Sign and Encrypt Any Element in a SOAP Message

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This article describes how to use IBM® WebSphere® Application Server Version 6.0 (hereafter called Application Server) and IBM Rational® Application Developer (hereafter called Application Developer) to sign and encrypt any element in a SOAP message using the Web Services Security 1.0 standard (WS-Security). WS-Security is designed to be flexible and extensible. However, that flexibility and extensibility is a double-edged sword: it enables security for many message-level scenarios, but adds significant complexity to the development process. WebSphere Application Server provides a simple keyword-based mechanism to specify which SOAP message elements are to be signed and encrypted. Keywords are defined to support the majority of common usage scenarios for standard message elements. However, SOAP messages frequently contain non-standard application-defined elements that must also be protected. This article describes how you can use an XPATH expression with WebSphere Application Server to sign and encrypt any element in a SOAP message. The article is intended for Web services application developers who need to secure their SOAP messages using message-level security.

You should have a good understanding of Java™ programming, XML, XPATH, Web services and general cryptographic security technology.

Introduction

Web services is an emerging technology for designing and developing loosely coupled, distributed systems. Web Services Security 1.0 (WS-Security) is an OASIS standard for message level security using XML encryption, XML signature, and security tokens.

WebSphere Application Server has provided support for WS-Security since release 5.0.2. WS-Security support in Application Server V5.0.2 and V5.1.x was based on a pre-standard draft of the specification. The WS-Security 1.0 specification became an OASIS standard in April 2004, and Application Server V6 supports this version of the standard. Similarly, Rational Application Developer V5.0.x and V5.1.x support the draft version of the WS-Security specification, and Rational Application Developer V6 supports both the draft version and the 1.0 standard.

The OASIS Web Services Security Technical Committee designed the WS-Security standard to be flexible and extensible. The intent was to provide a standard that developers could use to secure as many Web services scenarios as possible. However, flexibility and extensibility comes with a price: complexity. The challenge for vendors who provide implementations of the WS-Security standard lies in striking a balance between ease of use and flexibility. The WS-Security implementation in WebSphere Application Server concentrates on ease of use for the most common usage scenarios, while enabling more complex usage patterns for more expert users.

This article focuses on how to use Rational Application Developer and WebSphere Application Server to secure SOAP messages using XML Digital Signature and XML Encryption. There are two methods in Rational Application Developer for selecting a

SOAP element to be signed and encrypted. One uses a predefined keyword and the other uses an XPATH expression.

Each of these methods address different requirements. The predefined keyword method provides an easy way of selecting SOAP elements, like `body`, `securitytoken`, `bodycontent`, and so on. WebSphere provides a list of keywords that cover the most frequently signed and encrypted SOAP elements. This method makes it easy to select SOAP elements, but the trade-off is less flexibility, since the selections are limited to the predefined keywords.

The XPATH method provides the flexibility to select virtually any SOAP element in a message. XPATH is a powerful language for XML navigation, but the syntax is cryptic and complex.

This article covers both the predefined keyword and XPATH methods for selecting elements for signing and encryption.

WS-Security High-Level Architecture in WebSphere

Before we dive into the details of how to use digital signature and encryption support of WS-Security in Rational Application Developer, it would be beneficial to describe the high-level architecture.

Some vendors provide WS-Security support through APIs, but IBM WS-Security support is based on a deployment model. The WS-Security requirements are expressed as security constraints in deployment descriptors, which are separated from the application business logic. The deployment descriptors are XML files that describe security constraints. The application server runtime reads the deployment descriptors and enforces the security constraints. This programming model is similar to the J2EE model. Both the deployment descriptor and API –based programming models have their merits and limitations. This article focuses only on the deployment model and does not discuss in any detail the differences between these two approaches.

WS-Security processing is declared as security constraints in deployment descriptors using development tools, such as Rational Application Developer. These security constraints are separate from the application business logic. There is no industry standard format for the WS-Security deployment descriptor, but the security constraints are similar to those defined in the WS-SecurityPolicy language. During SOAP message exchange, the WS-Security runtime, which is implemented as a global handler in the Web service engine, intercepts the SOAP message in the outbound message and applies WS-Security mechanisms based on the security constraints in the deployment descriptor ((a) and (c) in Figure 1). Similarly, on the inbound message, the WS-Security runtime validates the security constraints based on the deployment descriptor. For example, if the WS-Security in the SOAP message satisfies the requirement in the deployment descriptor, then the SOAP message is dispatched to the target Web Service, otherwise, the SOAP message is rejected with a SOAP fault ((b) in Figure 1).

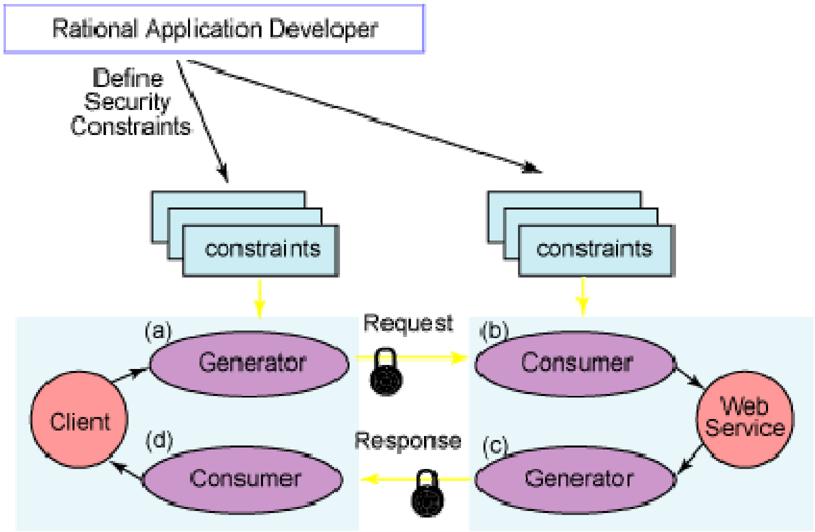


Figure 1. High-level architecture overview of WS-Security deployment model

WS-Security Deployment Model

The Application Server deployment model contains two configuration files: the deployment descriptor and the binding. The deployment descriptor is used to configure the high-level and platform-independent security constraints similar to WS-SecurityPolicy. The binding is used to configure platform-specific security constraints for the specific deployed instance. This section summarizes what you can configure in the deployment descriptor. We'll explain the details of the binding configuration in a later section.

You can configure the following security constraints with Application Developer, as shown in Figure 1:

For the client outbound (request generator: (a) in Figure 1):

- Integrity (SOAP elements to be signed)
- Confidentiality (SOAP elements to be encrypted)
- Security token (generated for authentication or identity assertion)
- Timestamp

For the Web service inbound (request consumer: (b) in Figure 1):

- Required integrity (SOAP elements should be signed)
- Required confidentiality (SOAP elements should be encrypted)
- Required security token (used for authentication or identity assertion)
- Required timestamp

For the Web service outbound (response generator: (c) in Figure 1):

- Integrity (SOAP elements to be signed)

- Confidentiality (SOAP elements to be encrypted)
- Timestamp

For the client inbound (response consumer: (d) in Figure 1):

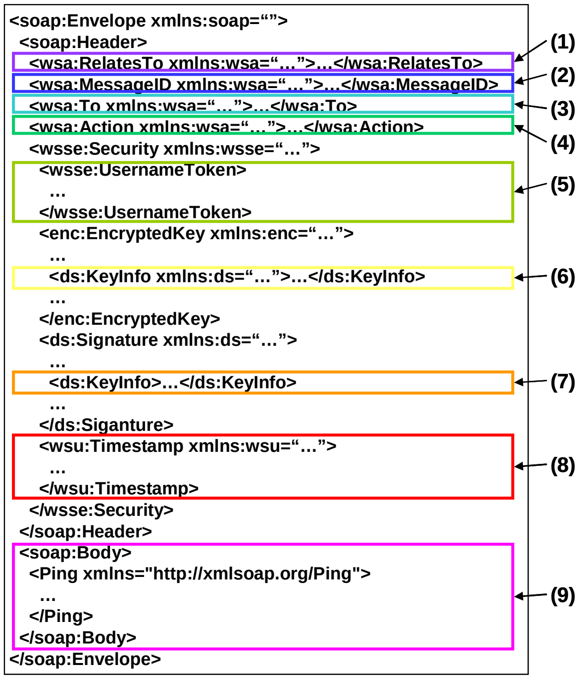
- Required integrity (SOAP elements should be signed)
- Required confidentiality (SOAP elements should be encrypted)
- Required timestamp

As described earlier, for integrity and confidentiality, Application Server provides two types of selection of the SOAP elements to be signed or encrypted: predefined keyword based selection and XPATH selection.

Predefined keywords

Application Server provides some useful predefined keywords for selecting the common SOAP elements to be signed or encrypted. The predefined keywords for digital signature are:

- **`relatesto`**: Select the `<wsa:RelatesTo>` element defined in the Web Services Addressing (WS-Addressing) specification.
- **`messageid`**: Select the `<wsa:MessageID>` element defined in the WS-Addressing specification.
- **`to`**: Select the `<wsa:To>` element defined in the WS-Addressing specification.
- **`action`**: Select the `<wsa:Action>` element defined in the WS-Addressing specification.
- **`securitytoken`**: Select all security tokens used for authentication.
- **`enckey`**: Select all `<ds:KeyInfo>` elements used in the `<enc:EncyptedKey>` elements or the `<enc:EncryptedData>` elements.
- **`dsigkey`**: Select all `<ds:KeyInfo>` elements used in the `<ds:Signature>` elements.
- **`timestamp`**: Select the `<wsu:Timestamp>` element that is the last child of the `<wsse:Security>` element.
- **`body`**: Select the SOAP body element.



```
<soap:Envelope xmlns:soap="">
  <soap:Header>
    <wsa:RelatesTo xmlns:wsa="…">…</wsa:RelatesTo>
    <wsa:MessageID xmlns:wsa="…">…</wsa:MessageID>
    <wsa:To xmlns:wsa="…">…</wsa:To>
    <wsa:Action xmlns:wsa="…">…</wsa:Action>
    <wsse:Security xmlns:wsse="…">
      <wsse:UsernameToken>
        …
      </wsse:UsernameToken>
      <enc:EncryptedKey xmlns:enc="…">
        …
        <ds:KeyInfo xmlns:ds="…">…</ds:KeyInfo>
        …
      </enc:EncryptedKey>
      <ds:Signature xmlns:ds="…">
        …
        <ds:KeyInfo>…</ds:KeyInfo>
        …
      </ds:Siganture>
      <wsu:Timestamp xmlns:wsu="…">
        …
      </wsu:Timestamp>
    </wsse:Security>
  </soap:Header>
  <soap:Body>
    <Ping xmlns="http://xmlsoap.org/Ping">
      …
    </Ping>
  </soap:Body>
</soap:Envelope>
```

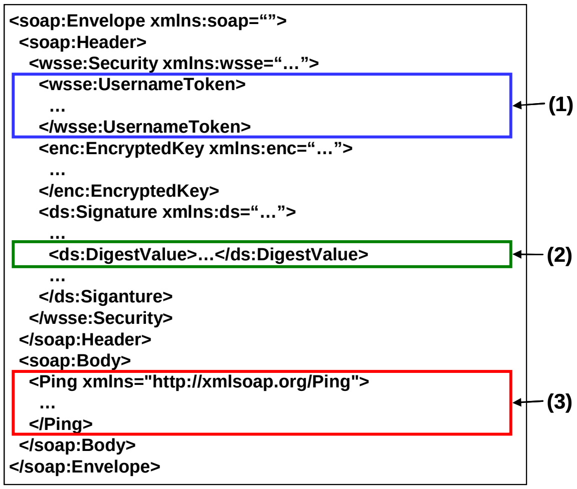
Figure 2 . Keywords for digital signature

The predefined keywords for encryption include the following:

(1) **`usernametoken`**: Select the `<wsse:UsernameToken>` element under the `<wsse:Security>` element.

