VMware Storage Policy Programming Guide

VMware Storage Policy SDK

vSphere 5.5

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Contents

About This Book

VMware Storage Policy Programming Guide describes how to use the VMware® Storage Policy API.

VMware provides different APIs and SDKs for different applications and goals. The VMware Storage Policy SDK supports the development of vCenter clients that use vCenter storage profiles for virtual machine configuration.

To view the current version of this book as well as all VMware API and SDK documentation, go to http://www.vmware.com/support/pubs/sdk_pubs.html.

Revision History

This book is revised with each release of the product or when necessary. A revised version can contain minor or major changes. Table 1 summarizes the significant changes in each version of this book.

Table 1. Revision History

Revision Date	Description
2013Sep12	vSphere 2013 release. First version.

Intended Audience

This book is intended for anyone who needs to develop applications using the VMware Storage Policy SDK. An understanding of Web Services technology and some programming background in Java is required.

VMware Technical Publications Glossary

VMware Technical Publications provides a glossary of terms that might be unfamiliar to you. For definitions of terms as they are used in VMware technical documentation go to http://www.vmware.com/support/pubs.

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VMware Storage Policies 1

A vSphere storage profile defines storage policy information that describes storage requirements for virtual machines and storage capabilities of storage providers. You use VMware Storage Policies to manage the assocation between virtual machines and datastores.

Storage Capabilities

Storage requirements are based on the storage capabilities available from a storage provider. A Storage Policy Server obtains storage capability data from VASA 2.0 providers or from tag-based storage policies.

- VASA 2.0 providers - vSphere supports VMware VSAN storage capabilities only.
- Tag-based storage - You use the vSphere Web Client to define storage policy tags.

Virtual Machine Storage

Virtual machine configuration and data are stored in datastores.

- Virtual machine configuration is stored in files with the .vmx file extension. The set of virtual machine configuration files also includes other system files that support virtual machine operation. Examples of these system files include log files (.log), BIOS state files (.nvram), paging files (.vmem), and snapshot data files (.vmsd).
- Virtual machine data is stored on virtual disks, in files with the .vmdk file extension.

VMware Storage Policies allow you to distinguish between virtual machine configuration and data files and to specify storage locations based on the distinction.

Storage Policy Operations

Use Storage Policy API methods to support virtual machine provisioning.

Table 1-1. Storage Policy Operations and Virtual Machine Provisioning

Storage Policy Operation (Storage Policy API)	Virtual Machine Provisioning (vSphere API)
Use the `PbmProfileProfileManager` methods to create and update storage profiles.	Associate storage profiles with virtual machines and virtual disks. See the description of the vSphere API data object properties `VirtualMachineConfigSpec.vmProfile` and `FileBackedVirtualDiskSpec.profile` in the vSphere API Reference. You can also use the vSphere Web Client to associate a storage profile with a virtual machine or virtual disk.

Table 1-1. Storage Policy Operations and Virtual Machine Provisioning (Continued)

Storage Policy Operation (Storage Policy API)	Virtual Machine Provisioning (vSphere API)
Use the `PbmPlacementSolver` methods to identify candidate datastores for storage locations.	Specify the datastores when you create virtual machines and virtual disks. See the description of the vSphere API data object properties `VirtualMachineFileInfo.vmPathName` and `VirtualDeviceFileBackingInfo.datastore` in the vSphere API Reference.
Use the `PbmComplianceManager` methods to check compliance between storage requirements and capabilities.	After you associate a storage profile with a virtual machine or virtual disk, the Server will identify non-compliance if the datastore does not satisfy the requirements of the profile.

Access to the VMware Storage Policy Server

The VMware Storage Policy client API is described in the WSDL (Web Service Definition Language) file that is included in the VMware Storage Policy SDK. This API defines a set of request operations that you use to manipulate storage profiles. The VMware Storage Policy SDK includes Java bindings for the VMware Storage Policy WSDL.

To gain access to the Storage Policy Server, your client connects to a vCenter Server and obtains the vCenter session cookie. Then you can use the vCenter session cookie to establish the connection with the Storage Policy Server. See "Establish a Connection with the VMware Storage Policy Server" on page 13.

After you establish a Storage Policy Server connection, your client uses language-specific Web Services access objects and the `PbmServiceInstance` and `PbmServiceInstanceContent` objects to access the Storage Policy managed objects and their methods.

The Storage Policy Web Services access objects are language-specific API binding objects that are generated from the Storage Policy WSDL. The VMware Storage Policy SDK contains JAXWS bindings to the Storage Policy API. The JAXWS bindings include the PbmService and PbmPortType Web Services access objects.

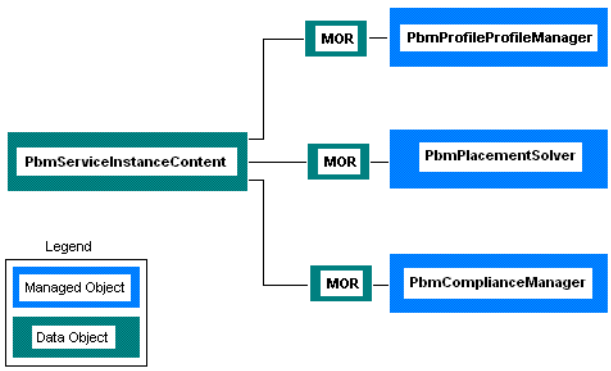
- `PbmService` – Provides access to the `PbmPortType` object and it provides support for the Storage Policy Service connection.
- `PbmPortType` – Provides access to Storage Policy methods.

The following code fragment shows the sequence of calls that you use to obtain access to the Storage Policay API methods.

```
PbmService = new PbmService()
PbmPortType pbmPort = PbmService.getPbmPort()
PbmServiceInstanceContent pbmServiceContent = pbmPort.pbmRetrieveServiceContent
```

The `PbmServiceInstanceContent` object contains managed object references to the Storage Policy services.

Figure 1-1. Storage Policy Service Instance Content



The set of Storage Policy services include the profile manager, placement solver, and compliance manager.

Table 1-2. Storage Policy Services

Service	ManagedObject	Usage
Profile Manager	PbmProfileProfileManager	Create and update VMware storage profiles. Storage profiles define storage requirements.
Placement Solver	PbmPlacementSolver	Identify candidate datastores for storage locations.
Compliance Manager	PbmComplianceManager	Check compliance between storage requirements and capabilities.

