Liberty ID-FF Authentication Context Specification

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Abstract:

If a service provider is to rely on the authentication of a Principal by an identity provider (or more generally of another provider by an authentication authority), the service provider may require information additional to the assertion itself in order to assess the level of confidence they can place in that assertion. This specification defines an XML Schema for the creation of *Authentication Context statements* - XML documents that allow the authentication authority to provide to the service provider this additional information. Additionally, this specification defines a number of *Authentication Context classes*; categories into which many Authentication Context statements will fall, thereby simplifying their interpretation.

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Contents

1. About this Document

This specification defines a syntax for the definition of authentication context statements and an initial list of Liberty authentication context classes.

1.1. Notation and Terminology

This section specifies the notations, namespaces and terminology used throughout this specification. This specification uses schema documents conforming to W3C XML Schema (see [Schema1]) and normative text to describe the syntax and semantics of XML-encoded messages.

1.1.1. Notational Conventions

Note: Phrases and numbers in brackets [ ] refer to other documents; details of these references can be found in References (at the end of this document).

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

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.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08">

   <!-- Add Stuff Here -->

</xs:schema>
```

1.1.2. Namespaces

The following namespaces are referred to in this document:

Table 1. Namespaces

Prefix	Namespace
ac	urn:liberty:ac:1.2
lib	urn:liberty:iff:1.2
xs	http://www.w3.org/2001/XMLSchema
xsi	http://www.w3.org/2001/XMLSchema-instance

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

2. Overview

Liberty will not prescribe a single technology, protocol, or policy for the processes by which identity providers issue identities to Principals and by which those Principals subsequently authenticate themselves to the identity provider. Different identity providers will choose different technologies, follow different processes, and be bound by different legal obligations with respect to how they authenticate Principals.

The choices that an identity provider makes here will be driven in large part by the requirements of the service providers with which the identity provider has affiliated into a circle of trust. These requirements themselves will be determined by the nature of the service (that is, the sensitivity of any information exchanged, the associated financial value, the service providers risk tolerance, etc.) that the service provider will be providing to the Principal.

Consequently, for anything other than trivial services, if the service provider is to place sufficient confidence in the authentication assertions it receives from an identity provider, it will be necessary for the service provider to know which technologies, protocols, and processes were used or followed for the original authentication mechanism on which the authentication assertion is based. Armed with this information and trusting the origin of the actual assertion, the service provider will be better able to make an informed entitlements decision regarding what services the subject of the authentication assertion should be allowed to access.

Authentication context is defined as the information, additional to the authentication assertion itself, that the service provider may require before it makes an entitlements decision with respect to an authentication assertion.

3. Authentication Context

If a relying party is to rely on the authentication of another entity by an authentication authority, the relying party may require information additional to the authentication itself to allow it to put the authentication into a risk-management context. This information could include:

- What were the initial user identification mechanisms (for example, face-to-face, online, shared secret).
- What are the mechanisms for minimizing compromise of credentials (for example, credential renewal frequency, client-side key generation).
- What are the mechanisms for storing and protecting credentials (for example, smartcard, password rules).
- What was the authentication mechanism (for example, password, certificate-based SSL).

The variations and permutations in the characteristics listed above guarantee that not all authentication assertions will be the same with respect to the confidence that a relying party can place in it; a particular authentication assertion will be characterized by the values for each of these (and other) variables.

4. Authentication Context Statement

A Liberty authentication authority will deliver to a relying party the additional authentication context information in the form of an Authentication Context Statement, an XML document either inserted or referenced within the <AuthnResponse> message the authentication authority returns to the relying party.

4.1. Authentication Context Statement Data Model

A particular Liberty authentication context statement will capture the characteristics of the processes, procedures, and mechanisms by which the authentication verified the subject before issuing an identity, protects the secrets on which subsequent authentications are based, and the mechanisms used for this authentication. These characteristics are categorized in the Liberty Authentication Context schema as follows:

- Identification - Characteristics that describe the processes and mechanism the authentication authority uses to initially create an association between a subject and the identity (or name) by which the subject will be known.
- Technical Protection - Characteristics that describe how the "secret" (the knowledge or possession of which allows the subject to authenticate to the authentication authority) is kept secure.
- Operational Protection - Characteristics that describe procedural security controls employed by the authentication authority (for example, security audits, records archival).
- Authentication Method - Characteristics that define the mechanisms by which the subject of the issued assertion authenticates to the authentication authority (for example, a password versus a smartcard).
- Governing Agreements - Characteristics that describe the legal framework (e.g. liability constraints and contractual obligations) underlying the authentication event and/or its associated technical authentication infrastructure.

4.2. Authentication Context Statement Schema

This section lists the complete Authentication Context XML Schema.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08">

   <!-- added to get the Extension element -->
   <xs:include schemaLocation="liberty-utility-v1.0.xsd"/>

   <xs:annotation>
      <xs:documentation> ### IMPORTANT NOTICE ###

         The source code in this XSD file was excerpted verbatim from:

         Liberty Authentication Context Specification
         Version 1.2-errata-v1.0
         12 September 2004

         Copyright (c) 2004 Liberty Alliance participants, see
         http://www.projectliberty.org/specs/idff_copyrights.html
      </xs:documentation>
   </xs:annotation>
   <xs:element name="AuthenticationContextStatement" type="AuthenticationContextStatementType">
      <xs:annotation>
         <xs:documentation>
            A particular assertion on an identity
            provider's part with respect to the authentication
```

```
            context associated with an authentication assertion.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="Identification" type="IdentificationType">
      <xs:annotation>
         <xs:documentation>
            Refers to those characteristics that describe the processes and mechanisms
            the Authentication Authority uses to initially create an association between a Principal
            and the identity (or name) by which the Principal will be known
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="PhysicalVerification">
      <xs:annotation>
         <xs:documentation>
            This element indicates that identification has been performed in a physical
            face-to-face meeting with the principal and not in an online manner.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:attribute name="credentialLevel">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="primary"/>
                  <xs:enumeration value="secondary"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:attribute>
      </xs:complexType>
   </xs:element>
   <xs:element name="WrittenConsent">
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="TechnicalProtection" type="TechnicalProtectionType">
      <xs:annotation>
         <xs:documentation>
            Refers to those characteristics that describe how the 'secret' (the knowledge or
            possession of which allows the Principal to authenticate to the Authentication
            Authority) is kept secure
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="SecretKeyProtection" type="SecretKeyProtectionType">
      <xs:annotation>
         <xs:documentation>
            This element indicates the types and strengths of facilities
            of a UA used to protect a shared secret key from unauthorized access and/or use.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="PrivateKeyProtection" type="PrivateKeyProtectionType">
      <xs:annotation>
         <xs:documentation>
            This element indicates the types and strengths of facilities
            of a UA used to protect a private key from unauthorized access and/or use.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="KeyActivation" type="KeyActivationType">
      <xs:annotation>
         <xs:documentation>The actions that must be performed before the private key can be used.
</xs:documentation>
```

```
      </xs:annotation>
   </xs:element>
   <xs:element name="KeySharing" type="KeySharingType">
      <xs:annotation>
         <xs:documentation>