(2) **`digestvalue`**: Select all `<ds:DigestValue>` elements in the `<ds:Signature>` element.

(3) **`bodycontent`**: Select all child nodes of the SOAP body element.



```
<soap:Envelope xmlns:soap="">
  <soap:Header>
    <wsse:Security xmlns:wsse="…">
      <wsse:UsernameToken>
        …
      </wsse:UsernameToken>
      <enc:EncryptedKey xmlns:enc="…">
        …
      </enc:EncryptedKey>
      <ds:Signature xmlns:ds="…">
        …
        <ds:DigestValue>…</ds:DigestValue>
        …
      </ds:Siganture>
    </wsse:Security>
  </soap:Header>
  <soap:Body>
    <Ping xmlns="http://xmlsoap.org/Ping">
      …
    </Ping>
  </soap:Body>
</soap:Envelope>
```

Figure 3. Keywords for encryption

Application Server provides a list of predefined keywords for most commonly used SOAP elements in a SOAP message. The predefined keywords provide a fast and easy way for specifying the SOAP elements for digital signature and encryption. This may be all you need in most scenarios. Later in this article, we'll provide a sample of how to use keywords to sign and encrypt the SOAP body and SOAP body content, respectively.

XPATH

Predefined keywords may not satisfy all scenarios; for example, signing and encrypting custom SOAP headers or signing or encrypting only parts of headers or the SOAP body. For that reason, WebSphere also provides another mechanism for selecting SOAP elements for digital signature and encryption. The alternative mechanism is to use XPATH language to select SOAP elements.

The XPATH language is a W3C standard for addressing parts of an XML document. It is flexible and powerful, but the language syntax is complex.

Application Server also provides XPATH support to select the parts of SOAP message for digital signature and encryption. The XPATH support[1] for selecting part of the SOAP message doesn't support full XPATH specification, but only node-set selection. For example, the following XPATH expression selects the SOAP body element. Of course, you can select the same SOAP body element with the predefined `body` keyword for digital signature feature described in the previous section. As you can see, the XPATH expression is much more complex than the predefined keyword. The sample in this article describes how to select the content of a custom SOAP header for encryption.

```
/*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/' and
local-name()='Envelope']/*[namespace-
uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
name()='Body']
```

Overview of the sample application

This article provides a sample to demonstrate the following:

- Using the predefined keyword `body` for signing and signature validation of the SOAP body and using the predefined keyword `bodycontent` for encrypting and decrypting the SOAP body content.
- Using XPATH expression to select a custom SOAP header and the SOAP header content for signature and encryption, respectively.

The sample application is a simple "Hello, World" Web service that sends a SOAP message with a custom header (`TestHeader`). The Web service client is implemented as a Web client and the Web service implementation is a Servlet Java Bean. In this sample, we'd like to:

[1] Don't confuse this with the XPATH reference for digital signature.

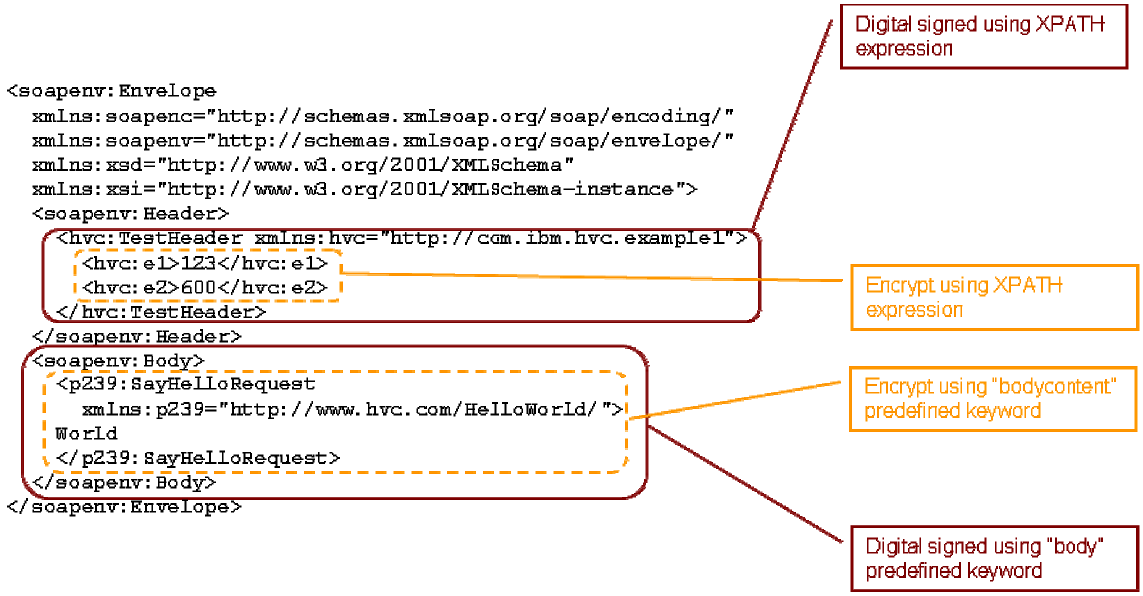
- Sign the SOAP body using the predefined keyword `body` and
- Sign the `TestHeader` using the XPATH expression:

```
/*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/' and
local-name()='Envelope']/*[namespace-
uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
name()='Header']/*[namespace-uri()='http://com.ibm.hvc.example1' and
local-name()='TestHeader']
```

- Encrypt the SOAP body content using predefined keyword `bodycontent` and
- Encrypt the `TestHeader` content using the XPATH expression:

```
/*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/' and
local-name()='Envelope']/*[namespace-
uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
name()='Header']/*[namespace-uri()='http://com.ibm.hvc.example1' and
local-name()='TestHeader']/node()
```

The following is a sample SOAP message without security:



```
<soapenv:Envelope
  xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
  xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <soapenv:Header>
   <hvc:TestHeader xmlns:hvc="http://com.ibm.hvc.example1">
     <hvc:e1>123</hvc:e1>
     <hvc:e2>600</hvc:e2>
   </hvc:TestHeader>
  </soapenv:Header>
  <soapenv:Body>
   <p239:SayHelloRequest
     xmlns:p239="http://www.hvc.com/HelloWorld/">
   World
   </p239:SayHelloRequest>
  </soapenv:Body>
</soapenv:Envelope>
```

Digital signed using XPATH expression

Encrypt using XPATH expression

Encrypt using "bodycontent" predefined keyword

Digital signed using "body" predefined keyword

Figure 4 . Sample unsecured SOAP message

Following is an overview of the steps. More details are provided in the subsequent sections:

1. Generate the keys for digital signature and encryption. The sample uses different sets of keys for digital signature and encryption.
2. Configure the WS-Security constraints for the request generator (client outbound)
3. Configure the WS-Security constraints for the request consumer (Web service inbound)

You can use a Web service you have already developed, or download the sample application provided with this article.

Run the sample application

Download the sample application and run it, as described below. The sample application has been tested on WebSphere Application Server 6.0.2.

1. Copy the key stores to the `${USER_INSTALL_ROOT}/etc/ws-security/hvc directory`, where `${USER_INSTALL_ROOT}` is the profile directory.
2. Deploy the sample application EAR file (SignEncryptAnyElement.ear).
3. Start the sample application.
4. Bring up a Web browser. The client URL is http://localhost:9080/SayHelloClient/.
5. Click OK to send a Web service request. You can change the port to redirect the request to a network monitor to capture the SOAP message; for example, TCPMON.

Generate the keys

The sample uses a self-signed certificate for digital signature. You can easily extend this to use a CA-issued certificate for digital signature. There are a few tools available to generate a self-signed certificate. In this case, we're using the keytool provided by the Java Development Toolkit for generating the keys for digital signature and encryption.

1. Generate an RSA key pair for digital signature. The alias of the key is `john`, and DN is `CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US.`   The password is `johnsmith` in the sender key store `sendersigner.jks`, and the store password is `signer`.

   ```
   keytool -genkey -alias john -keyalg RSA -validity 365 -keystore
   sendersigner.jks -storepass signer -dname "CN=John Smith,
   OU=Development, O=ACME, L=OneCity, ST=OneState, C=US" -keypass
   johnsmith
   ```

2. Export the public certificate of alias `john` and import it into the receiver trust store. This is used by the receiver to validate the trust of the public certificate. If you use a CA-issued certificate, you need to import the CA public certificate into the trust store instead.
   a. Export `john` public certificate to a file `john.cert:`

      ```
      keytool -export -alias john -keystore sendersigner.jks -storepass
      signer -file john.cert
      ```

   b. Import `john` public certificate in file `john.cert` into the receiver trust store (`receivertruststore.jks`). It is very important that you make sure the certificate is authentic. The certificates in the trust store are trusted by the receiver.

```
keytool -import -alias john -keystore receivertruststore.jks -
storepass truststore -file john.cert
```

3. Generate an RSA key pair for encryption. The alias of the key is `dev2`, and the DN is `CN=dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`. The password is `dev2receiver` in the receiver key store `receiver.jks`, and the store password is `receiver`.

   ```
   keytool -genkey -alias dev2 -keyalg RSA -validity 365 -keystore
   receiver.jks -storepass receiver -dname "CN=dev2, OU=Development,
   O=ACME, L=OneCity, ST=OneState, C=US" -keypass dev2receiver
   ```

4. Export the public key of alias `dev2`, which is in the public certificate and import it into the sender key store. The sender uses the public key of `dev2` to encrypt the message.
   a. Export `dev2` public certificate to a file `dev2.cert`:

      ```
      keytool -export -alias dev2 -keystore receiver.jks -storepass
      receiver -file dev2.cert
      ```

   b. Import `dev2` public certificate in file `dev2.cert` into the sender key store (`sender.jks`):

      ```
      keytool -import -alias dev2 -keystore sender.jks -storepass
      sender -file dev2.cert
      ```

Note that the expiration of the sample keys in the sample application is ten years, but in real life applications, you may want to have a shorter expiration for security reasons. You can also generate new keys using the script file provided with this article.

Results

The following key stores are created after this step:

Key store	**Content**	**Purpose**
`sendersigner.jks`	John Smith public (certificate) and private keys	Client uses John Smith private key to sign the SOAP message
`Sender.jks`	Dev2 public (certificate) key	Client uses Dev2 public key to encrypt the SOAP message
`receiver.jks`	Dev2 public (certificate) and private keys	Web service uses Dev2 private key to decrypt the message
`receivertruststore.jks`	John Smith public (certificate) key	Web service uses the trust store to verify trust of the signer certificate

Configure WS-Security constraints for the request generator

This section describes how to configure the WS-Security constraints and bindings for the request generator (client outbound request), which defines what WS-Security constraints apply to the client outbound SOAP message. This section assumes you have already developed your application using Rational Application Developer[4].

The WS-Security editors for constraints and bindings are tabs in the Web Deployment Descriptor (for Web-based client).

