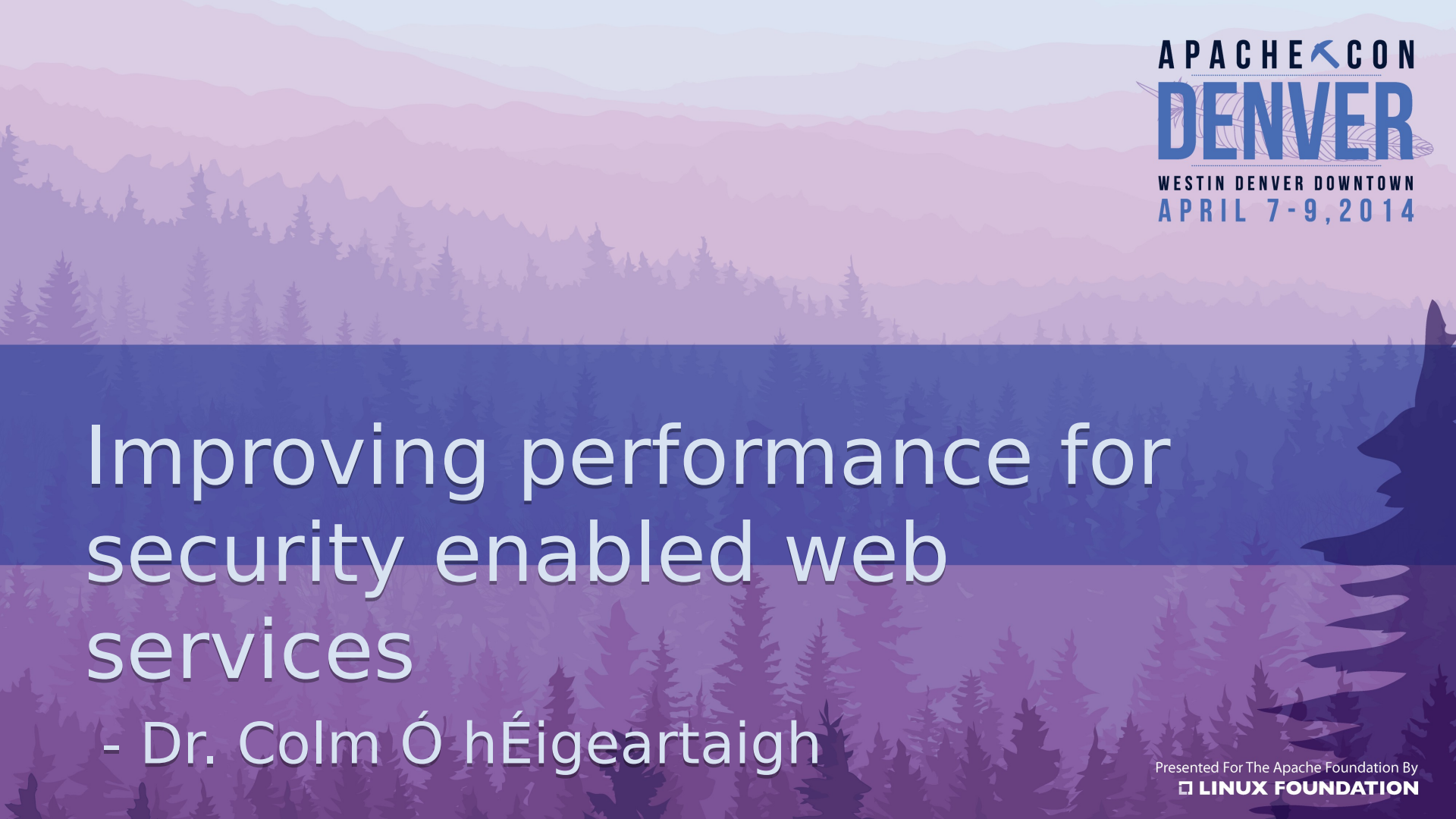

Improving performance for security enabled web services

- Dr. Colm Ó hÉigeartaigh

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Agenda

- Introduction to Apache CXF
- WS-Security in CXF 3.0.0
- Securing Attachments in CXF 3.0.0
- RS-Security in CXF 3.0.0
- Some empirical data
- Using Single Sign-On (SSO)

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Speaker Introduction

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Apache CXF

Apache Syncope

talend*
*open data solutions

Apache Santuario

Apache Webservices

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Apache CXF

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- One of the leading web service frameworks.
- Supports JAX-WS and JAX-RS frontend APIs
- Protocols: SOAP, XML/HTTP, RESTful HTTP, CORBA, etc.
- Transports: HTTP, JMS, JBI, etc.
- Comprehensive WS standards support.
- Security Services: STS, XKMS, Fediz.
- Strong OSGi support.

