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EdgeLock SE05x for device-to-device authentication

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Application note

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Document information

Information	Content
Keywords	EdgeLock SE05x, mutual authentication, proof of possession
Abstract	This document describes how to leverage EdgeLock SE05x for device-to-device authentication



Revision history

Revision history

Revision number	Date	Description
1.0	2019-06-08	First document release
1.1	2020-01-20	Added EdgeLock product name and other minor corrections
1.2	2020-12-07	Updated to new template and fixed broken URLs
1.3	2021-03-28	Update chapter 4 EdgeLock SE05x secure provisioning

1 Device-to-device authentication

The IoT environment increases the exposure of high value components to new security threats. OEM manufacturers need to protect themselves from non-authorized components, discriminate original devices from fake copies, avoid device misuse and over usage, and make sure customers purchase original equipment.

If we do not take security into account, attackers may try to compromise our devices by:

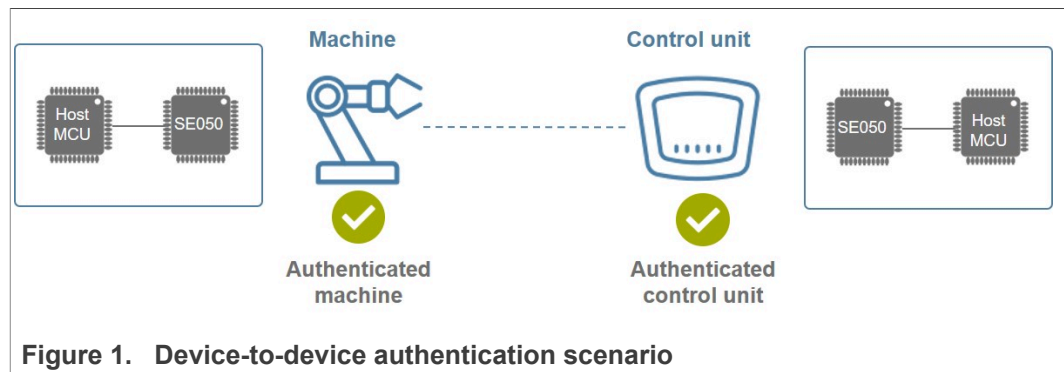
- Exploiting software bugs
- Extracting device keys
- Inserting counterfeit devices
- Abusing untrusted connections
- Disclosing confidential data, etc

These security threats are significantly serious for IoT systems dealing with real time processes, even risking safety in case of medical devices, industrial processes, energy grids or traffic lights automation, among others.

For illustrative purposes, let's assume an OEM which manufactures a certain type of machinery controlled by a centralized control unit as shown in [Figure 1](#). As these machines perform some critical tasks in the manufacturing plant:

- The control unit authenticates the machine that is attempting to connect to it.
- The machines also authenticate the control unit that will manage it.

Therefore, only authenticated machines and control units will be used in the supply chain. This mechanism ensures protection against rogue devices that might damage production, degrading security levels or risking employee safety.



The exchange of digital certificates is the basis of the authentication process. The two parties check that the certificate is valid and was issued by a trusted authority, known as Certificate Authority. [Section 2](#) describes how certificates are verified using a certificate chain of trust.

Digital certificates, as public information, are susceptible to be intercepted and be misused. For this reason, a proof of possession of the certificate private key is an essential requirement to validate the certificate source. [Section 3](#) describes how to leverage EdgeLock SE05x to conduct the proof of possession.

The private key must be kept secret and protected. The leakage of any private key compromises the identity verification and the overall system security. The EdgeLock SE05x provides a trust anchor at the silicon level, providing a tamper-resistant platform capable of securely storing keys and credentials needed for offline authentication.

