NemLog-in

NL3 Broker implementation Guide-lines

Contents

Version	Change	Date
0.1	Draft	09-07-2020
0.2	Internal review and update	06-11-2020
1.0	Version updated as part of release	12-11-2020
1.0.1	Updated based on review from Digst	11-12-2020
1.0.2	Support for multiple IdPs	04-01-2020
1.0.3	Added nemlogin-broker-mock to SignSDK	09-03-2021
1.0.4	Updated OIOSAML Attribute name format. Updated based on review from Digst	11-03-2021

References

NL-SP-IMPL	Signature SP Implementation Guideline, NemLog-in NL3 Signature SP Implementation Guideline.pdf
NL-SIG-PRO-FILE	AdES Signature Profile, NemLog-in. NL3 AdES Signature Format.pdf
SIGNSDK	The Java- or .Net-based NemLog-In SignSDK library used for first stage of the signing process.
OIOSAML	OIOSAML Web SSO Profile 3.0.1 is a SAML implementation profile governed by the Danish Agency for Digitisation. The specification is available here: https://digst.dk/media/21892/oiosaml-web-sso-profile-301.pdf
eIDAS	Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC. Available here: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0910&from=EN
PDF	ISO 32000-1, Document management – Portable document format – Part 1: PDF 1.7. Available here: https://www.adobe.com/content/dam/acom/en/devnet/pdf/pdfs/PDF32000_2008.pdf
PAdES	ETSI EN 319 142-1: AdES digital signatures; Part 1: Building blocks and PAdES baseline signatures, ETSI ESI. Available here: https://www.etsi.org/deliver/etsi_en/319100_319199/31914201/01.01.01_60/en_31914201v010101p.pdf
XAdES	ETSI EN 319 132-1: XAdES digital signatures; Part 1: Building blocks and XAdES baseline signature, ETSI ESI. Available here: https://www.etsi.org/deliver/etsi_en/319100_319199/31913201/01.01.01_60/en_31913201v010101p.pdf

NSIS	National Standard for Identity Assurance Levels (NSIS), Version 2.0.1, Digitaliseringsstyrelsen, 2019. Available here: https://digst.dk/media/22920/nsis-engelsk-version-201_final.pdf

1 The Purpose and Target Audience of the Document

This document is part of the NemLog-in Broker Package. The purpose of this document is to provide the technical documentation required to develop a signing client that integrates with the NemLog-in Signing backend.

This document is aimed at developers and architects.

1.1 Document Conventions

Code examples and XML snippets are written using a fixed width font. References are marked in square-brackets, e.g. [OIOSAML].

1.2 Abbreviations

Abbreviation	Description
SP	Service Provider. The entity delivering the documents to be signed. It is important to distinguish between NemLog-in SPs and the Broker SPs. In this document SP is used as a term for the Brokers SPs.
Signer	End user identity performing the actual document signing. This can be a person or an employee signing on behalf of an organization
SD Document Format	Signer's document input format (HTML, XML, Text or PDF)
SD	Signer's document. The original document that is input to the signing process. SD is in a valid Document Format.
Signature Format	The format (XAdES, PAdES) of the DTBS payload to be signed.
Signature	Signatures is produced for an individual. F.ex. a person or an employee
Seal	Seals is a signature produced for a legal identity, f.ex. a business or organization.
DTBS	Data To Be Signed. The transformed document in a valid Signature Format that is to be signed
SDO	Signed Data Object. The signed document XAdES or PAdES

JWS	JSON Web Signature https://tools.ietf.org/html/rfc7515
PAdES	PDF Advanced Electronic Signatures
XAdES	XML Advanced Electronic Signature
ASN.1	Abstract Syntax Notation 1
AdES	Advanced Electronic Signature
CMS	Cryptographic Message Syntax. For PDF a CMS may contain a AdES.
OCSP	Online Certificate Status Provider
QSCD	A Qualified Secure Signature Generation, part of the NemLog-In Signing backend.

2 Motivation

The NemLog-in signature client is aimed for SP's to quicly integrate signature facilities using NemLog-in as an identity provider.

For Brokers who use other identity schemes, the NemLog-in infrastructure supports them building their own signature client using the NemLog-in backend systems for certificate issuing and signature generation.

Now, as the signature flow used in NemLog-in, ensures that the document to be signed remains within the Brokers environment, the integration is quite technical as the Broker must implement part of the Advanced formatting into the final signature object. Brokers pursuing this road should consult the references describing the signature formats.

3 Introduction

This document serves as the technical documentation for brokers on how to implement a Signing Client using the NemLog-in Broker API. It supplements the document [NL-SP-IMPL] aimed for Service Providers using the NemLog-in signature client by providing details specific for using the Broker API. Anyone who wishes to become a Broker must be registered with and be approved by NemLog-In.

Part of the requirements for Brokers to implement a Signing Client is to use the SignSDK [SIGNSDK] to prepare a *Signing Payload* consisting of the Data To Be Signed (DTBS) and JWS-sealed signature parameters.

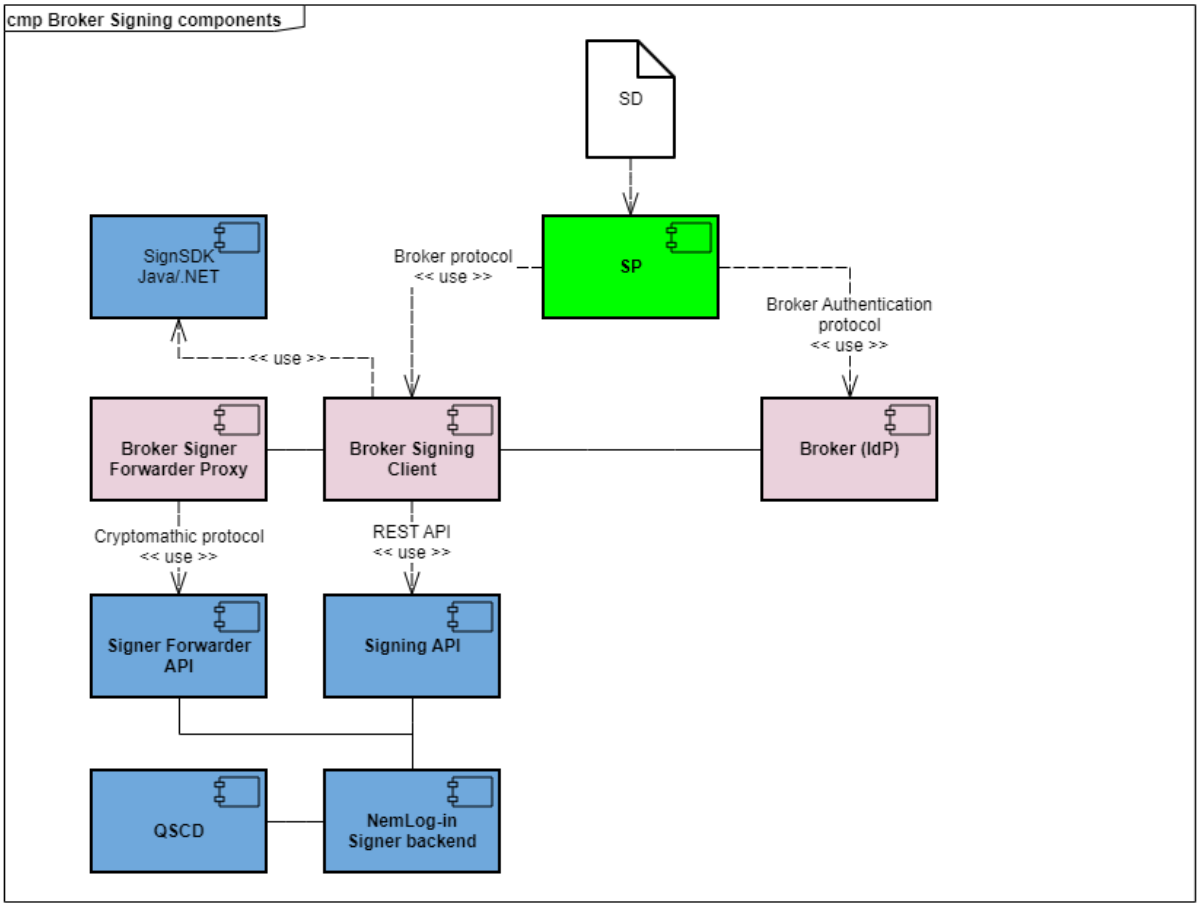
The SignSDK is documented in detail in chapter 4 of the Service Provider implementation guidelines [NL-SP-IMPL] for NemLog-in SPs.

The NemLog-in Broker API supports the creation of PAdES-B-LTA [PAdES] and XAdES-B-LTA [XAdES] signatures and seals based on the input formats HTML, Text, XML and PDF. The signature formats is described in [NL-SP-IMPL] chapter 3.

In this document, *signature* will be used at the general term for both signatures and seals, unless it is important for the implementation details.

