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`urn:oasis:names:tc:SAML:2.0:profiles:holder-of-key`

Abstract:

The *SAML V2.0 Holder-of-Key Assertion Profile* describes the issuing and processing of holder-of-key SAML assertions. Specifically, we show how a SAML issuer binds X.509 data to a `<ds:KeyInfo>` element and how a relying party confirms that a `<ds:KeyInfo>` element matches given X.509 data. The binding material used by the SAML issuer and the matching data used by the relying party are obtained from an X.509 certificate.

35 **Status**

36 This document was last revised or approved by the SSTC on the above date. The level of
37 approval is also listed above. Check the current location noted above for possible later revisions
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91 **Table of Contents**

92 1 Introduction.....5
93 1.1 Notation.....5
94 1.2 Terminology.....6
95 1.3 Normative References.....6
96 1.4 Non-normative References.....6
97 2 SAML V2.0 Holder-of-Key Assertion Profile.....7
98 2.1 Required Information.....7
99 2.2 Profile Description.....7
100 2.3 X.509 Certificate Usage.....7
101 2.4 Issuing Holder-of-Key Assertions.....8
102 2.4.1 KeyInfo Usage.....8
103 2.4.2 Example.....9
104 2.5 Processing Holder-of-Key Assertions.....10
105 2.6 Security and Privacy Considerations.....11
106 2.6.1 ASN.1 Encoding.....12
107 2.6.2 X.509 Serial Number.....12
108 3 Conformance.....13
109 3.0.1 SAML V2.0 Holder-of-Key Assertion Profile.....13
110 Appendix A. Acknowledgments.....14
111 Appendix B. Revision History.....15
112

1 Introduction

The *SAML V2.0 Holder-of-Key Assertion Profile* describes the issuing and processing of a holder-of-key SAML assertion, that is, an assertion containing a `<saml:SubjectConfirmation>` element whose `Method` attribute is set to `urn:oasis:names:tc:SAML:2.0:cm:holder-of-key`. Specifically, we describe the structural characteristics of a `<ds:KeyInfo>` element with bound X.509 data and show how a relying party confirms that such a `<ds:KeyInfo>` element matches given X.509 data. The binding material used by the SAML issuer and the matching data used by the relying party are obtained from an X.509 certificate.

This profile involves a SAML issuer and a SAML relying party, each with an X.509 certificate in its possession. The SAML issuer uses its certificate to produce a holder-of-key SAML assertion. The relying party consumes the assertion, confirming the attesting entity by comparing the X.509 data in the assertion with the X.509 data in its possession.

1.1 Notation

This specification uses normative text. The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this specification are to be interpreted as described in [RFC2119]:

...they MUST only be used where it is actually required for interoperation or to limit behavior which has potential for causing harm (e.g., limiting retransmissions)...

These keywords are thus capitalized when used to unambiguously specify requirements over protocol and application features and behavior that affect the interoperability and security of implementations. When these words are not capitalized, they are meant in their natural-language sense.

Listings of XML schemas appear like this.

Example code listings appear like this.

Conventional XML namespace prefixes are used throughout the listings in this specification to stand for their respective namespaces as follows, whether or not a namespace declaration is present in the example:

Prefix	XML Namespace	Comments
saml:	urn:oasis:names:tc:SAML:2.0:assertion	This is the SAML V2.0 assertion namespace defined in the SAML V2.0 core specification [SAML2Core].
ds:	http://www.w3.org/2000/09/xmldsig#	This is the XML Signature namespace [XMLSig].
xs:	http://www.w3.org/2001/XMLSchema	This is the XML Schema namespace [Schema1].
xsi:	http://www.w3.org/2001/XMLSchema-instance	This is the XML Schema namespace for schema-related markup that appears in XML instances [Schema1].

This specification uses the following typographical conventions in text: `<SAMLelement>`, `<ns:ForeignElement>`, `Attribute`, **Datatype**, `OtherCode`.

1.2 Terminology

In this specification, a *SAML issuer* is a producer of holder-of-key assertions. Similarly, a *relying party* is a consumer of holder-of-key assertions.