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Apache CXF Stats

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- Founded in 2006 as a merger of Celtix + XFire.
- Apache TLP releases go from 2.0.6 to the current 2.7.10 / 3.0.0-milestone2.
- 33 committers, 22 of whom are PMC members.
- Embedded in other Apache projects such as Apache Syncope, Apache Camel, Apache TomEE+.
- Used in industry products such as JBoss Web Services, Jboss Fuse, Talend ESB, etc.

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JAX-WS

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- A service is typically defined by a WSDL document
- Java code generated by “WSDL2Java” functionality
- Alternatively, can start with code + use annotations
- Typically a SOAP binding is used over HTTP
- SOAP Body contains service payload
- SOAP Header contains service metadata

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SOAP Envelope

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```
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
    <soap:Header>
        <Action xmlns="http://www.w3.org/2005/08/addressing">http://www.exampl...</Action>
    </soap:Header>
    <soap:Body>
        <ns2:DoubleIt xmlns:ns2="http://www.example.org/schema/DoubleIt">
            <numberToDouble>25</numberToDouble>
        </ns2:DoubleIt>
    </soap:Body>
</soap:Envelope>
```

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JAX-RS

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- Web Services using Representational State Transfer (REST) paradigm.
- Can use WADL to define the service, but typically code + annotations are used
- Messages can be marshalled/unmarshalled to/from Java Objects using JAXB
- Messages in XML/JSON format.

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Annotations Example

```
@Path("/customerservice/")
@Produces("application/xml")
public class CustomerService {

    public CustomerService() {
    }

    @GET
    public Customers getCustomers() {
        ......
    }

    @GET
    @Path("/customers/{id}")
    @Produces("application/json")
    public Customer getCustomer(@PathParam("id") String id) {
        ......
    }

}
```

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WS-Security in CXF 3.0.0

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WS-Security

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- A set of OASIS specifications to secure SOAP Messages
- Message Confidentiality (XML Encryption)
- Message Integrity (XML Signature)
- Client Authentication via tokens (Username Tokens, Kerberos Tokens, SAML Tokens, Asymmetric Signature Certificates/Public Keys).

Secured SOAP Envelope

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```
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
    <soap:Header>
        <wsse:Security soap:mustUnderstand="1">
            <xenc:EncryptedKey Id="EK-...">
                <xenc:EncryptionMethod Algorithm="http://www.w3.org/2001/04/xmlenc#rsa-oaep-mgf1p"/>
                <ds:KeyInfo>
                     <wsse:SecurityTokenReference>
                         <wsse:KeyIdentifier>u4QVnVV7jQhG8h2GiTSVJyB2g9c=</wsse:KeyIdentifier>
                     </wsse:SecurityTokenReference>
                </ds:KeyInfo>
                <xenc:CipherData><xenc:CipherValue>dubWhc...</xenc:CipherValue></xenc:CipherData>
            </xenc:EncryptedKey>
            <xenc:ReferenceList><xenc:DataReference URI="#ED-..."/></xenc:ReferenceList>
        </wsse:Security>
    </soap:Header>
    <soap:Body>
        <xenc:EncryptedData Id="ED-..." Type="http://www.w3.org/2001/04/xmlenc#Content">
            <xenc:EncryptionMethod Algorithm="http://www.w3.org/2001/04/xmlenc#aes128-cbc"/>
            <ds:KeyInfo>
                <wsse:SecurityTokenReference><wsse:Reference URI="#EK-1..."/></wsse:SecurityTokenReference>
            </ds:KeyInfo>
            <xenc:CipherData><xenc:CipherValue>+t2UI7i3M...</xenc:CipherData>
       </xenc:EncryptedData>
    </soap:Body>
</soap:Envelope>
```

WS-SecurityPolicy

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- WS-SecurityPolicy can be used to configure WS-Security via a WS-Policy expression.
- By embedding the policy in a WSDL, a service can publish security requirements to a client
- Client/Service only need to configure usernames, passwords, keys, etc.
- Requests are validated against the set of applicable policies