            Whether or not the private key is shared with the certificate authority.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="KeyStorage" type="KeyStorageType">
      <xs:annotation>
         <xs:documentation>
            In which medium is the key stored.
            memory - the key is stored in memory.
            smartcard - the key is stored in a smartcard.
            token - the key is stored in a hardware token.
            MobileDevice - the key is stored in a mobile device.
            MobileAuthCard - the key is stored in a mobile authentication card.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="Password" type="PasswordType">
      <xs:annotation>
         <xs:documentation>
            This element indicates that a password (or passphrase) has been used to
            authenticate the Principal to a remote system.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="ActivationPin" type="ActivationPinType">
      <xs:annotation>
         <xs:documentation>
            This element indicates that a Pin (Personal Identification Number) has been used
            to authenticate the Principal to some local system in order to activate a key.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="Token" type="TokenType">
      <xs:annotation>
         <xs:documentation>
            This element indicates that a hardware or software token is  used
            as a method of identifying the Principal.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="TimeSyncToken" type="TimeSyncTokenType">
      <xs:annotation>
         <xs:documentation>
            This element indicates that a time synchronization
            token is used to identify the Principal.
            hardware - the time synchronization token has been implemented in hardware.
            software - the time synchronization token has been implemented in software.
            SeedLength - the length, in bits, of the random seed used in the time synchronization
token.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="Smartcard">
      <xs:annotation>
         <xs:documentation>
            This element indicates that a smartcard is used to identity the Principal.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
```

```
      </xs:complexType>
   </xs:element>
   <xs:element name="Length" type="LengthType">
      <xs:annotation>
         <xs:documentation>
            This element indicates the minimum and/or maximum ASCII  length of the password
            which is enforced (by the UA or the IdP).  In other words,  this is the minimum
            and/or maximum number of ASCII characters required to represent a valid password.
            min - the minimum number of ASCII characters required in a valid password,
              as enforced by the UA or the IdP.
            max - the maximum number of ASCII characters required in a valid password,
              as enforced by the UA or the IdP.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="ActivationLimit" type="ActivationLimitType">
      <xs:annotation>
         <xs:documentation>
            This element indicates the length of time for which an PIN-based authentication is valid.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="Generation">
      <xs:annotation>
         <xs:documentation>
            Indicates whether the password was chosen by the Principal or auto-supplied
            by the Authentication Authority.
            principalchosen - the Principal is allowed to choose the value of the password.
            This is true even if the initial password is chosen at random by the UA or the
            IdP and the Principal is then free to change the password.
            automatic - the password is chosen by the UA or the IdP to be cryptographically strong
            in some sense, or to satisfy certain  password rules, and that the Principal
            is not free to change it or to choose a new password.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:attribute name="mechanism" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="principalchosen"/>
                  <xs:enumeration value="automatic"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:attribute>
      </xs:complexType>
   </xs:element>
   <xs:element name="AuthenticationMethod" type="AuthenticationMethodType">
      <xs:annotation>
         <xs:documentation>
            Refers to those characteristics that define the mechanisms by which the
            Principal authenticates to the Authentication Authority.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="PrincipalAuthenticationMechanis
m" type="PrincipalAuthenticationMechanismType">
      <xs:annotation>
         <xs:documentation>
            The method that a Principal employs to perform authentication to local system components.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="Authenticator" type="AuthenticatorType">
      <xs:annotation>
         <xs:documentation>
            The method applied to validate a principal’s authentication across a network
         </xs:documentation>
```

```
      </xs:annotation>
   </xs:element>
   <xs:element name="PreviousSession">
      <xs:annotation>
         <xs:documentation>
            Indicates that the Principal has been strongly authenticated in a previous session during which  the IdP has set a cookie in the UA.  During the present session the Principal has only been authenticated by the UA returning the cookie to the IdP.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="ResumeSession">
      <xs:annotation>
         <xs:documentation>
            Rather like PreviousSession but using stronger security.  A secret that was established in a previous session with the Authentication Authority has been cached by the local system and is now re-used (e.g. a Master Secret is used to derive new session keys in TLS, SSL, WTLS).
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="ZeroKnowledge">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Principal has been authenticated by a zero knowledge technique as specified in ISO/IEC 9798-5.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="SharedSecretChallengeResponse">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Principal has been authenticated by a challenge-response protocol utilizing shared secret keys and symmetric cryptography.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="DigSig">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Principal has been authenticated by a mechanism which involves the Principal computing a digital signature over at least challenge data provided by the IdP.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
```

```
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="IPAddress">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Principal has been authenticated through connection from a particular IP address.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="AsymmetricDecryption">
      <xs:annotation>
         <xs:documentation>
               The local system has a private key but it is used in decryption mode, rather than signature mode. For example, the Authentication Authority generates a secret and encrypts it using the local system's public key: the local system then proves it has decrypted the secret.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="AsymmetricKeyAgreement">
      <xs:annotation>
         <xs:documentation>
               The local system has a private key and uses it for shared secret key agreement with the Authentication Authority (e.g. via Diffie Helman).
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="SharedSecretDynamicPlaintext">
      <xs:annotation>
         <xs:documentation>
               The local system and Authentication Authority share a secret key.  The local system uses this to encrypt a randomized string to pass to the Authentication Authority.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>

   <xs:element name="AuthenticatorTransportProtocol" type="AuthenticatorTransportProtocolType">
      <xs:annotation>
         <xs:documentation>
            The protocol across which Authenticator information is transferred to an Authentication Authority verifier.
```

```
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="HTTP">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Authenticator has been transmitted using bare HTTP
utilizing no additional security protocols.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="IPSec">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Authenticator has been transmitted using a transport
mechanism protected by an IPSEC session.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="WTLS">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Authenticator has been transmitted using a transport
mechanism protected by a WTLS session.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="MobileNetworkNoEncryption">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Authenticator has been transmitted solely across a
mobile network using no additional security mechanism.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
  <xs:element name="MobileNetworkRadioEncryption">
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
  <xs:element name="MobileNetworkEndToEndEncryption">
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
```

```
      </xs:complexType>
   </xs:element>

   <xs:element name="SSL">
      <xs:annotation>
         <xs:documentation>
            This element indicates that the Authenticator has been transmitted using a transport mechanism protected by an SSL or TLS session.
         </xs:documentation>
      </xs:annotation>
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="OperationalProtection" type="OperationalProtectionType ">
      <xs:annotation>
         <xs:documentation>
            Refers to those characteristics that describe procedural security controls employed by the Authentication Authority.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="SecurityAudit" type="SecurityAuditType"/>
   <xs:element name="SwitchAudit">
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="DeactivationCallCenter">
      <xs:complexType>
         <xs:sequence>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:complexType>
   </xs:element>
   <xs:element name="GoverningAgreements" type="GoverningAgreementsType">
      <xs:annotation>