A Broker must implement the `Broker Signing Client` and `Broker IdP` components shown below. Depending on the Broker's choice of technology they can be implemented as one component. The SPs integrate with the `Broker Signing Client`. The details of the integration between the Broker and their SPs is up to the Broker.

A Broker must be registered to NemLog-in and have a valid Broker's entity ID and VOCES certificate. Once the registration and issuing is done, NemLog-in will use the entity ID and certificate to authorize the Broker and verify the SAML Assertions.



The Broker signing process involves the following actors:

- Broker Signing Client. The Signing Client implemented by the Broker capable of creating PAdES and XAdES signatures.

- Broker (IdP). The Broker (IdP) must be capable of authenticating end users and to create valid OIOSAML Assertions. See ‘8 SAML Integration’.
- Broker Signer Forwarder Proxy. The Broker must implement a Signer Forwarder Proxy that enables the requests to Signer Forwarder API from the Broker Signing Client to be proxied through the Brokers backend.
- Signer. The end entity performing the signing of the Signers Document (SD).
- SignSDK: A Java- or .Net-based NemLog-In SignSDK library used for first stage of signing. The library is documented in details in [NL-SP-IMPL] chapter 4. The SignSDK creates the Signing Payload required to initiate the signing process using the NemLog-in backend APIs.
- Signing API. Part of the NemLog-in backend and responsible for creating the AdES signatures.
- Signer forwarder API. Part of the NemLog-in backend and responsible for providing the signature value using a short term qualified certificate issued to the Signer.
- NemLog-in backend. The NemLog-in backend components required to create the signature.

4 Broker Integration – overview

Signing a document involves a series of steps. The following is a high level description of the required steps. See ‘6 Broker Integration – ’ for a detailed description of each step.

The supported types of the Signer’s Documents (SD) to be signed – hereafter denoted as SD Document Format – are either HTML, Text, XML or PDF. The resulting output of the signing process can be either PAdES or XAdES. All combinations are supported by the SignSDK.

Brokers are obligated to validate that any SD only contains content permitted by the whitelists defined in [NL-SP-IMPL] appendix C & D.

- Step 1: Prepare Signing Payload.
  Before any document can be signed, the Signing Payload consisting of JWS-sealed Signature Parameters and Data To Be Signed (DTBS) must be initialized using the SignSDK. Please refer [NL-SP-IMPL] for details.

- Step 2: Create Signing Session.
  Before presenting the document for the end user, a signing session must be initiated by sending the JWS-sealed Signature Parameters to the backend using the Signing API. If the backend is able to validate the Signature Parameters a Signing Session is created and a sessionId and security code is returned to the Broker.

- Step 3: Present document and security code to end user.
  When presenting the document for the end user to read and sign, the security code should be visible for the end user.

- Step 4: Authenticate end user and create OIOSAML Assertion.
  When the end user has agreed to sign the document the end user must be authenticated and an OIOSAML Assertion created. The Assertion must be unencrypted but signed.

- Step 5: Issue certificate.
  Based on the OIOSAML Assertion, a short term signing certificate is issued using the Signing API and a SAD SAML Assertion is returned.

  The issued certificate and corresponding private key is kept securely at the NemLog-in backend and after the signing is done, the private key is deleted. This ensures that a given certificate can only be used to sign a document once.

- Step 6: Calculate signature value.
  Based on the response values returned when issuing the signing certificate, the raw signature value is then calculated by the QSCD using the signer-forwarder API.

- Step 7: Create PAdES/XAdES LTV signature.
  The raw signature value is then used to create the LTV signature. When creating the LTV signature the Signing API will perform revocation checks on all certificates used during the signing process.

  For PAdES signatures, the signature AdES object is returned alongside a list of certificates used in the signing process and revocation information. The placeholder signature AdES object created by the SignSDK must then be replaced with the signature AdES object in the PDF document. Certificate and revocation dictionaries must also be added to the PDF document.

  For XAdES signatures a base64 encoded string is returned which must be used when preparing the LTA signature.

- Step 8: Create PAdES/XAdES LTA signature.
  In order to create the final LTA signature, the broker must calculate the document digest to be used when creating the archive timestamp.

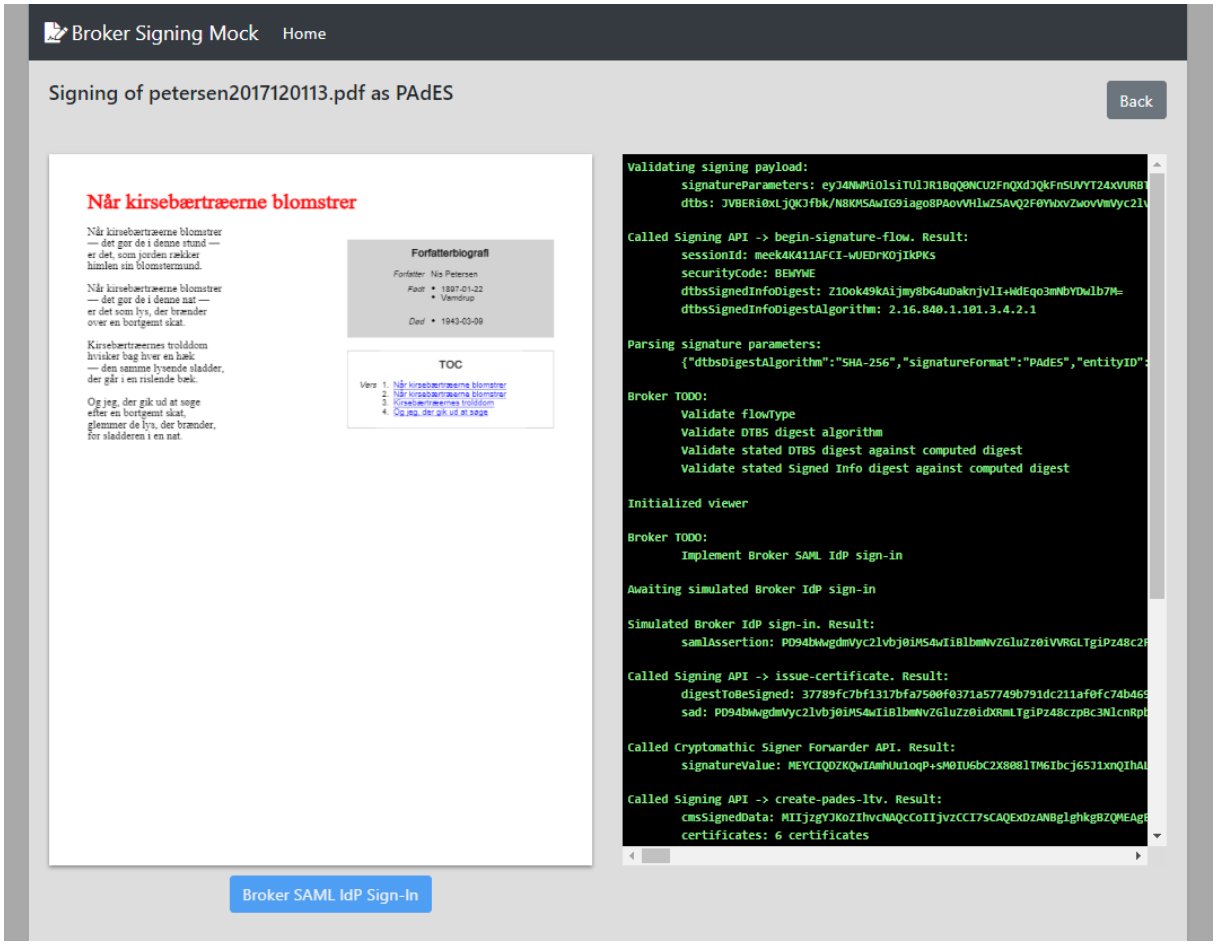
  For PAdES signatures, this requires a placeholder timestamp dictionary to be added to the PDF and then the digest value to be calculated over the bytes ranges covering the document, LTV signature dictionary, certificate and revocation dictionaries. The digest is then sent to the Signing API and the archieve time stamp is created. The placeholder timestamp dictionary in the PDF document must then be replaced by the timestamp returned by the Signing API.

  For XAdES signatures a digest must be calculated over the value of the SignText element in the XML, postfixed with the base64-decoded value returned by the Signing API in the previous step. The XMLDSig signature element created by the SignSDK must then be replaced by the signature element returned by the Signing API.

- Step 9: Validate Signature
  When the document has been signed, the Broker must verify that the document has been signed by the expected end user.

5 Broker Example Code

SignSDKJava contains an example web application, *nemlogin-broker-mock*, which illustrates how Brokers may use the SignSDK to generate a *Signing Payload* and how to subsequently call the back-end NemLog-In Signing API involved in the generating a signed document.



The Broker Signing Mock applications handles all Signer's Document formats (PDF, XML, HTML, TEXT) and Signature Formats (PAdES and XAdES) and performs all the back-end API calls needed to sign a document.
However, the code is not for production usage, and the task of converting the DTBS (Data To Be Signed) generated by SignSDK into the final signed document, using data obtained by calling the NemLog-In Signing API, is left to the Broker, in accordance with the specification of the following chapters.

