# AN12661 EdgeLock<sup>TM</sup> SE05x for Wi-Fi Credential Protection Rev. 1.2 — 7 December 2020 Ap 582911

**Application note** 

#### Document information

Information	Content
Keywords	EdgeLock SE05x, Wi-Fi credentials, WPA-EAP-TLS
Abstract	This application note describes how to leverage EdgeLock SE05x for Wi-Fi credential protection. It explains how to run a demo setup that showcases the use of EdgeLock SE05x ease of use configuration to authenticate devices to a Wi-Fi network based on WPA-EAP-TLS protocol.



# **Revision history**

Revision history			
Revision number	Date	Description	
1.0	2020-05-14	First version.	
1.1	2020-06-12	ssscli compilation instructions updated	
1.2	2020-12-07	Updated to the latest template and fixed broken URLs	

# 1 Abbreviations

Table 1. Abbreviations			
Acronym	Description		
WSN	Wireless Sensor Network		
AP	Access Point		
CA	Certificate Authority		
RADIUS	Remote Authentication Dial-In User Service		
PCR	Platform Configuration Registers		
OEM	Original Equipment Manufacturer		
ECC	Elliptic-Curve Cryptography		
MCU	Micro Controller Unit		
РМК	Pairwise Master Key		
РТК	Pairwise Transient Key		
PBKDF	Password-Based Key Derivation Function		
PSK	Pre-Shared Key		
EAP	Extensible Authentication Protocol		
TLS	Transport Layer Security		
SSL	Secure Sockets Layer		

#### EdgeLock SE05x for Wi-Fi credential protection 2

Today's networks include a wide range of wireless devices, from computers and phones to IP cameras, smart TVs and connected appliances. As such, wireless networks must be secured to protect your devices and your sensitive data from being compromised.

Wi-Fi Protected Access (WPA), and its evolution WPA2, are security standards designed to create secure wireless networks. There are different WPA versions based on the target end-user, method of authentication key distribution and encryption protocol used.

Designed for home networks, WPA-PSK secures wireless networks using Pre-Shared Key (PSK) authentication. The device network traffic is encrypted deriving its key from this shared key, which may be entered as hexadecimal digits or as a passphrase. For instance, if a passphrase is used, the encryption key is calculated by applying the PB-KDF2 key derivation function to the passphrase.

Designed for enterprise use, WPA-Enterprise typically secures wireless networks using a Remote Authentication Dial-In User Service (RADIUS) server dedicated to authentication purposes. The device authentication to the network is achieved using variants of the Extensible Authentication Protocol (EAP) protocol. For instance, EAP-TLS (Transport Layer Security) provides certificate-based and mutual authentication of the client and the network. It relies on client-side and server-side certificates to perform authentication and can be used to dynamically generate user-based and session-based keys to secure subsequent communications between the Wi-Fi client and the access point.

The EdgeLock SE05x allows us to securely authenticate devices to a Wi-Fi network based on the WPA-EAP-TLS authentication protocol. In this respect, the EdgeLock SE05x offers a tamper resistant platform that allows you to safely store credentials such as the sensitive private key and certificate in the case of WPA-EAP-TLS authentication. If the security of an IoT device is breached, the whole network can be compromised as well. By incorporating the EdgeLock SE05x in your design, it provides a very strong level of security for the network credentials that a regular host could not offer.



Note: The RADIUS server can also be an integral part of the access point. This simplified setup is especially convenient for the home-gateway use case.

## 3 EdgeLock SE05x demo setup for WPA-EAP-TLS authentication

To demonstrate the use of EdgeLock SE05x to authenticate devices to a Wi-Fi network based on WPA-EAP-TLS protocol, this section describes how to run the demo setup depicted in Figure 2:



The demo architecture consists of three main elements: the *IoT device*, the *access point* and the *RADIUS server*. The *IoT device* is represented by a Raspberry Pi connected to the OM-SE050ARD board; the *access point* is represented by any commercial wireless router or access point with WPA/WPA2 Enterprise capabilities, and the *RADIUS* server is represented by a FreeRADIUS instance running on a Linux machine.