         <xs:documentation>
            Provides a mechanism for linking to external (likely human readable) documents in which additional business agreements,(e.g. liability constraints, obligations, etc) can be placed.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="GoverningAgreementRef" type="GoverningAgreementRefType"/>
   <xs:element name="AuthenticatingAuthority" type="AuthenticatingAuthorityTyp e">
      <xs:annotation>
         <xs:documentation>
            The Authority that originally authenticated the Principal.
         </xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:complexType name="IdentificationType">
      <xs:sequence>
         <xs:element ref="PhysicalVerification" minOccurs="0"/>
         <xs:element ref="WrittenConsent" minOccurs="0"/>
         <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="nym">
         <xs:annotation>
            <xs:documentation>
               This attribute indicates whether or not the Identification mechanisms allow the actions of the Principal to be linked to an actual end user.
            </xs:documentation>
```

```
         </xs:annotation>
         <xs:simpleType>
            <xs:restriction base="xs:NMTOKEN">
               <xs:enumeration value="anonymity"/>
               <xs:enumeration value="verinymity"/>
               <xs:enumeration value="pseudonymity"/>
            </xs:restriction>
         </xs:simpleType>
      </xs:attribute>
   </xs:complexType>
   <xs:complexType name="GoverningAgreementsType">
      <xs:sequence>
         <xs:element ref="GoverningAgreementRef" maxOccurs="unbounded"/>
      </xs:sequence>
   </xs:complexType>
   <xs:complexType name="GoverningAgreementRefType">
      <xs:attribute name="governingAgreementRef" type="xs:anyURI" use="required"/>
   </xs:complexType>
   <xs:complexType name="AuthenticatingAuthorityType">
      <xs:sequence>
         <xs:element ref="GoverningAgreements"/>
      </xs:sequence>
      <xs:attribute name="ID" type="xs:anyURI" use="required"/>
   </xs:complexType>
   <xs:complexType name="AuthenticatorTransportProtocolType">
      <xs:choice>
         <xs:element ref="HTTP"/>
         <xs:element ref="SSL"/>
         <xs:element ref="MobileNetworkNoEncryption"/>
         <xs:element ref="MobileNetworkRadioEncryption"/>
         <xs:element ref="MobileNetworkEndToEndEncryption"/>
         <xs:element ref="WTLS"/>
         <xs:element ref="IPSec"/>
         <xs:element ref="Extension" maxOccurs="unbounded"/>
      </xs:choice>
   </xs:complexType>
   <xs:complexType name="PrincipalAuthenticationMechanismType">
      <xs:choice>
         <xs:element ref="Password"/>
         <xs:element ref="Token"/>
         <xs:element ref="Smartcard"/>
         <xs:element ref="ActivationPin"/>
         <xs:element ref="Extension" maxOccurs="unbounded"/>
      </xs:choice>
   </xs:complexType>
   <xs:complexType name="AuthenticationMethodType">
      <xs:sequence>
         <xs:element ref="PrincipalAuthenticationMechanism" minOccurs="0"/>
         <xs:element ref="Authenticator" minOccurs="0"/>
         <xs:element ref="AuthenticatorTransportProtocol" minOccurs="0"/>
         <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
   </xs:complexType>
   <xs:complexType name="AuthenticationContextStatementType">
      <xs:sequence>
         <xs:element ref="Identification" minOccurs="0"/>
         <xs:element ref="TechnicalProtection" minOccurs="0"/>
         <xs:element ref="OperationalProtection" minOccurs="0"/>
         <xs:element ref="AuthenticationMethod" minOccurs="0"/>
         <xs:element ref="GoverningAgreements" minOccurs="0"/>
         <xs:element ref="AuthenticatingAuthority" minOccurs="0" maxOccurs="unbounded"/>
         <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="ID" type="xs:ID"/>
   </xs:complexType>
   <xs:complexType name="TechnicalProtectionType">
      <xs:choice>
```

```
        <xs:element ref="PrivateKeyProtection" minOccurs="0"/>
        <xs:element ref="SecretKeyProtection" minOccurs="0"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
      </xs:choice>
  </xs:complexType>
  <xs:complexType name="OperationalProtectionType">
     <xs:sequence>
        <xs:element ref="SecurityAudit" minOccurs="0"/>
        <xs:element ref="DeactivationCallCenter" minOccurs="0"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
     </xs:sequence>
  </xs:complexType>
  <xs:complexType name="AuthenticatorType">
     <xs:choice>
        <xs:element ref="PreviousSession"/>
        <xs:element ref="ResumeSession"/>
        <xs:element ref="DigSig"/>
        <xs:element ref="Password"/>
        <xs:element ref="ZeroKnowledge"/>
        <xs:element ref="SharedSecretChallengeRespons e"/>
        <xs:element ref="SharedSecretDynamicPlaint ext"/>
        <xs:element ref="IPAddress"/>
<xs:element ref="AsymmetricDecryption"/>
<xs:element ref="AsymmetricKeyAgreement"/>
        <xs:element ref="Extension" maxOccurs="unbounded"/>
     </xs:choice>
  </xs:complexType>
  <xs:complexType name="KeyActivationType">
     <xs:choice>
        <xs:element ref="ActivationPin"/>
        <xs:element ref="Extension" maxOccurs="unbounded"/>
     </xs:choice>
  </xs:complexType>
  <xs:complexType name="KeySharingType">
     <xs:attribute name="sharing" type="xs:boolean" use="required"/>
  </xs:complexType>
  <xs:complexType name="PrivateKeyProtectionType">
     <xs:sequence>
        <xs:element ref="KeyActivation" minOccurs="0"/>
        <xs:element ref="KeyStorage" minOccurs="0"/>
        <xs:element ref="KeySharing" minOccurs="0"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
     </xs:sequence>
  </xs:complexType>

  <xs:complexType name="PasswordType">
     <xs:sequence>
        <xs:element ref="Length" minOccurs="0"/>
        <xs:element ref="Alphabet" minOccurs="0"/>
        <xs:element ref="Generation" minOccurs="0"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
     </xs:sequence>
  </xs:complexType>

  <xs:complexType name="ActivationPinType">
     <xs:sequence>
        <xs:element ref="Length" minOccurs="0"/>
        <xs:element ref="Alphabet" minOccurs="0"/>
        <xs:element ref="Generation" minOccurs="0"/>
        <xs:element ref="ActivationLimit" minOccurs="0"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
     </xs:sequence>
  </xs:complexType>

  <xs:element name="Alphabet" type="AlphabetType"/>

  <xs:complexType name="AlphabetType">
```

```
      <xs:attribute name="requiredChars" type="xs:string" use="required"/>
      <xs:attribute name="excludedChars" type="xs:string" use="optional"/>
      <xs:attribute name="case" type="xs:string" use="optional"/>
   </xs:complexType>

   <xs:complexType name="TokenType">
      <xs:sequence>
         <xs:element ref="TimeSyncToken"/>
         <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
   </xs:complexType>
   <xs:complexType name="TimeSyncTokenType">
      <xs:attribute name="DeviceType" use="required">
         <xs:simpleType>
            <xs:restriction base="xs:NMTOKEN">
               <xs:enumeration value="hardware"/>
               <xs:enumeration value="software"/>
            </xs:restriction>
         </xs:simpleType>
      </xs:attribute>
      <xs:attribute name="SeedLength" type="xs:integer" use="required"/>
      <xs:attribute name="DeviceInHand" use="required">
         <xs:simpleType>
            <xs:restriction base="xs:NMTOKEN">
               <xs:enumeration value="true"/>
               <xs:enumeration value="false"/>
            </xs:restriction>
         </xs:simpleType>
      </xs:attribute>
   </xs:complexType>
   <xs:complexType name="ActivationLimitType">
      <xs:choice>
        <xs:element ref="ActivationLimitDuration"/>
        <xs:element ref="ActivationLimitUsages"/>
        <xs:element ref="ActivationLimitSession"/>
      </xs:choice>
   </xs:complexType>

    <xs:element name="ActivationLimitDuration" type="ActivationLimitDurationType">
      <xs:annotation>
        <xs:documentation>
          This element indicates that the Key Activation Limit is defined
          as a specific duration of time.
        </xs:documentation>
      </xs:annotation>
    </xs:element>

    <xs:element name="ActivationLimitUsages" type="ActivationLimitUsagesType">
      <xs:annotation>
        <xs:documentation>
          This element indicates that the Key Activation Limit is defined as a number of usages.
        </xs:documentation>
      </xs:annotation>
    </xs:element>

    <xs:element name="ActivationLimitSession" type="ActivationLimitSessionType" >
      <xs:annotation>
        <xs:documentation>
          This element indicates that the Key Activation Limit is the session.
        </xs:documentation>
      </xs:annotation>
    </xs:element>

     <xs:complexType name="ActivationLimitDurationType">
       <xs:attribute name="duration" type="xs:duration" use="required"/>
     </xs:complexType>
```

```
      <xs:complexType name="ActivationLimitUsagesType">
        <xs:attribute name="number" type="xs:integer" use="required"/>
      </xs:complexType>

      <xs:complexType name="ActivationLimitSessionType"/>

    <xs:complexType name="LengthType">
       <xs:attribute name="min" type="xs:integer" use="required"/>
       <xs:attribute name="max" type="xs:integer" use="optional"/>
    </xs:complexType>

    <xs:complexType name="KeyStorageType">
       <xs:attribute name="medium" use="required">
          <xs:simpleType>
             <xs:restriction base="xs:NMTOKEN">
                <xs:enumeration value="memory"/>
                <xs:enumeration value="smartcard"/>
                <xs:enumeration value="token"/>
                <xs:enumeration value="MobileDevice"/>
                <xs:enumeration value="MobileAuthCard"/>
             </xs:restriction>
          </xs:simpleType>
       </xs:attribute>
    </xs:complexType>
    <xs:complexType name="SecretKeyProtectionType">
       <xs:sequence>
  <xs:element ref="KeyActivation" minOccurs="0"/>
          <xs:element ref="KeyStorage" minOccurs="0"/>
          <xs:element ref="Extension" maxOccurs="unbounded"/>
       </xs:sequence>
    </xs:complexType>
    <xs:complexType name="SecurityAuditType">
       <xs:sequence>
          <xs:element ref="SwitchAudit" minOccurs="0"/>
          <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
       </xs:sequence>
    </xs:complexType>
</xs:schema>
```