6 Broker Integration – details

This section contains a more in-depth explanation of the steps required to create an AdES LTA signature. The process has been divided into three parts:

1. Common Steps. With details of the first six steps, which are identical for both PAdES and XAdES signatures
2. PAdES Signature. The final steps required to create PAdES Signatures.
3. XAdES Signature. The final steps required to create XAdES Signatures.

6.1 Common Steps

6.1.1 ***Step 1: Prepare Signing Payload***

Before any document can be signed, the Signing Payload consisting of Signature Parameters and Data To Be Signed (DTBS) must be initialized using the SignSDK. Please refer to “18 Signing Formats and Data Models” and [NL-SP-IMPL] chapter 3 & 4 for details.

The JWS-sealed Signature Parameters contain the initial information required for the NemLog-in Signing backend to ensure that the signing request originates from a trusted broker and the integrity of the DTBS is intact. The Signature Parameters must contain the entity ID provisioned for the Broker using the NemLog-In Administration Component, and the parameters must be signed using the Brokers VOCES certificate and registered in NemLog-in.

The DTBS created by the SignSDK contains a placeholder signature elements that must be replaced as part of the signature flow. Please note that the DTBS is never sent to the NemLog-in backend.

For PAdES signatures a placeholder Signature Dictionary is added to the PDF. This must be updated by the Broker with the real AdES signature during the signing process. Example placeholder Signature Dictionary generated by SignSDK:

```
<<
/Type /Sig
/Filter /Adobe.PPKLite
/SubFilter /ETSI.CAdES.detached
/Name (NemLog-In Signing SDK)
/Reference [24 0 R]
/M (D:20200710105856+02'00')
/Contents <0000000000000.....0000000000000>
/ByteRange [0 7602 40372 512]
>>
```

For XAdES the SignedDocument element contains a preliminary XMLDSig element that will be extended by the NemLog-in backend during the signing process. The example XMLDsig signature element below is reproduced in a non-canonicalized format for increased legibility:

```
<ds:Signature Id="id-caaa8398-b576-4515-81bf-59030f476bb4">
```

```
  <ds:SignedInfo>
    <ds:CanonicalizationMethod
        Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#"/>
    <ds:SignatureMethod
        Algorithm="http://www.w3.org/2001/04/xmldsig-more#ecdsa-sha256"/>
    <ds:Reference Id="r-id-caaa8398-b576-4515-81bf-59030f476bb4-1"
                  URI="#id-b09c1f7a-74d8-49ed-bc91-b41bf0824673"
                  Type="http://dk.gov.certifikat/nemlogin#SignText">
      <ds:Transforms>
        <ds:Transform Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#"/>
      </ds:Transforms>
      <ds:DigestMethod
          Algorithm="http://www.w3.org/2001/04/xmlenc#sha256"/>
      <ds:DigestValue>
          T+7K+dtyvTNjbgjDBcUpRswbDXBATYW4d/tEXlkuRZQ=
      </ds:DigestValue>
    </ds:Reference>
  </ds:SignedInfo>
</ds:Signature>
```

*6.1.2 **Step 2: Create Signing Session***

A Signing Session is created by calling the Signing API REST operation `begin-signature-flow`. Input to this operation is the JWS-sealed Signature Parameters created by the SignSDK.

The NemLog-in backend will validate Signature Parameters using the VOCES certificate and verify that the VOCES certificate is associated to a Broker.

When the NemLog-in backend has validated the Signature Parameters, a signing session is created and a sessionId is returned to the Broker. The sessionId must be provided in a http header in all subsequent calls to the NemLog-in backend.

Furthermore, a security code is returned and is provided as a mean to let end users identity their signing session during the signing process. The security code should be visible for the Signer when presented with the document to be signed, on the login screen etc.

A mean to ensure the document to be signed matches the document pre-signed by the SignSDK is also returned by `begin-signature-flow` in the form of the Base64-encoded `dtbsSignedInfo-Digest` and `dtbsSignedInfoDigestAlgorithm`. The Broker client should recaclutate the DTBS digest using the stated algorithm and compare to the returned digest:

- For PAdES, the DTBS digest should be computed based on the `ByteRange` included in the Signature Dictionary added by SignSDK.

- For XAdES, the DTBS digest should be computed based on the extracted and canonicalized SignText element.

If the stated and computed digests do not match, then the document shown to the end user does not match the document pre-signed by the SignSDK and the signing flow must be aborted.

6.1.3 ***Step 3: Present document and security code to end user***

When presenting the document to sign to the end user, the security code should also be shown. This is to help the Signer identify their signing session during all steps.

It is the Broker's responsibility to ensure that what is presented to the Signer is also the content signed by the Signer. If e.g. a XLST transformation is used when presenting a XML document, it's the brokers responsibility to ensure all data in the XML document is visible after transformation.

6.1.4 ***Step 4: Authenticate end user and create OIOSAML Assertion***

When the Signer is ready to sign the document, the user must be authenticated using the Broker IdP. The SAML Assertion created by the IdP must adhere to the OIOSAML requirements specified in [OIOSAML] with the additional requirements stated in section '8 SAML Integration'. Furthermore, the Assertion must be unencrypted but be signed using the Brokers VOCES provisioned to the SigningComponent.

For more details of the authentication and SAML Assertion requirements see '8 SAML Integration'

Note that if the SAML Assertion states the Persistence Level as Global, explicit consent must be given by the signer, in order to comply with privacy regulations.

When presenting the Signer with the login, the security code identifying the signing session should be visible to the Signer.

6.1.5 ***Step 5: Issue Certificate***

Based on the information in the OIOSAML Assertion, a short term certificate will be issued to the Signer. The certificate is created by calling the Signing API REST operation `issue-certificate` with the OIOSAML Assertion as input. The issued certificate is kept securely on the NemLog-in Signing backend, and the private key is deleted after the signature session has been finalized, or when the signing session timeout is reached.

When issuing the signing certificate the NemLog-in Signing backend will also perform SAD exchange with the QSCD and return the `digestToBeSigned` and the SAD SAML assertion required to authenticate with the QSCD in the next step.

6.1.6 ***Step 6: Calculate signature value***

To calculate the signature value – please read about the SAP protocol enableling in 12.4.2 SAP Protocol to be able to calculate the signature value.

After the signature value has been calculated the remaining signing process for PAdES and XAdES will be described separately in the following sections.

6.2 PAdES Signature

To create a PAdES signature, the DTBS generated by the SignSDK must be extended with data returned from the NemLog-in backend Signing API and Signer forwarder API.

The examples do not contain all the implementation details required to create a valid PDF document containing a LTA signature. The Broker is excepted to have in-depth knowledge about the PDF specification and to know the additional elements (xref, trailer, root catalog, etc.) required also to be added and/or updated when adding the mentioned objects to a PDF document.

*6.2.1 **Step 7: Create PAdES LTV signature***

When calling the Signing API REST operation `create-pades-ltv` with the signature value calculated in the previous step, the final CMS Signed Data containing a signature adhering to the LTV-profile is returned alongside the certificates and OCSP revocation information.

The hex-encoded CMS Signed Data shall replace the Content of the placeholder `Sig` dictionary created by the SignSDK when initializing the document to be signed. The replacement `Sig` Content must be padded to the exact same length as the placeholder `Sig` content (green below).

```
<<
/Type /Sig
/Filter /Adobe.PPKLite
/SubFilter /ETSI.CAdES.detached
/Name (NemLog-In Signing SDK)
/Reference [24 0 R]
/M (D:20200710105856+02'00')
/Contents <308223eb06092.....0000000000000>
/ByteRange [0 7602 40372 512]
>>
```

Furthermore, the PDF must be incrementally updated to include the other PAdES LTV artifacts. This entails adding an updated root catalog dictionary containing the certificates and revocation information must also be added to the PDF by the broker.

```
<<
/Type /Catalog
```

```
/Version /1.7
/Pages 2 0 R
/Metadata 3 0 R
/MarkInfo 4 0 R
/Lang (EN-US)
/ViewerPreferences 5 0 R
/OutputIntents [6 0 R]
/Perms 21 0 R
/AcroForm <<
/Fields [22 0 R]
/SigFlags 3
>>
/DSS 26 0 R
>>
endobj
26 0 obj
<<
/OCSPs [27 0 R 28 0 R 29 0 R 30 0 R]
/Certs [31 0 R 32 0 R 33 0 R 34 0 R 35 0 R 36 0 R]
>>
Endobj
```

The referenced objects containing the actual certificates and OSCP revocation information has been omitted here. Please refer to [PAdES] and [PDF] for details.