For authentication of the IoT device to the WiFi network the NXP-pre-provisioned keys and certificates inside EdgeLock SE05x will be used.

To set up the demo, you can follow these steps:

- 1. <u>Check prerequisites</u>
- 2. Configure the access point
- 3. Configure the FreeRADIUS server on a Linux machine
- 4. Configure the client (Raspberry Pi)
- 5. <u>Run device network connection</u>

**Note:** The network settings shown in this example are provided only for demonstration purposes. Therefore, the subsequent procedure must be adapted as required for a production deployment.

#### 3.1 Prerequisites

Check the document <u>AN12570-Quick Start Guide with Raspberry Pi</u> for detailed instructions on how to bring up the hardware and software setup for the Raspberry Pi board.

#### 3.2 Configure the access point

This section explains how to configure the access point to work in cooperation with the FreeRADIUS server. The following instructions are prepared using ASUS RT-AC58U access point as a reference. You might need to check the user manual of your access point vendor to replicate the same network configuration for your access point model.

To configure the access point, follow these instructions using any laptop:

- 1. Connect to the access point with an Ethernet cable.
- 2. Open a browser and log in to the access point (AP). The address of the AP is usually 192.168.1.1 or 192.168.0.1, but this might be different for your access point. We will later refer to it as access\_point\_ip.
- 3. Go to the wireless settings menu and make the following adjustments:
  - a. Give the wireless network name (SSID) an identifiable name. We will later refer to it as ssid\_name.
  - b. Set the wireless security/authentication method to  ${\tt WPA/WPA2}$  <code>Enterprise</code>.
  - c. Provide the IP address of the linux machine behaving as the RADIUS server. We will later refer to it as <code>radius\_server\_ip</code>.
  - d. Set the RADIUS server port to 1812, which is the default for the RADIUS protocol.
  - e. Choose a password in RADIUS server password field. We will refer to this password as radius server password later.

**Note:** For your convenience, you can set up a static IP address to the Linux machine and the Raspberry Pi. Check the user manual of your AP for instructions.

See <u>Figure 3</u> as a reference on what the network configuration looks like on ASUS RT-AC58U access point.

/ISUS RT-AC58U	Logout Reboo	English 🔻
Quick Internet Setup	Operation Mode: <u>Wireless router</u> Firm SSID: <u>se050 wifi</u> ASUS_48_5G General WPS WDS Wireless MAG	ware Version: <u>3.0.0.4.382_51939</u> &
General	Wireless - General	
Guest Network	Set up the wireless related information below	ť
🔗 Traffic Manager	Band	2.4GHz 🔽
Parental Controls	Network Name (SSID) Hide SSID	se050_wifi <b>a</b>
👸 USB Application	Wireless Mode	Auto 🛛 Optimized for Xbox 🗖 b/g Protection
AiCloud 2.0	Channel bandwidth	20/40 MHz 🗸
Advanced Settings	Control Channel	Auto 🚽 Current control channel: 11
Wireless	Extension Channel	Auto 🗸
	Authentication Method	WPA2-Enterprise V
	WPA Encryption	AES V
(i) wan	Server IP Address	192.168.2.100 C
IPv6	Server Port	1812 d
VPN	Connection Secret	•••••••
🚵 Firewall	Group Key Rotation Interval	3600
Administration		Apply
Figure 3 Access	s point configuration	

#### 3.3 Configure the FreeRADIUS server on a Linux machine

This section explains how to install and configure FreeRADIUS server on a Linux computer. The Linux distribution chosen for this demonstration is Ubuntu 16.04 LTS, but

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it was tested on Debian Buster as well. You might need to adapt the instructions below if you use a different distribution.

#### 3.3.1 Install FreeRADIUS

To install FreeRADIUS in Ubuntu 16.04 LTS, follow the steps below.

- 1. Send \$ sudo apt-get update to update the list of available packages.
- 2. Send \$ sudo apt-get install freeradius to install FreeRADIUS
- 3. Send \$ freeradius -v to check that the FreeRADIUS has been installed correctly. Make sure the version is 3.0.x or newer.