4.3. Authentication Context Statement Extensibility

The Authentication Context Statement schema has well-defined extensibility points through the <Extension> element. Authentication authorities can use this element to insert additional authentication context details for the SAML assertions they issue (assuming that the consuming relying party will be able to understand these extensions). These additional elements MUST be in a separate XML Namespace to that of the base Authentication Context Statement schema.

4.4. Authentication Context Statement Processing Rules

The processing rules for Authentication Context Statements are listed in [LibertyProtSchema].

5. Authentication Context Classes

The number of permutations of the different authentication context characteristics ensure that there are a theoretically infinite number of unique authentication contexts. The implication is that in theory any particular relying party would be expected to be able to parse arbitrary authentication context statements and, more importantly, to analyze the statement in order to assess the 'quality' of the associated authentication assertion. Making such an assessment is non-trivial.

Fortunately, an optimization is possible. While theoretically infinite, in practice many authentication contexts will fall into categories - these categories determined by industry practices and technology. For instance, many B2C Web browser authentication contexts will be (partially) defined by the Principal authenticating to the identity provider through the presentation of a password over an SSL protected session. In the enterprise world, certificate-based authentication will be more common. Of course, the full authentication context is not limited to the specifics of how the Principal authenticated. Nevertheless, the authentication method is often the most *visible* characteristic and as such, can serve as a useful classifier for a class of related authentication contexts.

Liberty normalizes this concept through the definition of a number of *Authentication Context Classes*. Each class will define a proper subset of the full set of authentication contexts. Classes have been chosen as representative of the current practices and technologies for authentication technologies. Classes will provide identity and service providers a convenient shorthand when referring to authentication context issues. For instance, an identity provider, may include with the complete authentication context statement it provides to a service provider an assertion that the authentication context also belongs to one of the Liberty defined authentication classes. For some service providers, this assertion will be sufficient detail for it to be able to assign an appropriate level of confidence to the associated authentication assertion. Other service providers might prefer to examine the complete authentication context statement itself. Likewise, the ability to refer to an authentication context class rather than being required to list the complete details of a specific authentication content will simplify how the service provider expresses its desires and/or requirements to an identity provider.

5.1. Advantages of Authentication Context Classes

The introduction of the additional layer of classes and the definition of an initial list of representative and flexible classes are expected to:

- Make it easier for the identity provider and service provider to come to an agreement on what are acceptable authentication contexts by giving them a framework for discussion.
- Make it easier for service providers to indicate their preferences when requesting a step-up authentication assertion from an identity provider.
- Simplify for service providers the burden of processing authentication context statements by giving them the option of being satisfied by the associated class.
- Protect service providers from impact of new authentication technologies.
- Make it easier for identity providers to publish their authentication capabilities, for example, through WSDL.

5.2. Authentication Context Class Schemas

The initial Liberty authentication context classes are listed in the following sub-sections.

The classes are listed in alphabetical order, no ranking is implied by the order of classes.

Classes are identified by URIs with the initial stem: `http://www.projectliberty.org/schemas/authctx/classes`

The class schemas are defined as extension by restriction of the base Authentication Context schema. Consequently, any XML instances that satisfy the schema constraints of one of the class schemas will also conform to the base Authentication Context schema.

5.2.1. Internet Protocol

The Internet Protocol class is identified when a Principal is authenticated through the use of a provided IP address.