*6.2.2 **Step 8: Create PAdES LTA signature***

In order to prepare the final PAdES LTA signature, the PDF must again be incrementally extended with a PAdES LTA document timestamp. The updated root catalog should add additional dictionaries, including a placeholder `DocTimeStamp` dictionary. Example:

```
<<
/Type /Catalog
/Version /1.7
/Pages 2 0 R
/Metadata 3 0 R
/MarkInfo 4 0 R
/Lang (EN-US)
/ViewerPreferences 5 0 R
/OutputIntents [6 0 R]
```

```
/Perms 21 0 R
/AcroForm <<
/Fields [22 0 R 37 0 R]
/SigFlags 3
>>
/DSS 26 0 R
>>
endojb
37 0 obj
<<
/FT /Sig
/Type /Annot
/Subtype /Widget
/F 132
/T (Signature2)
/V 38 0 R
/P 8 0 R
/Rect [0.0 0.0 0.0 0.0]
>>
endobj
38 0 obj
<<
/Type /DocTimeStamp
/Filter /Adobe.PPKLite
/SubFilter /ETSI.RFC3161
/Contents <00000000000000000000000000.....>
/ByteRange [0 61685 94455 314]
>>
endobj
```

The ByteRange must cover the entire document except the content of the `DocTimeStamp Contents` element (in green). The `Contents` value will be replaced by the real TimeStamp AdES at a later stage.

Afterwards, a digest of the ByteRange-defiend part of the document must be calculated using the digest algorithm specified in [NL-SIG-PROFILE]

The digest is input to the Signing API REST operation `create-pades-lta` which returns the time stamp AdES needs to complete the PAdES LTA signature.

The broker must replace the `Contents` of the placeholder `DocTimeStamp` with the HEX-encoded time stamp returned by the NemLog-in Signing backend, padded to the exact length of the placeholder value.

The end result is a PAdES LTA level signature signed using a short term certicate issued to the end entity, specified in the SAML Assertion.

*6.2.3 **Step 9: Validate Signature***

When the document has been signed, the Broker must verify that the document has been signed by the expected end user.

6.3 XAdES Signature

When creating a XAdES signature the NemLog-in Signing backend will extend the preliminary XMLDSig signature created by the SignSDK and return the complete signature to the broker in the final step.

*6.3.1 **Step 7: Create XAdES LTV signature***

When calling the Signing API REST operation `create-xades-ltv` with the signature value calculated in the previous step, the NemLog-in Signing backend will update the XMLDSig signature received in the Signature Parameters, and return a Base64-encoded string containing the canonicalized value of most of the xml elements required to create the `<SignatureTimeStamp>` in the next step.

*6.3.2 **Step 8: Create XAdES LTA signature***

Since, for privacy reasons, the `<SignText>` element containing the document to be signed is never sent to the NemLog-in Signing backend, the broker must calculate the digest required to create the `<SignatureTimeStamp>`.

The response value returned when calling `create-xades-ltv` in the previous step must be Base64-decoded and postfixed to the value of of the `<SignText>` element so the end result consists of:

```
<SignText> +
<SignedProperties> +
<SignedInfo> +
<SignatureValue> +
<keyInfo> +
<SignatureTimeStamp> +
<CertificateValues> +
<RevocationValues>
```

The string must then be canocalized and a digest calculated. The digest is used as input to the Signing API REST operation `create-xades-lta`. The digest algorithm and canocalization method is defined in [NL-SIG-PROFILE].

The NemLog-in Signing backend creates the document time stamp and makes the final XMLDSig element. The Base64-encoded XMLDSig element returned by the `create-xades-lta` operation must be decoded. Then the preliminary XMLDSig Signature element added to the XAdES document by SignSDK must be replaced with the decoded XMLDSig element.

This finalizes the XAdES LTA signing process.

*6.3.3 **Step 9: Validate Signature***

When the document has been signed, the Broker must verify that the document has been signed by the expected end user.

7 Signing Formats and Data Models

The Signing Formats and Data Models are described in details in [NL-SP-IMPL]. The referenced document is focused on the requirements related to NemLog-in Service Providers. In this section the differences in the requirements related to Brokers will be described as a supplement to [NL-SP-IMPL]. The Service Providers using the Broker cannot use the SignSDK as the Signing Paylod must be signed by the Broker.

7.1 Signature Parameters

The Signature Parameters is used to control the document signing, and must be provided, by the Broker, as input to the SignSDK when producing a signing payload.

Signature Parameters listed below are mandatory.

Parameter	**Value**	**Description**
version	1	Signature Parameter version Defaults to 1
flowType	”ServiceProvider”/”Broker”	Can only be “Broker” in this context.
entityID	URI	A Broker-specific entity ID provisioned using the NemLog-In Administration Component.
documentFormat	”TEXT”/”HTML”/”PDF”/”XML”	Signer’s Document format (TEXT, HTML, XML, PDF)
signatureFormat	”XAdES” / ”PAdES”	The type of the signed document ”XAdES-B-LTA” or ”PAdES-B-LTA”

Signature Parameters listed below are not supported for Brokers and will result in a validation error if specified.

Parameter	**Value**	**Description**

referenceText	N/A	
minAge	N/A	
preferredLanguage	N/A	
signerSubjectNameID	N/A	
ssnPersistenceLevel	N/A	Brokers must specify this in the SAML Assertion
anonymizeSigner	N/A	Brokers must specify this in the SAML Assertion
acceptedCertificatePolicies	N/A	Brokers must specify this in the SAML Assertion

7.2 Signing Payload

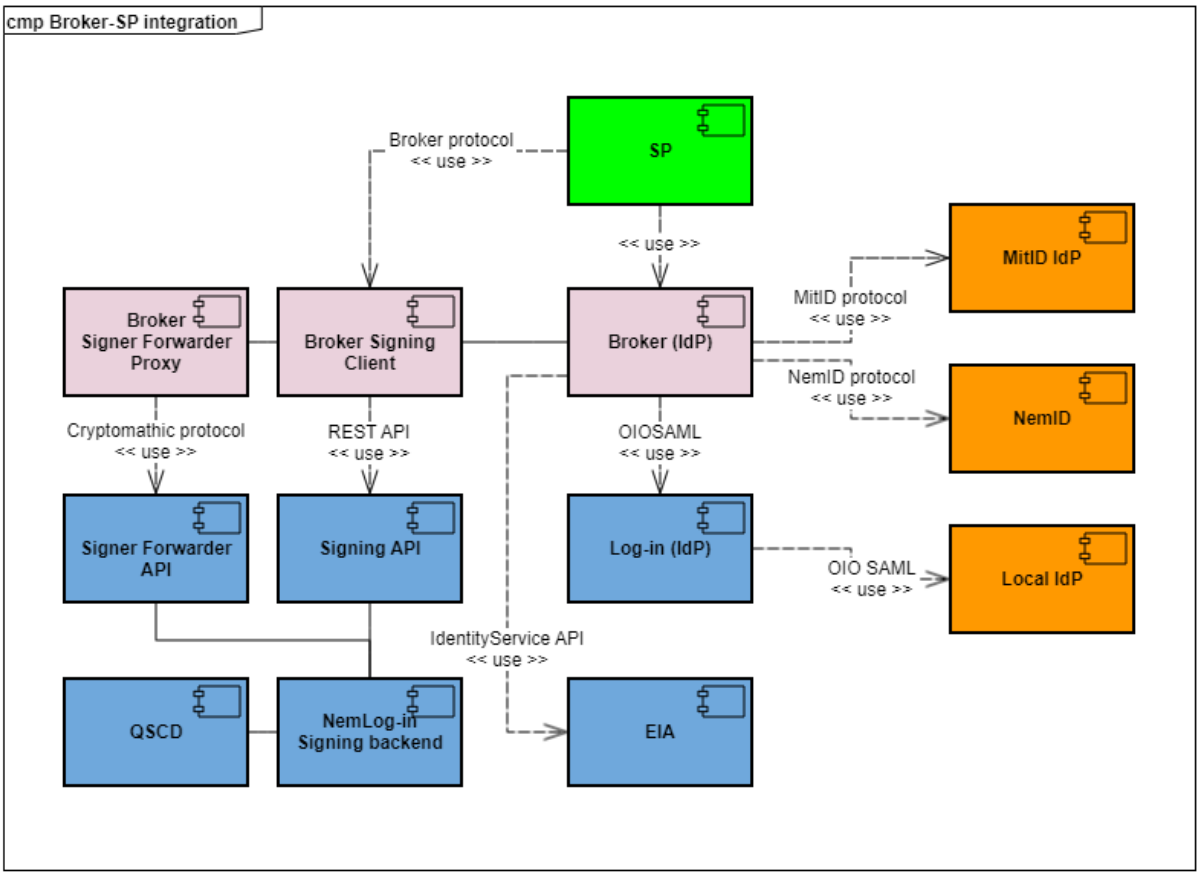
For Brokers the Signing Payload must be Signed by a VOCES keypair provisioned by the Broker using the Adminstration Client.

7.3 Signing Client Error

This section in [NL-SP-IMPL] is not directly applicable for Brokers as they implement their own Signing Client, however, the `SigningClientError` and `DetailedSigningClientError` models also defines the data structure used for Signing API errors.