#### 3.3.2 Set the client configuration

Run \$ sudo nano /etc/freeradius/3.0/clients.conf and add the following snippet outside any example clients in the file, detailing the IP address and the password we set in the previous section:

```
client router {
    ipaddr = <access_point_ip>
    secret = <radius_server_password>
}
```

This configuration allows the access point to forward any device network authentication request to the FreeRADIUS server to be handled.

#### 3.3.3 Generate the FreeRADIUS server credentials

Now we will generate the server credentials used for RADIUS authentication. We will be using an ECC-based X.509 key to create a self-signed certificate. Run the following commands in order:

\$ cd /etc/freeradius/3.0/certs

\$ sudo openssl ecparam -out server.key -name prime256v1 -genkey

\$ sudo openssl req -x509 -key server.key -out server.crt -days 365 -subj "/CN=radius server"

\$ sudo chown freerad:freerad server.key

The openssl ecparam command is used to generate a NISP256 ECC key for a selfsigned certificate. Then, the certificate itself is generated using the command openssl req, and finally we allow FreeRADIUS to access the key with the chown command.

**Note:** Please keep in mind this is the minimum required credential management needed to get the demo up and running. In a real-world case, the client can use a different key and certificate, setting up specific requirements or using their own custom solution.

#### 3.3.4 Set the FreeRADIUS server configuration

The FreeRADIUS server configuration requires these credentials:

- private\_key\_file: The FreeRADIUS server private key, created in <u>Section 3.3.3</u>.
- certificate\_file: The FreeRADIUS server certificate, created in Section 3.3.3.
- *ca\_file*: The NXP CA certificate used to sign the client certificates (here using IoT connectivity key and certificate 0 from EdgeLock SE05x) attempting to connect to the

network. You can download it and convert it to the expected format using these two instructions:

```
$ sudo wget https://www.gp-ca.nxp.com/CA/getCA?
caid=63709315060011 -O NXP_CAvE206.crt
$ sudo openssl x509 -inform der -in NXP_CAvE206.crt -out
NXP CAvE206.pem
```

**Note:** Refer to <u>AN12436 - SE050 configurations</u> for more details about EdgeLock SE05x ease of use configuration, including the EdgeLock SE05x chain of trust certificates.

Now configure the FreeRADIUS server to use the credentials above. This configuration is set in the file eap. Run

\$ sudo nano /etc/freeradius/3.0/mods-available/eap

and replace the  ${\tt eap}$  section with this snippet:

```
eap {
    default_eap_type = eap-tls
    timer_expire = 60
    ignore_unknown_eap_types = no
    tls-config tls-common {
        private_key_file = /etc/freeradius/3.0/certs/server.key
        certificate_file = /etc/freeradius/3.0/certs/server.crt
        ca_file = /etc/freeradius/3.0/certs/server.crt
        cipher_list = "DEFAULT"
        cipher_server_preference = no
        ecdh_curve = "prime256v1"
    }
    tls {
        tls = tls-common
    }
}
```

Create a temporary directory called radiusd and give permissions for user freerad. Run the following commands:

\$ mkdir /tmp/radiusd
\$ sudo chown freerad:freerad /tmp/radiusd

Please keep in mind that this temporary directory is automatically removed on system reboot, so you will need to run the last two commands when the system boots back up.

#### 3.4 Configure the client (Raspberry Pi)

This section explains the configuration of the Raspberry Pi as part of the IoT device of this demo. It includes:

- · Configuration of the RADIUS client
- Installation of the EdgeLock SE05x Plug & Trust Middleware
- Extraction of client certificate from the EdgeLock SE05x
- · Configuration of the Raspberry Pi network interface

To configure the Raspberry Pi, follow these instructions:

1. First, run the following commands one by one to make sure all needed packages are installed:

```
$ sudo apt-get update
$ sudo apt-get install cmake cmake-curses-gui cmake-gui libssl-
dev python3-pip libffi-dev
```

2. Copy the EdgeLock SE05x Plug & Trust Middleware zip file into your home directory ~/ and unzip it using the command: \$ unzip se050 mw vxx.xx.zip -d se050 middleware

Please note that your EdgeLock SE05x Plug & Trust Middleware version can be different, so you will need to set the name of the zip file accordingly.