VMware Storage Policy SDK

The VMware Storage Policy SDK is distributed as part of the VMware vSphere Management SDK. When you extract the contents of the distribution kit, the VMware Storage Policy SDK is located in the `spbm` sub-directory:

```
VMware-vSphere-SDK-build-num
    eam
    sms-sdk
    spbm
        docs
        java
            JAXWS
                javadoc
                lib
                samples
        wsdl
    ssoclient
    vsphere-ws
```

The following table shows the locations of the contents of the VMware Storage Policy SDK.

Table 1-3. VMware Storage Policy SDK Contents

VMware Storage Policy SDK Component	Location
JAX-WS VMware Storage Policy client binding	spbm/java/JAXWS/lib
Java Storage Policy samples	spbm/java/JAXWS/samples/com/vmware/spbm/samples/
Java Storage Policy Server connection sample	spbm/java/JAXWS/samples/com/vmware/spbm/connection/
VMware Storage Policy API Reference	spbm/docs/apiref/index.html
Documentation for example code	spbm/java/java/JAXWS/samples/javadoc/index.html
WSDL files	spbm/wsdl

VMware Storage Policy SDK Examples

The VMware Storage Policy SDK contains Java examples that show how to create and use VMware storage policies.

This manual describes examples from the VMware Storage Policy SDK. It also describes examples from the vCenter Single Sign On SDK that support the client connection to the Storage Policy Server:

- "vCenter Single Sign On Client Example" on page 21. This example shows how to obtain a holder-of-key token from the vCenter Single Sign On Server.
- "vCenter LoginByToken Example" on page 27. This example shows how to use the token to login to vCenter Server.

The following table lists the sample files in the VMware Storage Policy SDK:

Table 1-4. VMware Storage Profile SDK Sample File

Location	Examples	Description
`SDK/spbm/java/JAXWS/samples/com/vmware/spbm/samples/`		
	AboutInfo.java	Obtains identifying data about the Storage Policy Server.
	CheckCompliance.java	Checks the compliance of profiles associated with virtual machines and virtual disks.
	CreateProfile.java	Creates a requirement profile.
	DeleteProfile.java	Deletes a requirement profile.
	EditProfile.java	Adds or deletes subprofiles from a tag-based storage profile.
	ListProfiles.java	Retrieves all of the storage profiles known to the system.
	VMClone.java	Deploys mutliple instances of a virtual machine template to a datacenter. The clone specification has an associated storage profile.
	VMCreate.java	Creates a virtual machine. The virtual machine configuration specification has an associated storage profile.
	ViewProfile.java	Prints the contents of a tag-based storage profile.
`SDK/spbm/java/JAXWS/samples/com/vmware/spbm/connection/`		
	BasicConnection.java	Establishes an authenticated session with a VMware SSO Server, vCenter Server, and Storage Policy Server.
	ConnectedServiceBase.java	Connection base class for client application implementations.
	Connection.java	Storage Policy sample support; utility class that sets up a Storage Policy Server connection.
	ConnectionException.java	Base exception class for exceptions thrown by connection classes.
	ConnectionMalformedUrlException.java	URL exception.
	KeepAlive.java	Keep-alive utility class; maintains the vCenter Server connection.
	VcSessionHandler.java	Utility class; inserts vCenter session cookie into SOAP header.

Legacy Storage Profiles

A Storage Policy Server can obtain storage capability data from VASA providers. In vSphere 2013, this generally implies VMware VSAN storage capabilities. A Storage Policy Server can also obtain capability data from a VASA provider that was implemented for the vSphere 5.0/5.1 environment.

The early architecture (vSphere 5.0/5.1) supports a simple expression of storage capability. A VASA 1.0 provider can advertise one system label per datastore. A system label has an associated description.

The Storage Policy Server performs a runtime conversion on the system label. The Storage Policy API presents the system label as a storage capability profile associated with the datastore. The Server also generates a capability schema for the storage label. The generated storage capability profile references the generated schema.

A capability schema generated from a system label has the following characteristics:

- Located in a unique vendor-specific namespace.
- Contains a single category – “legacy”.
- Contains a single capability definition in that category – “SystemLabel” – with one property of type string.

A capability profile generated from a system label has the following characteristics:

- has a profile name taken from the system label’s label
- has a profile description taken from the system label’s description
- contains a single capability instance referencing the SystemLabel capability defined in the generated schema, with a string-valued constraint for the property that is taken from the system label’s label

Therefore a system label with the label “Vendor1Gold” and the description “This is our best storage” would lead to the generation of a capability profile such as

capability profile Vendor1Gold

```
(
“vendor1 legacy system label” = Vendor1Gold
)
```

where the profile metadata would contain the description “This is our best storage”, and the capability “vendor1 legacy system label” is defined in the generated vendor-specific namespace. Such a capability profile could be referenced by policy profiles either by binding to its name (which affords the possibility of cross-vendor-portable policies, if multiple profiles from different vendors share the same name) or by constraints for its vendor-namespace-specific “vendor1 legacy system label” capability.

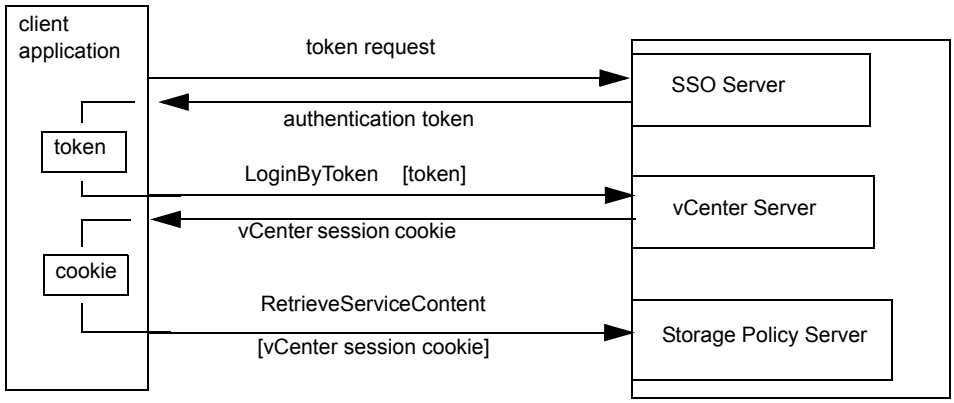
Storage Policy Server Connection 2

The connection between a Storage Policy client and the Storage Policy Server is based on the client's connection with a vCenter Server. A vCenter Server client uses an HTTP session cookie to maintain a persistent connection with the Server. A Storage Policy client uses the vCenter Server session cookie to establish the connection with the Storage Policy Server.