8 SAML Integration

Upon authenticating a Signer, the Broker IdP must produce a valid OIOSAML 3 Assertion. The short term certificate issued when calling `issue-certificate` is issued based on the information received in the SAML Assertion.



The details of how a Broker authenticate their SPs is up to the Broker to design and implement.

The actions of the Broker (IdP) depend on the type of credentials:

- Local credentials. When using local credentials, the Broker integrates with the Log-in component to perform the authentication. The resulting OIOSAML Assertion must be modified if needed to comply to the requirements in this chapter.

- Personal MitID or NemID credentials. When using MitID or NemID credentials, the Broker integrates directly with MitID or NemID.

- Employee MitID or NemID credentials. When creating signature or seals using MitID/NemID employee credentials, the Broker must query EIA (the IdentityService) accordingly.

According to this integration model, it is the Broker who issues the SAML Assertion used when communicating with the Signing API, independent of the end user's choice of credentials (MitID, NemID or local). The SAML Assertion sent to the NemLog-in backend must always be signed using the Brokers VOCES certificate provisioned to the Signing Component.

8.1 SAML Assertion requirements

The NemLog-in backend requires a number of attributes to be present in the SAML Assertion created by the Broker. Some of these attributes are optional in the OIOSAML 3 profile but are mandatory in a signing context.

The short term certificate used for signing is issued based on the on the information contained in the SAML Assertion.

This section describes the requirements for the SAML Assertions issued by the Broker. The SAML Assertion must always be signed using the Brokers VOCES certificate in order for the NemLog-in backend to verify it is issued by a trusted party. Furthermore, the SAML Assertion must not be encrypted.

The Broker must ensure that all mandatory attributes in the OIOSAML 3 profile, not mentioned below, are also present in the SAML Assertion.

8.2 Subject

Subject denotes the identity of the Signer (for person and employee signatures) or approver (for seals)

*8.2.1 **NameID***

The Broker must use the value of their own persistent `SubjectNameID` for employees (when signing) or approving employee (when creating a seal). When the Broker creates a seal, the Broker must verify employee authorization using the EIA Identity Service.

E.g.

```
<saml:NameID SPNameQualifier="https://saml.some-broker.dk"
    Format="urn:oasis:names:tc:SAML:2.0:nameid-format:persistent">
    https://data.gov.dk/model/core/eid/professional/uuid/123e4567-e89b-12d3-a456-426655440000
</saml:NameID>
```

For Personal signatures the Broker must use the CprUuid as persistent id. This is the same value as `CertificateHolderIdentifier` (without the ‘person’ prefix) e.g:

```
<saml:NameID SPNameQualifier="https://saml.some-broker.dk"
    Format="urn:oasis:names:tc:SAML:2.0:nameid-format:persistent">
    https://data.gov.dk/model/core/eid/person/uuid/123e4567-e89b-12d3-a456-426655440000
</saml:NameID>
```

*8.2.2 **SubjectConfirmation***

`SubjectConfirmation` is mandatory and is therefore always specified cf. OIOSAML 3.0. The Broker must specify `NotOnOrAfter,` which is validated by the NemLog-in backend. `InResponseTo`

must always be specified and the value must be the `SessionId` created when calling Signing API `begin-sign-flow` e.g.

```
<saml2:SubjectConfirmation Method="urn:oasis:names:tc:SAML:2.0:cm:bearer">
  <saml2:SubjectConfirmationData
              InResponseTo="xYyuqxDDkJ2yW3oq9qWWmTGu1uM"
              NotOnOrAfter="2020-09-02T11:57:05.889Z"
              Recipient=" https://signing.nemlog-in.dk/signing/auth/saml/assertion-consumer"/>
</saml2:SubjectConfirmation>
```

8.3 Conditions

The `Conditions` element must contain a `AudienceRestriction` element.

*8.3.1 **AudienceRestriction***

The `AudienceRestriction` element is specified as the Signing Component's `EntityID`:

Environment	Value
Customer Test Integration	https://saml.signer-cti-nemlog-in.dk
Production	https://saml.signer-prod-nemlog-in.dk

E.g.:

```
<saml:AudienceRestriction>
    <saml:Audience>https://saml.signer-cti.nemlog-in.dk</saml:Audience>
</saml:AudienceRestriction>
```

8.4 AttributeStatement

The SAML assertion must contain an `AttributeStatement` element containing a series of attributes used when the short term signing certificate is issued by the NemLog-in Signing backend.

The attributes will be part of the certificate's subjectDN for the five different Signer-types:

4. Person
5. Employee
6. Anonymized person
7. Anonymized employee
8. Seal

Unless explicitly stated, the attribute is mandatory.

*8.4.1 **SpecVersion***

The specVersion attribute value must be "`OIO-SAML-3.0`".

```
<saml:Attribute Name="https://data.gov.dk/model/core/specVersion"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>OIO-SAML-3.0</saml2:AttributeValue>
</saml:Attribute>
```

*8.4.2 **Loa***

The loa attribute value must be either '`Substantial`' or '`High`' as pr. [NSIS] requirement.

```
<saml:Attribute Name="https://data.gov.dk/concept/core/nsis/loa"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Substantial</saml2:AttributeValue>
</saml:Attribute>
```

*8.4.3 **CertificatePolicyQualifier***

The certificatePolicyQualifier attribute value must be one of:

- Person (for Personal Signature)
- Employee (for Employee Signature)
- Organization (for Seal)

```
<saml:Attribute Name="https://data.gov.dk/model/core/signing/certificatePolicyQualifier"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Person</saml2:AttributeValue>
</saml:Attribute>
```

Based on the policy, the signature type will be determined and a short term certicate will be issued based on the type.

*8.4.4 **AnonymizedSigner***

The anonymizedSigner attribute value must be either '`true`' or '`false`'

```
<saml:Attribute Name="https://data.gov.dk/model/core/signing/anonymizedSigner"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>false</saml2:AttributeValue>
</saml:Attribute>
```

If true, the certificate will be anonymized. For anynomized certificates, the SubjectDN element's `cn` and `pseudonym` will have the value 'Pseudonym'. Can only be true in conjunction with Person or Employee certificate policy.

Setting anonymizedSigner to true with the certificatePolicyIdentifier set to "Organization" will result in an error being thrown by the Signing API.

*8.4.5 **CertificateHolderIdentifier***

Global identifier for certificate holder. The certificate issued is associated to this identifier in CA to allow revocations to be performed given this identifier. If CertificatePolicy is “Person” the HolderIdentifier is equal to CPR-UUID for signer, if CerticicatePolicy is “Employeee” or “Organization”, the HolderIdentifier is equal to the global identifier for the corporate identity provided by NemLog-in Erhverv (EIA).

Values have the syntax <lowercase(certificatePolicy)>:<UUID>, see example.

```
<saml:Attribute Name="https://data.gov.dk/model/core/signing/certificateHolderIdentifier"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>person:22222222-ae53-443f-b7c6-01b94fbf7a51</saml2:AttributeValue>
</saml:Attribute>
```

*8.4.6 **CertificateSSNPersistenceLevel***

The certificateSSNPersistenceLevel attribute value must be either of ‘Session’ or ‘Global’.

```
<saml:Attribute Name="https://data.gov.dk/model/core/signing/certificateSSNPersistenceLevel"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Session</saml2:AttributeValue>
</saml:Attribute>
```

The attribute is used to determine the persistence level for the UUID specified in the subjectSerialNumber of the short term certificate.

A value of Session instructs the NemLog-in Signing backend to create a session-specific UUID to be used as subjectSerialNumber. Access to Lookup Service is required in order to subsequently identity the entity associated with the given session UUID.

A value of Global will use the global certificateHolderIdentifier as subjectSerialNumber. When using global UUIDs, explicit consent from the end entity is required to be GDPR compliant.

*8.4.7 **Certificate subjectDN attributes***

The subjectDN of the short term certificate is created based on the SAML Asserrtion attribute values specified in the table below.

Whether the attribute must be present in the SAML Assertion depends on the Signer-type.

Mandatory SAML Assertion attributes for each signer-type

Attribute (friendly name)	**Person**	**Employee**	**Anonymized person**	**Anonymized employee**	**Seal (Organization)**

FirstName	x	x			
LastName	x	x			
CommonName			“Pseudonym”	“Pseudonym”	x*
OrgName		x		x	x
CVR		x		x	x**

* Certificate CommonName is taken from SAML Assertion

** CVR prefixes according to certificate profile

FirstName

```
<saml:Attribute Name="https://data.gov.dk/model/core/eid/firstName"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Julie</saml2:AttributeValue>
</saml:Attribute>
```

LastName

```
<saml:Attribute Name="https://data.gov.dk/model/core/eid/lastName"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Sørensen</saml2:AttributeValue>
</saml:Attribute>
```

CommonName

For Person and Employee, `cn` of the certificate Subject DN will be the concatenated value of `firstName` and `lastName`.

If the anonymizedSigner attribute is true, however, then `commonName` must contain the value “Pseudonym” and the `firstName` and `lastName` attributes must be unspecified.

