SNIA Education

An Inside Look at Imminent Key Management Standards

Matt Ball, Oracle Corporation

SNIA Legal Notice

Abstract

- An Inside Look at Key Management Standards

This session provides storage managers and planners an inside look at the expected timing of publishing emerging key management standards, as well as the direction that these standards have taken and the technologies they use. Attendees will learn about existing standards, including OASIS KMIP and IEEE P1619.3, and the implications of the minimum requirements for compliance with each.

For example, the first draft of OASIS KMIP provides a good basic set of key management objects and operations, but leaves out some of the trickier aspects, such as enrollment and discovery. IEEE P1619.3 intends to augment OASIS KMIP by adding support for these features, among others.

Learning Objectives

- Discover the background of existing key management standards, including OASIS KMIP and IEEE P1619.3
- Learn the enabling technologies behind these key management standards
- Apply these standards to integration with existing systems or creation of new systems

Outline

- Motivation for key management
- Overview of key management standards
  - ISO 11770, NIST SP 800-57 part 1-3, OASIS EKMI, IETF KEYPROV, OASIS KMIP, IEEE P1619.3
- Details of OASIS KMIP – Objects, Attributes, Operations, Profiles
- IEEE P1619.3 enhancements to KMIP
- Summary/Questions

SNIA Education

Motivation for Key Management

Motivation – Why Key Management?

- Government legislation is driving the requirement to encrypt confidential data
  - Sarbanes-Oxley (SOX), California SB-1386 (July 2003), Health Insurance Portability and Accountability Act (HIPAA), Gramm-Leach-Bliley Act, Payment Card Industry standards (PCI),EU Data Protection Directives

Check out SNIA Tutorial:

Introduction to Storage Security

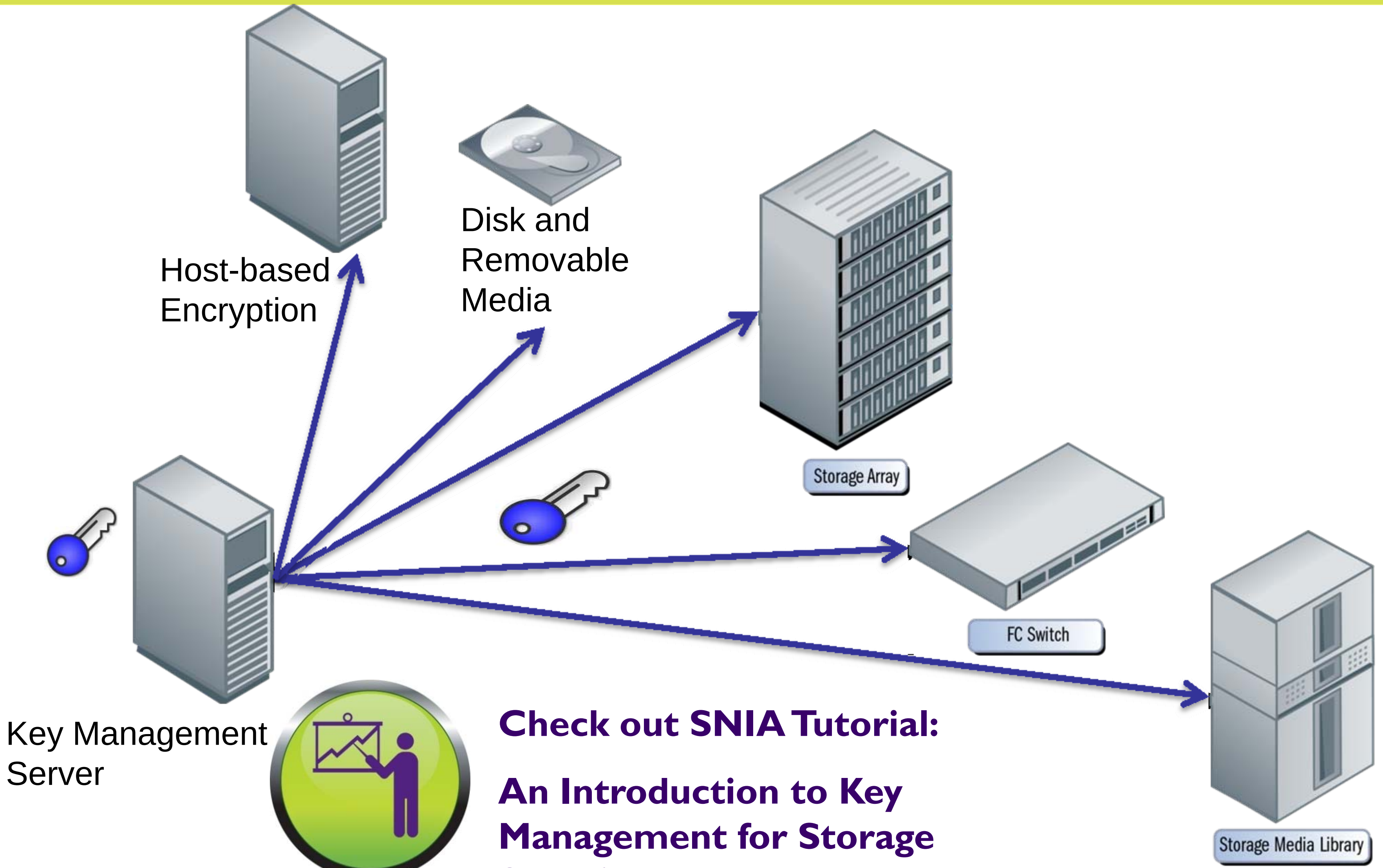
- Customers are demanding that key management vendors provide interoperability to avoid lock-in.