145 A *presenter* transmits a holder-of-key assertion to the relying party. An *attesting entity* is a presenter who
146 is able to satisfy the subject confirmation requirements of the holder-of-key assertion.

147 Usually the attesting entity is the subject of the assertion (hence the terms "subject confirmation" and
148 "confirming the subject"). In general, however, the attesting entity may not be the subject, in which case
149 the previous phrases are misnomers. Thus the terms "attestation" and "confirming the attesting entity" are
150 more technically correct than "subject confirmation" and "confirming the subject," respectively. We will
151 use the term "attesting entity" exclusively in this document.

152 1.3 Normative References

- 153 **[RFC2119]** S. Bradner. *Key words for use in RFCs to Indicate Requirement Levels*. IETF
154 RFC 2119, March 1997. <http://www.ietf.org/rfc/rfc2119.txt>
- 155 **[RFC4514]** K. Zeilenga. *Lightweight Directory Access Protocol (LDAP): String
156 Representation of Distinguished Names*. IETF RFC 4514, June 2006.
157 <http://www.ietf.org/rfc/rfc4514.txt>
- 158 **[RFC5280]** D. Cooper, S. Santesson, S. Farrell, S. Boeyen, R. Housley, W. Polk. *Internet
159 X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL)
160 Profile*. IETF RFC 5280, May 2008. <http://www.ietf.org/rfc/rfc5280.txt>
- 161 **[SAML2Core]** OASIS Standard, *Assertions and Protocols for the OASIS Security Assertion
162 Markup Language (SAML) V2.0*. March 2005. [http://docs.oasis-open.org/security/
163 saml/v2.0/saml-core-2.0-os.pdf](http://docs.oasis-open.org/security/saml/v2.0/saml-core-2.0-os.pdf)
- 164 **[SAML2Prof]** OASIS Standard, *Profiles for the OASIS Security Assertion Markup Language
165 (SAML) V2.0*. March 2005. [http://docs.oasis-open.org/security/saml/v2.0/saml-
profiles-2.0-os.pdf](http://docs.oasis-open.org/security/saml/v2.0/saml-
166 profiles-2.0-os.pdf)
- 167 **[Schema1]** H. S. Thompson et al. *XML Schema Part 1: Structures*. World Wide Web
168 Consortium Recommendation, May 2001. See [http://www.w3.org/TR/2001/REC-
xmlschema-1-20010502/](http://www.w3.org/TR/2001/REC-
169 xmlschema-1-20010502/)
- 170 **[XMLSig]** D. Eastlake, J. Reagle, D. Solo, F. Hirsch, T. Roessler. *XML Signature Syntax
171 and Processing (Second Edition)*. World Wide Web Consortium
172 Recommendation, 10 June 2008. <http://www.w3.org/TR/xmlsig-core/>

173 1.4 Non-normative References

- 174 **[RFC3820]** S. Tuecke, V. Welch, D. Engert, L. Pearlman, M. Thompson. *Internet X.509
175 Public Key Infrastructure (PKI) Proxy Certificate Profile*. IETF RFC 3820, June
176 2004. <http://www.ietf.org/rfc/rfc3820.txt>
- 177 **[RFC4346]** T. Dierks, E. Rescorla. *The Transport Layer Security (TLS) Protocol Version 1.1*.
178 IETF RFC 4346, April 2006. <http://www.ietf.org/rfc/rfc4346.txt>
- 179 **[SAML2ConDel]** S. Cantor. *SAML V2.0 Condition for Delegation Restriction*. OASIS SSTC
180 Committee Draft 01, 10 March 2009. [http://docs.oasis-
open.org/security/saml/Post2.0/sstc-saml-delegation-cd-01.pdf](http://docs.oasis-
181 open.org/security/saml/Post2.0/sstc-saml-delegation-cd-01.pdf)

2 SAML V2.0 Holder-of-Key Assertion Profile

2.1 Required Information

Identification: urn:oasis:names:tc:SAML:2.0:profiles:holder-of-key

Contact information: security-services-comment@lists.oasis-open.org

SAML Confirmation Method Identifiers: The SAML V2.0 holder-of-key confirmation method identifier (urn:oasis:names:tc:SAML:2.0:cm:holder-of-key) is associated with every <saml:SubjectConfirmation> element issued under this profile.