For seals, `commonName` must be the appointed name of the organization identity.

```
<saml:Attribute Name="https://data.gov.dk/model/core/signing/certificateCommonName"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Julie Sørensen</saml2:AttributeValue>
</saml:Attribute>
```

OrgName

```
<saml:Attribute Name=" https://data.gov.dk/model/core/eid/professional/orgName"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>Bennys Bagelbageri</saml2:AttributeValue>
</saml:Attribute>
```

CVR

```
<saml:Attribute Name=" https://data.gov.dk/model/core/eid/professional/cvr"
                NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
  <saml:AttributeValue>20301823</saml2:AttributeValue>
</saml:Attribute>
```

9 Logging

It is the responsibility of the Broker to store and provide the information needed to prove the correctness of a signature or an authentication at a later point of time, e.g. due to a dispute or fraud case.

The signed document from each signing operation must be stored by the Broker or SP. The user´s certificate (which includes a UUID to identifify the signer), the time stamp etc. are included in signed documents. Brokers are encouraged to consider to store other relevant information like time stamp, client IP number, user agent, correlation id and similar information subject to regulative requirements.

All requests to the Signing and Signer forwarder REST APIs will be logged by the NemLog-in Signing backend. The Broker must add a "`CorrelationIdManager.CorrelationId`" HTTP header containing a caller-selected value with a UUID v4 format when calling the Signing API, and all request will be logged with that value. This makes it possible to trace all requests for a given signing session.

Note that NemLog-in never handles the actual documents to be signed and therefore does not store the signed documents.

Brokers are encouraged to use the same correlationId internally and when interacting with the NemLog-in Signing backend as this will aid the troubleshooting process in case of errors.

10 Response codes and error handling

When interacting with the Signing and Signer forwarder REST APIs the following HTTP response codes may be returned.

Code	Description
200	Success
400	Internal error. When an error occurs the Broker must cancel the signing, remedy the error and create a new signing session to sign the document
401	Unauthorized. Will be returned if the NemLog-in Signing backend fails to recognize the Brokers VOCES certificate used to seal the Signature Parameters. No signing session can be created while this error occours

When an error occurs a JSON object describing the error will be returned. See [NL-SP-IMPL] Appendix B for a full list of error codes.

```
{
  "httpStatusCode": 0,
  "timestamp": "string",
  "message": "string",
  "details": [
    {
      "errorCode": "string",
      "errorMessage": "string"
    }
  ]
}
```

If the error can be rectified by the Broker an error message with details of the error is returned.

11 Security Guidelines

The security advice and best-practice in [NL-SP-IMPL] Chapter 6 Security Guidelines, is also recommended for Brokers.

12 Appendix – Broker API

Signing Frontend Service defines a two REST APIs:

- Signing API
- Signer Forwarder API

Required parameters and model fields are tagged with *.

*12.1.1 **Authentication***

Access to both REST APIs require TLS.

After a signature flow has been initialized the SigningAPI can only be called using a valid Session ID. The SessionId is created when the Broker invokes `begin-signature-flow` with valid signature parameters signed by the Broker's VOCES certificate provisioned to the Signing Component. All subsequent calls must contain the SessionId as a HTTP header.

If the Brokers VOCES certificate is unknown to the Nemlog-in backend a session will not be created.

*12.1.2 **Common Request Parameters***

All REST API endpoints accepts the following correlation ID header:

Name	In	Type	Description
CorrelationIdManager .CorrelationId*	header	string	The Correlation ID is defined by the caller and will be in all log records generated while signing. The value must have a UUID v4 format, but there is no requirement that it is unique.

12.2 Signing API

*12.2.1 **begin-signature-flow***

Initializes the signature flow by

Request

POST **https://<uri>/signing/begin-signature-flow**

Request Parameters

Name	In	Type	Description
Accept*	header	string	"application/json"
Content-type*	header	string	"application/json"
signatureParameters*	body	BeginSignatureFlow-Request	Signature parameters containing the document to be signed and other parameters required for signing. The JWS signed string is generated by SignSDK

Response

Code	Content-Type Type	Description
200 OK	"application/json" BeginSignatureFlowResponse	
400 Bad Request		Signature Parameters validation failure
401 Unauthorized		Not authorized to perform signing.

*12.2.2 **issue-certificate***

Request

POST **https://<uri>/signing/issue-certificate**

Request Parameters

Name	In	Type	Description
Accept*	header	string	“application/json”
Content-type*	header	string	“application/json”
X-DIGST-Signing-SessionId*	header	string	SessionId returned in BeginSignatureFlowResponse
	body	IssueCertificateRequest	

Response

Code	Content-Type Type	Description
200 OK	“application/json” IssueCertificateResponse	
400 Bad Request		
401 Unauthorized		Not authorized to perform signing. See 12.1.1 Authentication

*12.2.3 **create-pades-ltv***

Request

POST **https://<uri>/signing/create-pades-ltv**

Request Parameters

Name	In	Type	Description
Accept*	header	string	“application/json”
Content-type*	header	string	“application/json”
X-DIGST-Signing-SessionId*	header	string	SessionId returned in BeginSignatureFlowResponse
	body	CreatePadesLtvRequest	

Response

Code	Content-Type Type	Description
200 OK	“application/json” CreatePadesLtvResponse	
400 Bad Request		
401 Unauthorized		Not authorized to perform signing. See 12.1.1 Authentication

*12.2.4 **create-pades-lta***

Request

POST **https://<uri>/signing/create-pades-lta**

Request Parameters

Name	In	Type	Description
Accept*	header	string	“application/json”
Content-type*	header	string	“application/json”
X-DIGST-Signing-Ses-sionId*	header	string	SessionId returned in BeginSignature-FlowResponse
	body	CreatPadesLtaResponse	

Response

Code	Content-Type Type	Description
200 OK	“application/json” CreatePadesLtaResponse	
400 Bad Request		
401 Unauthorized		Not authorized to perform signing. See 12.1.1 Authentication

*12.2.5 **create-xades-ltv***

Request

POST **https://<uri>/signing/create-xades-ltv**

Request Parameters

Name	In	Type	Description
Accept*	header	string	“application/json”
Content-type*	header	string	“application/json”
X-DIGST-Signing-Ses-sionId*	header	string	SessionId returned in BeginSigna-tureFlowResponse
	body	CreateXadesLtvRequest	

Response

Code	Content-Type Type	Description
200 OK	“application/json” CreateXadesLtvReponse	
400 Bad Request		
401 Unauthorized		Not authorized to perform signing. See 12.1.1 Authentication

*12.2.6 **create-xades-lta***

Request

POST **https://<uri>/signing/create-xades-lta**

Request Parameters

Name	In	Type	Description
Accept*	header	string	“application/json”
Content-type*	header	string	“application/json”
X-DIGST-Signing-SessionId*	header	string	SessionId returned in BeginSignatureFlowResponse
	body	CreateXadesLtaRequest	

Response

Code	Content-Type Type	Description
200 OK	“application/json” CreateXadesLtaResponse	
400 Bad Request		
401 Unauthorized		Not authorized to perform signing. See 12.1.1 Authentication

*12.2.7 **session-creation-key.js***

Calling Signing frontend service provides the SCK for broker usage.

Request

POST **https://<signer-frontend-service>/signing/session-creation-key.js**

Response

Code	Content-Type	Description
200 OK	application/javascript;charset=UTF-8	

Response example

```
(function(sck) {
    sck.Details = {
        "KeyID": "0000000000000023",
        "Modulus":
"00E7E7E0599D73685DB70C75EBB58A941409987F7C7083FE602239BF80F33964F39C1541AB
411A593F5D409FC6AC-
DAFE4E576BC32532205914DC9A78E160086493B31FAF003082D1601E03F592F20B9BA88C45F
1F3B0BDC6C0233386FFD8681518AAA3F5015678C36D29C0C2E94C469F19AB59732514973DF0
2DB4B4005B810B32586EF6D05DF5BA20331D139D3CD047035D2E34F12E82CED00952F450A89
3378554958FC92321F45D450D67B8C13ACF91EB3D77597FCFF9B278A072043B0B5DAE8488DC
E007994013C47D7ABEE82247D93288FF0ED6F431557E445E30C5474838F2B98EEC59D54C7D4
FABD31627C5000B2EE58E21F4EE648AF799E9EA673CEF7149D8289BF77319CAC851293E1932
89FCD57E6F501025A55B4CC5B09420E7F096BD90AB66A26B02FF1D2D52E0C438823FBA13A9A
```

```
46F8D95DECF66AADB77EDC4364CA4B2A272A0C7CFA886016DB6EAFB7C7047D8DDF4AAE7F496
AB01D318E1F702144303725FB01272139C5CC3420903A98391624FD46ACEDC6413D15C687F2
633",
        "PublicExponent": "010001",
        "KeySize": 384
    };
}(Cryptomathic.namespace("Cryptomathic.SCK")));
```

12.3 Signing API Models

12.3.1 BeginSignatureFlowRequest

Name	Type	Description
signatureParameters	string	JWS-encoded and signed Signature Parameters