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Example

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```
<sp:TransportBinding>
    <wsp:Policy>
        <sp:TransportToken>
            <wsp:Policy>
                <sp:HttpsToken><wsp:Policy/></sp:HttpsToken>
            </wsp:Policy>
        </sp:TransportToken>
        <sp:IncludeTimestamp/>
        <sp:AlgorithmSuite>
            <wsp:Policy><sp:Basic128/></wsp:Policy>
        </sp:AlgorithmSuite>
    </wsp:Policy>
</sp:TransportBinding>
<sp:SupportingTokens>
    <wsp:Policy>
        <sp:UsernameToken sp:IncludeToken="http://docs.oasis-open.org/.../AlwaysToRecipient">
            <wsp:Policy><sp:WssUsernameToken10/></wsp:Policy>
        </sp:UsernameToken>
    </wsp:Policy>
</sp:SupportingTokens>
```

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WS-Security @ Apache

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- Apache Santuario: XML Signature + XML Encryption
- Apache WSS4J: WS-Security layer built on top of Santuario
- Apache CXF / Apache Axis/Rampart: Web Services stacks that include WSS4J – WS-SecurityPolicy support, WS-Trust, WS-SecureConveration, etc.

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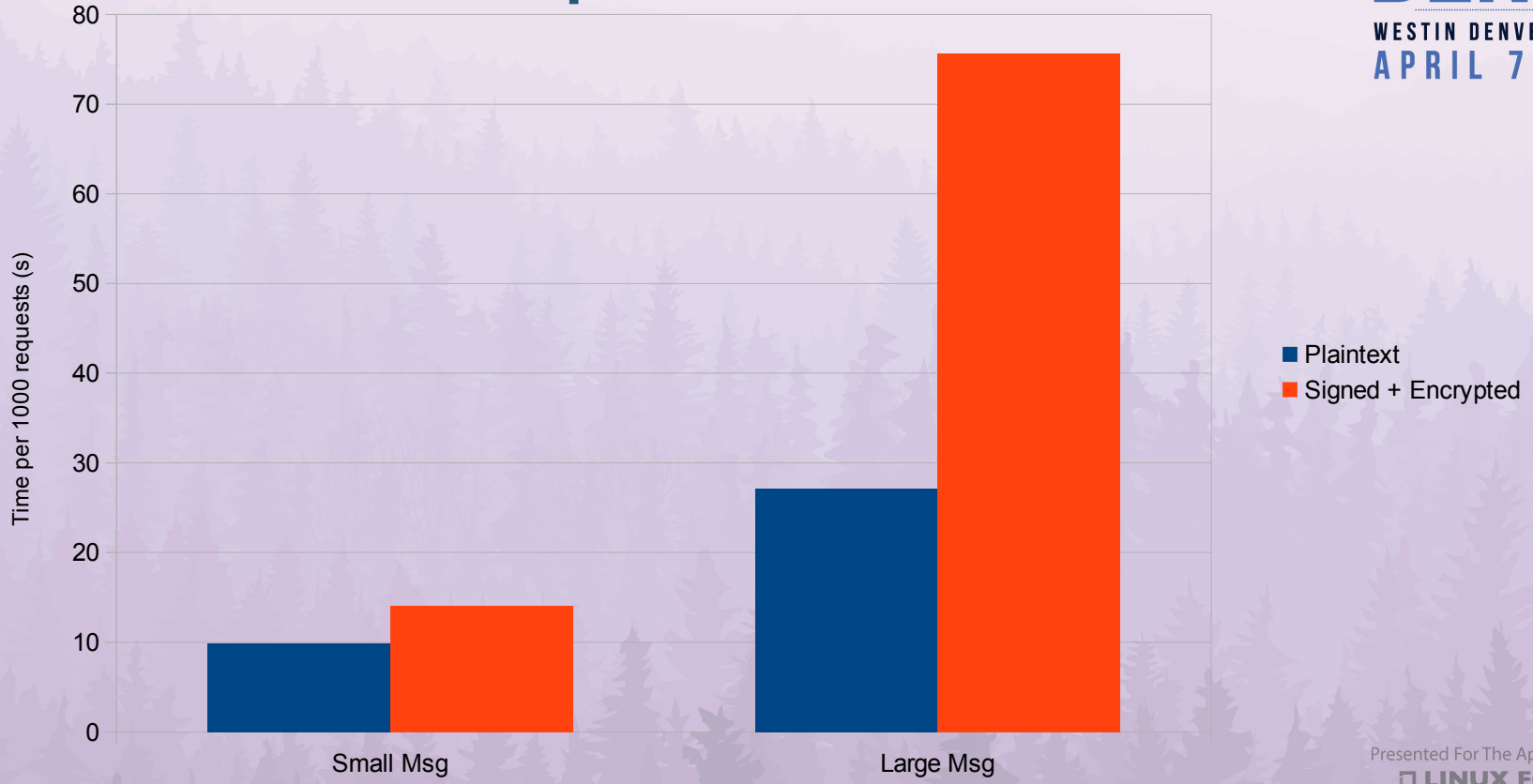
A familiar problem...



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Security is Expensive

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- There is a large performance penalty associated with using WS-Security.
- This is partly due to the work involved in signing and encrypting (in particular using XML).
- However, a large reason is due to the fact that up to now, WS-Security processing requires DOM.
- This requires a lot of memory for large requests
- Also, a StAX-enabled stack such as CXF needs to convert the request into DOM

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Streaming WS-Security

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- A WS-Security implementation based on StAX would solve the problem of large memory requirements and having to convert to DOM.
- However, there are huge difficulties with porting things like XML canonicalization to use a streaming approach.
- 2011: Problem solved by Marc Giger donating his SWSSF project to Apache, a streaming WS-Security prototype based on WSS4J.

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SWSSF @ Apache

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- Rather than create a new project, SWSSF has been integrated into the existing projects.
- The XML Signature + Encryption parts have been added to Apache Santuario 2.0.0.
- The WS-Security parts have been added to Apache WSS4J 2.0.0.
- WSS4J now has two WS-Security stacks, one based on DOM and one on StAX.

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CXF Integration

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- The new StAX code is fully integrated into CXF
- It uses the exact same configuration as for the DOM code
- New interceptors: WSS4JStax(Out|In)Interceptor
- Works with WS-SecurityPolicy - StAX functionality enabled by a boolean configuration property ("ws-security.enable.streaming)
- DOM functionality is enabled by default for WS-SecurityPolicy

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Real-time validation

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- Apache CXF parses the set of WSS4J results + evaluates the set of applicable WS-SecurityPolicy policies against them.
- The new StAX implementation does **real-time** validation of the policies while it is evaluating a request.
- SecurityEvents are generated during processing
- This has performance gains and is more resistant to Denial of Service (DoS) style attacks.

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Performance

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- The StAX WS-Security stack uses far less memory for large requests (see Empirical Data section)
- It should be more efficient for a service handling many simultaneous requests as a result
- It performs better in some scenarios than the DOM stack, and worse in others
- Profiling and future optimisations will hopefully improve performance to a point where we can switch the default stack in CXF

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What's not supported?

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- XPath evaluation
- “Strict” Layout validation
- Policy combinations that require two separate Encryption actions (EncryptBeforeSigning + EncryptSignature)
- Policy combinations that require two separate Signature actions (e.g. Endorsing tokens with (a)symmetric bindings – with some exceptions).

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WSS4J 2.0.0

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- Lots of new features apart from StAX implementation
- New consolidated WS-SecurityPolicy model
- Support for securing message attachments
- Support for caching based on EhCache
- Support for encrypting passwords in Crypto properties files using Jasypt

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Securing attachments in CXF 3.0.0

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Securing attachments

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- Signing/encrypting message attachments not supported prior to CXF 3.0.0.
- WSS4J 2.0.0 supports the WS-Security SOAP Messages with Attachments Profile.
- If a “<sp:Attachments />” policy is used as a (Signed|Encrypted)Parts in CXF 3.0.0, all attachments are automatically secured.
- There are also policies to only sign the content or to include the attachment headers.

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Example