A client performs the following operations to establish vCenter Server and Storage Policy Server sessions.

- Obtain a SAML token from the VMware SSO Server.
  See "vCenter Single Sign On Client Example" on page 21.
- Use the SAML token to login to the vCenter Server.
  See "vCenter LoginByToken Example" on page 27.
- Use the the `RetrieveServiceContent` method to send the session cookie to the Storage Policy Server and establish the connection with the Server.

Figure 2-1. Storage Policy Server Connection



Establish a Connection with the VMware Storage Policy Server

Use the session cookie from the vCenter Server session to establish the Storage Policy session. The session cookie represents the authenticated vCenter Server session, which is based on the SSO token.

The following code fragments establish connections both with the vCenter Server and the Storage Policy Server. These examples are based on the `BasicConnection` sample which is located in the Storage Policy SDK connection sample directory:

`SDK/spbm/java/JAXWS/samples/com/vmware/spbm/connection/BasicConnection.java`

The `BasicConnection` sample uses an instance of the `LoginByTokenSample` class. (See vCenter LoginByToken Example). Although the `LoginByToken` example restores the cookie in the vCenter Server connection that it has established, the `BasicConnection` sample establishes its own connection with the vCenter Server. A different implementation might integrate those capabilities to reduce the number of vCenter Server connections. The example uses a string cookie value (`cookieVal`) that is obtained from the vCenter Server session. See "Saving the vCenter Server Session Cookie" on page 29.

Server URLs

The BasicConnection sample creates connections to three VMware Servers.

- SSO Server
- vCenter Server
- Storage Policy Server

The SSO and Storage Policy Servers are located on the same system as the vCenter Server.

Table 2-1. VMware Server URLs

VMware Server	URL
vCenter Server	`https://`*`server-name`*`|`*`IPaddress`*`/sdk/vimService`
SSO Server	`https://`*`server-name`*`|`*`IPaddress`*`:7444/ims/STSService`
Storage Policy Server	`https://`*`server-name`*`|`*`IPaddress`*`/pbm`

Establish the vCenter Session Connection for the Local Instance

The following code fragment sets up the HTTP connection with the vCenter Server.

1. Retrieve the `VimPort` interface. This provides access to the vSphere API methods.
2. Retrieve the request context and set the vCenter Server endpoint address in the request context.
3. Set the session cookie in the request context. The cookie (`cookieVal`) is obtained from the vCenter LoginByToken Example.
4. Call the RetrieveServiceContent method to establish the HTTP connection with the vCenter Server.

Example 2-1. vCenter Server Connection

```
// Retrieve the VimPort interface.
vimService = new VimService();
vimPort = vimService.getVimPort();

// Retrieve the request context and set the vCenter Server endpoint.
Map<String, Object> ctxt = ((BindingProvider) vimPort).getRequestContext();
ctxt.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, vcurl.toString());
ctxt.put(BindingProvider.SESSION_MAINTAIN_PROPERTY, true);

// Put the extracted vCenter session cookie into the VimPortType request header.
Map<String, List<String>> headers =
    (Map<String, List<String>>) ctxt .get(MessageContext.HTTP_REQUEST_HEADERS);
if (headers == null) {
    headers = new HashMap<String, List<String>>();
}
headers.put("Cookie", Arrays.asList(cookieVal));
ctxt.put(MessageContext.HTTP_REQUEST_HEADERS, headers);

// Retrieve the vCenter Server service content.
vimServiceContent = vimPort.retrieveServiceContent(this.getVimServiceInstanceReference());
```

Create the Storage Policy Server Connection

The following code fragment uses a vCenter session cookie to create a Storage Policy Server session.

1 Extract the actual cookie value from the `name=value` expression in the cookie string obtained from the vCenter session connection.

2 Create a PbmService object.

3 Set up a header handler to support adding the vCenter session cookie to the Storage Policy Server connection.

4 Retrieve the PbmPort object for access to the Storage Policy API methods.

5 Retreive the request context and set the endpoint to the Storage Policy Server URL.

6 Call the PbmRetrieveServiceContent method to establish the HTTP connection to the Storage Policy Server.

Example 2-2. Storage Policy Server Connection

```
// 1. Set the extracted cookie into PbmPortType
//
// Need to extract only the cookie value
String[] tokens = cookieVal.split(";");
tokens = tokens[0].split("=");
String extractedCookie = tokens[1];

// 2. Create a PbmService object.
pbmService = new PbmService();

// 3. Setting the header resolver for adding the VC session cookie to the
// requests for authentication
HeaderHandlerResolver headerResolver = new HeaderHandlerResolver();
headerResolver.addHandler(new VcSessionHandler(extractedCookie));
pbmService.setHandlerResolver(headerResolver);

// 4. Retrieve the PbmPort object for access to the Storage Policy API
pbmPort = pbmService.getPbmPort();

// 5. Set the Storage Policy Server endpoint
Map<String, Object> pbmCtxt = ((BindingProvider) pbmPort).getRequestContext();
pbmCtxt.put(BindingProvider.SESSION_MAINTAIN_PROPERTY, true);
pbmCtxt.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, spbmurl.toString());

// 6. Retrieve the service content (creates the connection)
pbmServiceContent = pbmPort.pbmRetrieveServiceContent(getPbmServiceInstanceReference());
```

VSAN Storage Profile Example 3

Storage requirements are based on the storage capabilities available from a storage provider. vSphere supports VMware VSAN storage capabilities. To create a requirements profile based on VSAN capabilities, you retrieve metadata that describes the VSAN capabilities and create a subprofile that expresses the storage requirements for virtual machine or virtual disk files.

NOTE A Storage Policy API profile consists of a set of *subprofiles*. A subprofile defines a set of storage capabilities. A subprofile corresponds to a *rule set* in the vSphere Web Client.

Create a VSAN Requirements Profile

The following example demonstrates how to create a storage requirements profile based on vSphere VSAN storage capabilities. The example creates a requirement for VSAN stripe width.