12.3.2 BeginSignatureFlowResponse

Name	Type	Description
securityCode*	string	Security code to use for end-user identification
sessionId*	string	A session ID for the signing work flow
dtbsSignedInfoDigest*	string	Base64-encoded digest extracted from the dtbsSignedInfo field of the signatureParamaters This together with the dtbsSignedInfoDigestAlgorithm can be used to verify that the document presented to the end user corresponds to the document initialized by the SignSDK by recalculating the digest value of the document to be signed
dtbsSignedInfoDigestAlgo-rithm*	string	Digest algorithm extracted from the dtbsSignedInfo field of the signatureParameters

12.3.3 IssueCertificateRequest

Name	Type	Description
samlAssertion*	string	Base64 encoded OIOSAML assertion

12.3.4 IssueCertificateResponse

Name	Type	Description
digestToBeSigned*	string	Hex encoded document digest to be signed by the QSCD
sad*	string	Base64 encoded QSCD SAD SAML assertion to be used for authentication with the QSCD

12.3.5 CreatePadesLtvRequest

Name	Type	Description
signatureValue*	string	Base64 encoded signature value from the QSCD

12.3.6 *CreatePadesLtvResponse*

Name	Type	Description
cmsSignedData*	string	Base64 encoded AdES CMS containing the signature. The returned AdES must replace the placeholder AdES added to the PDF document by the SignSDK
certificates*	array	List of Base64 encoded x509 certificates to be included in PDF document when creating archieve timestamp
ocspResponses*	array	List of Base64 encoded OCSP ASN1 responses to be included in PDF document when creating archieve timestamp

12.3.7 *CreatePadesLtaRequest*

Name	Type	Description
timeStampDigestValue*	string	Base64 encoded byte array containing the digest value to time stamp

12.3.8 *CreatePadesLtaResponse*

Name	Type	Description
timeStamp*	string	Base64 encoded AdES CMS containing the time stamp. The returned AdES must replace the placeholder timestamp AdES added to the PDF document when calculating the time stamp digest value.

12.3.9 *CreateXadesLtvRequest*

Name	Type	Description
signatureValue*	string	Base64 encoded signature value from the QSCD

12.3.10 *CreateXadesLtvResponse*

Name	Type	Description
archiveTimeStampInitialContent*	string	Base64 encoded string with the canocalised concatenated value of SignedProperties + SignedInfo + SignatureValue + KeyInfo + SignatureTimeStamp + CertificateValues + RevocationValues. This is to postfixed to the SignText element. The digest value of this is to used as input for CreateXadesLtaRequest.

12.3.11 *CreateXadesLtaRequest*

Name	Type	Description
timeStampDigestValue*	String	Base64 encoded digest value of canocalised SignText + SignedProperties + SignedInfo + SignatureValue + KeyInfo + SignatureTimeStamp + CertificateValues + RevocationValues to time stamp

12.3.12 ***CreateXadesLtaResponse***

Name	Type	Description
signature*	String	Base64 encoded xml signature element at CAdES level LTA. The signature element is to replace the Signarure element in the SignedDocument created by the SignSDK

12.4 Signer forwarder API

Signer Forwarder api is used together with QSCD SDK to calculate signature value (signer-forwarder)

12.4.1 ***signer-forwarder***

REST endpoint uses to expose QSCD SAP protocol to Cryptomathic JavaScript User SDK. All calls from the broker client is routed from Broker Signing Client -> Broker Signer Backend Proxy on Broker backend -> Signer Forwarder API -> Signing backend -> QSCD to handle browser CORS issues.

The signer-forwarder does not support CORS[1] so the Broker Signing Client can not use the Signer Forwarder API directly from the client, but must handle the signer-forward logic from a Signer Forwarder Proxy on the Broker backend.

Request

POST **https://<uri>/signer-forwarder**

Request Parameters

Name	In	Type	Description
Accept*	header	string	“*/*”
Content-type*	header	string	“text/plain;charset=UTF-8”
sessionId*	parameter	string	Contains the signing session ID from begin-sign-flow.
correlationId	parameter	string	CorrelationIdManager.CorrelationId used to track QSCD logging
	body		Encrypted payload to forwarder

Response

Code	Content-Type	Description
200 OK	“*/*”	
Errorcode varies		Cryptomathic forwarder errorcodes varies, please refer to Cryptomathic documentation.

[1] CORS : Cross-origin resource sharing see https://fetch.spec.whatwg.org/

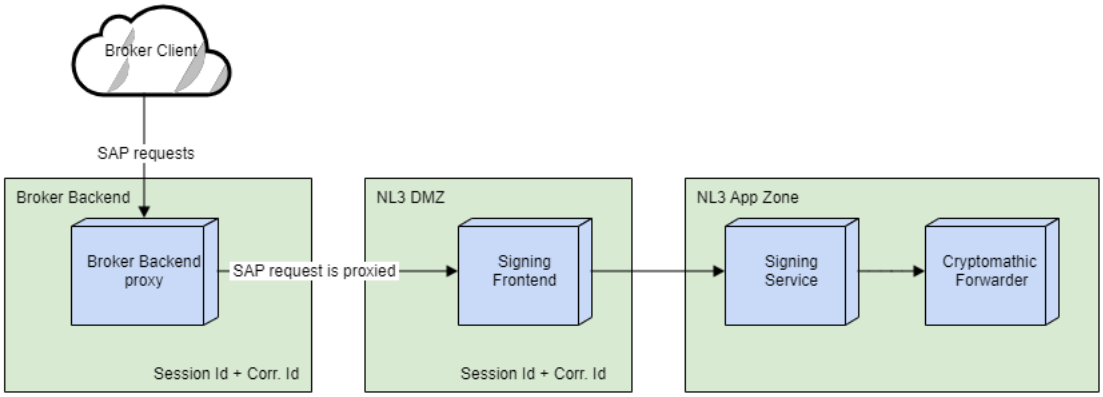
12.4.2 ***SAP Protocol***

When a Broker is implementing a signing client, they must use a qualified SAP protocol provider certified with ETSI EN 419-241-2 to be considered a valid qualified signer. Part of the protocol requirement is that the signing is controlled from the client side all the way to the QSCD server.

In NL3 this has been implemented with Cryptomathic Signer as a SAP API protocol provider that all client must utilize to be a qualified signing client.

The underlying protocol used is called SAP API and is used in the Broker Client by including Cryptomathic Signer SDK and then calling a Broker Backend service that proxies calls to the signer-forwarder referenced in 12.4.1 signer-forwarder.

Example of a Broker Client.



The reason the Broker Backend is proxing calls is to solve CORS issues between browser domains (assuming the Broker Client is running in another domain than signer-frontend service).

Implement the following steps in order to be able to enable the SAP Protocol.

Step	**Description**
1. Signer sdk in client	Add signersdk.min.js to client, this is used to call the signer-forwarder. Can be taken from Cryptomathic User SDK.
2. Add SCK	SCK is short for Session Creation Key and is used to establish a protocol to the backend.

	This can be included from signing frontend service: https://<frontend-service>/signing/session-creation-key.js See [12.2.7 session-creation-key.js]
3. Call Issue Certificate	Implement “Issue Certificate” [6.1.5 Step 5: Issue Certificate] in broker client and extract the field “sad” from response.

4. Initialize QSCD API	Now the client should establish the SAP protocol by using Cryptomathic User SDK.
	To avoid CORS issues, the <Forwarderurl> used in the example below must be proxied to the signing frontend via the Brokers own signer forwarder proxy. The format of the request being proxied to the signing frontend is:
	https://<frontend-service>/signer-forwarder?sessionId=<session-id>&correlationId=<correlation-id>.
	The <session-id> is the URI-encoded session ID retrieved in the call to `begin-signature-flow`.
	The optional <correlation-id> parameter is the URI-encoded correlation ID used for logging purposes – please refer to chapter 9.
	