1. Open the Web Deployment Descriptor in the Project Explorer of the J2EE perspective by double-clicking the **web.xml** file of the Web application (the example Web service client is a Web-based client), as shown in Figure 5:

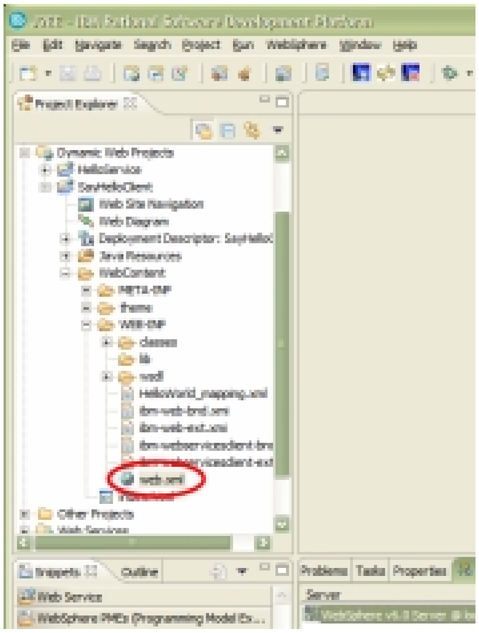
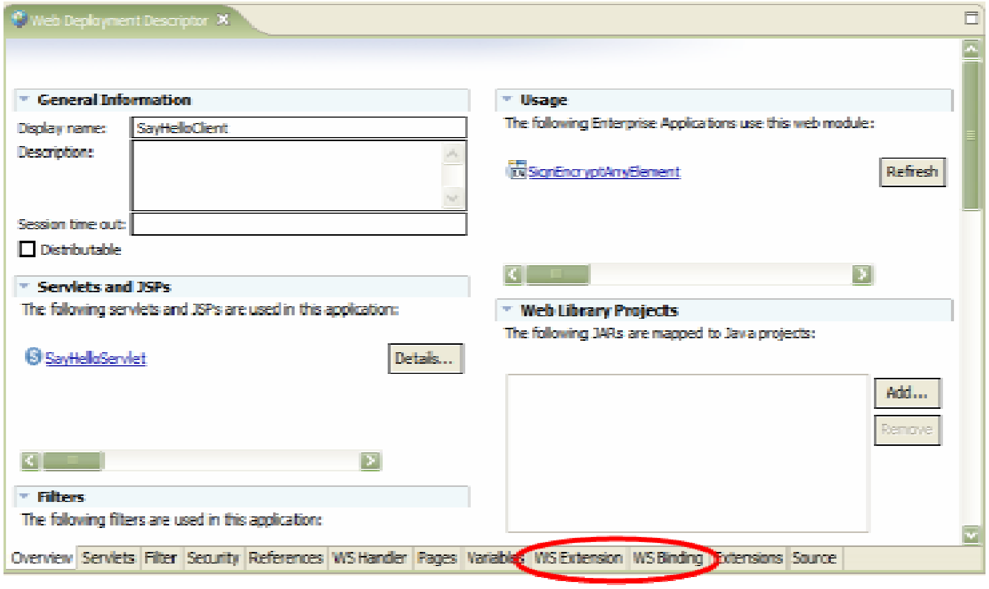


Figure 5 . Open the Web Deployment Descriptor of the Web-based Web service client

2. Open the WS-Security constraints editor by clicking the **WS Extension** tab and the bindings editor by clicking the **WS Binding** tab, as shown in Figure 6:

[4] You can also use Application Server Toolkit to configure the WS-Security constraints and bindings.



Display name: SayHelloClient

The following servlets and JSPs are used in this application:

The following filters are used in this application:

The following Enterprise Applications use this web module:

The following JARs are mapped to Java projects:

Figure 6 . Open the WS Extension and WS Binding editors

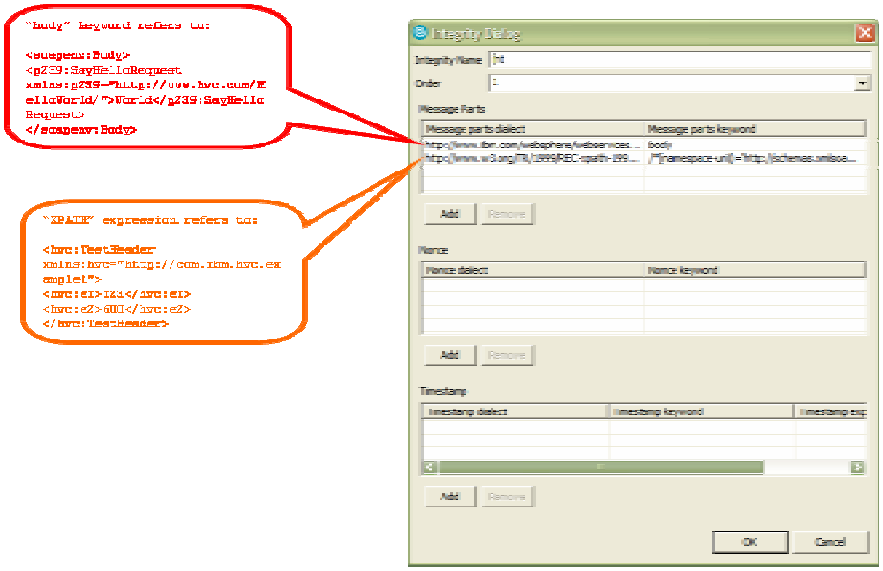
Configure integrity (digital signature)

The XML digital signature standard is a complex specification, which is reflected in the number of steps required to enable digital signature. First, you need to define what to sign (integrity security constraints) and then define the binding information, such as the token generator to send the public key of the signer as a X509 binary security token, the key locator to locate the signer key, the key information for the security token reference, and signature information (signature algorithm, digest method and transform).

To configure integrity, complete the following steps:

1) Define the integrity constraints (what to sign) in the **WS Extension** tab.
   - In the WS Extension editor, select **Request Generator configuration -> Integrity**, then click **Add**.
   - Specify `int` for **Integrity Name.**
   - Specify `1` for **Order** (sign first, then encrypt).
   - In the **Message Parts** field, specify two parts to be signed in this integrity constraint: the SOAP body using the predefined keyword `body,` and the `TestHeader` using the following XPATH expression:

```
/*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/'
and local-name()='Envelope']/*[namespace-
uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
name()='Header']/*[namespace-uri()='http://com.ibm.hvc.example1'
and local-name()='TestHeader']
```



```
"body" keyword refers to:

<soapenv:Body>
<p239:SayHelloRequest
xmlns:p239="http://www.hvc.com/H
elloWorld/">World</p239:SayHello
Request>
</soapenv:Body>
```

```
"XPATH" expression refers to:

<hvc:TestHeader
xmlns:hvc="http://com.ibm.hvc.ex
ample1">
<hvc:e1>123</hvc:e1>
<hvc:e2>600</hvc:e2>
</hvc:TestHeader>
```

Integrity Name: int

Order: 1

Message Parts

Message parts dialect	Message parts keyword
http://www.ibm.com/websphere/webservices....	body
http://www.w3.org/TR/1999/REC-xpath-199...	/*[namespace-uri()='http://schemas.xmlsoa...

Nonce

Nonce dialect	Nonce keyword

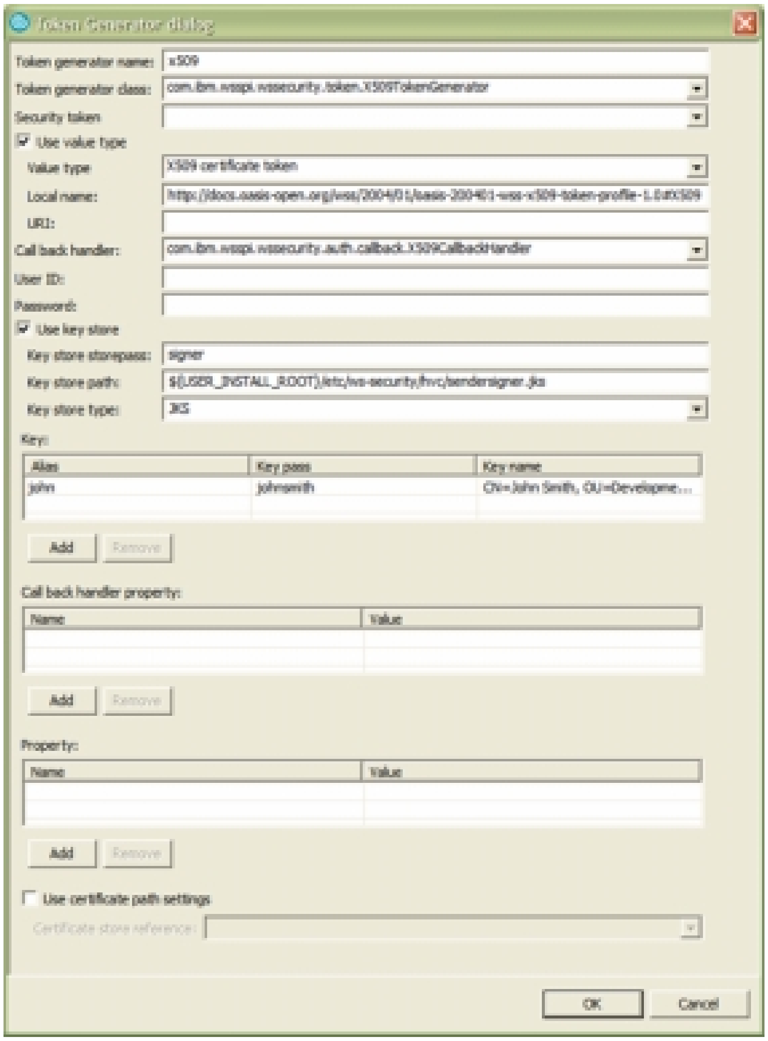
Timestamp

Timestamp dialect	Timestamp keyword	Timestamp exp

Figure 7. Configure integrity

2) Next, define the binding information for integrity (digital signature). Open the bindings editor in the **WS Binding** tab by clicking **Security Request Generator Binding Configuration**.

- Select **Token Generator** and click **Add** to create an X509 Token Generator (`x509`) to send the public certificate of the signer `CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`.
- Leave the **Security token** field blank, because the token is not a standalone token for authentication, but is used for digital signature.



Token generator name: x509

Token generator class: com.ibm.wsspi.wssecurity.token.X509TokenGenerator

Security token:

☑ Use value type

Value type: X509 certificate token

Local name: http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-x509-token-profile-1.0#X509

URI:

Call back handler: com.ibm.wsspi.wssecurity.auth.callback.X509CallbackHandler

User ID:

Password:

☑ Use key store

Key store storepass: signer

Key store path: ${USER_INSTALL_ROOT}/etc/ws-security/hvc/sendersigner.jks

Key store type: JKS

Key:

Alias	Key pass	Key name
john	johnsmith	CN=John Smith, OU=Developme...

Call back handler property:

Name	Value

Property:

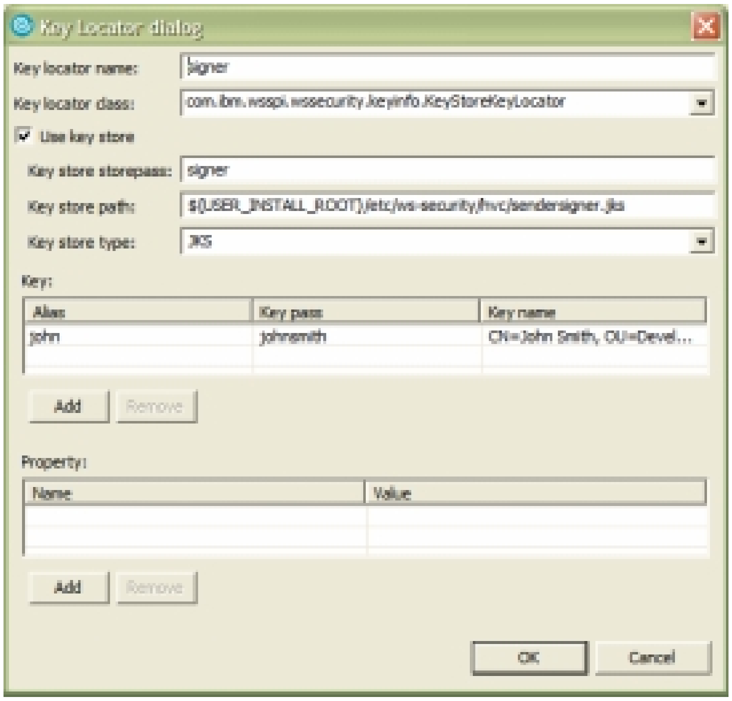
Name	Value

☐ Use certificate path settings

Certificate store reference:

Figure 8. Generate token

3) Select **Key Locators** and click **Add** to create a key locator (or signer) to locate the private key of the signer `CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`.