1 Retrieve the Storage Policy Profile Manger.

2 Verify that there is VSAN Storage Policy support.

3 Retrieve the VSAN storage capability metadata.

4 Add capabilities to be used as requirements.

5 Add the requirement capabilities to a subprofile. A subprofile corresponds to a rule set in the vSphere Web Client.

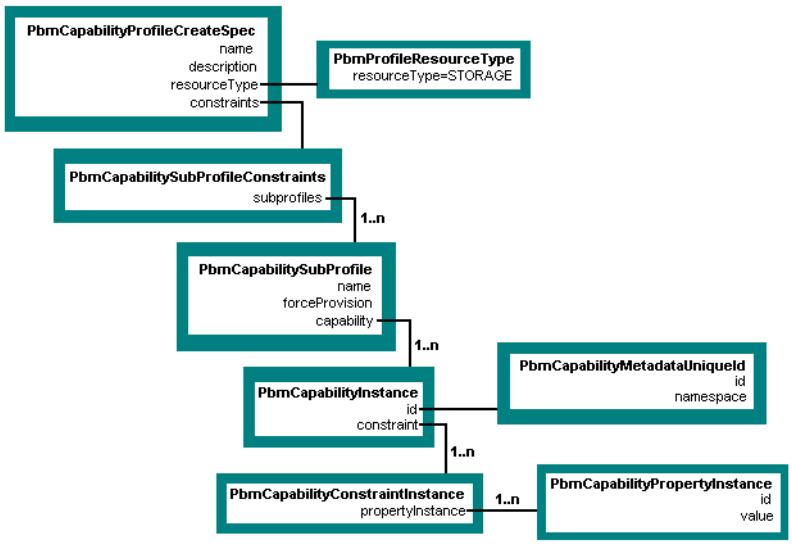
6 Specify the subprofile as capability constraints.

7 Build a profile specification.

8 Create the storage profile.

The following figure shows the data objects used for a profile specification.

Figure 3-1. Storage Profile Specificaiton



Example 3-1. VSAN Storage Profile Creation

```
// 1: Get PBM Profile Manager & Associated Capability Metadata
spbmsc = connection.getPbmServiceContent();
ManagedObjectReference profileMgr = spbmsc.getProfileManager();

// 2: Verify that there is vSAN Storage Policy support
Boolean vSanCapabale = false;
List<PbmCapabilityVendorResourceTypeInfo> vendorInfo =
    connection.getPbmPort().pbmFetchVendorInfo(profileMgr, null);
for (PbmCapabilityVendorResourceTypeInfo vendor : vendorInfo)
    for (PbmCapabilityVendorNamespaceInfo vnsi : vendor.getVendorNamespaceInfo())
        if (vnsi.getNamespaceInfo().getNamespace().equals("vSan")) {
            vSanCapabale = true;
            break;
        }

if (!vSanCapabale)
    throw new RuntimeFaultFaultMsg(
                  "Cannot create storage profile. vSAN Provider not found.", null);

// 3: Get PBM Supported Capability Metadata
List<PbmCapabilityMetadataPerCategory> metadata =
    connection.getPbmPort().pbmFetchCapabilityMetadata(profileMgr,
                        PbmUtil.getStorageResourceType(), null);

// 4: Add Provider Specific Capabilities
List<PbmCapabilityInstance> capabilities = new ArrayList<PbmCapabilityInstance>();
capabilities.add(buildCapability("stripeWidth", stripeWidth, metadata));

// 5: Add Capabilities to a RuleSet (subprofile)
PbmCapabilitySubProfile ruleSet = new PbmCapabilitySubProfile();
ruleSet.getCapability().addAll(capabilities);

// 6: Add Rule-Set (subprofile) to Capability Constraints
PbmCapabilitySubProfileConstraints constraints = new PbmCapabilitySubProfileConstraints();
ruleSet.setName("Rule-Set " + (constraints.getSubProfiles().size() + 1));
constraints.getSubProfiles().add(ruleSet);

// 7: Build Capability-Based Profile
PbmCapabilityProfileCreateSpec spec = new PbmCapabilityProfileCreateSpec();
spec.setName(profileName);
spec.setDescription("Storage Profile Created by SDK Samples. Rule based on vSAN capability");
spec.setResourceType(PbmUtil.getStorageResourceType());
spec.setConstraints(constraints);
```

```
// 8: Create Storage Profile
PbmProfileId profile = connection.getPbmPort().pbmCreate(profileMgr, spec);
System.out.println("Profile " + profileName + " created with ID: " + profile.getUniqueId());
```

Create a Storage Requirement

The following example builds a property instance for a capability. The property instance represents a single storage requirement. The code performs the following steps:

1 Verifies that the capability exists.

2 Creates a property instance for the requirement.

3 Creates a capability contraint for the property instance.

4 Create a capability instance for the constraint and add the subprofile (rule) to the capability.

Example 3-2.

```
PbmCapabilityInstance buildCapability(String capabilityName, Object value,
         List<PbmCapabilityMetadataPerCategory> metadata)
         throws InvalidArgumentFaultMsg {

    // Retrieve the metadata for the capability (stripeWidth)
    PbmCapabilityMetadata capabilityMeta = PbmUtil.getCapabilityMeta(capabilityName, metadata);
    if (capabilityMeta == null)
        throw new InvalidArgumentFaultMsg("Specified Capability does not exist", null);

    // Create a New Property Instance based on the Stripe Width Capability
    PbmCapabilityPropertyInstance prop = new PbmCapabilityPropertyInstance();
    prop.setId(capabilityName);
    prop.setValue(value);

    // Associate Property Instance with a Rule (subprofile)
    PbmCapabilityConstraintInstance rule = new PbmCapabilityConstraintInstance();
    rule.getPropertyInstance().add(prop);

    // Associate Rule (subprofile) with a Capability Instance
    PbmCapabilityInstance capability = new PbmCapabilityInstance();
    capability.setId(capabilityMeta.getId());
    capability.getConstraint().add(rule);

    return capability;
}
```

vCenter Single Sign On Client Example

A

This chapter describes a Java example of acquiring a vCenter Single Sign On security token.

vCenter Single Sign On Token Request Overview

The code examples in the following sections show how to use the `Issue` method to acquire a holder-of-key security token. To see an example of using the token to login to a vCenter Server, see "vCenter LoginByToken Example" on page 27. The code examples in this chapter are based on the following sample file located in the vCenter Single Sign On SDK JAX-WS client `samples` directory:

```
.../JAXWS/samples/com/vmware/sso/client/samples/AcquireHoKTokenByUserCredentialSample.java
```

The `AcquireHoKTokenByUserCredentialSample` program creates a token request and calls the issue method to send the request to a vCenter Single Sign On Server. The program uses a sample implementation of Web services message handlers to modify the SOAP security header for the request message.