```
Payload: --uuid:e49a5dc5-689d-4879-b51e-d1e192a5276d^M
Content-Type: text/xml; charset=UTF-8; type="text/xml"^M
Content-Transfer-Encoding: binary^M
Content-ID: <root.message@cxf.apache.org>
<soap:Envelope ....>
  <xenc:EncryptedData...>
      <xenc:CipherData>
          <xenc:CipherReference
              URI="cid:attachment=e02d4dde-bcd4-45ab-99c6-824a848697b8@apache.org">
              <xenc:Transforms>
                  <ds:Transform Algorithm="...-SwAProfile-1.1#Attachment-Ciphertext-Transform"/>
              </xenc:Transforms>
          </xenc:CipherReference>
      </xenc:CipherData>
  </xenc:EncryptedData>
</soap:Envelope>
--uuid:e49a5dc5-689d-4879-b51e-d1e192a5276d^M
Content-Type: application/octet-stream^M
Content-Transfer-Encoding: binary^M
Content-ID: <attachment=e02d4dde-bcd4-45ab-99c6-824a848697b8@apache.org>^M
^M
{\◆}м◆◆:^Dr◆Æ<◆й◆E....
--uuid:e49a5dc5-689d-4879-b51e-d1e192a5276d--
```

Using MTOM

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- If MTOM is enabled with WS-Security, attachments are inlined before the SOAP Body is secured.
- Signing/encrypting using MTOM is targeted for CXF 3.0.1.
- However, the cost associated with BASE-64 encoding the attachment + inlining it for signature digest calculation may make the SwA approach more efficient.
- CXF 3.0.0 has a minor efficiency gain not to inline the attachments with MTOM for most TransportBinding use-cases.

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RS-Security in CXF 3.0.0

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RS-Security

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- CXF supports XML Signature + Encryption for JAX-RS clients and endpoints as well.
- XML Signature options: Enveloped, Enveloping, Detached.
- Separate interceptors for Signature + Encryption, that can be chained.
- Using XML Signature with PKI allows an alternative to the standard HTTP/BA over TLS or TLS with client auth.

Sample signed request

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```
<Book Id="b3854300-8e43-47fa-8665-cdc44eb35028">
    <id>126</id><name>CXF</name>
    <ds:Signature>
        <ds:SignedInfo>
            <ds:CanonicalizationMethod Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
            <ds:SignatureMethod Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
            <ds:Reference URI="#b3854300-8e43-47fa-8665-cdc44eb35028">
                <ds:Transforms>
                    <ds:Transform Algorithm="http://www.w3.org/2000/09/xmldsig#enveloped-signature"/>
                    <ds:Transform Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#"/>
                </ds:Transforms>
                <ds:DigestMethod Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
                <ds:DigestValue>Yg5/JPuT44...</ds:DigestValue>
            </ds:Reference>
        </ds:SignedInfo>
        <ds:SignatureValue>Qdzxkxm5...<ds:SignatureValue>
        <ds:KeyInfo>...</ds:KeyInfo>
    </ds:Signature>
</Book>
```