5.2.1.1. Associated Liberty URI

`http://www.projectliberty.org/schemas/authctx/classes/InternetProtocol`

5.2.1.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08"
   version="1.2-08" finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/InternetProtocol</x
s:documentation>
   </xs:annotation>
   <xs:complexType name="InternetProtocolAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="IPAddress"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:schema>
```

5.2.2. InternetProtocolPassword

The Internet Protocol Password class is identified when a Principal is authenticated through the use of a provided IP address, in addition to username/password.

5.2.2.1. Associated Liberty URI

`http://www.projectliberty.org/schemas/authctx/classes/InternetProtocolPassword`

5.2.2.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns="urn:liberty:ac:2003-08"
```

```
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   version="1.2-08" finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/InternetProtocolPas
sword</xs:documentation>
   </xs:annotation>

   <xs:complexType name="InternetProtocolPasswordType">
      <xs:complexContent>
         <xs:restriction base="PasswordType">
            <xs:sequence>
               <xs:element ref="Length"/>
               <xs:element ref="Generation" minOccurs="0"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="InternetProtocolPasswordLengthType">
      <xs:complexContent>
         <xs:restriction base="LengthType">
            <xs:attribute name="min" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:integer">
                     <xs:minInclusive value="3"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="max" type="xs:integer" use="optional"/>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="InternetProtocolPasswordAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:sequence>
               <xs:element ref="IPAddress"/>
               <xs:element ref="Password"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:schema>
```

5.2.3. MobileOneFactorUnregistered

Reflects no mobile customer registration procedures and an authentication of the mobile device without requiring explicit end-user interaction. Again, this context authenticates only the device and never the user, it is useful when services other than the mobile operator want to add a secure device authentication to their authentication process.

5.2.3.1. Associated Liberty URI

`http://www.projectliberty.org/schemas/authctx/classes/MobileOneFactorUnregistered`

5.2.3.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
    xmlns="urn:liberty:ac:2003-08"
```

```
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    finalDefault="extension" version="1.2-08">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>http://www.projectliberty.org/schemas/authctx/classes/Mo
bileOneFactorUnregistered</xs:documentation>
   </xs:annotation>
   <xs:complexType name="MobileOneFactorUnregisteredAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="DigSig"/>
               <xs:element ref="ZeroKnowledge"/>
               <xs:element ref="SharedSecretChallengeResponse"/>
               <xs:element ref="AsymmetricDecryption"/>
               <xs:element ref="AsymmetricKeyAgreement"/>
               <xs:element ref="SharedSecretDynamicPlaintext"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredAuthenticatorTransportProtocolType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorTransportProtocolType">
            <xs:choice>
               <xs:element ref="MobileNetworkNoEncryption"/>
               <xs:element ref="MobileNetworkRadioEncryption"/>
               <xs:element ref="MobileNetworkEndToEndEncryption"/>
               <xs:element ref="WTLS"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredOperationalProtectionType">
      <xs:complexContent>
         <xs:restriction base="OperationalProtectionType">
            <xs:sequence>
               <xs:element ref="SecurityAudit"/>
               <xs:element ref="DeactivationCallCenter"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredTechnicalProtectionType">
      <xs:complexContent>
         <xs:restriction base="TechnicalProtectionType">
            <xs:choice>
               <xs:element ref="PrivateKeyProtection"/>
               <xs:element ref="SecretKeyProtection"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredPrivateKeyProtectionType">
      <xs:complexContent>
         <xs:restriction base="PrivateKeyProtectionType">
            <xs:sequence>
               <xs:element ref="KeyStorage"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredSecretKeyProtectionType">
      <xs:complexContent>
         <xs:restriction base="SecretKeyProtectionType">
```

```
            <xs:sequence>
               <xs:element ref="KeyStorage"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredKeyStorageType">
      <xs:complexContent>
         <xs:restriction base="KeyStorageType">
            <xs:attribute name="medium" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="MobileDevice"/>
                     <xs:enumeration value="MobileAuthCard"/>
                     <xs:enumeration value="smartcard"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredSecurityAuditType">
      <xs:complexContent>
         <xs:restriction base="SecurityAuditType">
            <xs:sequence>
               <xs:element ref="SwitchAudit"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorUnregisteredIdentificationType">
      <xs:complexContent>
         <xs:restriction base="IdentificationType">
            <xs:attribute name="nym">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="anonymity"/>
                     <xs:enumeration value="pseudonymity"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:schema>
```

5.2.4. MobileTwoFactorUnregistered

Reflects no mobile customer registration procedures and a two-factor based authentication, such as secure device and user PIN. This context class is useful when a service other than the mobile operator wants to link their customer ID to a mobile supplied two-factor authentication service by capturing mobile phone data at enrollment.

5.2.4.1. Associated Liberty URI

`http://www.projectliberty.org/schemas/authctx/classes/MobileTwoFactorUnregistered`

5.2.4.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
```

```
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/MobileTwoFactorUnregistered
      </xs:documentation>
   </xs:annotation>

   <xs:complexType name="MobileTwoFactorUnregisteredAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="DigSig"/>
               <xs:element ref="ZeroKnowledge"/>
               <xs:element ref="SharedSecretChallengeResponse"/>
               <xs:element ref="AsymmetricDecryption"/>
               <xs:element ref="AsymmetricKeyAgreement"/>
               <xs:element ref="SharedSecretDynamicPlaintext"/>
               <xs:sequence>
                  <xs:element ref="Password" minOccurs="1"/>
                  <xs:choice>
                     <xs:element ref="SharedSecretDynamicPlaintext"/>
                     <xs:element ref="SharedSecretChallengeResponse"/>
                  </xs:choice>
                  <xs:element ref="Extension" maxOccurs="unbounded"/>
               </xs:sequence>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileTwoFactorUnregisteredAuthenticatorTransportProtocolType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorTransportProtocolType">
            <xs:choice>
               <xs:element ref="MobileNetworkNoEncryption"/>
               <xs:element ref="MobileNetworkRadioEncryption"/>
               <xs:element ref="MobileNetworkEndToEndEncryption"/>
               <xs:element ref="WTLS"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileTwoFactorUnregisteredOperationalProtectionType">
      <xs:complexContent>
         <xs:restriction base="OperationalProtectionType">
            <xs:sequence>
               <xs:element ref="SecurityAudit"/>
               <xs:element ref="DeactivationCallCenter"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileTwoFactorUnregisteredTechnicalProtectionType">
      <xs:complexContent>
         <xs:restriction base="TechnicalProtectionType">
            <xs:choice>
               <xs:element ref="PrivateKeyProtection"/>
               <xs:element ref="SecretKeyProtection"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