This example uses the username-password security policy (`STSSecPolicy_UserPwd`). This policy requires that the SOAP security header include a timestamp, username and password, and a digital signature and certificate. The sample message handlers embed these elements in the message.

The example performs the following operations:

1. Create a security token service client object (`STSService_Service`). This object manages the vCenter Single Sign On header handlers and it provides access to the vCenter Single Sign On client API methods. This example uses the issue method.
2. Create a vCenter Single Sign On header handler resolver object (`HeaderHandlerResolver`). This object acts as a container for the different handlers.
3. Add the handlers for timestamp, user credentials, certificate, and token extraction to the handler resolver.
4. Add the handler resolver to the security token service.
5. Retrieve the STS port (`STS_Service`) from the security token service object.
6. Create a security token request.
7. Set the request fields.
8. Set the endpoint in the request context. The endpoint identifies the vCenter Single Sign On Server.
9. Call the issue method, passing the token request.
10. Handle the response from the vCenter Single Sign On server.

Using Handler Methods for SOAP Headers

The VMware vCenter Single Sign On SDK provides sample code that is an extension of the JAX-WS XML Web services message handler (`javax.xml.ws.handler`). The sample code consists of a set of SOAP header handler methods and a header handler resolver, to which you add the handler methods. The handler methods insert timestamp, user credential, and message signature data into the SOAP security header for the request. A handler method extracts the SAML token from the vCenter Single Sign On Server response.

The VMware vCenter Single Sign On client SOAP header handler files are located in the `soaphandlers` directory:

```
SDK/sso/java/JAXWS/samples/com/vmware/sso/client/soaphandlers
```

To access the SOAP handler implementation, the example code contains the following import statements:

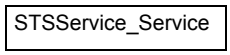
```
import com.vmware.sso.client.soaphandlers.HeaderHandlerResolver;
import com.vmware.sso.client.soaphandlers.SSOHeaderHandler;
import com.vmware.sso.client.soaphandlers.SamlTokenExtractionHandler
import com.vmware.sso.client.soaphandlers.TimeStampHandler;
import com.vmware.sso.client.soaphandlers.UserCredentialHandler;
import com.vmware.sso.client.soaphandlers.WsSecurityUserCertificateSignatureHandler;
```

This example uses the following handler elements:

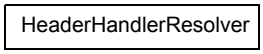
- HeaderHandlerResolver
- SamlTokenExtractionHandler
- TimestampHandler
- UserCredentialHandler
- WsSecurityUserCertificateSignatureHandler (SSOHeaderHandler)

The following sequence shows the operations and corresponding Java elements for message security.

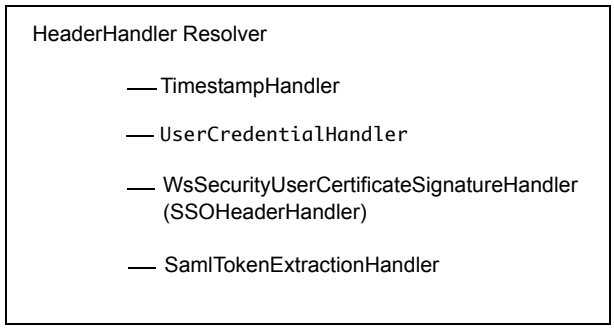
1. Create an STS service object (`STSService_Service`). This object will bind the handlers to the request and provide access to the issue method.



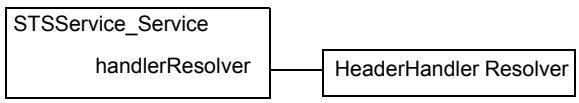
2. Create a handler resolver object (`HeaderHandlerResolver`). This object acts as a receptacle for the handlers.



3. Add the header handlers:
   - Timestamp – The handler will use system time to set the timestamp values.
   - User credential – The handler requires a username and a password; it will create a username token for the supplied values.
   - User certificate signature – The handler requires a private key and an x509 certificate. The handler will use the private key to sign the body of the SOAP message (the token request), and it will embed the certificate in the SOAP security header.
   - SAML token extraction – The handler extracts the SAML token directly from vCenter Single Sign On Server response to avoid token modification by the JAX-WS bindings.



4. Add the handler resolver to the STS service.



The following code fragment creates a handler resolver and adds the handler methods to the handler resolver. After the handlers have been established, the client creates a token request and calls the `Issue` method. See "Sending a Request for a Security Token" on page 24.

IMPORTANT You must perform these steps for message security before retrieving the STS service port. An example of retrieving the STS service port is shown in "Sending a Request for a Security Token" on page 24.

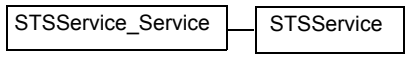
Example A-1. Acquiring a vCenter Single Sign On Token – Soap Handlers

```
/*
 * Instantiate the STS Service
 */
STSService_Service stsService = new STSService_Service();

/*
 * Instantiate the HeaderHandlerResolver.
 */
HeaderHandlerResolver headerResolver = new HeaderHandlerResolver();

/*
 * Add handlers to insert a timestamp and username token into the SOAP security header
 * and sign the message.
 *
 * -- Timestamp contains the creation and expiration time for the request
 * -- UsernameToken contains the username/password
 * -- Sign the SOAP message using the combination of private key and user certificate.
 *
 * Add the TimeStampHandler
 */
headerResolver.addHandler(new TimeStampHandler());

/*
 * Add the UserCredentialHandler. arg[1] is the username; arg[2] is the password.
 */
UserCredentialHandler ucHandler = new UserCredentialHandler(args[1],args[2]);
headerResolver.addHandler(ucHandler);

/*
 * Add the message signature handler (WsSecurityUserCertificateSignatureHandler);
 * The client is responsible for supplying the private key and certificate.
 */
SSOHeaderHandler ssoHandler =
               new WsSecurityUserCertificateSignatureHandler(privateKey, userCert);
headerResolver.addHandler(ssoHandler);

/*
 * Add the token extraction handler (SamlTokenExtractionHandler).
 */
SamlTokenExtractionHandler sbHandler = new SamlTokenExtractionHandler;
headerResolver.addHandler(sbHandler);

/*
 * Set the handlerResolver for the STSService to the HeaderHandlerResolver created above.
 */
stsService.setHandlerResolver(headerResolver);
```

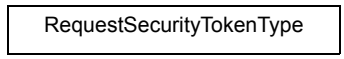
Sending a Request for a Security Token

After setting up the SOAP header handlers, the example creates a token request and calls the issue method. The following sequence shows the operations and corresponding Java elements.