Typical Enterprise Key Management Requirements

Education SNIA

- Securely deliver encryption keys to authorized users
- Fail-over and disaster recovery for key management servers
- Maintain audit records to show compliance
- Ease-of-use to manage users (e.g., LDAP)
- Interoperability with other servers and devices
- One use per key (e.g., signing vs. encrypting)

Key Management For Storage



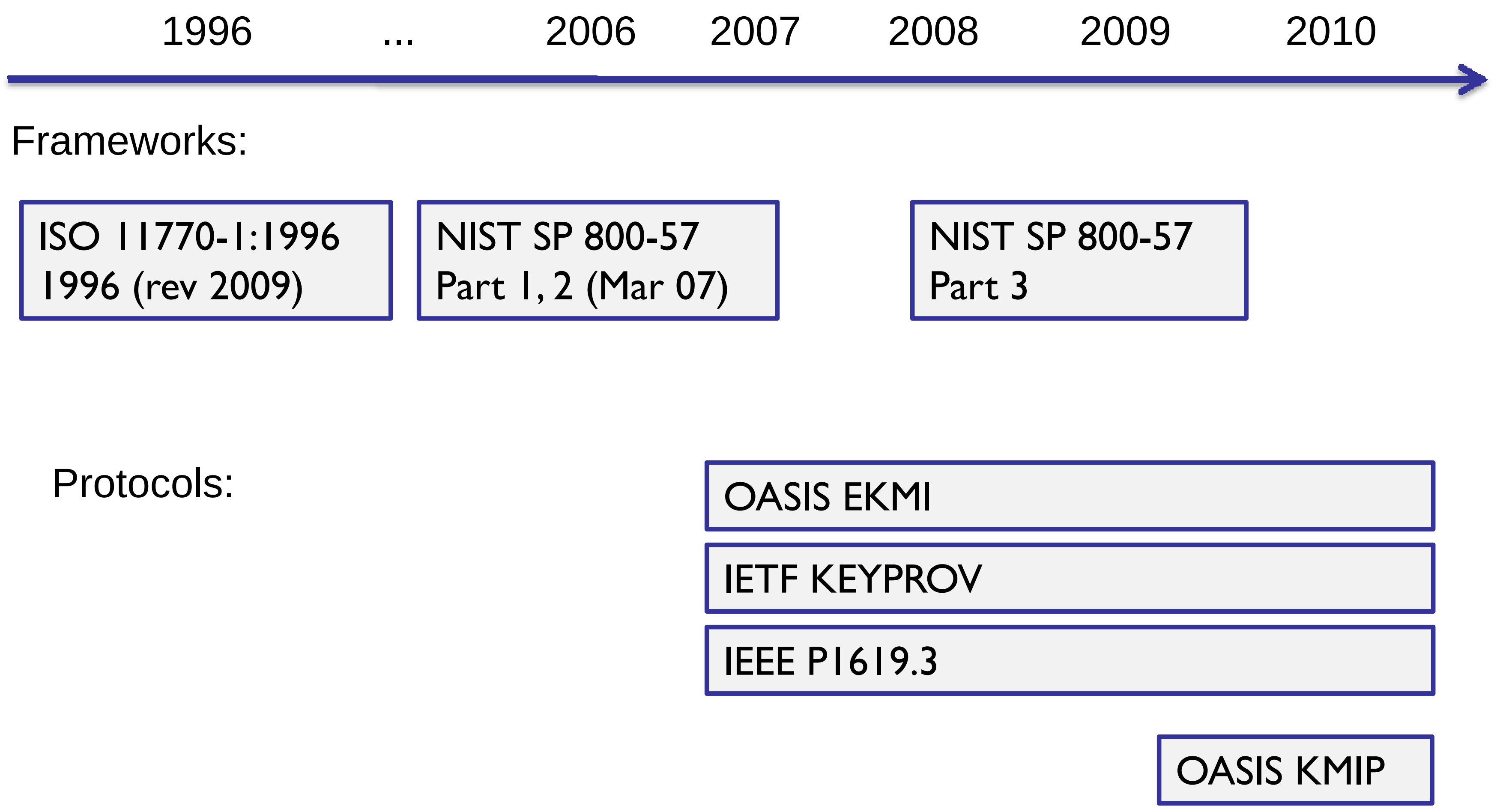
Check out SNIA Tutorial:

An Introduction to Key Management for Storage Security

SNIA Education

Overview of Key Management Standards

Standards Timeline History



Education

Details of OASIS KMIP

OASIS KMIP Overview

- Objects:
  - Base Objects
  - Managed Objects
- Attributes
- Client-to-Server Operations
- Server-to-Client Operations
- Message Contents and Format
- Message Encoding
- Conformance

KMIP Base Objects

- Attribute
- Credential (e.g., Username & Password)
- Key Block
- Key Value
- Key Wrapping Data
- Key Wrapping Specification
- Transparent Key Structures
- Template-Attribute Structures

KMIP Managed Objects

- Certificate (e.g., X509, PGP)
- Keys:
  - Symmetric Key
  - Public Key
  - Private Key
  - Split Key
- Template
- Secret Data
- Opaque Object

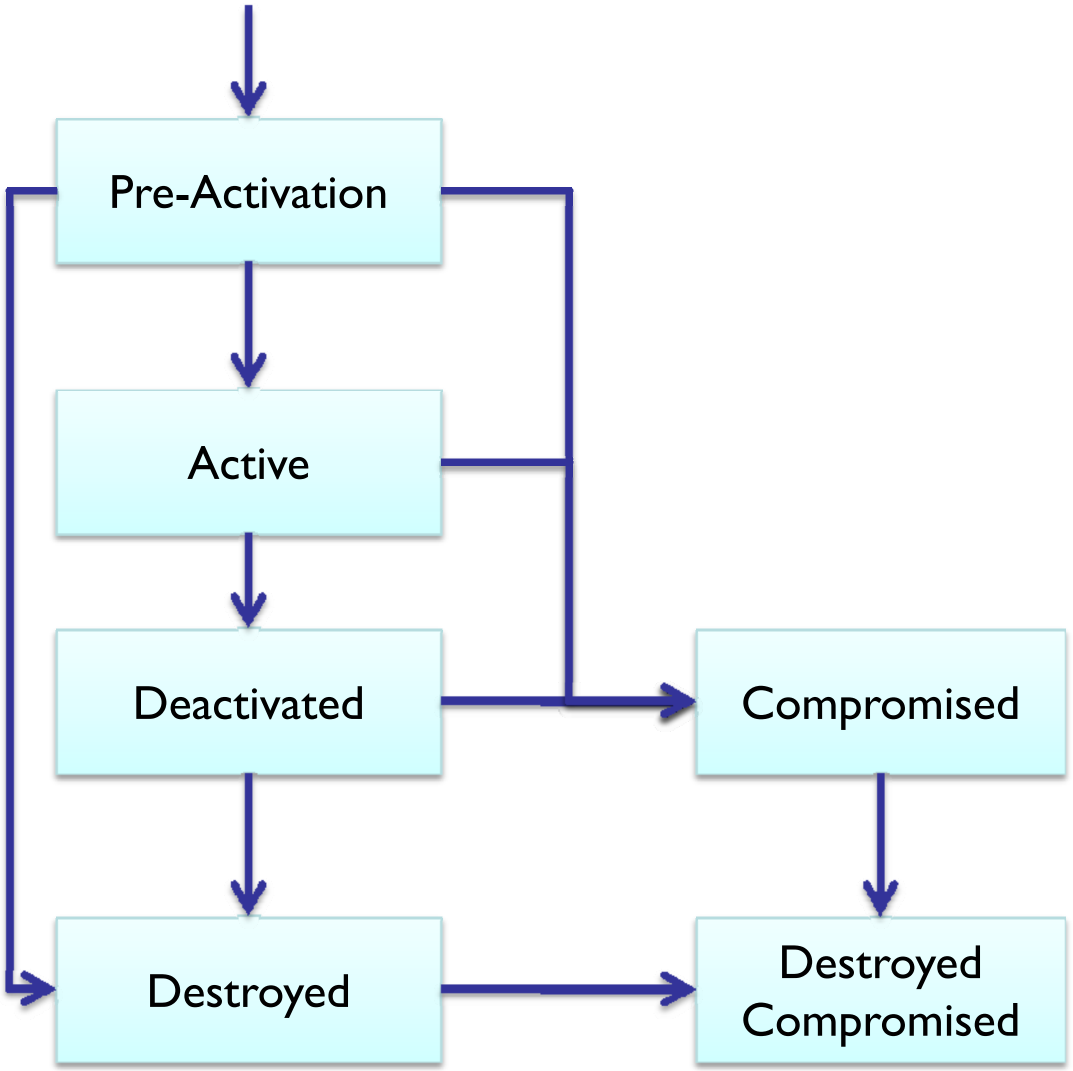
KMIP Attributes (Page 1)