```

```
<xs:complexType name="MobileTwoFactorUnregisteredPrivateKeyProtectionType">
   <xs:complexContent>
      <xs:restriction base="PrivateKeyProtectionType">
         <xs:sequence>
            <xs:element ref="KeyActivation" minOccurs="1" maxOccurs="1"/>
            <xs:element ref="KeyStorage" minOccurs="0"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:restriction>
   </xs:complexContent>
</xs:complexType>

<xs:complexType name="MobileTwoFactorUnregisteredSecretKeyProtectionType">
   <xs:complexContent>
      <xs:restriction base="SecretKeyProtectionType">
         <xs:sequence>
            <xs:element ref="KeyActivation"/>
            <xs:element ref="KeyStorage"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:restriction>
   </xs:complexContent>
</xs:complexType>

<xs:complexType name="MobileTwoFactorUnregisteredKeyActivationType">
  <xs:complexContent>
    <xs:restriction base="KeyActivationType">
      <xs:sequence>
        <xs:element ref="ActivationPin"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:restriction>
  </xs:complexContent>
</xs:complexType>

<xs:complexType name="MobileTwoFactorUnregisteredKeyStorageType">
  <xs:complexContent>
    <xs:restriction base="KeyStorageType">
       <xs:attribute name="medium" use="required">
        <xs:simpleType>
          <xs:restriction base="xs:NMTOKEN">
             <xs:enumeration value="MobileDevice"/>
             <xs:enumeration value="MobileAuthCard"/>
             <xs:enumeration value="smartcard"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:attribute>
    </xs:restriction>
  </xs:complexContent>
</xs:complexType>

<xs:complexType name="MobileTwoFactorUnregisteredSecurityAuditType">
   <xs:complexContent>
      <xs:restriction base="SecurityAuditType">
         <xs:sequence>
            <xs:element ref="SwitchAudit"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
         </xs:sequence>
      </xs:restriction>
   </xs:complexContent>
</xs:complexType>

<xs:complexType name="MobileTwoFactorUnregisteredIdentificationType">
   <xs:complexContent>
      <xs:restriction base="IdentificationType">
         <xs:attribute name="nym">
            <xs:simpleType>
```

```
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="anonymity"/>
                     <xs:enumeration value="pseudonymity"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

</xs:schema>
```

5.2.5. MobileOneFactorContract

Reflects mobile contract customer registration procedures and a single factor authentication. For example, a digital signing device with tamper resistant memory for key storage, such as the mobile MSISDN, but no required PIN or biometric for real-time user authentication.

5.2.5.1. Associated Liberty URI

`http://www.projectliberty.org/schemas/authctx/classes/MobileOneFactorContract`

5.2.5.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08"
   version="1.2-08" finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
<xs:documentation>http://www.projectliberty.org/schemas/authctx/classes/MobileOneFa
ctorContract</xs:documentation></xs:annotation>

   <xs:complexType name="MobileOneFactorContractAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
               <xs:choice maxOccurs="1">
                 <xs:element ref="DigSig"/>
                 <xs:element ref="ZeroKnowledge"/>
                 <xs:element ref="SharedSecretChallengeResponse"/>
                 <xs:element ref="AsymmetricDecryption"/>
                 <xs:element ref="AsymmetricKeyAgreement"/>
                 <xs:element ref="SharedSecretDynamicPlaintext"/>
               </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorContractAuthenticatorTransportProtocolType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorTransportProtocolType">
            <xs:choice>
           <xs:element ref="MobileNetworkNoEncryption"/>
           <xs:element ref="MobileNetworkRadioEncryption"/>
           <xs:element ref="MobileNetworkEndToEndEncryption"/>
              <xs:element ref="WTLS"/>
           </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="MobileOneFactorContractOperationalProtectionType">
      <xs:complexContent>
```

```
        <xs:restriction base="OperationalProtectionType">
          <xs:sequence>
            <xs:element ref="SecurityAudit"/>
            <xs:element ref="DeactivationCallCenter"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
          </xs:sequence>
        </xs:restriction>
      </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MobileOneFactorContractTechnicalProtectionType">
      <xs:complexContent>
        <xs:restriction base="TechnicalProtectionType">
          <xs:choice>
            <xs:element ref="PrivateKeyProtection"/>
            <xs:element ref="SecretKeyProtection"/>
          </xs:choice>
        </xs:restriction>
      </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileOneFactorContractPrivateKeyProtectionType">
      <xs:complexContent>
        <xs:restriction base="PrivateKeyProtectionType">
          <xs:sequence maxOccurs="1">
            <xs:element ref="KeyStorage"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
          </xs:sequence>
        </xs:restriction>
      </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileOneFactorContractSecretKeyProtectionType">
      <xs:complexContent>
        <xs:restriction base="SecretKeyProtectionType">
          <xs:sequence>
            <xs:element ref="KeyStorage"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
          </xs:sequence>
        </xs:restriction>
      </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileOneFactorContractKeyStorageType">
     <xs:complexContent>
      <xs:restriction base="KeyStorageType">
        <xs:attribute name="medium" use="required">
         <xs:simpleType>
          <xs:restriction base="xs:NMTOKEN">
            <xs:enumeration value="MobileDevice"/>
            <xs:enumeration value="MobileAuthCard"/>
            <xs:enumeration value="smartcard"/>
          </xs:restriction>
         </xs:simpleType>
        </xs:attribute>
      </xs:restriction>
     </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileOneFactorContractSecurityAuditType">
      <xs:complexContent>
        <xs:restriction base="SecurityAuditType">
          <xs:sequence>
            <xs:element ref="SwitchAudit"/>
            <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
          </xs:sequence>
        </xs:restriction>
      </xs:complexContent>
```

```
   </xs:complexType>

   <xs:complexType name="MobileOneFactorContractIdentificationType">
      <xs:complexContent>
         <xs:restriction base="IdentificationType">
            <xs:sequence>
               <xs:element ref="PhysicalVerification"/>
               <xs:element ref="WrittenConsent"/>
               <xs:element ref="GoverningAgreements"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attribute name="nym">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="anonymity"/>
                     <xs:enumeration value="verinymity"/>
                     <xs:enumeration value="pseudonymity"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

</xs:schema>
```

5.2.6. MobileTwoFactorContract

Reflects mobile contract customer registration procedures and a two-factor based authentication. For example, a digital signing device with tamper resistant memory for key storage, such as a GSM SIM, that requires explicit proof of user identity and intent, such as a PIN or biometric.

5.2.6.1. Associated Liberty URI