5 Retrieve the STS service port (`STSService`). The service port provides access to the vCenter Single Sign On client API methods. The vCenter Single Sign On handler resolver must be associated with the STS service before you retrieve the service port. See "Using Handler Methods for SOAP Headers" on page 22.

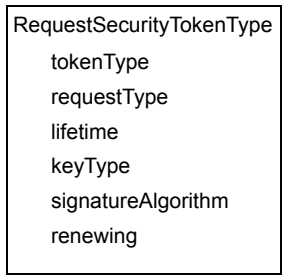


6 Create a token request (`RequestSecurityTokenType`). Your vCenter Single Sign On client will pass the token request to the `Issue` method. The `Issue` method will send the token request in the body of the SOAP message. This example sets the token request fields as appropriate for a holder-of-key token request.

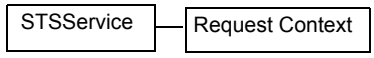


7 Set the token request fields.

- lifetime – Creation and expiration times.
- token type – urn:oasis:names:tc:SAML:2.0:assertion
- request type – http://docs.oasis-open.org/ws-sx/ws-trust/200512/Issue
- key type – http://docs.oasis-open.org/ws-sx/ws-trust/200512/PublicKey (for holder-of-key token type)
- signature algorithm – http://www.w3.org/2001/04/xmldsig-more#rsa-sha256
- renewable status



8 Set the endpoint address for the token request.



9 Call the Issue method.

10 Handle the response from the vCenter Single Sign On Server.

The following example shows Java code that performs these operations.

Example A-2. Acquiring a vCenter Single Sign On Token – Sending the Request

```
/*
 * Retrieve the STSServicePort from the STSService_Service object.
 */
STSService stsPort = stsService.getSTSServicePort();

/*
 * Create a token request object.
 */
RequestSecurityTokenType tokenType = new RequestSecurityTokenType();

/*
 *  Create a LifetimeType object.
 */
LifetimeType lifetime = new LifetimeType();

/*
 * Derive the token creation date and time.
 * Use a GregorianCalendar to establish the current time,
```

```
 * then use a DatatypeFactory to map the time data to XML.
 */
DatatypeFactory dtFactory = DatatypeFactory.newInstance();
GregorianCalendar cal = new GregorianCalendar(TimeZone.getTimeZone("GMT"));
XMLGregorianCalendar xmlCalendar = dtFactory.newXMLGregorianCalendar(cal);
AttributedDateTime created = new AttributedDateTime();
created.setValue(xmlCalendar.toXMLFormat());

/*
 * Specify a time interval for token expiration (specified in milliseconds).
 */
AttributedDateTime expires = new AttributedDateTime();
xmlCalendar.add(dtFactory.newDuration(30 * 60 * 1000));
expires.setValue(xmlCalendar.toXMLFormat());

/*
 * Set the created and expires fields in the lifetime object.
 */
lifetime.setCreated(created);
lifetime.setExpires(expires);

/*
 * Set the token request fields.
 */
tokenType.setTokenType("urn:oasis:names:tc:SAML:2.0:assertion");
tokenType.setRequestType("http://docs.oasis-open.org/ws-sx/ws-trust/200512/Issue");
tokenType.setLifetime(lifetime);
tokenType.setKeyType("http://docs.oasis-open.org/ws-sx/ws-trust/200512/PublicKey");
tokenType.setSignatureAlgorithm("http://www.w3.org/2001/04/xmldsig-more#rsa-sha256");

/*
 * Specify a token that can be renewed.
 */
RenewingType renewing = new RenewingType();
renewing.setAllow(Boolean.TRUE);
renewing.setOK(Boolean.FALSE); // WS-Trust Profile: MUST be set to false
tokenType.setRenewing(renewing);



/* Get the request context and set the endpoint address. */
Map<String, Object> reqContext = ((BindingProvider) stsPort).getRequestContext();
reqContext.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, args[0]);

/*
 * Use the STS port to invoke the "issue" method to acquire the token
 * from the vCenter Single Sign On Server.
 */
RequestSecurityTokenResponseCollectionType issueResponse = stsPort.issue(tokenType);

/*
 * Handle the response - extract the SAML token from the response. The response type
 * contains the token type (SAML token type urn:oasis:names:tc:SAML:2.0:assertion).
 */
RequestSecurityTokenResponseType rstResponse = issueResponse.getRequestSecurityTokenResponse();
RequestedSecurityTokenType requestedSecurityToken = rstResponse.getRequestedSecurityToken();

/*
 * Extract the SAML token from the RequestedSecurityTokenType object.
 * The generic token type (Element) corresponds to the type required
 * for the SAML token handler that supports the call to LoginByToken.
 */
Element token = requestedSecurityToken.getAny();
```

vCenter LoginByToken Example

B

This chapter describes a Java example of using the `LoginByToken` method.

vCenter Server Single Sign On Session

After you obtain a SAML token from the vCenter Single Sign On Server, you can use the vSphere API method `LoginByToken` to establish a single sign on session with a vCenter Server. See "vCenter Single Sign On Client Example" on page 21 for an example of obtaining a vCenter Single Sign On token.

At the beginning of a vCenter Single Sign On session, your client is responsible for the following tasks:

- Maintain the vCenter session cookie. The vSphere architecture uses an HTTP cookie to support a persistent connection between a vSphere client and a vCenter Server. During the initial connection, the Server produces a session cookie. Operations during the login sequence will reset the request context so your client must save this cookie and re-introduce it at the appropriate times.
- Insert the vCenter Single Sign On token and a timestamp into the SOAP header of the `LoginByToken` message.