- Unique Identifier
- Name
- Object Type
- Cryptographic Algorithm/Length/Parameters
- Certificate Type/Identifier/Subject/Issuer
- Digest
- Operation Policy Name
- Cryptographic Usage Mask
- Lease Time
- Usage Limits
- State

KMIP Attributes (Page 2)

- Date: Initial / Activation / Process Start / Protect Stop / Deactivation / Destroy / Compromise Occurrence / Compromise
- Revocation Reason
- Archive Date
- Object Group
- Link
- Application Specific Information
- Contact Information
- Last Change Date
- Custom Attribute

NIST Key Lifecycle Model



KMIP Client-to-Server Operations

- Create
- Create Key Pair
- Register
- Re-key
- Derive Key
- Certify
- Re-certify
- Locate
- Check
- Get (attributes (list))
- Add/Modify/Delete Attribute
- Obtain Lease
- Get Usage Allocation
- Activate
- Revoke
- Destroy
- Archive
- Recover
- Validate
- Query/Cancel/Poll

KMIP Message Encoding TTLV

- TTLV = Tag, Type, Length, Value
- Chosen to be simple to process with 32-bit/64-bit embedded processors
- Types:
  - Integer, Long Integer, Big Integer
  - Enumeration
  - Boolean
  - Text String, Byte String
  - Date-Time
  - Interval
  - Structure

KMIP TTLV Examples

- An Integer containing the decimal value 8: 1699
  - 42 00 20 | 02 | 00 00 00 04 | 00 00 00 08 00 00 00 00
- A Long Integer containing the decimal value 123456789000000000:
  - 42 00 20 | 03 | 00 00 00 08 | 01 B6 9B 4B A5 74 92 00
- A Big Integer containing the decimal value 1234567890000000000000000000:
  - 42 00 20 | 04 | 00 00 00 10 | 00 00 00 00 03 FD 35 EB 6B C2 DF 46 18 08 00 00
- An Enumeration with value 255:
  - 42 00 20 | 05 | 00 00 00 04 | 00 00 00 FF 00 00 00 00
- A Boolean with the value *True:*
  - 42 00 20 | 06 | 00 00 00 08 | 00 00 00 00 00 00 00 01

KMIP TTLV Examples (Cont)