Description: Given below.

Updates: Supplements the holder-of-key confirmation method described in section 3.1 of [SAML2Prof].

2.2 Profile Description

This specification profiles a type of assertion called a holder-of-key assertion. By definition, a *holder-of-key SAML assertion* contains a <saml:SubjectConfirmation> element whose Method attribute is set to urn:oasis:names:tc:SAML:2.0:cm:holder-of-key. This specification describes how the SAML issuer binds selected X.509 data from an X.509 certificate to the <saml:SubjectConfirmation> element of a holder-of-key assertion. The complementary process involves a relying party who confirms that the X.509 data bound to the assertion matches the data in a given X.509 certificate.

Suppose a SAML response issued by a SAML issuer contains one or more holder-of-key assertions (otherwise this specification is not applicable). At the time the assertion is issued, the issuer possesses an X.509 certificate known to be associated with the attesting entity (who may or may not be present when the assertion is issued). The SAML issuer binds some (or all) of the X.509 data in the certificate to the holder-of-key assertion.

Subsequently, the attesting entity presents the holder-of-key assertion and an X.509 certificate to the relying party. The attesting entity proves possession of the private key corresponding to the public key bound to the certificate, the details of which are out of scope with respect to this profile. The relying party compares the X.509 data in the certificate to the X.509 data bound to the assertion, thereby confirming the attesting entity.

Precisely how the issuer comes to possess a certificate known to be associated with attesting entity and how the assertion and the certificate are presented to the relying party are all out of scope with respect to this profile. On the other hand, the issuing of the holder-of-key assertion itself and the ultimate confirmation of the attesting entity are in scope.

We assume that the relying party trusts the SAML issuer to issue holder-of-key assertions. The SAML issuer, on the other hand, may not even know the intended relying party, so there is no underlying assumption that the SAML issuer trusts the relying party.

2.3 X.509 Certificate Usage

There are no explicit requirements with respect to the X.509 certificate(s) possessed by the SAML issuer and the relying party. If, however, a certificate contains a Subject Key Identifier (SKI) extension, then the certificate MUST be an X.509 v3 certificate [RFC5280]. Other than that, the specific characteristics of these certificates are wholly out of scope with respect to this specification. In particular, there is no expectation that either the SAML issuer or the relying party trusts the issuer of the certificate, and

222 therefore all portions of the certificate, apart from the X.509 data specified in the following sections, are
223 unspecified.

224 The only exception to the above rule is the case where the `<ds:X509Data>` element specified in
225 section 2.4.1 contains a `<ds:X509SubjectName>` element or a `<ds:X509SerialIssuer>` element. In
226 these two cases, the relying party MUST trust the X.509 issuer in order to confirm the attesting entity. This
227 is discussed more fully in section 2.5 below.

228 2.4 Issuing Holder-of-Key Assertions

229 Every assertion containing a holder-of-key `<saml:SubjectConfirmation>` element MUST conform to
230 [SAML2Core] (see section 2.4.1 of Core, especially section 2.4.1.3) and section 3.1 of [SAML2Prof].
231 Where this specification conflicts with the SAML V2.0 specification, the former takes precedence.

232 Suppose a SAML issuer wishes to issue a response containing one or more holder-of-key assertions. As
233 a prerequisite, the SAML issuer MUST possess an X.509 certificate known to be associated with the
234 attesting entity. The SAML issuer binds some or all of the X.509 data in the certificate to the
235 `<saml:SubjectConfirmation>` element of a SAML assertion.