	`let sdk = new Cryptomathic.SignerUserSDK.SDK(<Fowarderurl>, 10000);`
	`sdk.initialize();`

Create Session	Create session with callback objects `sdk.createSession(resolve, reject, samlAssertion);` **Important**: It is very important that the SAD from [6.1.5 Step 5: Issue Certificate] is formatted before calling createSession! Please read [15.1 Code example – formatting saml (sad) assertion]
Implement resolve	Example of calling userSDK sign Convert `digestToBeSigned` from `issue-certificate` via convertStringToNumbers `let messageHashToBeSigned = convertStringToNumbers(digestToBeSigned);`

Convert method:

```
convertStringToNumbers(values: string): number[] {
  let bytes = [];
  for (let c = 0; c < values.length; c += 2) {
    bytes.push(parseInt(values.substr(c, 2), 16));
  }

  return bytes;
}
```

The call userSDK sign method

```
sdk.sign(keyEntry, callForwarderRequest.hashToSign, re-
solveSign, rejectSign)
```

Implement resolveSign, this will receive the signing response from QSCD

```
let resolveSign = function (signatureBytes) {
};
```

Client Javascript pseudo example:

```
<html>
<head>
    <script type="text/javascript" src="https://<signing-client>/as-
sets/signersdk.min.js"></script>
    <script type="text/javascript" src="https://<frontend-service>/sign-
ing/session-creation-key.js"></script>

    <script type="application/javascript">
        function demoSigning() {
            // call previous steps (begin-signature-flow,issue-certificate)
            // to create session and signing certificate [1]
            // from /begin-signature-flow response sessionId [2]
            const sessionId = "dZOpNilun-MDJ4ZwvIFbrSU3WG4";

            // log correlation from Broker Client (must be generated by
            // broker client) [3]
            const correlationId = "a1fa4b69-62cf-4772-ab99-e846f90ad74f";

            // extract IssueCertificateResponse.digestToBeSigned from
            // /issue-certificate (encoded to number[] array) [4]
            let messageHashToBeSigned = [0x01, 0x02, 0x01];

            let forwarderURL = "https://<broker-backend-proxy>/?sessionId="
                + sessionId + "&correlationId=" + correlationId;

            let sdk = new Cryptomathic.SignerUserSDK.SDK(forwarderURL,
```

```
10000);
            try {
                sdk.initialize();
                console.log("Successfully initialized SDK.");

                let rejectLogOff = function (errorType, message) {
                    console.debug("logoff failed msg:'" + message + "'")
                };

                let cleanup = function () {
                    sdk.logoff(resolveLogOff, rejectLogOff)
                    sdk.free();
                };

                let resolveLogOff = function () {
                    console.debug("logoff successful");
                    cleanup();
                };

                let resolveSign = function (signatureBytes) {
                    console.info("signed '" + signatureBytes + "'");
                };

                let rejectSign = function (errorType, message) {
                    console.error("signing rejected msg:'"
                                  + message + "'");
                    cleanup();
                };

                let resolve = function (tokenList, policyList) {
                    console.log("Successfully created session.");
                    let aPolicy = policyList[0];

                    // keyEntry from a PolicyEntry received in
                    // createSession resolve callback.
                    let keyEntry = aPolicy.KEY_LIST[0];
                    let hashToSign = messageHashToBeSigned;

                    console.log("executing sign");
                    sdk.sign(keyEntry, hashToSign, resolveSign, rejectSign)
                }

                // sad is taken from /issue-certificate response sad
                // field [5]
                let sad = "PD94bWwgdmVyc2lvbj0iMS4wIiBlbmNvZGluZRmLTg..."
                let samlAssertion = encodeSAMLAssertion(sad);

                sdk.createSession(resolve, reject,samlAssertion);
            } catch (error) {
                console.error("error " + error);
                sdk.free();
            }
        }

        window.onload = demoSigning;
    </script>
</head>
</html>
```

The Broker Client must Implement [1],[2],[3],[4],[5] in the client to make this pseude example into a real running client.

13 Appendix – Error API

Reference SP documentation

14 Appendix – Broker SAML Assertion

Example of a SAML Assertion consumed by the NemLog-in backend. The information received in the SAML Assertion is used when issuing the short term signing certificate used to sign the document.

```
<?xml version="1.0" encoding="UTF-8"?>
<saml:Assertion xmlns:saml="urn:oasis:names:tc:SAML:2.0:assertion"
                ID="_ce0e53df9f39c35c695972c054cc5463"
                IssueInstant="2020-09-02T11:52:05.889Z"
                Version="2.0">
    <saml:Issuer Format="urn:oasis:names:tc:SAML:2.0:nameid-format:entity">
        https://broker-entity-id
    </saml:Issuer>
    <saml:Subject>
        <saml:NameID Format="urn:oasis:names:tc:SAML:2.0:nameid-format:persistent"
                     SPNameQualifier="https://broker-entity-id">
            ff7db82f-d5e6-4377-ac62-ef22a4acb134
        </saml:NameID>
        <saml:SubjectConfirmation Method="urn:oasis:names:tc:SAML:2.0:cm:bearer">
            <saml:SubjectConfirmationData InResponseTo="xYyuqxDDkJ2yW3oq9qWWmTGu1uM"
                  NotOnOrAfter="2020-09-02T11:57:05.889Z"
                  Recipient="https://127.0.0.1:8181/signing/auth/saml/assertion-consumer"/>
        </saml:SubjectConfirmation>
    </saml:Subject>
    <saml:Conditions NotBefore="2020-09-02T11:52:05.889Z" NotOnOrAfter="2020-09-02T12:52:05.889Z">
        <saml:AudienceRestriction>
            <saml:Audience>https://signer.nemlog-in.dk</saml:Audience>
        </saml:AudienceRestriction>
    </saml:Conditions>
    <saml:AuthnStatement AuthnInstant="2020-09-02T11:52:06.208Z"
                         SessionIndex="_d264e96a232fc98249a0a9875809f50b">
        <saml:AuthnContext>
            <saml:AuthnContextClassRef>
                urn:oasis:names:tc:SAML:2.0:ac:classes:PasswordProtectedTransport
            </saml:AuthnContextClassRef>
        </saml:AuthnContext>
    </saml:AuthnStatement>
    <saml:AttributeStatement>
        <saml:Attribute FriendlyName="SpecVer"
                        Name="https://data.gov.dk/model/core/specVersion"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>OIO-SAML-3.0</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="LoA"
                        Name="https://data.gov.dk/concept/core/nsis/loa"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Substantial</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="CertificatePolicyQualifier"
                        Name="https://data.gov.dk/model/core/signing/certificatePolicyQualifier"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Employee</saml:AttributeValue>
```

```
        </saml:Attribute>
        <saml:Attribute FriendlyName="CertificateSSNPersistenceLevel"
                        Name="https://data.gov.dk/model/core/signing/certificateSSNPersistenceLevel"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Session</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="CertificateHolderIdentifier"
                        Name="https://data.gov.dk/model/core/signing/certificateHolderIdentifier"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>employee:ff7db82f-d5e6-4377-ac62-ef22a4acb134</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="CertificateCommonName"
                        Name="https://data.gov.dk/model/core/signing/certificateCommonName"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Jane Fonda</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="FirstName"
                        Name="https://data.gov.dk/model/core/eid/firstName"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Jane</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="LastName"
                        Name="https://data.gov.dk/model/core/eid/lastName"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Fonda</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="OrganizationName"
                        Name="https://data.gov.dk/model/core/eid/professional/orgName"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>Three Mile Island</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="CVR"
                        Name="https://data.gov.dk/model/core/eid/professional/cvr"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>11111111</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="Age"
                        Name="https://data.gov.dk/model/core/eid/age"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>93</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="AnonymizedSigner"
                        Name="https://data.gov.dk/model/core/signing/anonymizedSigner"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>false</saml:AttributeValue>
        </saml:Attribute>
        <saml:Attribute FriendlyName="ReferenceText"
                        Name="https://data.gov.dk/model/core/signing/referenceText"
                        NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:uri">
            <saml:AttributeValue>U2lnbiBkb2N1bWVudCBmcm9tIFVua25vd24gU1A=</saml:AttributeValue>
        </saml:Attribute>
    </saml:AttributeStatement>
</saml:Assertion>
```

15 Appendix – SAP API Utillities

15.1 Code example – formatting saml (sad) assertion

When a SAML Assertion (SAD) is received from issue-certificate, it must be base64 decoded and then encoded as UTF8. The following JavaScript provides guidance in how to achieve this. The formatting shall be conducted prior establishing a session with ‘createSession’.

```
let samlAssertion = encodeSAMLAssertion(sad); ← IMPORTANT!

sdk.createSession(resolve, reject, samlAssertion);
```

EncodeSAMLAssertion function

```
function encodeSAMLAssertion(assertion) {
  function toUTF8Array(str) {
    let utf8 = [];
    for (let i = 0; i < str.length; i++) {
      let charcode = str.charCodeAt(i);
      if (charcode < 0x80) utf8.push(charcode);
      else if (charcode < 0x800) {
        utf8.push(0xc0 | (charcode >> 6),
          0x80 | (charcode & 0x3f));
      } else if (charcode < 0xd800 || charcode >= 0xe000) {
        utf8.push(0xe0 | (charcode >> 12),
          0x80 | ((charcode >> 6) & 0x3f),
          0x80 | (charcode & 0x3f));
      }
      // surrogate pair
      else {
        i++;
        // UTF-16 encodes 0x10000-0x10FFFF by
        // subtracting 0x10000 and splitting the
        // 20 bits of 0x0-0xFFFFF into two halves
        charcode = 0x10000 + (((charcode & 0x3ff) << 10)
          | (str.charCodeAt(i) & 0x3ff));
        utf8.push(0xf0 | (charcode >> 18),
          0x80 | ((charcode >> 12) & 0x3f),
          0x80 | ((charcode >> 6) & 0x3f),
          0x80 | (charcode & 0x3f));
      }
    }
    return utf8;
  }

  function base64decode(data) {
    return window.atob(data)
  }

  return toUTF8Array(base64decode(assertion));
}
```