- A Text String with the value "Hello World":
  - 42 00 20 | 07 | 00 00 00 0B | 48 65 6C 6C 6F 20 57 6F 72 6C 64 00 00 00 00 00
- A Byte String with the value { 0x01, 0x02, 0x03 }:
  - 42 00 20 | 08 | 00 00 00 03 | 01 02 03 00 00 00 00 00
- A Date-Time, containing the value for Friday, March 14, 2008, 11:56:40 GMT:
  - 42 00 20 | 09 | 00 00 00 08 | 00 00 00 00 47 DA 67 F8
- An Interval, containing the value for 10 days:
  - 42 00 20 | 0A | 00 00 00 04 | 00 0D 2F 00 00 00 00 00
- A Structure containing an Enumeration, value 254, followed by an Integer, value 255, having tags 420004 and 420005 respectively:
  - 42 00 20 | 01 | 00 00 00 20 | 42 00 04 | 05 | 00 00 00 04 | 00 00 00 FE
  - 00 00 00 00| 42 00 05 | 02 | 00 00 00 04 | 00 00 00 FF 00 00 00 00

KMIP Request Message Format

- Request Header
  - Protocol Version
  - Maximum Response Size (optional)
  - Asynchronous Indicator (optional)
  - Authentication (optional)
  - …
  - Batch Count
- Batch Item (one or more)
  - Operation
  - Unique Batch Item ID (optional)
  - Request Payload

KMIP Response Message Format

- Response Header
  - Protocol Version
  - Time Stamp
  - Batch Count
- Batch Item (one or more)
  - Operation
  - Unique Batch Item ID
  - Result Status/Reason/Message
  - Asynchronous Correlation Value
  - Response Payload
  - Message Extension

KMIP Create Key Request/Response

Education SNIA

Create Key Request

- Request Message
  - Request Header
    - Protocol Version: 1.0
    - Batch Count: 1
  - Batch Item
    - Operation: Create
    - Request Payload
      - Object Type: Symmetric Key
      - Template-Attribute
        - Name: Template1
        - Attribute: Crypto Algorithm: AES
        - Attribute: Crypto Length: 128
        - Attribute: Crypto Usage Mask: E/D

Create Key Response

- Response Message
  - Request Header
    - Protocol Version: 1.0
    - Time Stamp: Nov 12 11:47:33, 2009
    - Batch Count: 1
  - Batch Item
    - Operation: Create
    - Result Status: Success
    - Response Payload
      - Object Type: Symmetric Key
      - Unique Identifier: 61b10614-d8b5-...

KMIP Create Key Request

Request:

Create (symmetric key using template)
In: objectType=’00000002’, template={ NameValue=’Template1’, NameType=’00000001’ }, attributes={ CryptographicAlgorithm=’AES’, CryptographicLength=’128’, CryptographicUsageMask=‘0000000C’ }

```
Tag: Request Message (0x420078), Type: Structure (0x01), Data:
  Tag: Request Header (0x420077), Type: Structure (0x01), Data:
    Tag: Protocol Version (0x420069), Type: Structure (0x01), Data:
      Tag: Protocol Version Major (0x42006A), Type: Integer (0x02), Data: 0x00000001 (1)
      Tag: Protocol Version Minor (0x42006B), Type: Integer (0x02), Data: 0x00000000 (0)
    Tag: Batch Count (0x42000D), Type: Integer (0x02), Data: 0x00000001 (1)
  Tag: Batch Item (0x42000F), Type: Structure (0x01), Data:
    Tag: Operation (0x42005C), Type: Enumeration (0x05), Data: 0x00000001 (Create)
    Tag: Request Payload (0x420079), Type: Structure (0x01), Data:
      Tag: Object Type (0x420057), Type: Enumeration (0x05), Data: 0x00000002 (Symmetric Key)
      Tag: Template-Attribute (0x420091), Type: Structure (0x01), Data:
        Tag: Name (0x420053), Type: Structure (0x01), Data:
          Tag: Name Value (0x420055), Type: Text String (0x07), Data: Template1
          Tag: Name Type (0x420054), Type: Enumeration (0x05), Data: 0x00000001 (Uninterpreted text string)
        Tag: Attribute (0x420008), Type: Structure (0x01), Data:
          Tag: Attribute Name (0x42000A), Type: Text String (0x07), Data: Cryptographic Algorithm
          Tag: Attribute Value (0x42000B), Type: Enumeration (0x05), Data: 0x00000003 (AES)
        Tag: Attribute (0x420008), Type: Structure (0x01), Data:
          Tag: Attribute Name (0x42000A), Type: Text String (0x07), Data: Cryptographic Length
          Tag: Attribute Value (0x42000B), Type: Integer (0x02), Data: 0x00000080 (128)
        Tag: Attribute (0x420008), Type: Structure (0x01), Data:
          Tag: Attribute Name (0x42000A), Type: Text String (0x07), Data: Cryptographic Usage Mask
          Tag: Attribute Value (0x42000B), Type: Integer (0x02), Data: 0x0000000C (Encrypt, Decrypt)
```