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Streaming RS-Security

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- It's possible to use the new StAX functionality for JAX-RS as well in CXF 3.0.0.
- New interceptors: XmlSec(Out|In)Interceptor
- XML Signature (enveloped only) + Encryption supported.
- Testcase: https://github.com/coheigea/testcases/tree/master/apache/cxf/cxf-jaxrs-xmlsec

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Some empirical data...

Benchmarks I

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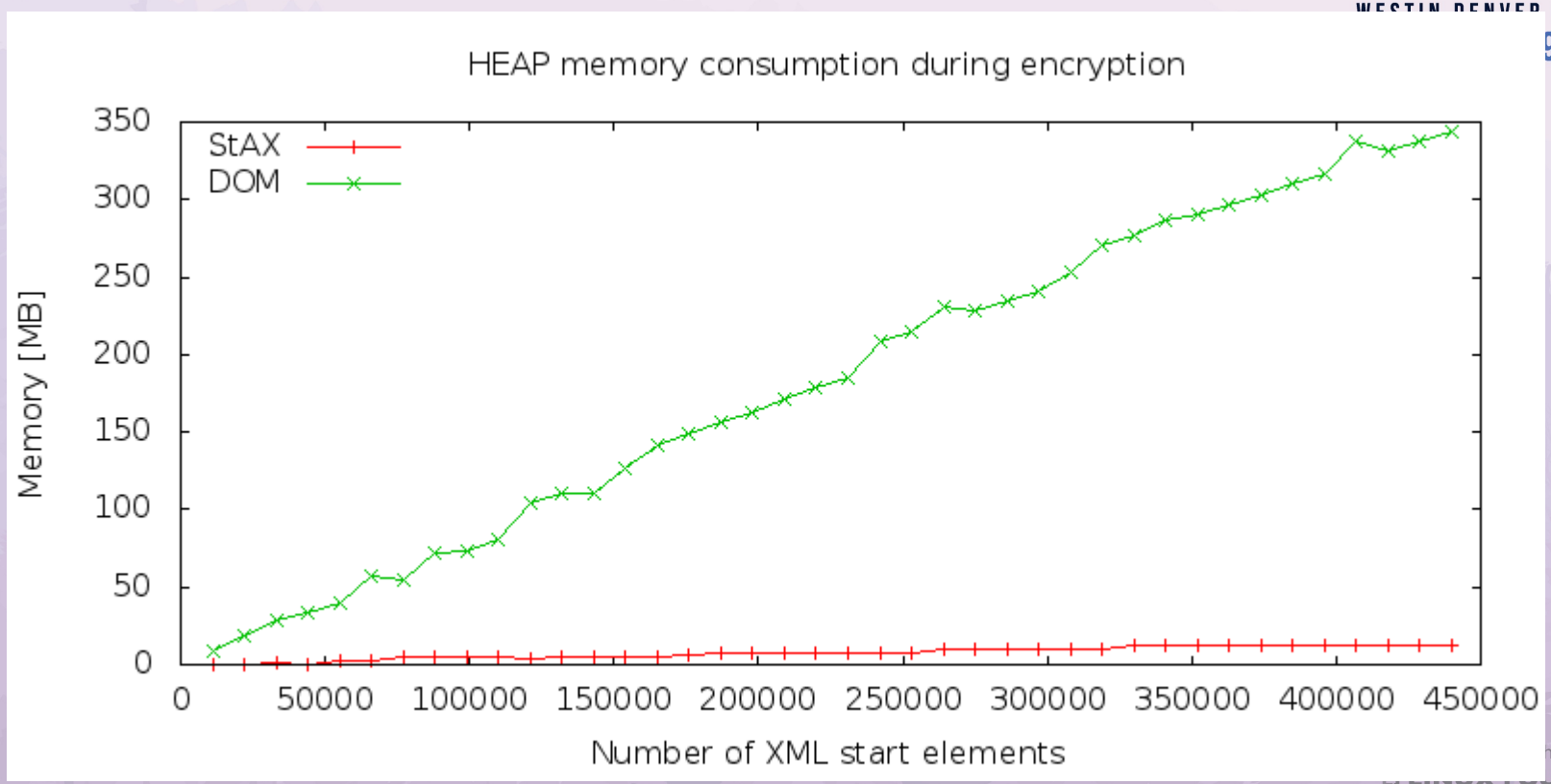