Key locator name: signer

Key locator class: com.ibm.wsspi.wssecurity.keyinfo.KeyStoreKeyLocator

☑ Use key store

Key store storepass: signer

Key store path: ${USER_INSTALL_ROOT}/etc/ws-security/hvc/sendersigner.jks

Key store type: JKS

Key:

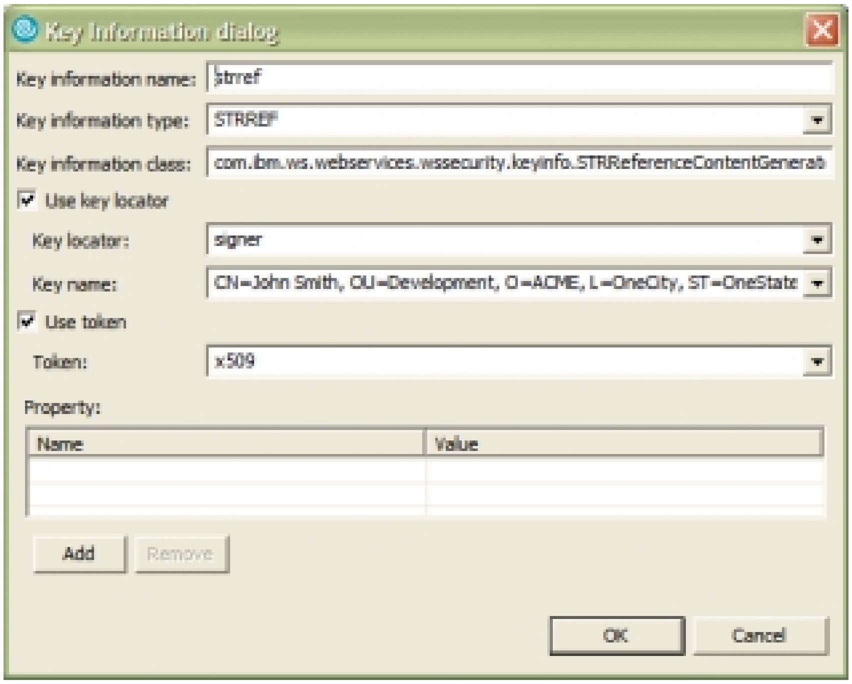
Alias	Key pass	Key name
john	johnsmith	CN=John Smith, OU=Devel...

Property:

Name	Value

Figure 9. Create key locator `signer`

4) Select **Key Information** and click **Add** to create security token reference (STR) key information (`strref`). Note that the **Token** field is the token generator name `x509` created in step 2; the **Key locator** field is the name of the key locator created in step 3 which is `signer`, and the **Key name** field is the signer `CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`.



Key information name: strref

Key information type: STRREF

Key information class: com.ibm.ws.webservices.wssecurity.keyinfo.STRReferenceContentGenerat

☑ Use key locator

Key locator: signer

Key name: CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState

☑ Use token

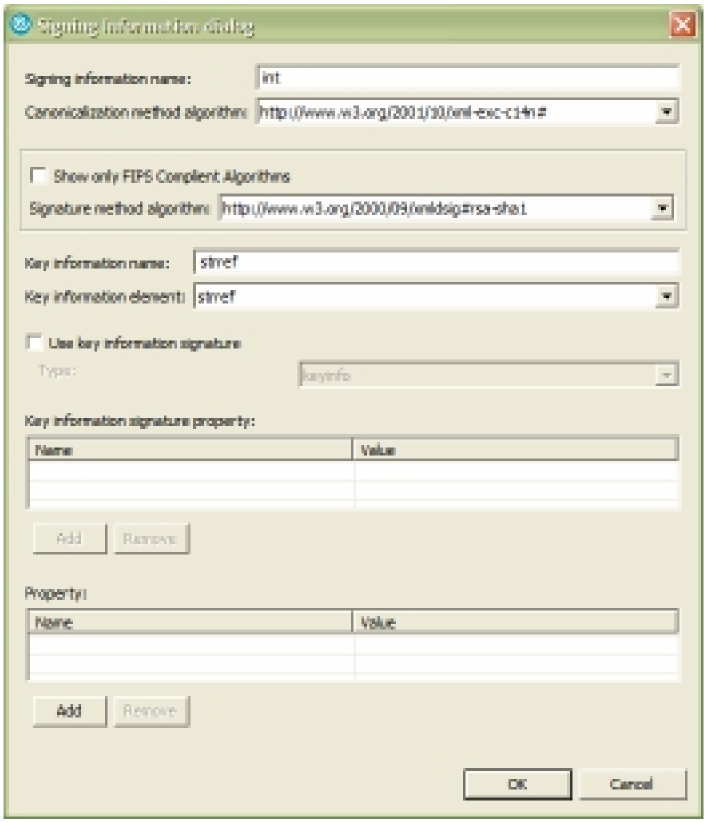
Token: x509

Property:

Name	Value

Figure 10. Create STR key information

5) Select **Signing Information** and click **Add** to define the signing information (`int`). Note that the **Key information element** is the name of the key information created in step 4, which is `strref`.



Signing information name: int

Canonicalization method algorithm: http://www.w3.org/2001/10/xml-exc-c14n#

□ Show only FIPS Compliant Algorithms

Signature method algorithm: http://www.w3.org/2000/09/xmldsig#rsa-sha1

Key information name: strref

Key information element: strref

□ Use key information signature

Type: keyinfo

Key information signature property:

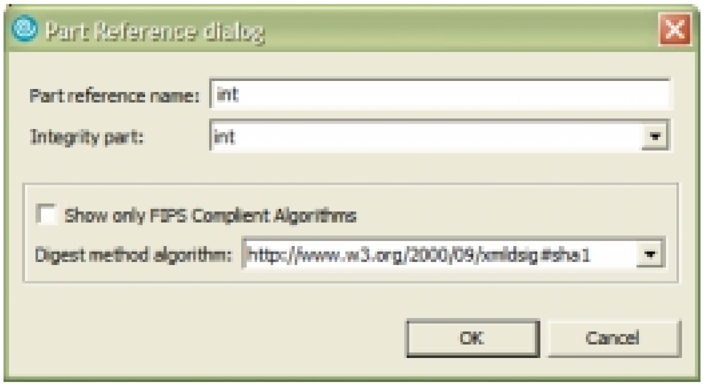
Name	Value

Property:

Name	Value

Figure 11. Define signing information

6) Next, link the `int` signing information created in step 5 with the `int` security constraints defined in step 1. Make sure the `int` signing information created in step 5 is selected, then select **Part References** and click **Add** to add a part reference (`int`). Note that the **Integrity part** field in the **Part Reference** dialog is `int`, the integrity name you created in step 1. For this example, use the default digest method algorithm.



Part reference name: int

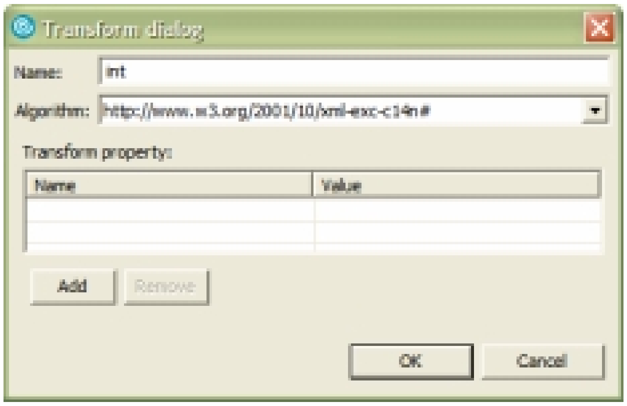
Integrity part: int

□ Show only FIPS Compliant Algorithms

Digest method algorithm: http://www.w3.org/2000/09/xmldsig#sha1

Figure 12. Add part reference

7) Finally, define the transform algorithm for the `int` part reference created in step 6. Make sure the `int` part reference is selected, then select **Transforms** and click **Add** to create the transform algorithm (`int`). For this example, use the default transform.



Name: int

Algorithm: http://www.w3.org/2001/10/xml-exc-c14n#

Figure 13. Define transform algorithm

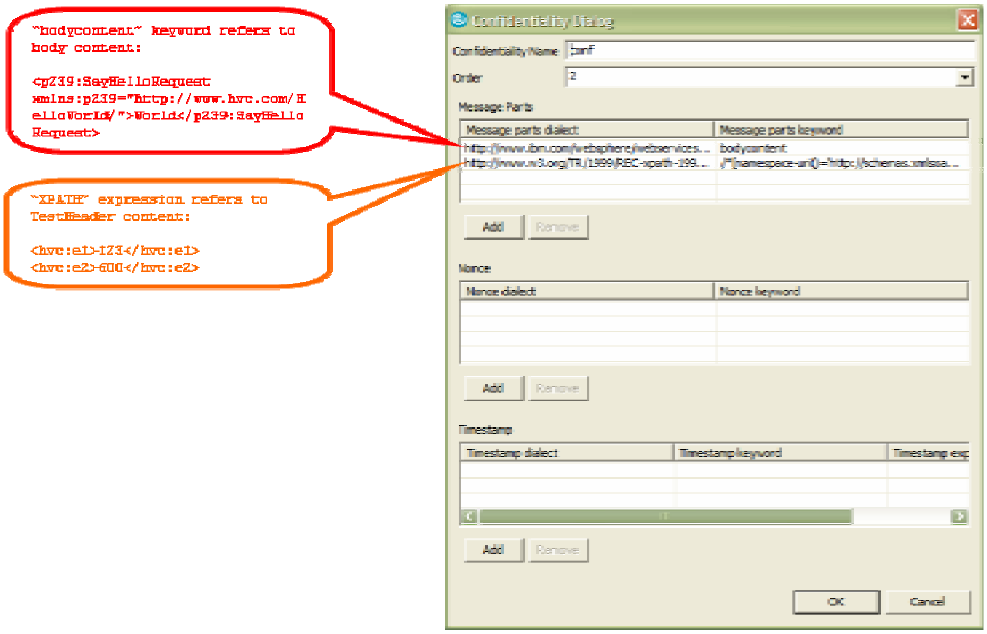
Configure Confidentiality (Encryption)

To configure confidentiality, or encryption, you need to first define what to encrypt (confidentiality security constraints), and then define the binding information, such as the key locator to locate the public key to encrypt, key identifier key information, and encryption information (that is, data and key encryption algorithms).