KMIP Create Key Response

Out: objectType='00000002', uuidKey

```
Tag: Response Message (0x42007B), Type: Structure (0x01), Data:
  Tag: Response Header (0x42007A), Type: Structure (0x01), Data:
    Tag: Protocol Version (0x420069), Type: Structure (0x01), Data:
      Tag: Protocol Version Major (0x42006A), Type: Integer (0x02), Data: 0x00000001 (1)
      Tag: Protocol Version Minor (0x42006B), Type: Integer (0x02), Data: 0x00000000 (0)
    Tag: Time Stamp (0x420092), Type: Date-Time (0x09), Data: 0x000000004AFBE7C5
            (Thu Nov 12 11:47:33 CET 2009)
    Tag: Batch Count (0x42000D), Type: Integer (0x02), Data: 0x00000001 (1)
  Tag: Batch Item (0x42000F), Type: Structure (0x01), Data:
    Tag: Operation (0x42005C), Type: Enumeration (0x05), Data: 0x00000001 (Create)
    Tag: Result Status (0x42007F), Type: Enumeration (0x05), Data: 0x00000000
            (Success)
    Tag: Response Payload (0x42007C), Type: Structure (0x01), Data:
      Tag: Object Type (0x420057), Type: Enumeration (0x05), Data: 0x00000002
            (Symmetric Key)
      Tag: Unique Identifier (0x420094), Type: Text String (0x07), Data: 61b10614-d8b5-
            46f9-8d17-2fa6ea1d747a
```

KMIP Conformance Profiles

- (Based on second public review of v1.0 draft)
- To claim conformance, a "KMIP Server" must support at least one of these profiles:
  - Secret Data Server
  - Basic Symmetric Key Store and Server
  - Basic Symmetric Key Foundry and Server
- Must also support an https authentication suite:
  - Basic Authentication Suite: TLS 1.0, or
  - TLS 1.2 Authentication Suite
- Must support 3DES and AES Keys

OASIS KMIP Tools

- Roll your own! (for handling the binary)
  - No publicly available KMIP implementations yet
  - Interop demo at the 2010 RSA Conference
- For TLS encryption, could use OpenSSL
- The usual Linux and Windows tools still apply:
  - Linux: Apache, Tomcat, etc
  - Windows: Internet Information Server (IIS), etc

SNIA

Education

Details of IEEE P1619.3

Using P1619.3 extensions to KMIP

- Standard in progress, so details may change!
- Defines a RESTful and SOAP-based web service using WSDL 2.0.
  - RESTful interface is based on resources (objects)
  - SOAP is based on procedure calls (actions)
- Map KMIP binary types to XML types
- Many tools exist to help with XML processing
- Keep the same object model as KMIP so that the back-end database can be the same.

REST Summary

- Stands for REpresentational State Transfer
- Introduced by Roy Fielding in 2000 thesis
- A web service that follows the REST guidelines is said to be "RESTful"
- Uses HTTP/1.1 commands:
  - GET – Retrieve a resource without side-effects
    - Allows for caching
  - PUT – Update or create a resource or collection
  - POST – Issue command with potential side-effects, or create a new resource or collection
  - DELETE – Remove a resource or collection

Web Services Description Language

- A WSDL (pronounced Wiz-Dull) is an XML-based schema for describing the objects and operations of a web service
- WSDL 1.1 was originally for describing SOAP
- WSDL version 2.0 was published in June 2007
- New features include support for RESTful bindings
- Some tools support WSDL 2.0, including Apache AXIS2 (for both Java and C)

Comparison of Primitive Types

KMIP Primitive Type	P1619.3 XML Type	Typical C++ Encoding
Integer	xsd:int	int (32-bit)
Long Integer	xsd:long	long long (64-bit)
Big Integer	xsd:base64Binary	struct { }
Enumeration	xsd:string	enum { ... }
Boolean	xsd:boolean	bool
Text String	xsd:string	wchar_t *
Byte String	xsd:base64Binary	struct { }
Date-Time	xsd:dateTime	time_t (64-bit)
Interval	xsd:duration	char * (or long long)