236 Briefly, the SAML issuer binds a `<ds:KeyInfo>` element to the `<saml:SubjectConfirmationData>`
237 element of a holder-of-key assertion. The `<ds:KeyInfo>` element contains one or more of the following
238 elements: `<ds:X509Certificate>`, `<ds:X509SKI>`, `<ds:X509SubjectName>`, or
239 `<ds:X509IssuerSerial>`. A `<ds:X509Certificate>` element contains a base64 encoding of the
240 certificate possessed by the SAML issuer. A `<ds:X509SKI>` element contains the base64 encoding of
241 the Subject Key Identifier (SKI) extension (if there is one) bound to the certificate. A
242 `<ds:X509SubjectName>` element contains the subject distinguished name (DN) bound to the certificate.
243 A `<ds:X509IssuerSerial>` element contains the issuer DN and the issuer serial number bound to the
244 certificate. In each case, the content of the `<ds:KeyInfo>` element conforms to the XML Signature
245 specification [XMLSig]. These requirements are spelled out more clearly in the next section.

246 If the SAML issuer has reason to believe that the relying party trusts the certificate issuer, the SAML issuer
247 MAY include `NotBefore` or `NotOnOrAfter` XML attributes on the
248 `<saml:SubjectConfirmationData>` element. If so, the values bound to the assertion MUST be
249 consistent with the values in the certificate. In particular, the value of the `NotBefore` attribute (resp., the
250 `NotOnOrAfter` attribute) MUST be greater than or equal to (resp., less than or equal to) the `NotBefore`
251 field (resp., the `NotOnOrAfter` field) of the certificate.

252 The `<saml:SubjectConfirmation>` element MAY contain a `<saml:NameID>` element. If it does, the
253 latter identifies an attesting entity different from the subject of the assertion. If the
254 `<saml:SubjectConfirmation>` element does not contain a `<saml:NameID>` element, then the
255 attesting entity and the subject are one and the same.

256 If the `<saml:SubjectConfirmation>` element contains a `<saml:NameID>` element, the attesting
257 entity is presumably acting on behalf of the subject. To more strongly signal such a delegation scenario, a
258 `<saml:Condition>` element MAY be used (cf. [SAML2ConDel]).

259 2.4.1 KeyInfo Usage

260 According to the SAML V2.0 specification, a holder-of-key assertion MUST contain at least one
261 `<ds:KeyInfo>` element within the `<saml:SubjectConfirmationData>` element and that the
262 `<ds:KeyInfo>` element MUST conform to the XML Signature specification. This SAML V2.0 Holder-of-
263 Key Assertion Profile requires that the `<ds:KeyInfo>` element MUST conform to the *Second Edition* of
264 the XML Signature specification [XMLSig] and further constrains the content of each `<ds:KeyInfo>`
265 element to contain exactly one `<ds:X509Data>` element. The `<ds:X509Data>` element MUST NOT
266 contain a `<ds:X509CRL>` element. Instead, the following content options are specified, at least one of
267 which MUST be satisfied:


```

319 DQEBAQUAA4IBDwAwggEKAoIBAQDIDVKdO2CCVYA0TspOPmcSNnivjQq7jCacrgRPawKi3/pTuvnW
320 3c2XCpyT2s6Sks3Eg5T4HIXta5E+lOpN8VbTunVdSrac54r2uK8x+8AqX7M0wQw+98iGw9E2an5q
321 xRZfqqE1T5jWL/a/G1/e2TG1mp521W3k1nNtf8rYH39JpwBSZMeW7uHOSZOkT/pVvqPTgG7vUQT6
322 BiRh7PfwslrLOMubbeQ6Z2m3Vnsv20E1FbPzswszh4X1gXj9bnyI2UsuoisW9Y4p4byjL3GJ/hxp
323 mjRjXs+aIpzi0V3MH+jVJ98eomhlUFLaE83xycC8lns+FcCSQZ8RsbnaLZrtC8r7AgMBAAEwDQYJ
324 KoZThvcNAQEEBQADggEBACwnWSEpwq5aE7QBdDNNXyok34RIonYi9690yw7i+JU7R/QdE42GERJS
325 DVKBN959ELLJf5d0vybGv08QWbZVQ7eBGn9xaZ7MhSnb1YNDXs9vuv1V2Dy32q1J5nCSzqpJDyln
326 lVFWe9UQMCJOO6ibUtWLhiDQ49kmMabgyYfx28qB6oRdVL+mDI/XTt+mkCgk4Rs78n4kbX6qnRlj
327 dE/YnibP1A7iMh8pQkv49J6sP9SeUmQ2zxKct3tSRzzyypWc8JjOZGuBYGQH19Xm7WEs4CXs7iZJW
328 E32frMatavMcTM/gnDtCc8tZAx12PSLOF1954vapfMjBhg3VTI6QRW//wPE=
329 </ds:X509Certificate>
330
331 <!-- the above X.509 certificate does not contain a
332 Subject Key Identifier extension so the SAML issuer
333 must not include a <ds:X509SKI> element -->
334
335 <!-- the subject DN (in RFC 5414 format) bound to the
336 above X.509 certificate -->
337 <ds:X509SubjectName>emailAddress=some-address@host.org,CN=Joana
338 Trindade,OU=GSoc 2008,O=GSoc 2008,L=Some-City,ST=Some-
339 State,C=BR</ds:X509SubjectName>
340
341 <!-- the issuer DN (in RFC 5414 format) and the issuer serial
342 number (in decimal) bound to the above X.509 certificate -->
343 <ds:X509IssuerSerial>
344 <ds:X509IssuerName>emailAddress=some-address@host.org,CN=Joana
345 Trindade,OU=GSoc 2008,O=GSoc 2008,L=Some-City,ST=Some-
346 State,C=BR</ds:X509IssuerName>
347 <ds:X509SerialNumber>9900230501951362398</ds:X509SerialNumber>
348 </ds:X509IssuerSerial>
349
350 </ds:X509Data>
351 </ds:KeyInfo>
352 </saml:SubjectConfirmationData>
353 </saml:SubjectConfirmation>