To configure confidentiality, complete the following steps:

1. Define the confidentiality constraints (what to encrypt) in the **WS Extension** tab. In the WS Extension editor, select **Request Generator configuration -> Confidentiality**, then click **Add**.
    - For **Confidentiality Name**, specify `conf`.
    - For **Order**, specify `2` (sign then encrypt).
    - In the **Message Parts** field, specify two parts to be encrypted in this confidentiality constraint: the SOAP body content using the predefined keyword `bodycontent`, and the `TestHeader` content using the following XPATH expression:

    ```
    /*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/'
    and local-name()='Envelope']/*[namespace-
    uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
    name()='Header']/*[namespace-uri()='http://com.ibm.hvc.example1'
    and local-name()='TestHeader']/node()
    ```



"bodycontent" keyword refers to body content:

```
<p239:SayHelloRequest xmlns:p239="http://www.hvc.com/HelloWorld/">World</p239:SayHelloRequest>
```

"XPATH" expression refers to TestHeader content:

```
<hvc:e1>123</hvc:e1>
<hvc:e2>600</hvc:e2>
```

Confidentiality Name: conf

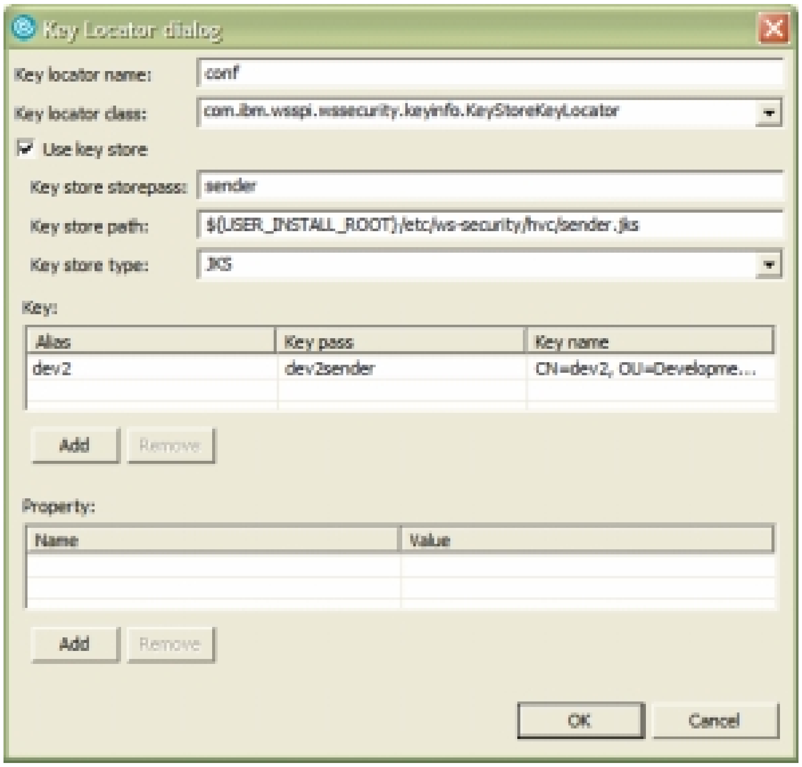
Order: 2

Message Parts

Message parts dialect	Message parts keyword
http://www.ibm.com/websphere/webservices...	bodycontent
http://www.w3.org/TR/1999/REC-xpath-199...	/*[namespace-uri()='http://schemas.xmlsoa...

Figure 14. Configure integrity

2. Select **Key Locators** and click **Add** to create the key locator (`conf`) to locate the public key of the receiver `CN=Dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`. The public key is used to encrypt the shared key automatically generated by the WS-Security runtime.



Key locator name: conf

Key locator class: com.ibm.wsspi.wssecurity.keyinfo.KeyStoreKeyLocator

☑ Use key store

Key store storepass: sender

Key store path: ${USER_INSTALL_ROOT}/etc/ws-security/hvc/sender.jks

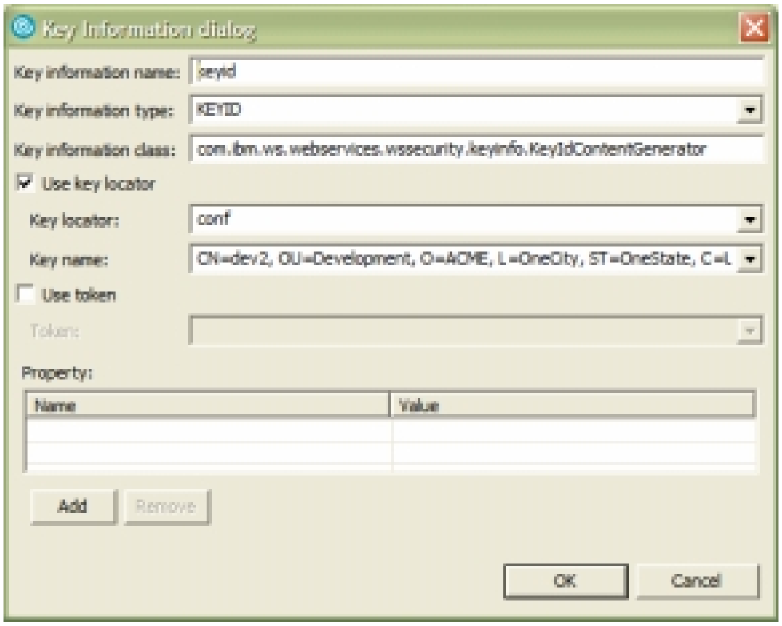
Key store type: JKS

Key:

Alias	Key pass	Key name
dev2	dev2sender	CN=dev2, OU=Developme...

Figure 15. Create key locator `conf`

3. Select **Key Information** and then click **Add** to create KEYID (Key Identifier) key information (`keyid`). Note that no **Token** field is required, the **Key locator** field is the name of the key locator created in step 2 (`conf`), and the **Key name** field is the receiver `CN=Dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`.



Key Information dialog

Key information name: keyid

Key information type: KEYID

Key information class: com.ibm.ws.webservices.wssecurity.keyinfo.KeyIdContentGenerator

☑ Use key locator

Key locator: conf

Key name: CN=dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=L

☐ Use token

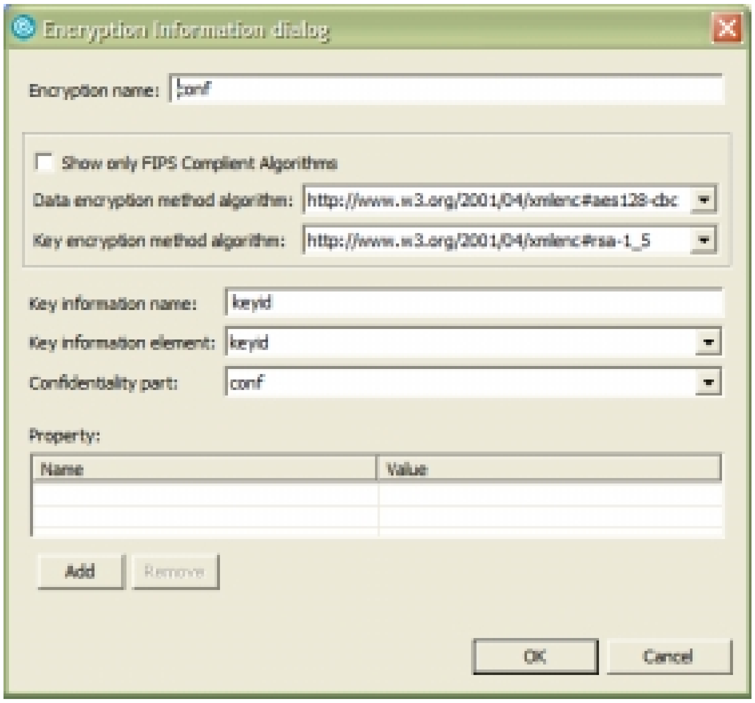
Token:

Property:

Name	Value

Figure 16. Create key information `keyid`

4. Finally, you need to create the encryption information. Select **Encryption Information,** then click **Add** to create encryption information (`conf`). The **Data encryption method algorithm** is AES (128 bits), **the Key encryption method algorithm** is RSA, the **Key information name** is `keyid`, which you defined in Step 3, and the **Confidentiality part** is `conf`, defined in step 1.



Encryption name: conf

□ Show only FIPS Compliant Algorithms

Data encryption method algorithm: http://www.w3.org/2001/04/xmlenc#aes128-cbc

Key encryption method algorithm: http://www.w3.org/2001/04/xmlenc#rsa-1_5

Key information name: keyid

Key information element: keyid

Confidentiality part: conf

Property:

Name	Value

Add Remove

Figure 17. Create encryption information

Configure WS-Security constraints for the request consumer

This section describes how to configure the WS-Security constraints and bindings requirements for the request consumer (Web service inbound request). The WS-Security of the inbound SOAP message must meet the security constraints defined, otherwise the SOAP message is rejected with a SOAP fault. For example, if the security constraints define that the SOAP body must be signed and the inbound SOAP message body is not signed, the request is rejected and a SOAP fault is returned. This section assumes you have already developed your application and are using Rational Application Developer[5].

The WS-Security editors for constraints and bindings are tabs in the Web services editor.

1. Open the Web Service editor in the Project Explorer of the J2EE perspective by double-clicking the **webservices.xml** file of the Web application. The example Web service is implemented as Servlet Java Bean:

[5] You can also use Application Server Toolkit for configuring the WS-Security constraints and bindings.

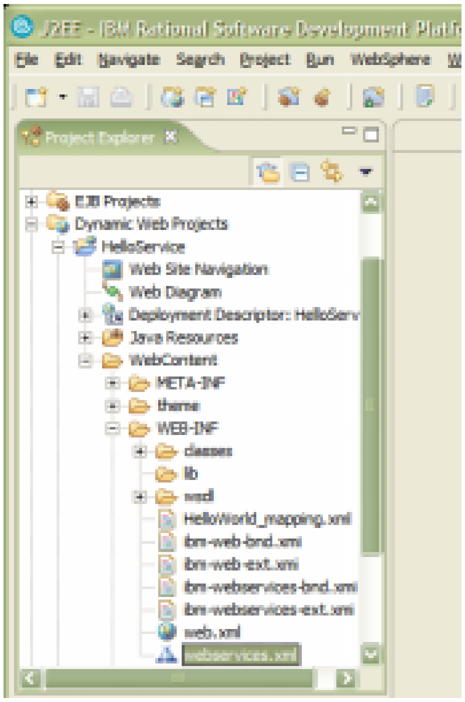
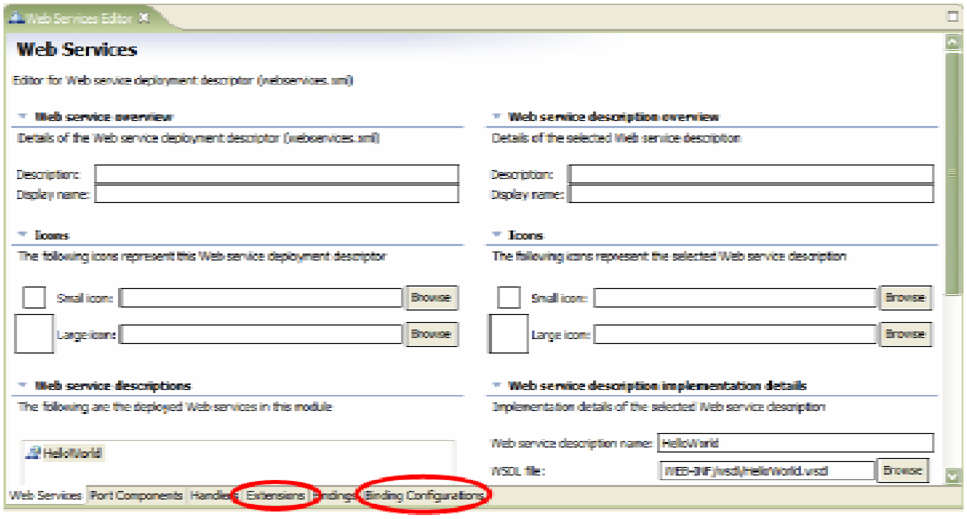