```
http://www.projectliberty.org/schemas/authctx/classes/MobileTwoFactorContract
```

5.2.6.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation><xs:documentation>http://www.projectliberty.org/schemas/authctx/classes/MobileTwoFactorContract</xs:documentation>
</xs:annotation>

   <xs:complexType name="MobileTwoFactorContractAuthenticatorType">
 <xs:complexContent>
 <xs:restriction base="AuthenticatorType">
                <xs:choice>
                  <xs:element ref="DigSig"/>
                  <xs:element ref="ZeroKnowledge"/>
                  <xs:element ref="SharedSecretChallengeResponse"/>
                  <xs:element ref="AsymmetricDecryption"/>
                  <xs:element ref="AsymmetricKeyAgreement"/>
                  <xs:element ref="SharedSecretDynamicPlaintext"/>
                  <xs:sequence>
                    <xs:element ref="Password" minOccurs="1"/>
                    <xs:choice>
```

```
                    <xs:element ref="SharedSecretDynamicPlaintext"/>
                    <xs:element ref="SharedSecretChallengeResponse"/>
                  </xs:choice>
                  <xs:element ref="Extension" maxOccurs="unbounded"/>
                </xs:sequence>
              </xs:choice>
    </xs:restriction>
  </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MobileTwoFactorContractAuthenticatorTransportProtocolType">
       <xs:complexContent>
          <xs:restriction base="AuthenticatorTransportProtocolType">
             <xs:choice>
            <xs:element ref="MobileNetworkNoEncryption"/>
            <xs:element ref="MobileNetworkRadioEncryption"/>
            <xs:element ref="MobileNetworkEndToEndEncryption"/>
                <xs:element ref="WTLS"/>
             </xs:choice>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MobileTwoFactorContractOperationalProtectionType">
       <xs:complexContent>
          <xs:restriction base="OperationalProtectionType">
             <xs:sequence>
                <xs:element ref="SecurityAudit"/>
                <xs:element ref="DeactivationCallCenter"/>
                <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
             </xs:sequence>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MobileTwoFactorContractTechnicalProtectionType">
       <xs:complexContent>
          <xs:restriction base="TechnicalProtectionType">
             <xs:choice>
                <xs:element ref="PrivateKeyProtection"/>
                <xs:element ref="SecretKeyProtection"/>
             </xs:choice>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileTwoFactorContractPrivateKeyProtectionType">
       <xs:complexContent>
          <xs:restriction base="PrivateKeyProtectionType">
             <xs:sequence>
                <xs:element ref="KeyActivation" minOccurs="1" maxOccurs="1"/>
                <xs:element ref="KeyStorage" minOccurs="0"/>
                <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
             </xs:sequence>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileTwoFactorContractSecretKeyProtectionType">
       <xs:complexContent>
          <xs:restriction base="SecretKeyProtectionType">
             <xs:sequence>
                <xs:element ref="KeyActivation"/>
                <xs:element ref="KeyStorage"/>
                <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
             </xs:sequence>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>

```

```
    <xs:complexType name="MobileTwoFactorContractKeyActivationType">
     <xs:complexContent>
      <xs:restriction base="KeyActivationType">
       <xs:sequence>
        <xs:element ref="ActivationPin"/>
        <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
       </xs:sequence>
      </xs:restriction>
     </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileTwoFactorContractKeyStorageType">
     <xs:complexContent>
      <xs:restriction base="KeyStorageType">
         <xs:attribute name="medium" use="required">
          <xs:simpleType>
           <xs:restriction base="xs:NMTOKEN">
              <xs:enumeration value="MobileDevice"/>
              <xs:enumeration value="MobileAuthCard"/>
              <xs:enumeration value="smartcard"/>
           </xs:restriction>
          </xs:simpleType>
         </xs:attribute>
      </xs:restriction>
     </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileTwoFactorContractSecurityAuditType">
       <xs:complexContent>
          <xs:restriction base="SecurityAuditType">
             <xs:sequence>
                <xs:element ref="SwitchAudit"/>
                <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
             </xs:sequence>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>

    <xs:complexType name="MobileTwoFactorContractIdentificationType">
       <xs:complexContent>
          <xs:restriction base="IdentificationType">
             <xs:sequence>
                <xs:element ref="PhysicalVerification"/>
                <xs:element ref="WrittenConsent"/>
                <xs:element ref="GoverningAgreements"/>
                <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
             </xs:sequence>
             <xs:attribute name="nym">
                <xs:simpleType>
                   <xs:restriction base="xs:NMTOKEN">
                      <xs:enumeration value="anonymity"/>
                      <xs:enumeration value="verinymity"/>
                      <xs:enumeration value="pseudonymity"/>
                   </xs:restriction>
                </xs:simpleType>
             </xs:attribute>
          </xs:restriction>
       </xs:complexContent>
    </xs:complexType>
</xs:schema>
```

5.2.7. Password

The Password class is identified when a Principal authenticates to an identity provider through the presentation of a password over an unprotected HTTP session.

5.2.7.1. Associated Liberty URI

```
http://www.projectliberty.org/schemas/authctx/classes/Password
```

5.2.7.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/Password</xs:documentation>
   </xs:annotation>
   <xs:complexType name="PasswordAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="Password"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="PasswordPasswordType">
      <xs:complexContent>
         <xs:restriction base="PasswordType">
            <xs:sequence>
               <xs:element ref="Length" minOccurs="1"/>
               <xs:element ref="Generation" minOccurs="0"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="PasswordLengthType">
      <xs:complexContent>
         <xs:restriction base="LengthType">
            <xs:attribute name="min" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:integer">
                     <xs:minInclusive value="3"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="max" type="xs:integer" use="optional"/>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

</xs:schema>
```

5.2.8. PasswordProtectedTransport

The PasswordProtectedTransport class is identified when a Principal authenticates to an identity provider through the presentation of a password over a protected session.

5.2.8.1. Associated Liberty URI

http://www.projectliberty.org/schemas/authctx/classes/PasswordProtectedTransport

5.2.8.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/PasswordProtec
tedTransport</xs:documentation>
   </xs:annotation>
   <xs:complexType name="PasswordProtectedTransportAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="Password"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="PasswordProtectedTransportPasswordType">
      <xs:complexContent>
         <xs:restriction base="PasswordType">
            <xs:sequence>
               <xs:element ref="Length"/>
               <xs:element ref="Generation" minOccurs="0"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="PasswordProtectedTransportLengthType">
      <xs:complexContent>
         <xs:restriction base="LengthType">
            <xs:attribute name="min" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:integer">
                     <xs:minInclusive value="3"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="max" type="xs:integer" use="optional"/>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="PasswordProtectedTransportAuthenticatorTransportProtocolType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorTransportProtocolType">
            <xs:choice>
               <xs:element ref="SSL"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:schema>
```

5.2.9. PreviousSession

The PreviousSession class is identified when a Principal had authenticated to an identity provider at some point in the past using any authentication context supported by that identity provider. Consequently, a subsequent authentication event that the identity provider will assert to the service provider may be significantly separated in time from the Principals current resource access request.

The context for the previously authenticated session is explicitly not included in this context class because the user has not authenticated during this session, and so the mechanism that the user employed to authenticate in a previous session should not be used as part of a decision on whether to now allow access to a resource.

5.2.9.1. Associated Liberty URI

```
http://www.projectliberty.org/schemas/authctx/classes/PreviousSession
```

5.2.9.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/PreviousSession</xs:documentation>
   </xs:annotation>
   <xs:complexType name="PreviousSessionAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="PreviousSession"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

</xs:schema>
```

5.2.10. Smartcard

The Smartcard class is identified when a Principal authenticates to an identity provider using a smartcard.

5.2.10.1. Associated Liberty URI

```
http://www.projectliberty.org/schemas/authctx/classes/Smartcard
```

5.2.10.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation> http://www.projectliberty.org/schemas/authctx/classes/Smartcard
```

```
   </xs:documentation>
   </xs:annotation>
   <xs:complexType name="SmartCardPrincipalAuthenticationMechanismType">
      <xs:complexContent>
         <xs:restriction base="PrincipalAuthenticationMechanismType">
            <xs:choice>
               <xs:element ref="Smartcard"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:schema>
```

5.2.11. SmartcardPKI

The SmartcardPKI class is identified when a Principal authenticates to an identity provider through a two-factor authentication mechanism using a smartcard with enclosed private key and a PIN.