```

354 A relying party can confirm the attesting entity by the matching the available X.509 data to any of the
355 above child elements of the <ds:X509Data> element.

356 2.5 Processing Holder-of-Key Assertions

357 The attesting entity presents a holder-of-key assertion and an X.509 certificate to the relying party. The
358 attesting entity **MUST** prove possession of the private key corresponding to the public key bound to the
359 certificate, the details of which are out of scope with respect to this profile. The relying party confirms the
360 attesting entity by comparing the X.509 data in the certificate to the X.509 data bound to the assertion. If
361 the X.509 data in the certificate matches the X.509 data bound to the assertion, the attesting entity is said
362 to be *confirmed*.

363 Regardless of the protocol used, any assertions relied upon **MUST** be valid according to the processing
364 rules specified in [SAML2Core]. In particular, the relying party **MUST** verify the signature (if any) on each
365 assertion containing a holder-of-key <saml:SubjectConfirmation> element. Any assertion that is not
366 valid, or whose subject confirmation requirements cannot be met, **SHOULD** be discarded and **SHOULD**
367 **NOT** be used to establish a security context for the subject.

368 If the <ds:X509Data> element contains multiple child elements, the relying party may choose to confirm
369 the attesting entity based on any one of them. Specifically, the relying party **MUST** confirm that the
370 certificate matches the content of the <ds:X509Data> element as follows:

- 371 • If the <ds:X509Data> element contains a <ds:X509Certificate> element, and the relying
372 party chooses to confirm the attesting entity based on this element, the relying party **MUST** ensure
373 that the certificate bound to the assertion matches the X.509 certificate in its possession.

374 Matching is done by comparing the base64-decoded certificates, or the hash values of the
375 base64-decoded certificates, byte-for-byte.

- 376 • If the `<ds:X509Data>` element contains a `<ds:X509SKI>` element, and the relying party
377 chooses to confirm the attesting entity based on this element, the relying party MUST ensure that
378 the value bound to the assertion matches the Subject Key Identifier (SKI) extension bound to the
379 X.509 certificate. Matching is done by comparing the base64-decoded SKI values byte-for-byte.
380 If the X.509 certificate does not contain an SKI extension, the attesting entity is not confirmed and
381 the relying party SHOULD disregard the assertion.
- 382 • If the `<ds:X509Data>` element contains a `<ds:X509SubjectName>` element, and the relying
383 party chooses to confirm the attesting entity based on this element, the relying party MUST ensure
384 that the subject distinguished name (DN) bound to the assertion matches the DN bound to the
385 X.509 certificate. If, however, the relying party does not trust the certificate issuer to issue such a
386 DN, the attesting entity is not confirmed and the relying party SHOULD disregard the assertion.
- 387 • If the `<ds:X509Data>` element contains a `<ds:X509IssuerSerial>` element, and the relying
388 party chooses to confirm the attesting entity based on this element, the relying party MUST ensure
389 that the issuer DN and issuer serial number bound to the assertion match the issuer DN and the
390 issuer serial number (resp.) bound to the X.509 certificate. If the relying party does not trust the
391 certificate issuer to issue X.509 certificates, however, the attesting entity is not confirmed and the
392 relying party SHOULD disregard the assertion.