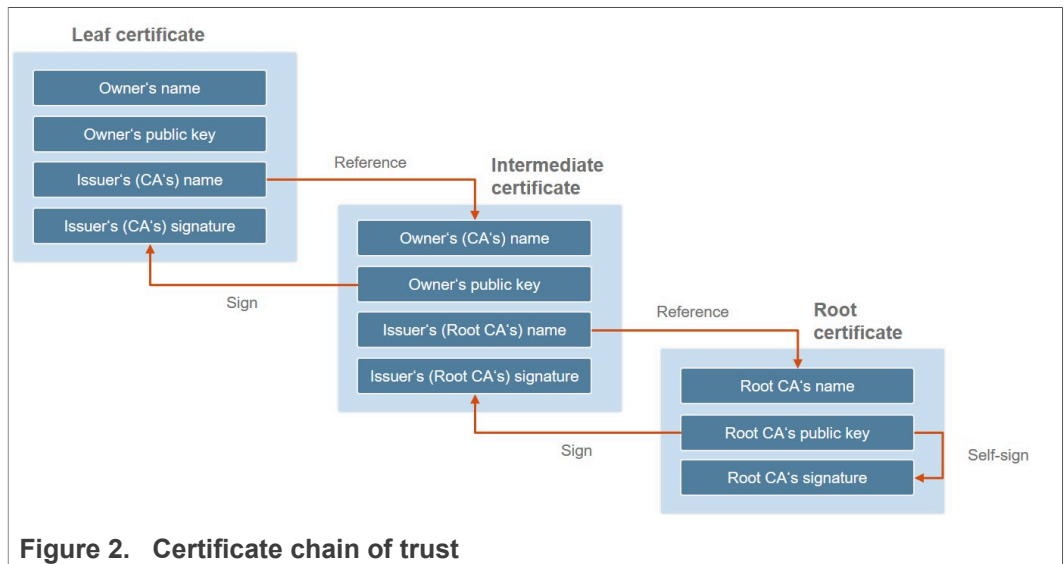
2 Certificate chain of trust

IoT requires each device to possess a unique identity. For certificate-based authentication scheme, the identity is made of:

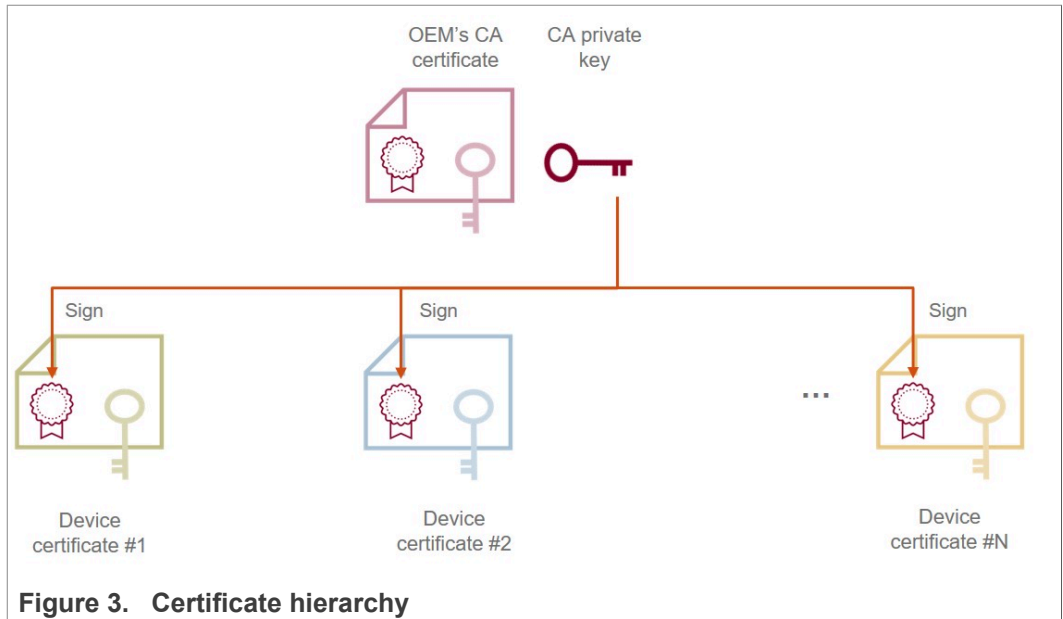
- Device certificate
- Device key pair

The digital certificate binds an identity with a public key. Digital certificates are verified using a chain of trust. The certificate chain of trust is a structure of certificates that enable the receiver to verify that the sender and all CA's are trustworthy. The trust anchor for the digital certificate is the root CA.