5.2.11.1. Associated Liberty URI

`http://www.projectliberty.org/schemas/authctx/classes/SmartcardPKI`

5.2.11.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/SmartcardPKI</xs:documentation>
   </xs:annotation>

   <xs:complexType name="SmartCardPKIPrincipalAuthenticationMechanismType">
      <xs:complexContent>
         <xs:restriction base="PrincipalAuthenticationMechanismType">
            <xs:sequence>
               <xs:element ref="ActivationPin"/>
               <xs:element ref="Smartcard"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SmartCardPKIAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="AsymmetricDecryption"/>
               <xs:element ref="AsymmetricKeyAgreement"/>
               <xs:element ref="DigSig"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SmartCardPKIKeyActivationType">
      <xs:complexContent>
```

```
         <xs:restriction base="KeyActivationType">
            <xs:choice>
               <xs:element ref="ActivationPin"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SmartcardPKIKeyStorageType">
      <xs:complexContent>
         <xs:restriction base="KeyStorageType">
            <xs:attribute name="medium" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="smartcard"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>


   <xs:complexType name="SmartCardPKIPrivateKeyProtectionType">
      <xs:complexContent>
         <xs:restriction base="PrivateKeyProtectionType">
            <xs:sequence>
               <xs:element ref="KeyActivation"/>
               <xs:element ref="KeyStorage"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

</xs:schema>
```

5.2.12. SoftwarePKI

The Software-PKI class is identified when a Principal uses an X.509 certificate stored in software to authenticate to the identity provider.

5.2.12.1. Associated Liberty URI

```
http://www.projectliberty.org/schemas/authctx/classes/SoftwarePKI
```

5.2.12.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   version="1.2-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation>
         http://www.projectliberty.org/schemas/authctx/classes/SoftwarePKI</xs:documentation>
   </xs:annotation>

   <xs:complexType name="SoftwarePKIPrincipalAuthenticationMechanismType">
      <xs:complexContent>
```

```
         <xs:restriction base="PrincipalAuthenticationMechanismType">
            <xs:sequence>
               <xs:element ref="ActivationPin"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SoftwarePKIAuthenticatorType">
      <xs:complexContent>
         <xs:restriction base="AuthenticatorType">
            <xs:choice>
               <xs:element ref="AsymmetricDecryption"/>
               <xs:element ref="AsymmetricKeyAgreement"/>
               <xs:element ref="DigSig"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SoftwarePKIKeyActivationType">
      <xs:complexContent>
         <xs:restriction base="KeyActivationType">
            <xs:choice>
               <xs:element ref="ActivationPin"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SoftwarePKIPrivateKeyProtectionType">
      <xs:complexContent>
         <xs:restriction base="PrivateKeyProtectionType">
            <xs:sequence>
               <xs:element ref="KeyActivation"/>
               <xs:element ref="KeyStorage"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

   <xs:complexType name="SoftwarePKIKeyStorageType">
      <xs:complexContent>
         <xs:restriction base="KeyStorageType">
            <xs:attribute name="medium" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="memory"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>

</xs:schema>
```

5.2.13. TimeSyncToken

The TimeSyncToken class is identified when a Principal authenticates through a time synchronization token.

5.2.13.1. Associated Liberty URI

http://www.projectliberty.org/schemas/authctx/classes/TimeSyncToken

5.2.13.2. Class Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:liberty:ac:2003-08"
   xmlns:xs="http://www.w3.org/2001/XMLSchema"
   xmlns="urn:liberty:ac:2003-08"
   finalDefault="extension">
   <xs:include schemaLocation="lib-arch-authentication-context-v1.2-08.xsd"/>
   <xs:annotation>
      <xs:documentation> http://www.projectliberty.org/schemas/authctx/classes/TimeSyncToken</xs:
documentation>
   </xs:annotation>
   <xs:complexType name="TimeSyncTokenPrincipalAuthenticationMechanismType">
      <xs:complexContent>
         <xs:restriction base="PrincipalAuthenticationMechanismType">
            <xs:choice>
               <xs:element ref="Token"/>
            </xs:choice>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="TimeSyncTokenTokenType">
      <xs:complexContent>
         <xs:restriction base="TokenType">
            <xs:sequence>
               <xs:element ref="TimeSyncToken"/>
               <xs:element ref="Extension" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="TimeSyncTokenTimeSyncTokenType">
      <xs:complexContent>
         <xs:restriction base="TimeSyncTokenType">
            <xs:attribute name="DeviceType" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="hardware"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="SeedLength" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:integer">
                     <xs:enumeration value="64"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="DeviceInHand" use="required">
               <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                     <xs:enumeration value="true"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:attribute>
         </xs:restriction>
      </xs:complexContent>
   </xs:complexType>
</xs:schema>
```

5.3. Authentication Context Classes Extensibility

As did the core Authentication Context Statement schema, the separate Authentication Context Classes schemas allow the <Extension> element in certain locations of the tree structure. In general, where the <Extension> element occurred as a child of a <Choice> element, this option was removed in creating the appropriate class schema definition as an extension of the base type. When the <Extension> element occurred as an optional child of a <Sequence> element, the <Extension> element was allowed to remain in addition to any required elements.

Consequently, authentication context statements can include the <Extension> element (with additional elements in different namespaces) and still conform to authentication context class schemas (if they meet the other requirements of the schema of course)

The Authentication Context Class schemas extend (as restrictions) appropriate type definitions in the core Authentication Context Statement schema. As an extension point, the Authentication Context Classes schemas themselves can be extended - their type definitions serving as base types in some other schema (potentially defined by some community wishing a more tightly defined authentication context class). To prevent logical inconsistencies, any such extensions can only further constrain the type definitions of the core Authentication Context Statement schema. To enforce this constraint, the Authentication Context Class schemas are defined with the finalDefault="extension" attribute on the <schema> element to prevent this type of extension derivation.

5.4. Authentication Context Classes Processing Rules

The processing rules for both Service and Identity Provider for Authentication Context Classes are listed in [LibertyProtSchema].

References

References

[LibertyProtSchema] Cantor, Scott, Kemp, John, eds. "Liberty ID-FF Protocols and Schema Specification," Version 1.2-errata-v2.0, Liberty Alliance Project (12 September 2004). *http://www.projectliberty.org/specs*

[RFC2119] Bradner, S., eds. "Key words for use in RFCs to Indicate Requirement Levels," RFC 2119, The Internet Engineering Task Force (March 1997). *http://www.ietf.org/rfc/rfc2119.txt [March 1997]*.

[Schema1] Thompson, Henry S., Beech, David, Maloney, Murray, Mendelsohn, Noah, eds. (May 2002). "XML Schema Part 1: Structures," Recommendation, World Wide Web Consortium *http://www.w3.org/TR/xmlschema-1/*