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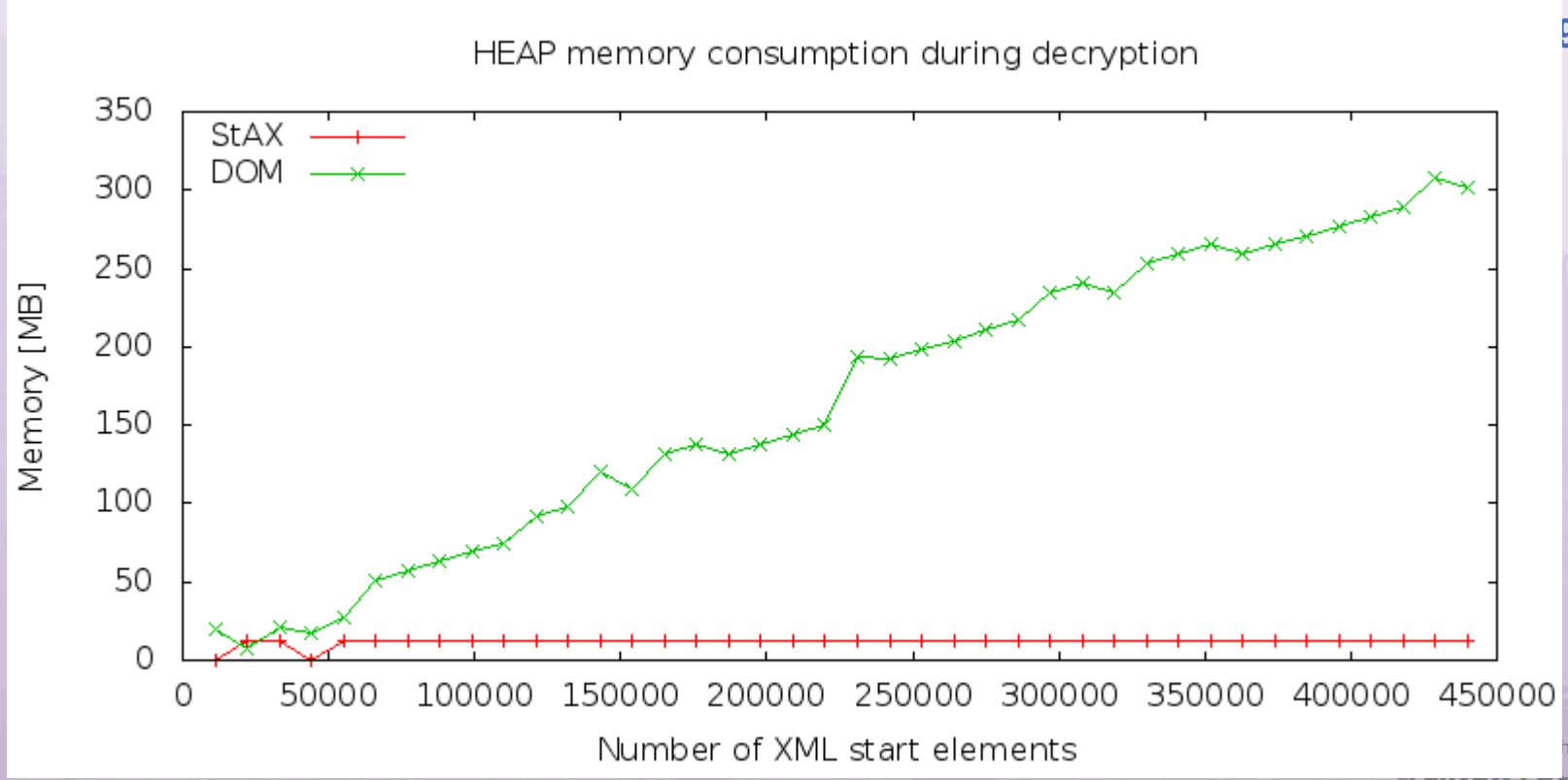
Benchmarks II