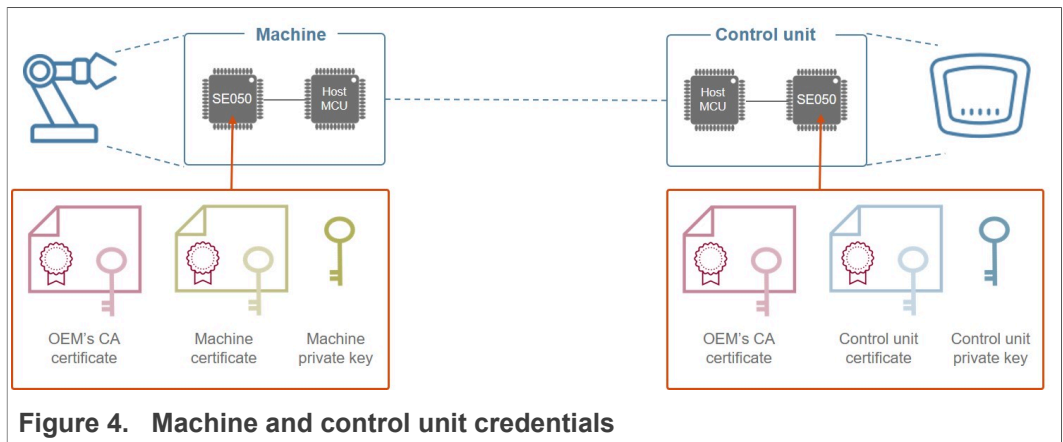
Certificates are issued and signed by certificates that reside higher in the certificate hierarchy, so the validity and trustworthiness of a given certificate is determined by the corresponding validity of the certificate that signed it. The certificate chain of trust results in a root CA signing an intermediate CA that in turn signs a leaf certificate as shown in [Figure 2](#)



IoT devices manufactured by the OEM should be equipped with a unique key pair and a digital certificate signed by the OEM's CA certificate. The OEM's CA certificate is used to sign all the certificates of the devices manufactured by the OEM. Precisely, this signature provides the means to verify the validity of device certificates in the field ([Figure 3](#)).



Before a machine or control unit manufactured by the OEM goes to the operation phase, they must possess the CA certificate, an individual certificate and a key pair securely stored as shown in [Figure 4](#).



Secure silicon chips like EdgeLock SE05x are capable of internally protecting private keys in IoT devices. The CA certificate could optionally be stored outside the EdgeLock SE05x. [Section 4](#) outlines the EdgeLock SE05x trust provisioning models available.

3 Mutual authentication flow

The authentication flow consists of a mutual authentication procedure. First, the machine will authenticate the control unit that it will be connected to. After that, the control unit will authenticate the machine that attempts to connect.

3.1 Control unit authentication

The authentication of the control unit consists of two steps: the *certificate validation* and the private key *proof of possession* as shown in [Figure 5](#).

Certificate validation:

The first step is the verification of the control unit digital certificate.

1. The control unit sends its device certificate together with its hierarchy of CA certificates.
2. The machine validates that the provided certificate chain of trust is valid by verifying the signatures of all the certificates in the chain up to the root CA

