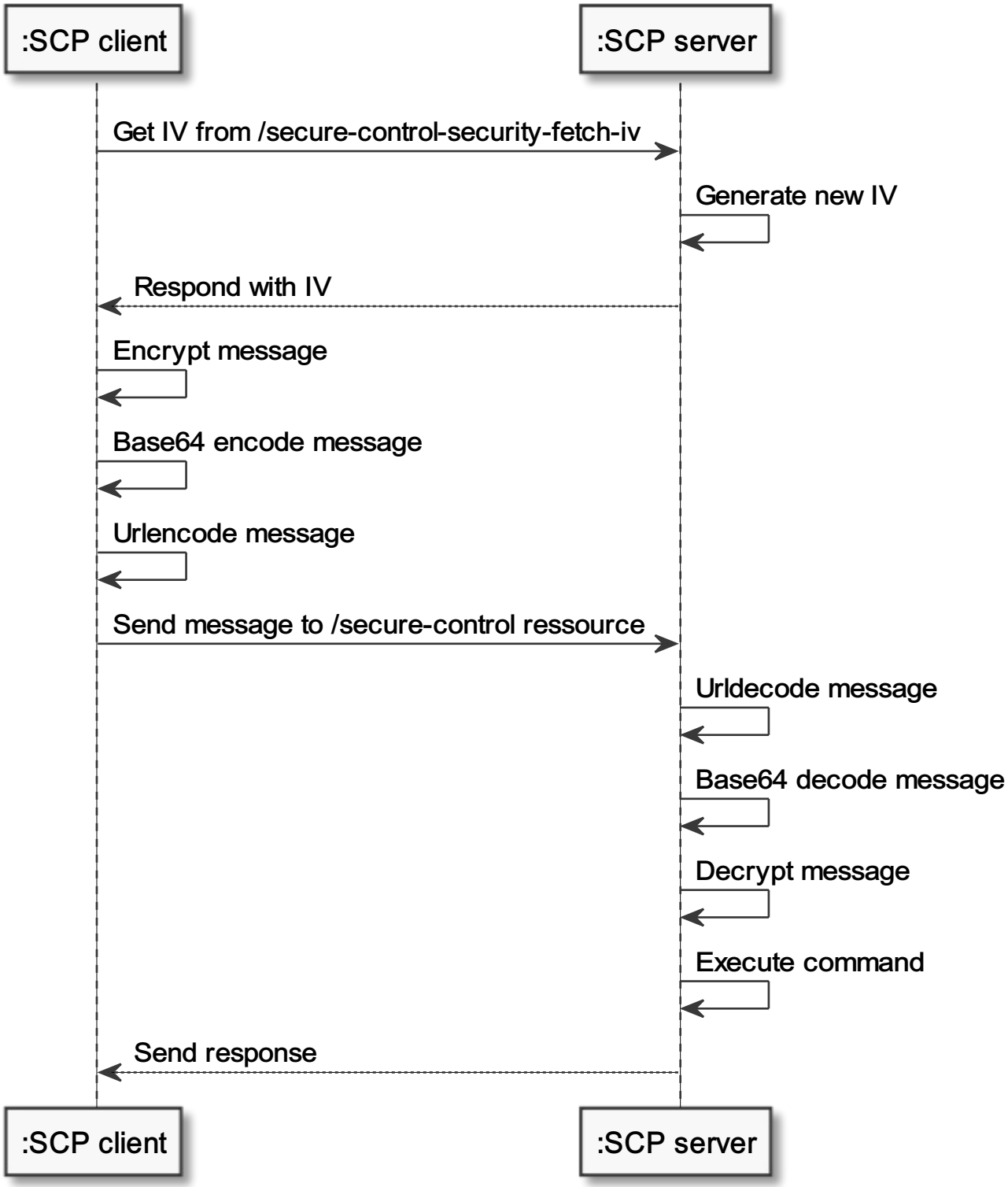
The encrypted message consists of the device ID of the targeted device and the type of the message. The device ID and the type are being concetenated seperated by a colon and encrypted using AES-128-CBC afterwards using the IV and the password of the target device.

```
encrypted message = AES-128-CBC(deviceID + ":" + message type, password))
```

All messages except for the discover-hello message, respond with a HTTP 200 OK message containing a JSON object with the encrypted payload:

Key	Possible values
payload	encrypted-payload

```
{
    "payload" : "encrypted-payload"
}
```



Message Processing Sequence Diagram

6.1 Discover message types

6.1.1 discover-hello

```
Ressource: http://device-ip/secure-control/discover-hello?payload=payload
```

payload: discover-hello

The discover-hello message is sent to all IP addresses of the subnet to determine wether the device is a shutter-control device, it is the only message being sent without encryption. If the device is a shutter-control device it responds with a HTTP 200 OK message containing a JSON representation of the following information.