 Set the OPENSSL\_ENGINE\_EMBSE\_ID definition to pkcs11 in the header file called ax\_embSeEngine.h. Run

```
$ nano ~/se050_middleware/simw-top/sss/plugin/openssl/engine/
inc/ax_embSeEngine.h
```

and modify lines 73 and 75 so that it looks like Figure 4.

pi@raspberrypi: ~	~ ^	×
File Edit Tabs Help		
GNU nano 3.2 /home/pi/se050_middleware/simw-top/sss/plugin/openssl/engine/inc/ax_embSeEngine.h		÷.
#include "fsl_sss_ftr.h" #else #include "fsl_sss_ftr_default.h" #endif		l
<pre>#ifdefcplusplus extern "C" { #endif</pre>		
<pre>#if (SSS_HAVE_A71CH    SSS_HAVE_SE050_EAR_CH) #define OPENSSL_ENGINE_EMBSE_ID "pkcsl1" #delif (SSS_HAVE_SE05X    SSS_HAVE_MEDTLS    SSS_HAVE_OPENSSL) #define OPENSSL_ENGINE_EMBSE_ID "pkcsl1" #delse #deror "Define a valid target Secure Element" #endif</pre>		
// Signature to indicate that the RSA/ECC key is a reference to a key stored in the Secure Element AG Get Help AO Write Out AM Where Is AK Cut Text AJ Justify AC Cur Pos M-U Undo AX Exit AR Read File AA Replace AU Uncut Text AT To Spell A Go To Line M-E Redo		

Figure 4. Set the engine id to pkcs11 in the header file ax\_embSeEngine.h

4. Build and install the openssl engine. Run these commands in order:

```
$ cd ~/se050 middleware/simw-top
```

- \$ python scripts/create\_cmake\_projects.py
- \$ cd ~/se050 middleware/simw-top build/
- raspbian\_native\_se050\_t1oi2c
- \$ cmake --build .
- \$ sudo make install
- \$ sudo ldconfig /usr/local/lib
- 5. Build and install the ssscli command line client. Run these commands in order:
  - \$ cd ~/se050\_middleware/simw-top/pycli
  - \$ sudo pip3 install -r requirements.txt
  - \$ sudo pip3 install --editable src

Please refer to <u>AN12570-Quick start guide with Raspberry Pi</u> for a detailed guide on building the EdgeLock SE05x Plug & Trust Middleware.

6. The device public key can be directly read from the EdgeLock SE05x ease of use configuration. <u>Table 2</u> shows the ECC256 key pair we selected for this purpose:

 Table 2. ECC256 public key selected from the EdgeLock SE05x ease of use configuration

Key name and type	Certificate	Usage policy	Erasable by customer	Identifier
IoT connectivity	Cloud Connectivity Certificate 0, ECC signed	Anybody, read	No	Key: 0xF0000000 Cert: 0xF0000001

**Note**: This ECC256 key pair has been selected as an example, for a complete detail of the EdgeLock SE05x ease of use configuration, refer to <u>AN12436 - SE050</u> configurations.

Now, use the ssscli tool to extract the client ECC certificate from the EdgeLock SE05x with the argument get. Then, the argument refpem is used to obtain a reference key which tells the OpenSSL engine to forward the cryptographic request to the EdgeLock SE05x.

Run the commands:

```
$ cd ~/wifiEAP
```

\$ ssscli connect se050 tloi2c none

\$ ssscli get cert 0xF0000001 client.crt

\$ ssscli refpem ecc pair 0xF0000000 client\_ref.pem

If you are not able to connect to the EdgeLock SE05x with an error saying that there is a session already open, run \$ ssscli disconnect first. See Figure 5 for reference.