The example program uses these general steps:

1. Call the `RetrieveServiceContent` method to establish an HTTP connection with the vCenter Server and save the HTTP session cookie. The client uses an HTTP header handler method to extract the cookie from the vCenter Server response.
2. Call the `LoginByToken` method to authenticate the vCenter session. To send the token to the vCenter Server, the client uses a handler to embed the token and a time stamp in the SOAP header for the message. To identify the session started with the `RetrieveServiceContent` method, the client uses a handler to embed the session cookie in the HTTP header.
3. Restore the session cookie.

HTTP and SOAP Header Handlers

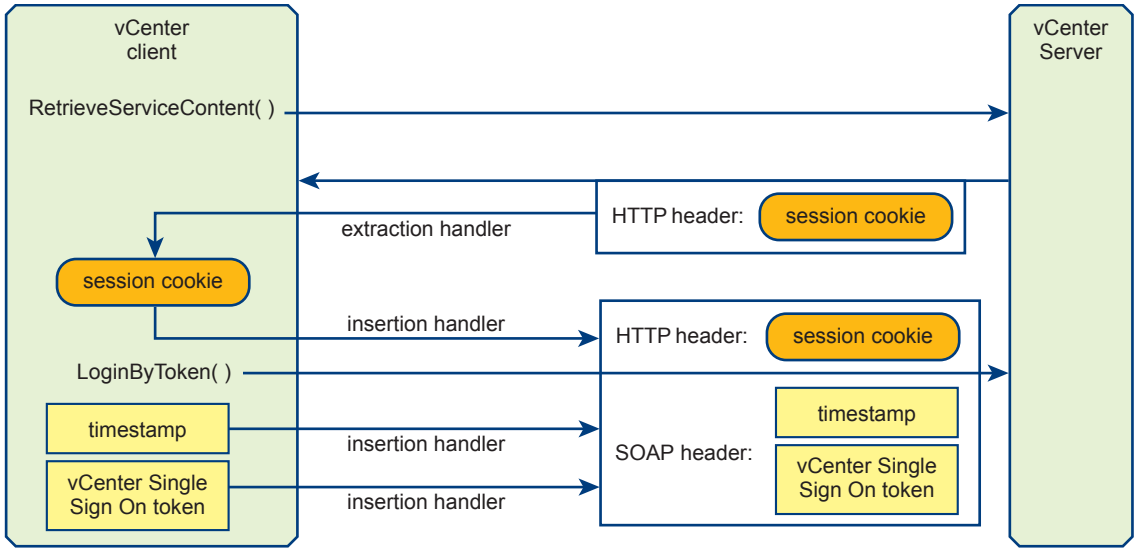
To use a vCenter Single Sign On token to login to a vCenter Server, the example uses header handlers to manipulates the HTTP and SOAP header elements of the login request. After establishing a handler, subsequent requests automatically invoke the handler.

- An extraction handler obtains the HTTP session cookie provided by the vCenter Server. After setting up the handler, a call to the `RetrieveServiceContent` method will invoke the handler to extract the cookie from the Server response.

- Insertion handlers put the vCenter Single Sign On token and a timestamp into the SOAP header and the session cookie into the HTTP header of the login request.

The following figure shows the use of handlers to manipulate header elements when establishing a vCenter Single Sign On session with a vCenter Server.

Figure B-1. Starting a vCenter Session



IMPORTANT Every call to the vCenter Server will invoke any message handlers that have been established. The overhead involved in using the SOAP and HTTP message handlers is not necessary after the session has been established. The example saves the default message handler before setting up the SOAP and HTTP handlers. After establishing the session, the example will reset the handler chain and restore the default handler.

The example code also uses multiple calls to the `VimPortType.getVimPort method` to manage the request context. The `getVimPort` method clears the HTTP request context. After each call to the `getVimPort` method, the client resets the request context endpoint address to the vCenter Server URL. After the client has obtained the session cookie, it will restore the cookie in subsequent requests.

Sample Code

The code examples in the following sections show how to use the `LoginByToken` method with a holder-of-key security token. The code examples are based on the sample code contained in the vCenter Single Sign On SDK. The files are located in the Java samples directory (`SDK/ssoclient/java/JAXWS/samples`):

- LoginByToken sample:

  `samples/com/vmware/vsphere/samples/LoginByTokenSample.java`

- Header cookie handlers:

  ```
  samples/com/vmware/vsphere/soaphandlers/HeaderCookieHandler.java
  samples/com/vmware/vsphere/soaphandlers/HeaderCookieExtractionHandler.java
  ```

- SOAP header handlers. These are the same handlers that are used in "vCenter Single Sign On Client Example (JAX-WS)" on page 33. The SOAP handler files are located in the vCenter Single Sign On client `soaphandlers` directory:

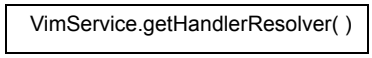
  `samples/com/vmware/sso/client/soaphandlers`

Saving the vCenter Server Session Cookie

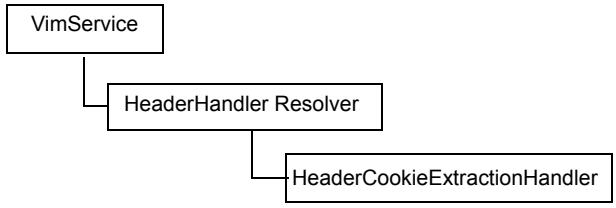
The code fragment in this section establishes an HTTP session with the vCenter Server and saves the HTTP session cookie.

The following sequence describes these steps and shows the corresponding objects and methods.

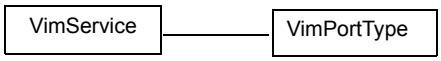
1 Use the `getHandlerResolver` method to save the default message handler. To use the HTTP and SOAP message handlers, you must first save the default message handler so that you can restore it after login. The HTTP and SOAP message handlers impose overhead that is unneccessary after login.



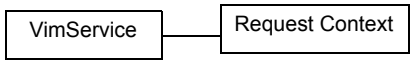
2 Set the cookie handler. The `HeaderCookieExtractionHandler` method retrieves the HTTP cookie.



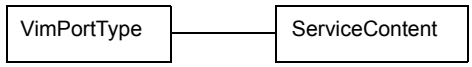
3 Get the VIM port. The VIM port provides access to the vSphere API methods, including the `LoginByToken` method.