P1619.3 Create Key Request

```
POST /P1619-3-KMIP/Create HTTP/1.1
Host: www.example.com
Authorization: Basic QWxhZGRpbjpvcGVuIHNlc2FtZQ==
Accept: application/xml
X-P1619-3-KMIP-Version: 1.0

   <ObjectType>SymmetricKey</ObjectType>
   <TemplateAttribute>
    <NameList><item>
      <NameValue>Template1</NameValue>
      <NameType>UninterpretedTextString</NameType>
     </item></NameList>
    <AttributeList><item>
      <AttributeName>CryptographicAlgorithm</AttributeName>
      <AttributeValue>
       <Enumeration><CryptographicAlgorithm>AES</CryptographicAlgorithm></Enumeration>
      </AttributeValue>
     </item><item>
      <AttributeName>CrytographicLength</AttributeName>
      <AttributeValue><Integer>128</Integer></AttributeValue>
     </item><item>
      <AttributeName>CryptographicUsageMask</AttributeName>
      <AttributeValue><Enumeration>
        <CryptographicUsageMask>Encrypt</CryptographicUsageMask>
        <CryptographicUsageMask>Decrypt</CryptographicUsageMask>
      </Enumeration></AttributeValue>
     </item></AttributeList>
   </TemplateAttribute>
```

P1619.3 Create Key Response

```
HTTP/1.1 200 OK
Content-Type: application/xml
Content-Length: nnn
Date: Tue, 15 Nov 2009 08:12:31 GMT

<ObjectType>SymmetricKey</ObjectType>
<UniqueIdentifier>61b10614-d8b5-46f9-8d17-
2fa6ea1d747a</UniqueIdentifier>
```

P1619.3 "Get" Example

- Can pass parameters as IRI-encoded URL
  - Example: GET /get?UniqueIdentifier=abc
- Can also access directories with UIDs
  - Example: GET /Objects/abc
- Example:

```
GET /P1619-3-KMIP/get?UniqueIdentifier=abc
Host: www.example.com
Accept: application/xml
P1619-3-KMIP-Version: 1.0

HTTP/1.1 200 OK
Content-Type: application/xml
Content-Length: nnn
Date: Tue, 15 Nov 2009 08:12:31 GMT

<ObjectType>Certificate</ObjectType> ...
```

P1619.3 RESTful services

- Operations mapped as URIs
- Managed objects optionally mapped as URIs:
  - /Objects/{UniqueIdentifier}
- Attributes as a proper of particular objects:
  - /Objects/{UniqueIdentifier}/Attributes/{AttributeName}
- Can use HTTP GET to view objects or attributes, allowing the server to cache the results

P1619.3 Cluster Discovery

- P1619.3 Discovery service allows client to discover other available servers in the cluster
- Provides way for client to perform automatic failover if primary server is unavailable
- Details are still being worked out by the P1619.3 task group.
- Many of these changes will likely be integrated into future KMIP specifications or profiles

P1619.3 Enrollment

- P1619.3 will also provide a way to perform a client enrollment operation, using some form of credentials (like username/password, token, etc)
- Details are being worked on within the P1619.3 task group
- Similar changes are under consideration for KMIP v1.1

P1619.3 Implementation Tools

- Many tools that convert WSDL to source code
- gSOAP for C/C++
  - See http://www.cs.fsu.edu/~engelen/soap.html
- Apache AXIS2 (available for both Java and C)
  - See http://ws.apache.org/axis2/index.html for Java
  - See http://ws.apache.org/axis2/c/index.html for C
- Apache CXF
  - See http://cxf.apache.org/
- Many more!