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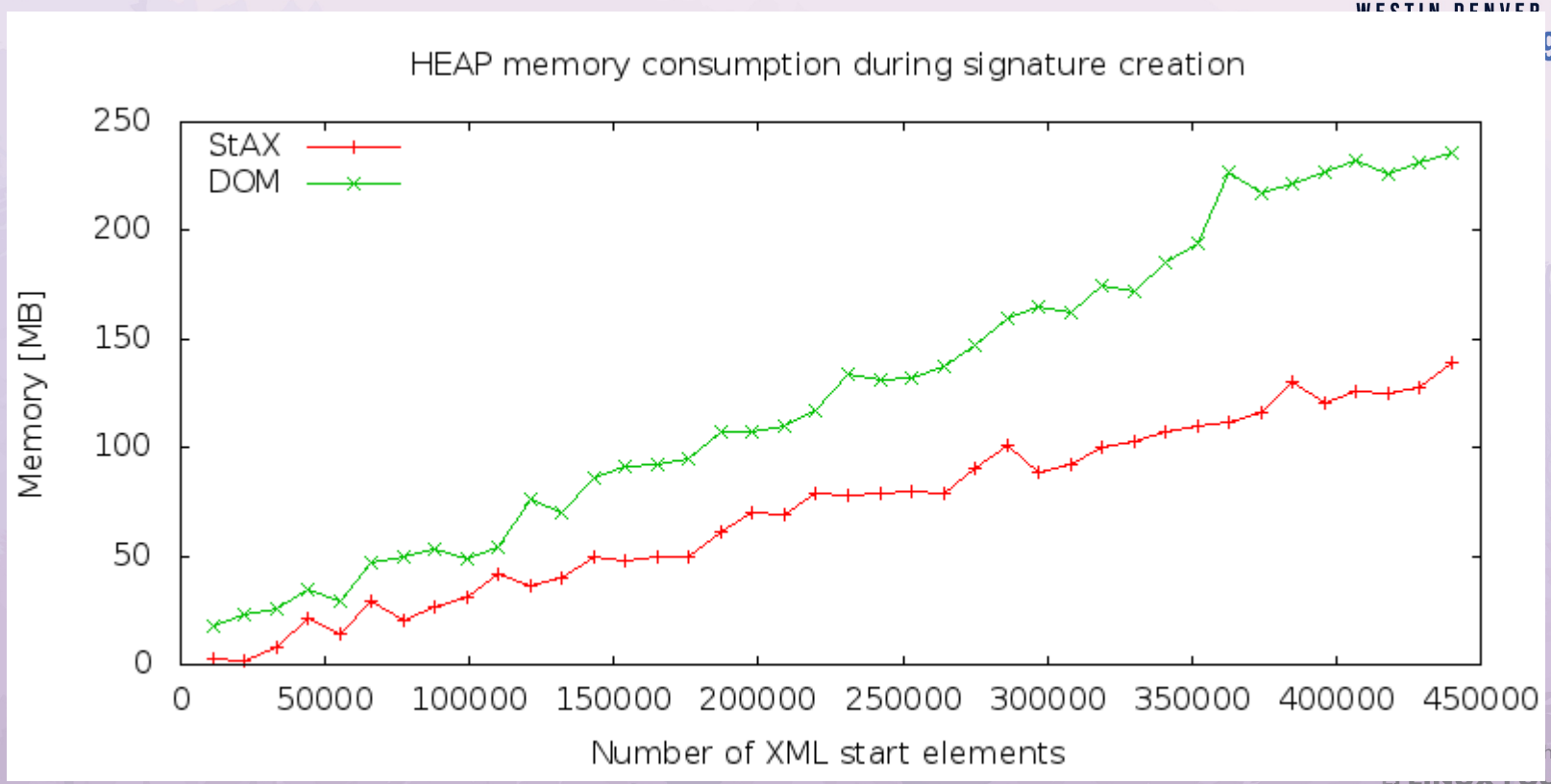
Benchmarks III