393 In the case of a `<ds:X509Certificate>` element or a `<ds:X509SKI>` element, the matching process
394 is relatively straightforward. If the `<ds:X509Data>` element contains a `<ds:X509SubjectName>`
395 element or a `<ds:X509IssuerSerial>` element, however, and the relying party chooses to confirm the
396 attesting entity based on one of these elements, the relying party MUST trust the issuer of the X.509
397 certificate before the attesting entity can be considered confirmed. If such a trust relationship between the
398 relying party and the certificate issuer does not exist, the relying party SHOULD disregard the assertion.

399 If the `<saml:SubjectConfirmationData>` element includes `NotBefore` or `NotOnOrAfter`
400 attributes, and the relying party trusts the issuer of the X.509 certificate, the relying party MUST confirm
401 that the current time is greater than or equal to (resp., less than or equal to) the value of the `NotBefore`
402 (resp., the `NotOnOrAfter`) attribute. If this requirement is not met, the attesting entity is not confirmed
403 and the relying party SHOULD disregard the assertion.

404 2.6 Security and Privacy Considerations

405 This profile assumes that both the SAML issuer and the relying party have access to an X.509 certificate.
406 For those deployments that wish to avoid or do not require an X.509-based public key infrastructure (PKI),
407 this may seem unnecessarily restrictive. In fact, the use of X.509 certificates is typical and provides a
408 number of advantages. First, observe that the SSL/TLS protocol [RFC4346] requires the use of X.509
409 certificates. Second, and most importantly, since there is no presumption of an underlying trust model for
410 X.509 certificates, the full range of possible content for the `<ds:KeyInfo>` element is avoided. Those
411 deployments that are in fact based on such a trust model, or wish to avoid X.509 certificates altogether,
412 may choose to profile additional child elements such as `<ds:KeyName>` or `<ds:KeyValue>`.

413 Deployments that rely on holder-of-key SAML assertions will no doubt impose their own requirements on
414 the X.509 certificates used to obtain those assertions. For example, some deployments will require the
415 certificate to be an X.509 end-entity certificate [RFC5280] issued by a trusted X.509 certification authority
416 (CA) or a certificate based on a trusted X.509 end-entity certificate (such as an X.509 proxy certificate
417 [RFC3820]). This specification imposes no such restrictions, however.

418 2.6.1 ASN.1 Encoding

419 For compatibility with the XML Signature specification [XMLSig], this profile intentionally avoids any
420 discussion of the ASN.1 encoding of the X.509 certificate possessed by the SAML issuer and the relying

421 party. Indeed, in the case of the `<ds:X509Certificate>` element, the ASN.1 encoding of the
422 certificate doesn't matter. In this case, the SAML issuer simply base64-encodes the ASN.1-encoded
423 certificate in its possession and binds it to the `<ds:X509Certificate>` element. Later the relying party
424 base64-decodes the content of the `<ds:X509Certificate>` element and compares the resulting
425 certificate (byte-for-byte) with the ASN.1-encoded certificate in its possession.

426 In the case of the `<ds:X509SKI>`, `<ds:X509SubjectName>`, or `<ds:X509IssuerSerial>` elements,
427 however, the ASN.1 encoding of the certificates *does* matter. To produce these elements, the SAML
428 issuer must ASN.1-decode the certificate in its possession and parse the ASN.1 to obtain the X.509 data
429 to be bound to the assertion. Likewise the relying party must ASN.1-decode the certificate in its
430 possession, parsing the ASN.1 to obtain the required X.509 data, which it compares to the X.509 data
431 bound to the assertion.