Figure 18. Open the Web service editor for the Web service

2. Open the WS-Security constraints editor from the **Extensions** tab and the bindings editor from **Bindings Configuration** tab, as shown in the following:


Web Services Editor
Web Services
Editor for Web service deployment descriptor (webservices.xml)
Web service overview
Details of the Web service deployment descriptor (webservices.xml)
Description:
Display name:
Icons
The following icons represent this Web service deployment descriptor
Small icon:
Browse
Large icon:
Browse
Web service descriptions
The following are the deployed Web services in this module
HelloWorld
Web service description overview
Details of the selected Web service description
Description:
Display name:
Icons
The following icons represent the selected Web service description
Small icon:
Browse
Large icon:
Browse
Web service description implementation details
Implementation details of the selected Web service description
Browse
Web Services
Port Components
Handlers
Extensions
Bindings
Binding Configurations

Web service description name: HelloWorld

WSDL file: WEB-INF/wsdl/HelloWorld.wsdl

Figure 19. Open the Extensions and Bindings editors

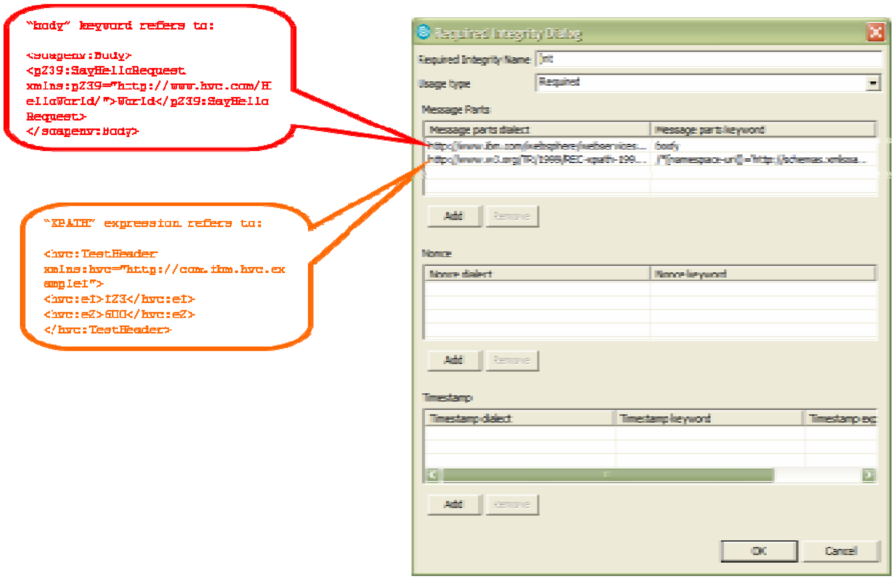
Configure required integrity

The number of steps for configuring required integrity is similar to the steps to configure integrity in the request generator configuration. First, you define what is required to be signed and then define the binding information, such as trust anchors, token consumer to validate the signer’s public key as X509 binary security token, key locator to locate the public key for signature validation, key information for security token reference, and signature information (signature algorithm, digest method and transform requirement).

To configure required integrity, complete the following steps:

1. Define the required integrity constraints (what needs to be signed) in the **Extensions** tab. In the Extensions editor, select **Request Consumer Service Configuration Details → Required Integrity**, then click **Add**.
   - Specify `int` for the **Required Integrity Name**.
   - In the **Message Parts** field, specify two parts required to be signed: the SOAP body using the predefined keyword `body`, and the `TestHeader` using the following XPATH expression:

     ```
     /*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/'
     and local-name()='Envelope']/*[namespace-
     uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
     name()='Header']/*[namespace-uri()='http://com.ibm.hvc.example1'
     and local-name()='TestHeader']
     ```



“body” keyword refers to:

```
<soapenv:Body>
<p239:SayHelloRequest
xmlns:p239="http://www.hvc.com/H
elloWorld/">World</p239:SayHello
Request>
</soapenv:Body>
```

“XPATH” expression refers to:

```
<hvc:TestHeader
xmlns:hvc="http://com.ibm.hvc.ex
ample1">
<hvc:e1>123</hvc:e1>
<hvc:e2>600</hvc:e2>
</hvc:TestHeader>
```

Required Integrity Dialog

Required Integrity Name: int

Usage type: Required

Message Parts

Message parts dialect	Message parts keyword
http://www.ibm.com/websphere/webservices...	body
http://www.w3.org/TR/1999/REC-xpath-199...	/*[namespace-uri()='http://schemas.xmlsoa...

Nonce

Nonce dialect	Nonce keyword

Timestamp

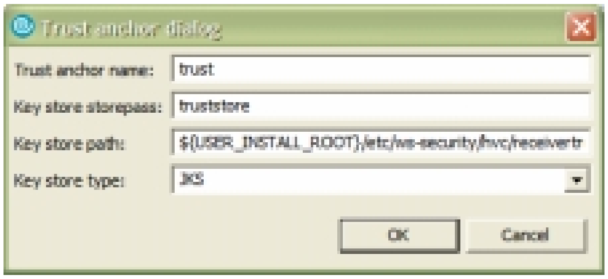
Timestamp dialect	Timestamp keyword	Timestamp exp

Figure 20. Configure required integrity

2. To define the binding information for required integrity, open the Bindings editor in the **Bindings Configuration** tab by selecting **Request Consumer Binding**

Configuration Details.

3. Select **Trust Anchor** and click **Add** to create the trust anchor configuration the name `trust` and the trust store `${USER_INSTALL_ROOT}/etc/ws-security/hvc/receivertruststore.jks`.



Trust anchor name: trust

Key store storepass: truststore

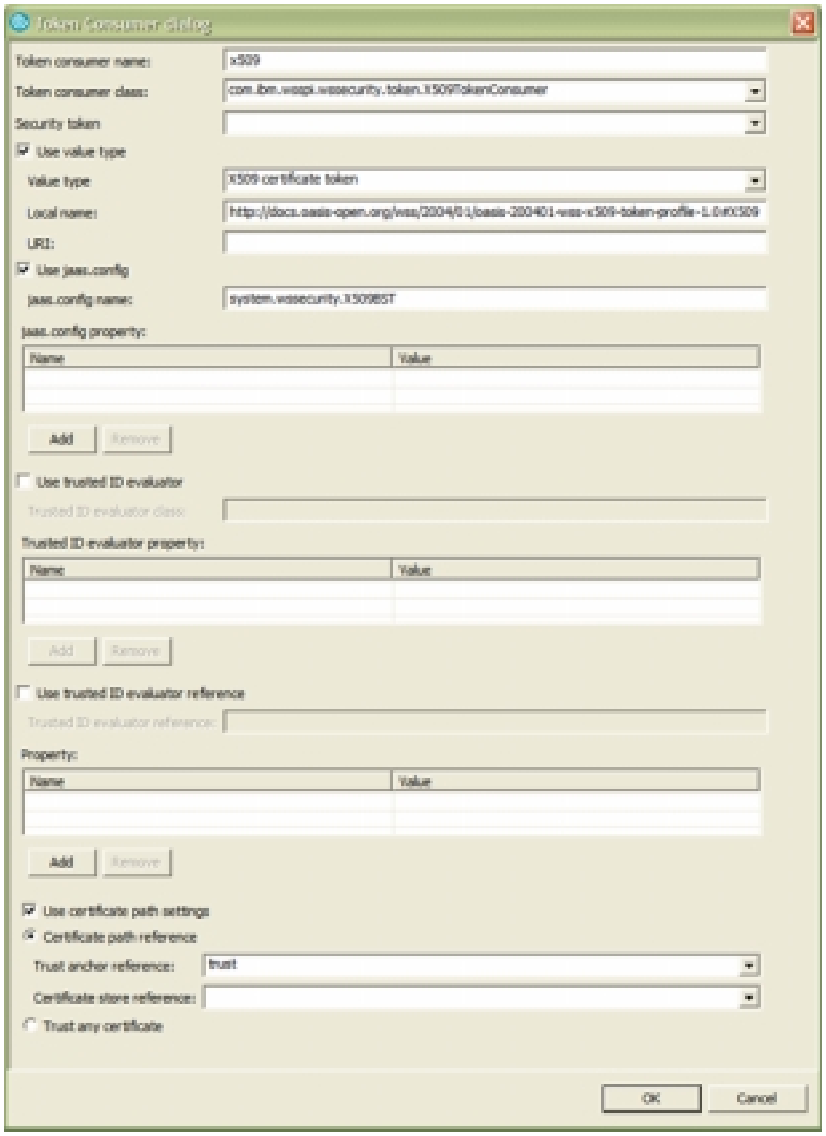
Key store path: ${USER_INSTALL_ROOT}/etc/ws-security/hvc/receivertr

Key store type: JKS

Figure 21. Configure trust anchor

4. Select **Token Consumer** and click **Add** to create an X509 Token Consumer (`x509`) to validate the public certificate of the signer `CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`.

- Leave the **Security token** field blank, because this is not a standalone token for authentication, but is used for digital signature.
- Specify `trust` in the **Trust anchor reference** field.
- In the **jaas.config name** field, specify `system.wssecurity.X509BST`, which is one of the predefined JAAS login configuration names.



Token Consumer dialog

Token consumer name: x509

Token consumer class: com.ibm.wsspi.wssecurity.token.X509TokenConsumer

Security token:

☑ Use value type

Value type: X509 certificate token

Local name: http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-x509-token-profile-1.0#X509

URI:

☑ Use jaas.config

jaas.config name: system.wssecurity.X509BST

jaas.config property:

Name	Value

☐ Use trusted ID evaluator

Trusted ID evaluator class:

Trusted ID evaluator property:

Name	Value

☐ Use trusted ID evaluator reference

Trusted ID evaluator reference:

Property:

Name	Value

☑ Use certificate path settings

● Certificate path reference

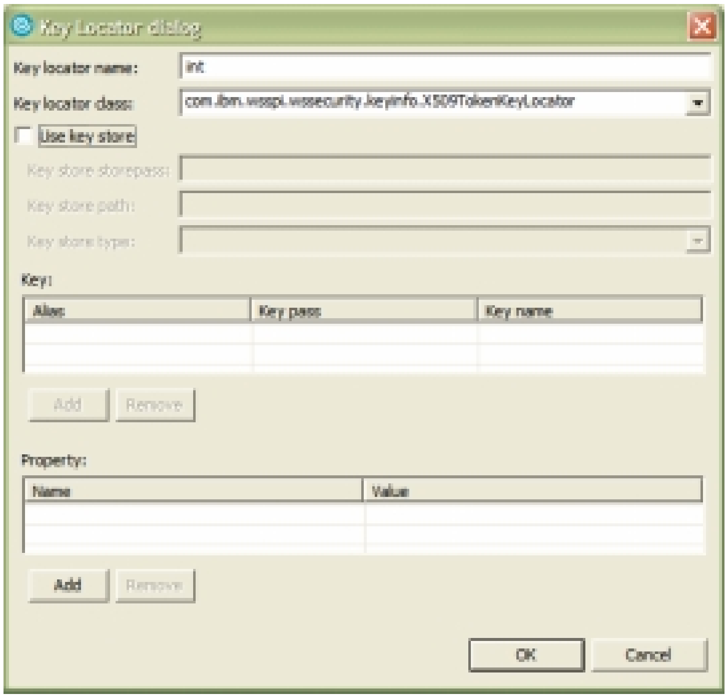
Trust anchor reference: trust

Certificate store reference:

○ Trust any certificate

Figure 22. Create token consumer

5. Select **Key Locators**, then click **Add** to create a key locator (`int`) for locating the signer public certificate `CN=John Smith, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US` in the SOAP message. Note that the **Key locator class** field is `com.ibm.wsspi.wssecurity.keyinfo.X509TokenKeyLocator`, which locates the key with the X509 certificate embedded in the received incoming SOAP message.