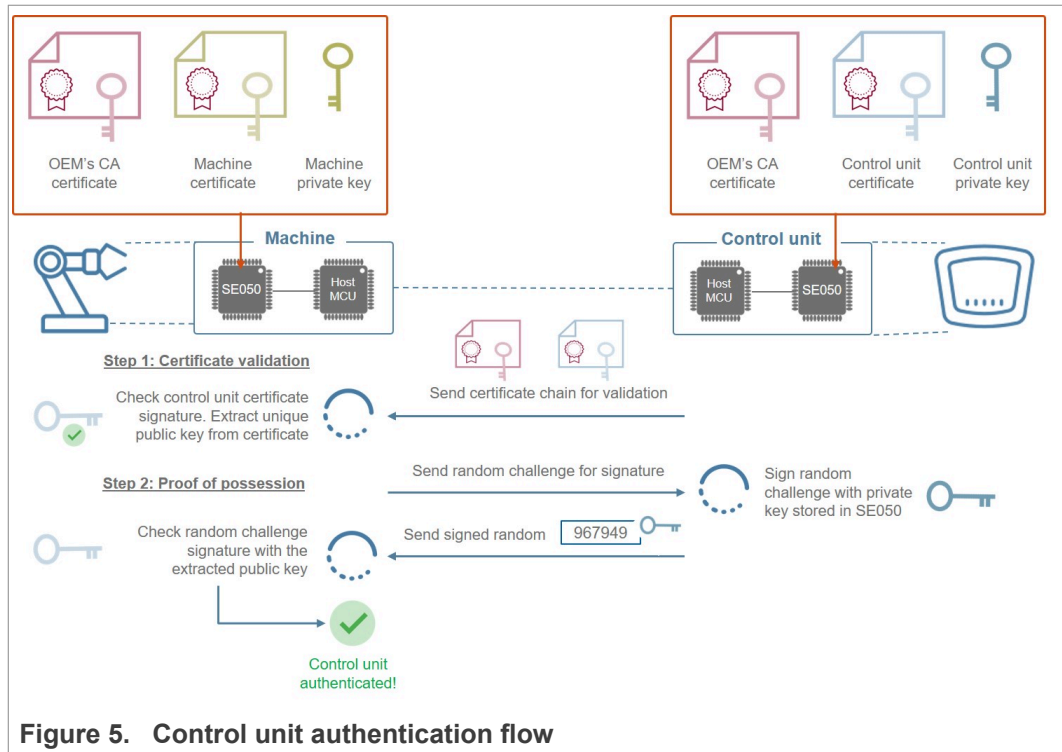
If the control unit certificate is valid, it means that the public key included in it can be trusted.

Proof of possession:

The second step is the proof of possession. This procedure is needed to make sure that the certificate we verified belongs to the control unit. This proof of possession mechanism ensures that the uploader of the certificate also knows the associated private key. For that,

1. The machine generates a random challenge
2. The control unit returns the random challenge signed, using its private key stored inside EdgeLock SE05x.
3. The machine validates the random number signature with the public key obtained from the machine certificate

A successful response means that the control unit is authentic. Bear in mind that the trust relies on protecting the private key. For this reason, the use of EdgeLock SE05x is fundamental to make sure the private key is not compromised.



3.2 Machine authentication

The authentication of the machine also consists of two steps: the *certificate validation* and the private key *proof of possession* as shown in [Figure 6](#). These two steps are equivalent to the ones performed for the control unit authentication.

Certificate validation:

The first step is the verification of the machine digital certificate.

1. The machine sends its device certificate together with its hierarchy of CA certificates.
2. The control unit validates that the provided certificate chain of trust is valid by verifying the signatures of all the certificates in the chain up to the root CA

If the machine certificate is valid, it means that the public key included in it can be trusted.

Proof of possession:

The second step is the proof of possession. This procedure is needed to make sure that the certificate we received belongs to the machine. This proof of possession mechanism ensures that the uploader of the certificate also knows the associated private key. For that,

1. The control unit generates a random challenge
2. The machine returns the random challenge signed, using its private key stored inside EdgeLock SE05x.
3. The control unit validates the random number signature with the public key obtained from the machine certificate

A successful response means that the machine is authentic. Bear in mind that the trust relies on protecting the private key. For this reason, the use of EdgeLock SE05x is fundamental to make sure the private key is not compromised.