Education

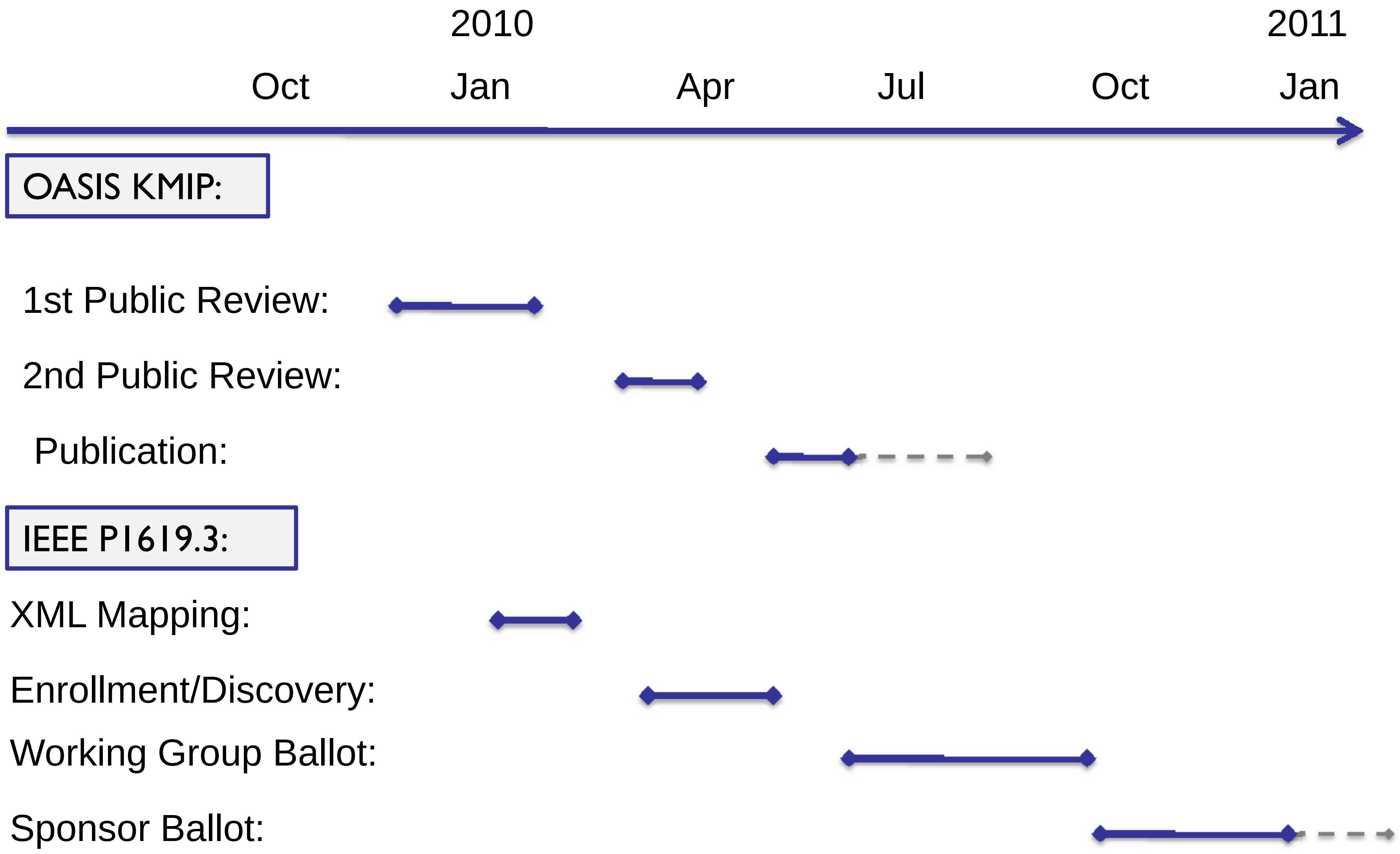
Summary

Encoding: KMIP vs. P1619.3

Education SNIA

Attribute	OASIS KMIP	IEEE P1619.3
Overall Format	TTLV Binary	RESTful XML
Message Version	Version field in header	HTTP header version
Error Reporting	Error field in header	HTTP Error codes
Tool Support	No tool support	Many XML libraries
Grammar Validation	Manual	WSDL validation
Code size	Small	Medium
Processing Overhead	Low	Medium
Security	HTTPS with TLS	HTTPS with TLS
HTTP Command	POST	GET, POST, DELETE
Asynchronous Msg	Async flag in header	POST to startCmd
Command Batching	Count in header	Keep session alive

Projected Timeline



For more information

- OASIS KMIP Homepage:
  - http://www.oasis-open.org/committees/kmip
- IEEE P1619 Security in Storage Working Group:
  - http://siswg.net
- IEEE Key Management Summit 2010
  - May 4-5, 2010 at Lake Tahoe, NV
  - See http://2010.keymanagementsummit.org/

Q&A / Feedback

- Please send any questions or comments on this presentation to SNIA: tracksecurity@snia.org

Many thanks to the following individuals for their contributions to this tutorial.

- SNIA Education Committee

Gianna DaGiau
Mark Carlson
Larry Hofer, CISSP, PE