Key locator name: int

Key locator class: com.ibm.wsspi.wssecurity.keyinfo.X509TokenKeyLocator

□ Use key store

Key store storepass:

Key store path:

Key store type:

Key:

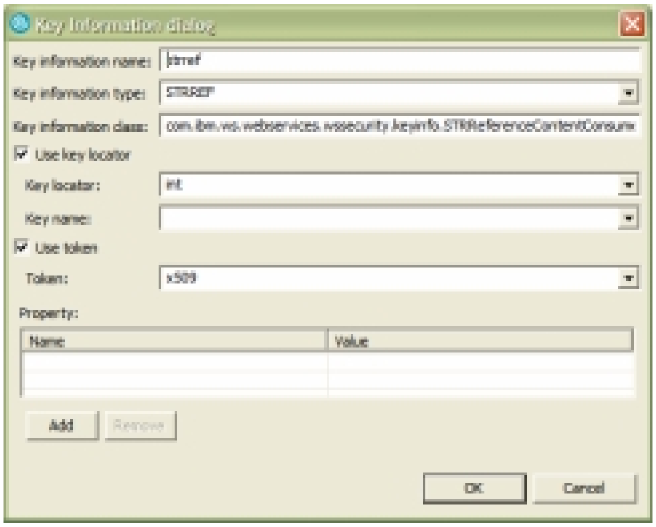
Alias	Key pass	Key name

Property:

Name	Value

Figure 23. Create key locators

6. Select **Key Information,** then click **Add** to create security token reference (STR) key information (`strref`). Note that the **Token** field is the token generator name `x509` created in step 4, the **Key locator** field is the name of the key locator created in step 5 (`int`), and the **Key name** field is not required.



Key information name: strref

Key information type: STRREF

Key information class: com.ibm.ws.webservices.wssecurity.keyinfo.STRReferenceContentConsume

☑ Use key locator

Key locator: int

Key name:

☑ Use token

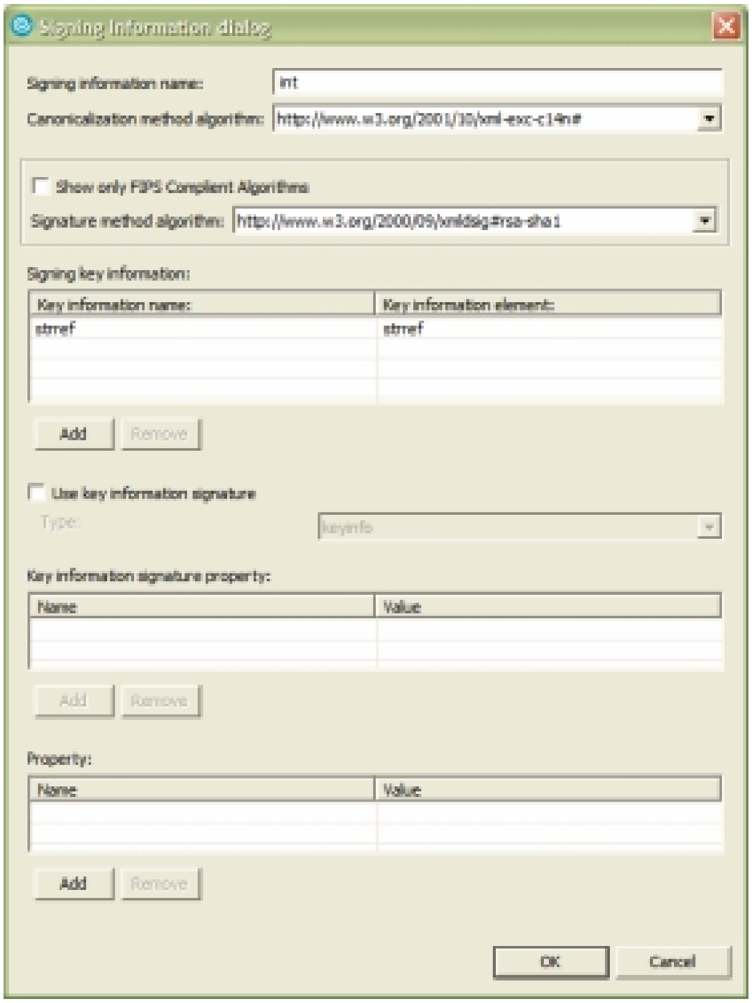
Token: x509

Property:

Name	Value

Figure 24. Create key information

7. Select **Signing Information**, then click **Add** to define the signing information (`int`). Note that the **Key information element** field is `strref`, the key information created in step 6.



Signing information name: int

Canonicalization method algorithm: http://www.w3.org/2001/10/xml-exc-c14n#

☐ Show only FIPS Compliant Algorithms

Signature method algorithm: http://www.w3.org/2000/09/xmldsig#rsa-sha1

Signing key information:

Key information name:	Key information element:
strref	strref

☐ Use key information signature

Type: keyinfo

Key information signature property:

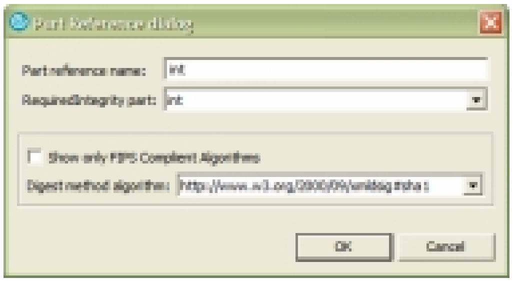
Name	Value

Property:

Name	Value

Figure 25. Define signing information

8. Link the `int` signing information created in step 7 with the `int` security constraints defined in step 1. Make sure the `int` signing information created in step 7 is selected, then select **Part References**, and click **Add** to add a part reference (`int`). Note that that the **RequiredIntegrity part** field `int`, which is the Required Integrity name created in step 1. In this example, use the default digest method algorithm.



Part reference name: int

RequiredIntegrity part: int

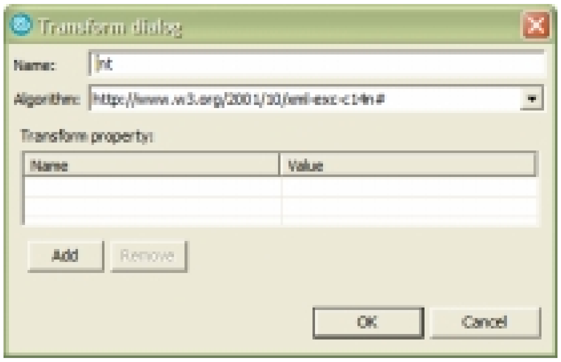
☐ Show only FIPS Compliant Algorithms

Digest method algorithm: http://www.w3.org/2000/09/xmldsig#sha1

Figure 26. Add part reference

9. Finally, define the transform algorithm for the `int` part reference created in step 8. Make sure the `int` part reference is selected, then select **Transforms** and click **Add**

to create a transform algorithm. Use the default transform algorithm.



Name: int

Algorithm: http://www.w3.org/2001/10/xml-exc-c14n#

Name	Value

Figure 27. Define transform algorithm

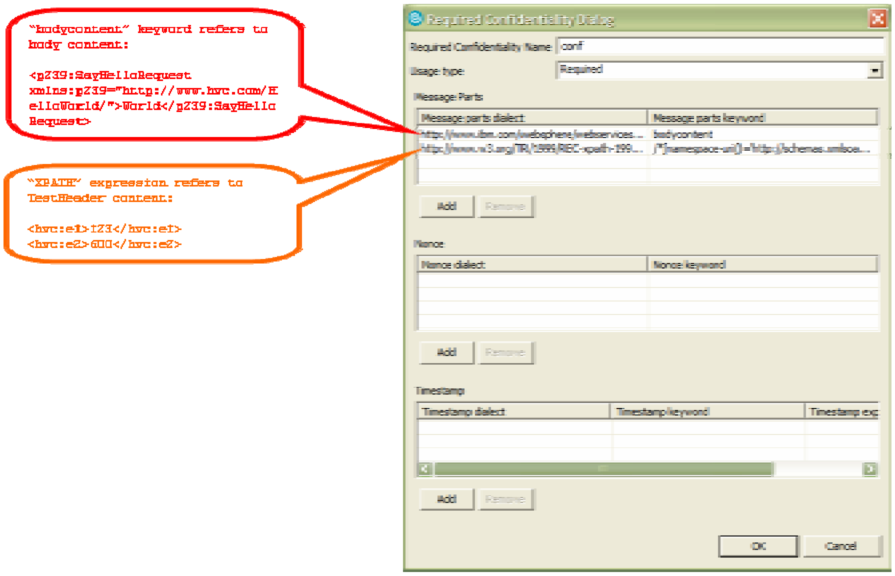
Configure required confidentiality

To configure required confidentiality, you must first define which part is required to be encrypted, then define the binding information, such as the key locator to locate private key to decrypt, key identifier key information, and encryption information (like data and key encryption algorithms).

To configure required confidentiality, complete the following steps:

1. Define the Required Confidentiality constraints (which part is required to be encrypted) in the **Extensions** tab. In the Extensions editor, select **Request Consumer Service Configuration Details** -> **Required Confidentiality**, then click **Add**.
   - Specify `conf` for the **Required Confidential Name.**
   - In the **Message Parts** field, specify two parts that are required to be encrypted: the SOAP body content using the predefined keyword `bodycontent` and the `TestHeader` content using the following XPATH expression:

     ```
     /*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/'
     and local-name()='Envelope']/*[namespace-
     uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
     name()='Header']/*[namespace-uri()='http://com.ibm.hvc.example1'
     and local-name()='TestHeader']/node()
     ```



"bodycontent" keyword refers to body content:

```
<p239:SayHelloRequest
xmlns:p239="http://www.hvc.com/HelloWorld/">World</p239:SayHelloRequest>
```

"XPATH" expression refers to TestHeader content:

```
<hvc:e1>123</hvc:e1>
<hvc:e2>600</hvc:e2>
```

Required Confidentiality Dialog

Required Confidentiality Name: conf

Usage type: Required

Message Parts

Message parts dialect	Message parts keyword
http://www.ibm.com/websphere/webservices...	bodycontent
http://www.w3.org/TR/1999/REC-xpath-199...	/*[namespace-uri()='http://schemas.xmlsoa...

Nonce

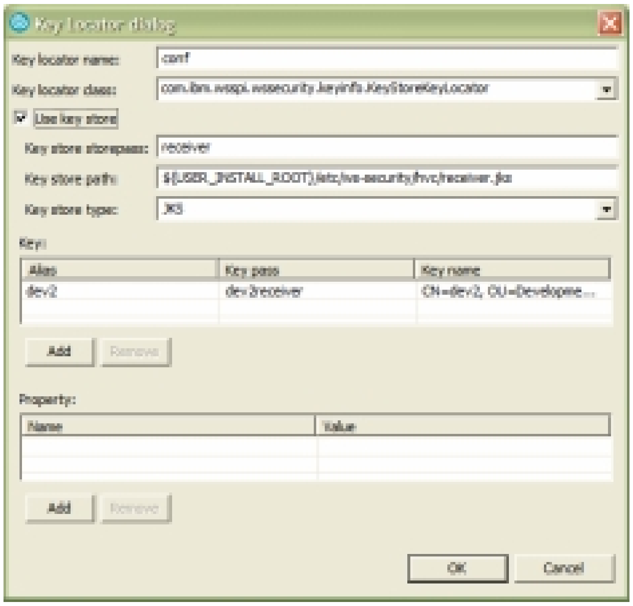
Nonce dialect	Nonce keyword

Timestamp

Timestamp dialect	Timestamp keyword	Timestamp exp

Figure 28. Configure required confidentiality

2. Select **Key Locators**, then click **Add** to create a key locator (`conf`) to locate the private key of the receiver `CN=Dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US` to decrypt the shared key that is used to decrypt the encrypted data.