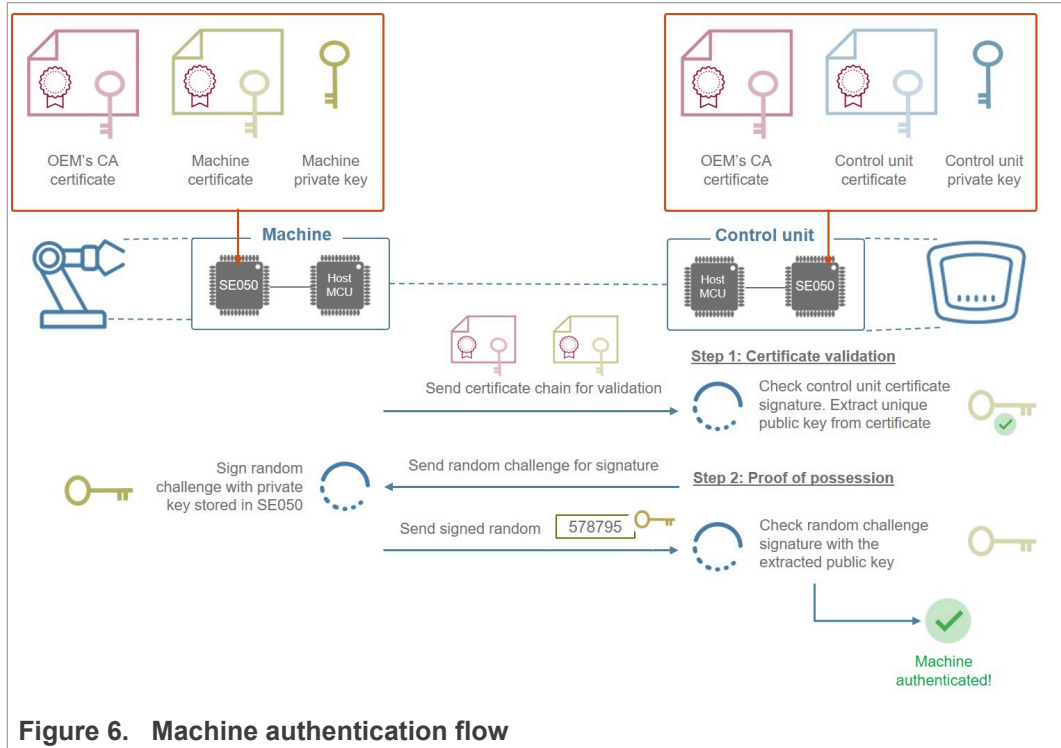


Figure 6. Machine authentication flow

4 EdgeLock SE05x secure provisioning

The IoT device identity should be unique, verifiable and trustworthy so that device registration attempts and any data uploaded to the OEM's servers can be trusted.

The EdgeLock SE05x is designed to provide a tamper-resistant platform to safely store keys and credentials needed for device authentication and registration to OEM's cloud service. Leveraging the EdgeLock SE05x security IC, OEMs can safely authenticate their devices without writing security code or exposing credentials or keys.

You can rely on any of the secure provisioning options for the EdgeLock SE05x security IC:

- **EdgeLock SE05x pre-configuration for ease of use:** Every EdgeLock SE05x product variant comes pre-provisioned with keys which can be used for all major use cases, including device-to-device authentication.
- **EdgeLock SE05x secure provisioning by NXP:** The NXP Trust Provisioning service offers customized and secure injection of die-individual keys and credentials into EdgeLock SE05x on behalf of the OEM. This service is available for high volume orders of more than 150K units.
- **EdgeLock SE05x secure provisioning by NXP EdgeLock 2Go - Managed cloud service:** NXP offers to connect your devices to the cloud with this remotely operated service. OEMs configure the services they want to connect to, using NXP's EdgeLock 2GO web portal www.nxp.com/EdgeLock2GO and NXP takes care of everything else. The EdgeLock 2GO managed service provisions the necessary device keys, certificates and even registers the device certificates with the OEMs cloud service of choice. It's the zero-touch way to deploy with end-to-end security, from chip to cloud. EdgeLock 2GO - Managed supports all cloud types and comes pre-integrated with AWS IoT Core and Azure DPS.
- **EdgeLock SE05x secure provisioning by NXP distributors or third-party partners:** NXP has agreements with distributors and third-party partners to offer customized and secure injection of die-individual keys and credentials into EdgeLock SE05x for orders of any size.

Note: *EdgeLock SE05x provisioning can optionally be done by the OEM in case it owns or invests in PKI infrastructure at their facilities.*

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