Variables

Key	Possible values
type	discover-response
device-id	device id (16 byte)
device-type	shutter-control
current password number	number of password changes
hmac	Keyed-Hashed Massage Authentication Code

```
{
    "type" : "discover-response",
    "deviceId" : "device ID",
    "deviceType" : "shutter-control",
    "currentPasswordNumber" : number of password changes   ,
    "hmac" : Keyed-Hashed Massage Authentication Code
}
```

6.2 Control messages

6.2.1 control-up

The control-up message tells the shutters to open, but only if the password has been changed.

Additionally the deviceID provided in the payload must match the configured device ID.

decrypted payload: deviceID:control-up

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	control-up
deviceId	device ID
status	neutral / up / error

```
{
    "type" : "control-up",
    "deviceId" : "device ID",
    "status" : neutral / up / error
}
```

6.2.2 control-down

The control-down message tells the shutters to close, but only if the password has been changed.

Additionally the deviceID provided in the payload must match the configured device ID.

decrypted payload: deviceID:control-down

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values

type	control-down
deviceId	device ID
status	neutral / down / error

```
{
    "type" : "control-down",
    "deviceId" : "device ID",
    "status" : neutral / down / error
}
```

6.2.3 control-stop

The control-stop message tells the shutters to stop, but only if the password has been changed.

Additionally the deviceID provided in the payload must match the configured device ID.

decrypted payload: deviceID:control-stop

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	control-stop
deviceId	device ID
status	neutral / stop / error

```
{
    "type" : "control-stop",
    "deviceId" : "device ID",
    "status" : neutral / stop / error
}
```

6.2.4 control-status

The control-status message return the current status of the shutters to the client, but only if the password has been changed.

Additionally the deviceID provided in the payload must match the configured device ID.

decrypted payload: deviceID:control-status

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	control-status
deviceId	device ID
status	neutral / status / error

```
{
    "type" : "control-status",
    "deviceId" : "device ID",
    "status" : neutral / status / error
}
```

6.3 Security messages

6.3.1 security-fetch-iv

The security-fetch-iv message fetches the initialization vector from the device. The message and response are not encrypted as the IV has not to be secret.

Additionally the deviceID provided in the payload must match the configured device ID.

```
Ressource: http://device-ip/secure-control/security-fetch-iv
```

payload = deviceID

The payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	security-fetch-iv
iv	Stored initilization vector

```
{
    "type" : "security-fetch-iv",
    "deviceId" : "device ID",
    "iv" : Stored initilization vector
}
```

6.3.2 security-pw-change

The security-pw-change message tells the device to change it's old password to the new one.

Additionally the deviceID provided in the payload must match the configured device ID.

decrypted payload = deviceID:security-pw-change:new password

Hint:
The old password does not has to be send because it is used by the device for the encryption of the message.

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	security-pw-change
result	done / error

```
{
    "type" : "security-pw-change",
    "result" : done / error
}
```

6.3.3 security-wifi-config

The security-wifi-change message tells the device to set the Wifi client credentials it should use to access the target network.

Additionally the deviceID provided in the payload must match the configured device ID.

decrypted payload = deviceID:security-wifi-config:ssid:pre-shared-key

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	security-wifi-config
result	successfull / failed / error

```
{
    "type" : "security-wifi-config",
    "result" : successfull / failed / error
}
```

6.3.4 security-reset-to-default

The security-reset-to-default message tells the device to reset all persistent changes to the factory default settings, e.g. the password.

decrypted payload = deviceID:security-reset-to-default

The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	security-reset-to-default
result	done / error

```
{
    "type" : "security-reset-to-default",
    "result" : done / error
}
```

6.3.5 security-restart

The security-restart message tells the device to apply a new configuration by restarting.