Key locator dialog

Key locator name: conf

Key locator class: com.ibm.wsspi.wssecurity.keyinfo.KeyStoreKeyLocator

☑ Use key store

Key store storepass: receiver

Key store path: ${USER_INSTALL_ROOT}/etc/ws-security/hvc/receiver.jks

Key store type: JKS

Key:

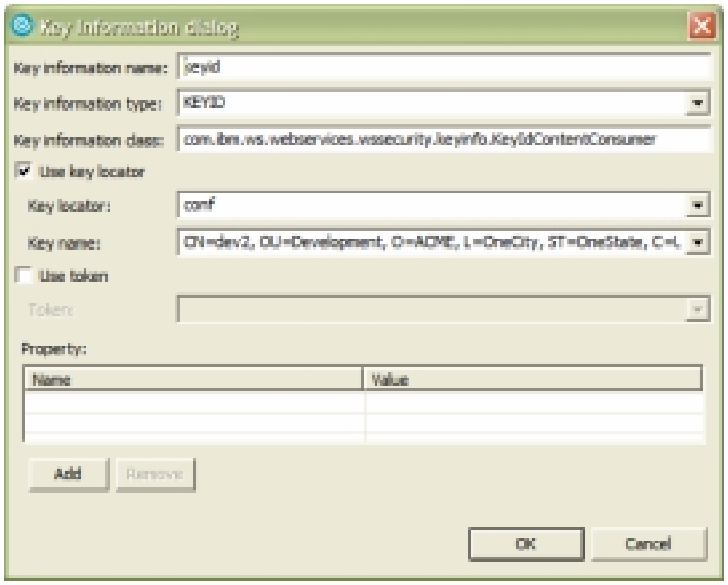
Alias	Key pass	Key name
dev2	dev2receiver	CN=dev2, OU=Developme...

Property:

Name	Value

Figure 29. Create key locator

3. Select **Key Information**, then click **Add** to create KEYID (Key Identifier) key information (`keyid`). Note that no **Token** field is required, the **Key locator** field is the name of the key locator created in step 2 (`conf`), and the **Key name** field is the receiver `CN=Dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=US`.



Key information name: keyid

Key information type: KEYID

Key information class: com.ibm.ws.webservices.wssecurity.keyinfo.KeyIdContentConsumer

☑ Use key locator

Key locator: conf

Key name: CN=dev2, OU=Development, O=ACME, L=OneCity, ST=OneState, C=I,

☐ Use token

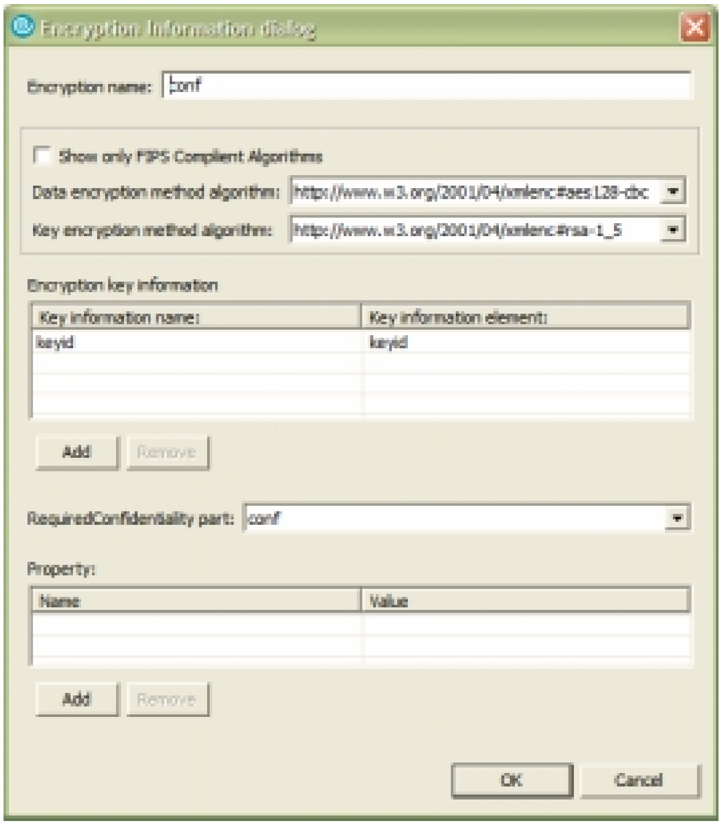
Token:

Property:

Name	Value

Figure 30. Define key information

4. Finally, create the encryption information. Select **Encryption Information**, then click **Add** to create the encryption information (`conf`). The **Data encryption method algorithm** is AES (128 bits), the **Key encryption method algorithm** is RSA, the **Key information Name** is `keyid`, defined in step 3, and the **Required Confidentiality Part** is `conf`, defined in step 1.



Encryption name: conf

☐ Show only FIPS Compliant Algorithms

Data encryption method algorithm: http://www.w3.org/2001/04/xmlenc#aes128-cbc

Key encryption method algorithm: http://www.w3.org/2001/04/xmlenc#rsa-1_5

Encryption key information

Key information name:	Key information element:
keyid	keyid

RequiredConfidentiality part: conf

Property:

Name	Value

Figure 31. Create encryption information

5.

SOAP message with WS-Security

You can specify a port other than 9080 to redirect the request to a network traffic monitor to capture a SOAP message secured with the WS-Security constraints.

In the captured SOAP message below, you can see that the SOAP body and `TestHeader` are signed and the SOAP body content and the `TestHeader` content are encrypted.

```
<soapenv:Envelope ……">
<soapenv:Header>
  <wsse:Security xmlns:wsse="http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd"
soapenv:mustUnderstand="1">
   <wsse:BinarySecurityToken xmlns:wsu="http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd"
EncodingType="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-
soap-message-security-1.0#Base64Binary" ValueType="http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-x509-token-profile-1.0#X509"
wsu:Id="x509bst_2">MIIC……joZQ==</wsse:BinarySecurityToken>
   <EncryptedKey xmlns="http://www.w3.org/2001/04/xmlenc#">
    <EncryptionMethod Algorithm="http://www.w3.org/2001/04/xmlenc#rsa-
1_5"/>
    <ds:KeyInfo xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
     <wsse:SecurityTokenReference>
      <wsse:KeyIdentifier ValueType="http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-x509-token-profile-
1.0#X509SubjectKeyIdentifier">59FYdEaWcm2ey3HNZyY8Rq0oE5w=</wsse:KeyIde
ntifier>
     </wsse:SecurityTokenReference>
    </ds:KeyInfo>
    <CipherData>
     <CipherValue>LfLr……yK4Q=</CipherValue>
    </CipherData>
    <ReferenceList>
     <DataReference URI="#wssecurity_encryption_id_3"/>
     <DataReference URI="#wssecurity_encryption_id_4"/>
    </ReferenceList>
   </EncryptedKey>
   <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
    <ds:SignedInfo>
     <ds:CanonicalizationMethod
Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#">
      <ec:InclusiveNamespaces xmlns:ec="http://www.w3.org/2001/10/xml-
exc-c14n#" PrefixList="wsse ds xsi soapenc xsd soapenv "/>
     </ds:CanonicalizationMethod>
     <ds:SignatureMethod
Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
     <ds:Reference URI="#wssecurity_signature_id_0">
      <ds:Transforms>
       <ds:Transform Algorithm="http://www.w3.org/2001/10/xml-exc-
c14n#">
```

```
        <ec:InclusiveNamespaces
xmlns:ec="http://www.w3.org/2001/10/xml-exc-c14n#" PrefixList="xsi
soapenc xsd p239 wsu soapenv "/>
       </ds:Transform>
      </ds:Transforms>
      <ds:DigestMethod
Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
      <ds:DigestValue>Jmo/XVjmpblCmHGsAlAlhRb2tb4=</ds:DigestValue>
     </ds:Reference>
     <ds:Reference URI="#wssecurity_signature_id_1">
      <ds:Transforms>
       <ds:Transform Algorithm="http://www.w3.org/2001/10/xml-exc-
c14n#">
        <ec:InclusiveNamespaces
xmlns:ec="http://www.w3.org/2001/10/xml-exc-c14n#" PrefixList="hvc xsi
soapenc xsd wsu soapenv "/>
       </ds:Transform>
      </ds:Transforms>
      <ds:DigestMethod
Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
      <ds:DigestValue>bPotI7bz9g3eTPwwN8pGFcK8yBI=</ds:DigestValue>
     </ds:Reference>
    </ds:SignedInfo>
    <ds:SignatureValue>pyiq……Y980=</ds:SignatureValue>
    <ds:KeyInfo>
     <wsse:SecurityTokenReference>
      <wsse:Reference URI="#x509bst_2" ValueType="http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-x509-token-profile-1.0#X509"/>
     </wsse:SecurityTokenReference>
    </ds:KeyInfo>
   </ds:Signature>
  </wsse:Security>
  <hvc:TestHeader xmlns:hvc="http://com.ibm.hvc.example1"
xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-
wssecurity-utility-1.0.xsd" wsu:Id="wssecurity_signature_id_1">
   <EncryptedData xmlns="http://www.w3.org/2001/04/xmlenc#"
Id="wssecurity_encryption_id_4"
Type="http://www.w3.org/2001/04/xmlenc#Content">
    <EncryptionMethod
Algorithm="http://www.w3.org/2001/04/xmlenc#aes128-cbc"/>
    <CipherData>
     <CipherValue>W9Q+……9Kpw==</CipherValue>
    </CipherData>
   </EncryptedData>
  </hvc:TestHeader>
 </soapenv:Header>
 <soapenv:Body xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-
200401-wss-wssecurity-utility-1.0.xsd"
wsu:Id="wssecurity_signature_id_0">
  <EncryptedData xmlns="http://www.w3.org/2001/04/xmlenc#"
Id="wssecurity_encryption_id_3"
Type="http://www.w3.org/2001/04/xmlenc#Content">
   <EncryptionMethod
Algorithm="http://www.w3.org/2001/04/xmlenc#aes128-cbc"/>
   <CipherData>
    <CipherValue>7qH0……i9hA==</CipherValue>
   </CipherData>
  </EncryptedData>
 </soapenv:Body>
</soapenv:Envelope>
```

Conclusion

WebSphere Application Server supports the WS-Security 1.0 standard and the signing and encryption of any SOAP element within the message. There are two methods available for selection of elements to be signed and encrypted. The keyword-based method is easy to use and supports most common usage scenarios. The XPATH method, while more complex, allows you to select elements not supported by keywords to be signed and encrypted. Using these two methods, you can secure virtually any SOAP element in the SOAP message.

Note that the `Signature` element is not encrypted in this sample. The Basic Security Profile recommends encryption of the `Signature` element for a simple SOAP message, such as the one in this sample. You can use the following XPATH expression in the Confidentiality on the client side and RequiredConfidentiality on the service side to encrypt the Signature element:

```
/*[namespace-uri()='http://schemas.xmlsoap.org/soap/envelope/' and
local-name()='Envelope']/*[namespace-
uri()='http://schemas.xmlsoap.org/soap/envelope/' and local-
name()='Header']/*[namespace-uri()='http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd' and
local-name()='Security']/*[namespace-uri()='
http://www.w3.org/2000/09/xmldsig#' and local-name()='Signature']
```