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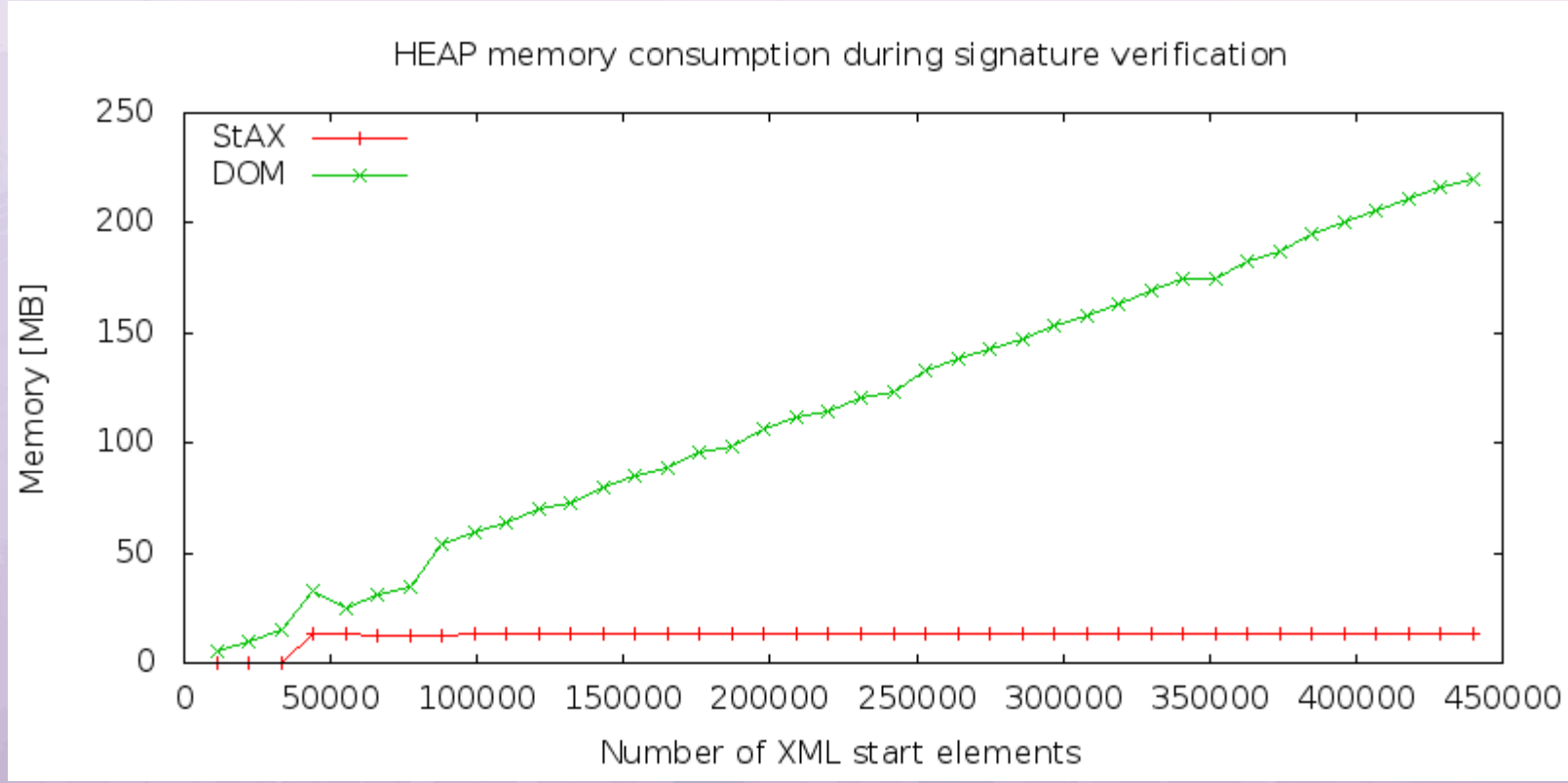
Benchmarks IV



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Using Single Sign-On (SSO)

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Single Sign-On (SSO)

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- Thus far we have focused on securing messages
- However, client authentication can also be expensive...
- This is where Single Sign-On (SSO) comes in
- The client “signs-on” to a centralized authentication service of some kind, and retains a resulting token for any subsequent authentication (until the user signs out).

Shibboleth

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SSO using WS-SecConv

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- A really simple way supported in CXF for SSO is to use WS-SecureConversation.
- A rudimentary STS is embedded with a CXF endpoint
- The client authenticates and receives a token + negotiated secret.
- The client signs the request using the secret + references the token in any subsequent request.
- Testcase (SSOTest): https://github.com/coheigea/testcases/tree/master/apache/cxf/cxf-shiro

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SSO using an STS

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- CXF ships with an advanced SecurityTokenService (STS)
- The client authenticates to the STS + receives a SAML Token.
- The client caches the token + re-uses it until expiry.
- Roles/claims are embedded in the token for authorization
- Testcase (SSOTest): https://github.com/coheigea/testcases/tree/master/apache/cxf/cxf-sts

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SSO using SAML SSO

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- CXF supports SSO via the SAML SSO Web Profile
- A JAX-RS filter can redirect a service request to an IdP
- The IdP authenticates the client and redirects to the service
- Authenticated state saved as a cookie
- The SAML Assertion is also saved to allow for role retrieval
- Testcase
  https://github.com/coheigea/testcases/tree/master/apache/cxf/cxf-saml-sso

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Questions

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