Pi@raspberrypi: ~/wifiEAP	_	×
pi@raspberrypi:~ \$		$\sim$
pi@raspberrypi:~ \$		
pi@raspberrypi:~ \$ mkdir wifiEAP		
pi@raspberrypi:~ \$ cd wifiEAP		
pi@raspberrypi:~/wifiEAP \$ ssscli connect se050 tloi2c none		
pi@raspberrypi:~/wifiEAP \$ ssscli get cert 0xF0000001 client.crt		
Getting Certificate from KeyID = 0xF0000001		
sss :INFO :atr (Len=35)		
00 AO 00 00 03 96 04 03 E8 00 FE 02 0B 03 E8 08		
01 00 00 00 00 64 00 00 0A 4A 43 4F 50 34 20 41		
54 50 4F		
sss :WARN :Communication channel is Plain.		
sss :WARN :!!!Not recommended for production use.!!!		
INFO:sss.util:writing to file in der format		
Retrieved Certificate from KeyID = 0xF0000001		
pi@raspberrypi:~/wifiEAP \$ ssscli refpem ecc pair OxF0000000 client_ref.pem		
sss :INFO :atr (Len=35)		
00 AO 00 00 03 96 04 03 E8 00 FE 02 0B 03 E8 08		
01 00 00 00 00 64 00 00 0A 4A 43 4F 50 34 20 41		
54 50 4F		
sss :WARN :Communication channel is Plain.		
sss :WARN :!!!Not recommended for production use.!!!		
Created reference key for ECC Pair from KeyID = 0xF0000000		
pi@raspberrypi:~/wifiEAP \$		
		$\sim$

Figure 5. Raspberry Pi connecting to the EdgeLock SE05x, extracting the client key and creating a reference certificate

 Set the wpa\_supplicant configuration so that the Raspberry Pi connects to the wireless network and uses the appropriate credentials, as configured in <u>Figure 3</u>. Run the command

\$ sudo nano /etc/wpa\_supplicant/wpa\_supplicant.conf
and replace all contents with the following snippet:

```
pkcs11_engine_path=/usr/local/lib/libsss_engine.so
pkcs11_module_path=/usr/local/lib/libsss_engine.so
network={
    ssid="ssid_name"
    priority=1
    engine=1
    key_mgmt=WPA-EAP
    pairwise=CCMP TKIP
    auth_alg=OPEN
    eap=TLS
    # identity string, will not be checked on server
    identity="user1"
    # disable server CA checking for demo purpose
    # ca_cert="/home/pi/wifiEAP/ca.pem"
    client_cert="/home/pi/wifiEAP/client.crt"
    private_key="/home/pi/wifiEAP/client_ref.pem"
}
```

#### 3.5 Run device network connection

After the configuration of the access point, the FreeRADIUS server and the Raspberry Pi, we will proceed with the device network connection leveraging EdgeLock SE05x and WPA2 EAP-TLS authentication by following the steps below.

**Note:** For clarity, command windows with a white background correspond to the client (Raspberry Pi), and the black background corresponds to the FreeRADIUS server.

 Start the FreeRADIUS server on the Linux machine. Launch the service in debugging mode to be able to watch the log. To do this, run the command:
 \$ sudo freeradius -X

When it's ready, it should say 'Ready to process requests', as shown in Figure 6.

🚱 192.168.4.41 - PuTTY	-	×
TTUIL (		
max connections = 16		
lifetime = 0		
idle timeout = 30		
}		
Listening on auth address 127.0.0.1 nort 18120 bound to server inner-tunnel		
Listening on auth address * nort 1812 hound to server default		
Listening on each educes a nort 1813 hound to server default		
Listening on auto address port 1012 bound to source default		
Listening on auto address :: port 1012 bound to server default		
Listening on acct address :: port 1813 bound to server default		
Listening on proxy address * port 55535		
Listening on proxy address :: port 38366		
Ready to process requests		
		$\sim$

Figure 6. Log window of the FreeRADIUS server being launched in debugging mode

2. Back on the Raspberry Pi acting as a client, kill the current wpa\_supplicant process with the command:

\$ sudo pkill wpa\_supplicant

3. Restart the supplicant on the wireless network interface with the settings we configured in the last section using this command on one line:

\$ sudo wpa supplicant -c /etc/wpa supplicant/

wpa supplicant.conf -i wlan0 -D wext

After a short time, you should see in the log that the authentication was successful, as shown in Figure 7

i∰ pi@raspberrypi: ~	- 🗆 X
pi@raspberrypi:~ \$ sudo killall wpa_supplicant	^
pi@raspberrypi:~ \$ sudo wpa_supplicant -c /etc/wpa_supplicant/wpa_supplicant.conf -i wlan0 -D	wext
Successfully initialized wpa_supplicant	
ioctl[SIOCSIWENCODEEXT]: Invalid argument	
ioctl[SIOCSIWENCODEEXT]: Invalid argument	
wlan0: Trying to associate with 64:70:02:dl:63:d5 (SSID='iot-eap' freq=2412 MHz)	
Failed to add supported operating classes IE	
wlan0: Associated with 64:70:02:d1:63:d5	
wlan0: CTRL-EVENT-EAP-STARTED EAP authentication started	
wlan0: CTRL-EVENT-EAP-PROPOSED-METHOD vendor=0 method=13	
ssse-flw: EmbSe_Init(): Entry	
App : INFO : If you want to over-ride the selection, use ENV=EX_SSS_BOOT_SSS_PORT or pass in a	command line arguments.
sss :INFO :atr (Len=35)	Initialize Connection to SE
00 A0 00 00 03 96 04 03 E8 00 FE 02 0B 03 E8 08	
01 00 00 00 64 00 00 0A 4A 43 4F 50 34 20 41	
54 50 4F	
sss :WARN :Communication channel is Plain.	
sss :WARN :!!!Not recommended for production use.!!!	
ssse-flw: Version: 1.0.5	Sonver Cartificate
ssse-flw: EmbSe Init(): Exit	Server Certificate
wlan0: CTRL-EVENT-EAP-METHOD EAP vendor 0 method 13 (TLS) selected	
wlan0: CTRL-EVENT-EAP-PEER-CERT depth=0 subject='/CN=radius server' hash=cbc34d755ca47f4891bc	d2482b25f882fdcda6eb5c9f16cb9da203761f5bc677
wlan0: CTRL-EVENT-EAP-PEER-CERT depth=0 subject='/CN=radius server' hash=cbc34d755ca47f4891bc	d2482b25f882fdcda6eb5c9f16cb9da203761f5bc677
ssse-flw: Invoking EmbSe ECDSA Do Verify()	
ssse-dbg: ====>SIGNATURE (len=70)	Public Key Verify and ECDH
ssse-dbg:	
30 44 02 20 30 5F 7D DD AC 71 85 E5 26 2F 2D 46	
52 42 63 38 6E 47 9B FA 07 5C 3E 90 28 60 06 60	
3E 2B 7C 99 02 20 7A 85 6A AD AA DD BC 1B 12 40	
BA FE 33 AC 67 33 10 D4 8B DB FA 4D C4 0E 47 CD	
02 D2 7D D6 C3 8B	
ssse-dbg: ====>DIGEST	
4D F0 4C 3E 3D 5F 4D A7 E5 1F F7 D2 3F 10 D3 0A	
A4 6C BD BF 3A 1D 91 07 56 F5 4B 92 CA 14 50 FF	
ssse-flw: No matching key in Secure Element. Invoking OpenSSL API: ECDSA_do_verify.	
ssse-flw: Verification by OpenSSL PASS	
ssse-flw: EmbSe_Simple_Compute_Key invoked (ecdh)	
ssse-dbg: ** nid = 415 **	
ssse-flw: No matching key in SE. Invoking OpenSSL API: ECDH_compute_key.	
ssse-flw: ECDH_compute_kev_bv_OpenSSL_PASS	
ssse-dbg: Using keyId=0xF0000000	
ssse-dbg: shaAlgo: 771	SE signs request
ssse-flw: SSS based sign (keyId=0xF0000000, dgstLen=32)	5 1
ssse-flw: SSS based sign called successfully (sigDERLen=71)	
ssse-flw: EmbSe ECDSA Do Sign success.	
wlan0: CTRL-EVENT-EAP-SUCCESS EAP authentication completed successfully	A sublement in a finance of the second second
wlan0: PMKSA-CACHE-ADDED 64:70:02:d1:63:d5 0	Authentication finished
wlan0: WPA: Key negotiation completed with 64:70:02:dl:63:d5 [PTK=CCMP GTK=CCMP]	
wlan0: CTRL-EVENT-CONNECTED - Connection to 64:70:02:dl:63:d5 completed [id=0 id_str=]	
	×