432 The basic problem is that the ASN.1 encoding of an X.509 certificate is not guaranteed. While it is true
433 that an X.509 certificate is often DER-encoded, a robust implementation must be prepared to handle other
434 ASN.1 encodings besides DER, mainly BER and CER. Consequently it is anticipated that deployments
435 will prefer the `<ds:X509Certificate>` element for maximum interoperability. In fact, this preference is
436 reflected in the conformance requirements of this profile (section 3).

437 **2.6.2 X.509 Serial Number**

438 Note that some CAs use large random numbers as serial numbers to prevent sequence guessing.
439 However, not all XML libraries are capable of dealing with large integers in the
440 `<ds:X509IssuerSerial>` element. The problem is that the `<ds:X509SerialNumber>` child element
441 of the `<ds:X509IssuerSerial>` element is typed as an arbitrary integer in [XMLSig] yet conforming
442 implementations are required to support only 18 decimal digits. Thus the `<ds:X509IssuerSerial>`
443 element should be used with care.

444 **3 Conformance**

445 **3.0.1 SAML V2.0 Holder-of-Key Assertion Profile**

446 Both the SAML issuer and the relying party **MUST** conform to section 2.3.

447 A SAML issuer **MUST** follow the issuing rules in section 2.4. In particular, a SAML issuer **MUST** produce
448 `<ds:KeyInfo>` elements that conform to section 2.4.1. Likewise, a relying party **MUST** follow the
449 processing rules in section 2.5.

450 To claim conformance to this specification, a SAML issuer implementation **MUST** support the
451 `<ds:X509Certificate>` element specified in section 2.4.1. Support for the remaining child elements
452 specified in section 2.4.1 is **OPTIONAL** for SAML issuers.

453 Likewise a conforming relying party implementation **MUST** support the `<ds:X509Certificate>`
454 element specified in section 2.5. Support for the remaining child elements specified in section 2.5 is
455 **OPTIONAL** for relying parties.

456 **Appendix A. Acknowledgments**

457 The editor would like to acknowledge the contributions of the OASIS Security Services (SAML) Technical
458 Committee, whose voting members at the time of publication were:

- 459 • TBD

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Appendix B. Revision History

Document ID	Date	Committer	Comment
sstc-saml2-holder-of-key-draft-01	7 Aug 2008	T. Scavo	Initial draft
sstc-saml2-holder-of-key-draft-02	14 Aug 2008	T. Scavo	Remove all refs to <code>samlp:</code>
sstc-saml2-holder-of-key-draft-03	7 Sep 2008	T. Scavo	Remove proof of possession requirement
sstc-saml2-holder-of-key-draft-04	6 Oct 2008	T. Scavo	Response to comments
sstc-saml2-holder-of-key-draft-05	20 Oct 2008	T. Scavo	Updated KeyInfo Usage rules
sstc-saml2-holder-of-key-draft-06	13 Nov 2008	T. Scavo	Dropped DER-encoding requirement
sstc-saml2-holder-of-key-draft-07	7 Dec 2008	T. Scavo	Added NotBefore/NotOnOrAfter attributes
sstc-saml2-holder-of-key-draft-08	11 Jan 2009	T. Scavo	Relaxed the X.509 v3 requirement
sstc-saml2-holder-of-key-draft-09	20 Jan 2009	T. Scavo	Response to comments
sstc-saml2-holder-of-key-cd-01	9 Mar 2009	T. Scavo	Committee Draft 01
sstc-saml2-holder-of-key-draft-10	14 Jun 2009	T. Scavo	Response to Public Comments
sstc-saml2-holder-of-key-cd-02	5 Jul 2009	T. Scavo	Committee Draft 02
sstc-saml2-holder-of-key-cs-01	29 Jul 2009	tc-admin	Committee Specification 01
sstc-saml2-holder-of-key-draft-11	4 Oct 2009	T. Scavo	Fixed minor bugs in CS 01