decrypted payload = deviceID:security-restart

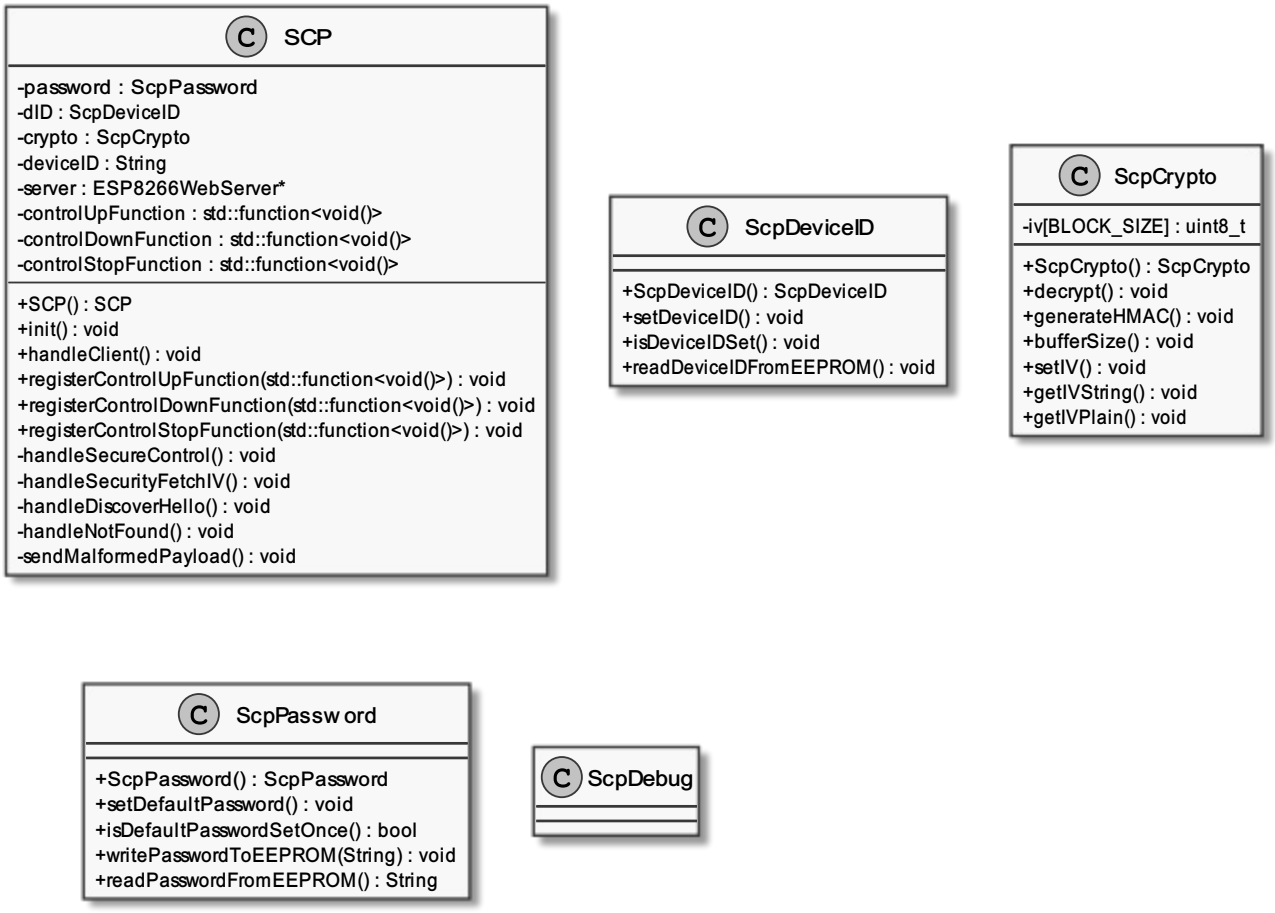
The encrypted payload of the response consists of a JSON representation of the following data:

Key	Possible values
type	security-restart
result	done / error

```
{
    "type" : "security-restart",
    "result" : done / error
}
```

7. SCP Stack Software Architecture

7.1 Class Diagrams



Class Diagram

8. Annex

8.1 Default credentials

8.1.1 Default device password

The default device password is 124567890123456.

8.1.2 Default Wifi Access Point credentials

SSID: "scp-controller-" + MAC Address

Pre-Shared-Key: default device password

Project Philosophy

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