Figure 7. Authentication and association log of the service wpa\_supplicant running on the Raspberry Pi

4. The Raspberry Pi will be assigned an IP address on the successful EAP-TLS handshake. In the FreeRADIUS server, you should now see a new connection request in the terminal window, as shown in Figure 8.

🚰 192.168.4.41 - PuTTY	– 🗆 X
Listening on proxy address * port 55535	^
Listening on proxy address :: port 38366	
Ready to process requests	
ЧК	
III) # Eveniting	
(0) authenticate (	
(0) eap: Peer sent packet with method EAP Identity (1) (0) eap: Calling submodule can the to process data	ate from client
(0) eap tls: Initiating new EAP-TLS session	
(0) eap_tls: Setting verify mode to require certificate from client	
(0) eap tis: [eaptis start] = request (0) Sending EAP Request (code 11) length 6	
90354	
(2) eap tis. [length Olu.,	
(2) eap tls: Creating attributes from certificate OrDs	
(2) eap_t1s: TLS-Cert-Serial := "U3" (2) eap_t1s: TLS-Cert-Expiration := "3404251417512"	Client CA
(2) eap_tls: TLS-Cert-Subject := "/OU=Plug and Trust/O=NXP/CN=NXP Interme	diate-Connectivi
tyCAvE206'' (2) ean tist TLS_Cert_Issuer to "/OHEPlug and Trust/OHMYP/CMENVP RootCive	506"
(2) eap tls: TLS-Cert-Common-Name := "NXP Intermediate-ConnectivityCAvE20	06"
(2) eap tls: Creating attributes from certificate OIDs	
(2) eap_tls: TLS-Client-Cert-Serial := "0400500143e762907abd8b04420a59550 (2) eap_tls: TLS-Client-Cert-Expiration := "3106150000002"	ent certificate
(2) eap_tls: TLS-Client-Cert-Subject := "/OU=Plug and Trust/O=NXP/CN=DevC	Conn0-0400500143E
7C2907ABD8B04420A59550000" (2) een tig:TLS_Client_Cert_Tequer := "/OH=Plug and Trust/O=NYP/CN=NYP	Intermediate-Conn
ectivityCAvE206"	.nocimearaoe com
(2)	D8B04420A5955000
(J) } # po-	
<ul> <li>(3) y # post-auth = hoop</li> <li>(3) Sent Access-Accept Id 152 from 192.168.4.41:1812 to 192.168.4.1:37485 1</li> </ul>	ength O
(3) MS-MPPE-Recv-Key = 0xc9883def256b2f5a1d2b230b7b36b7def02f441eeaa8c7c5	0e648c2856ccb344
<ul> <li>(3) EAP-Message = 0x030d0004</li> </ul>	6066691622710335
(3) Message-Authenticator = 0x0000000000000000000000000000000000	cess granted
<pre>(3) User-Name = "user1" (3) Finished request</pre>	
4 6 seconds.	L
(3) Cleaning up required TD 152 with timeson	
Ready to process requests	~
Figure 8. Log window of the FreeRADIUS server showing a set	uccessful
authentication request	

In this demo we have covered the complete setup process of a network using WPA2 Enterprise. We have set up the access point, the FreeRADIUS machine as the authentication server, and successfully connected a client to the network. We have used a Raspberry Pi as a wireless device with the EdgeLock SE05x as a companion security chip to safely store credentials.

## EdgeLock<sup>™</sup> SE05x for Wi-Fi Credential Protection

# 4 Legal information

### 4.1 Definitions

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