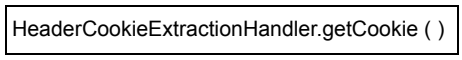
4 Set the request context endpoint address to the vCenter Server URL.



5 Retrieve the ServiceContent. This method establishes the HTTP connection and sets the session cookie.



6 Extract the cookie and save it for later use.



The following example shows Java code that saves the session cookie.

Example B-1. Saving the vCenter Server Session Cookie

```
/*
 * The example uses a SAML token (obtained from a vCenter Single Sign On Server)
 * and the vCenter Server URL.
 * The following declarations indicate the datatypes; the token datatype (Element) corresponds
 * to the token datatype returned by the vCenter Single Sign On Server.
 *
 * Element token;       -- from vCenter Single Sign On Server
 * String vcServerUrl;  -- identifies vCenter Server
 *
 * First, save the default message handler.
 */

HandlerResolver defaultHandler = vimService.getHandlerResolver();

/*
 * Create a VIM service object.
 */
vimService = new VimService();

/*
 * Construct a managed object reference for the ServiceInstance.
```

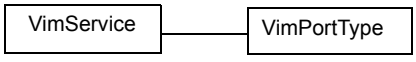
```
 */
ManagedObjectReference SVC_INST_REF = new ManagedObjectReference();
SVC_INST_REF.setType("ServiceInstance");
SVC_INST_REF.setValue("ServiceInstance");

/*
 * Create a handler resolver.
 * Create a cookie extraction handler and add it to the handler resolver.
 * Set the VIM service handler resolver.
 */
HeaderCookieExtractionHandler cookieExtractor = new HeaderCookieExtractionHandler();
HeaderHandlerResolver handlerResolver = new HeaderHandlerResolver();
handlerResolver.addHandler(cookieExtractor);
vimService.setHandlerResolver(handlerResolver);

/*
 * Get the VIM port for access to vSphere API methods. This call clears the request context.
 */
vimPort = vimService.getVimPort();

/*
 * Get the request context and set the connection endpoint.
 */
Map<String, Object> ctxt = ((BindingProvider) vimPort).getRequestContext();
ctxt.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, vcServerUrl);
ctxt.put(BindingProvider.SESSION_MAINTAIN_PROPERTY, true);

/*
 * Retrieve the ServiceContent. This call establishes the HTTP connection.
 */
serviceContent = vimPort.retrieveServiceContent(SVC_INST_REF);

/*
 * Save the HTTP cookie.
 */
String cookie = cookieExtractor.getCookie();
```

Using LoginByToken

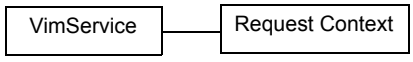
The code fragment in this section sets up the message handlers and calls the `LoginByToken` method. The following sequence describes the steps and shows the corresponding objects and methods.

1 Create a new `HeaderHandlerResolver`. Then set the message security handlers for cookie insertion and for inserting the SAML token and credentials in the SOAP header.

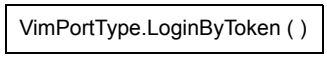
2 Get the VIM port.



3 Set the connection endpoint in the HTTP request context.



4 Call the LoginByToken method. The method invocation executes the handlers to insert the elements into the message headers. The method authenticates the session referenced by the session cookie.



The following examples shows Java code that calls the `LoginByToken` method.

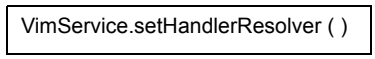
Example B-2. Using LoginByToken

```
/*
 * Create a handler resolver and add the handlers.
 */
HeaderHandlerResolver handlerResolver = new HeaderHandlerResolver();
handlerResolver.addHandler(new TimeStampHandler());
handlerResolver.addHandler(new SamlTokenHandler(token));
handlerResolver.addHandler(new HeaderCookieHandler(cookie));
handlerResolver.addHandler(new WsSecuritySignatureAssertionHandler(
                           userCert.getPrivateKey(),
                           userCert.getUserCert(),
                           Utils.getNodeProperty(token, "ID")));
vimService.setHandlerResolver(handlerResolver);

/*
 *  Get the Vim port; this call clears the request context.
 */
vimPort = vimService.getVimPort();

/*
 * Retrieve the request context and set the server URL.
 */
Map<String, Object> ctxt = ((BindingProvider) vimPort).getRequestContext();
ctxt.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, vcServerUrl);
ctxt.put(BindingProvider.SESSION_MAINTAIN_PROPERTY, true);

/*
 * Call LoginByToken.
 */
UserSession us = vimPort.loginByToken(serviceContent.getSessionManager(), null);
```

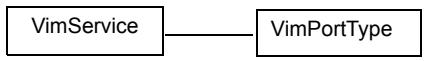
Restoring the vCenter Server Session Cookie

After you log in, you must restore the standard vCenter session context. The code fragment in this section restores the default message handler and the session cookie. As the cookie handler has been replaced by the default handler, the client resets the session cookie by calling request context methods to access the context fields directly. The following sequence describes these steps and shows the corresponding objects and methods.

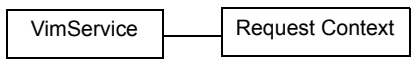
1. Restore the default message handler. The handlers used for `LoginByToken` are not used in subsequent calls to the vSphere API.



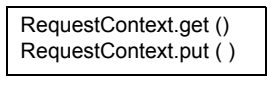
2. Get the VIM port.



3. Set the connection endpoint in the HTTP request context.



4. Set the HTTP request header (vCenter session cookie).



The following example shows Java code that restores the vCenter session. This code requires the vCenter URL and the cookie and default handler that were retrieved before login. See "Sample Code" on page 28.

Example B-3. Restoring the vCenter Server Session

```
/*
 * Reset the default handler. This overwrites the existing handlers, effectively removing them.
 */
vimService.setHandlerResolver(defaultHandler);
vimPort = vimService.getVimPort();

/*
 * Restore the connection endpoint in the request context.
 */
// Set the validated session cookie and set it in the header for once,
// JAXWS will maintain that cookie for all the subsequent requests

Map<String, Object> ctxt = ((BindingProvider) vimPort).getRequestContext();
ctxt.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, vcServerUrl);
ctxt.put(BindingProvider.SESSION_MAINTAIN_PROPERTY, true);

/*
 * Reset the cookie in the request context.
 */
Map<String, List<String>> headers = (Map<String, List<String>>)
                ctxt.get(MessageContext.HTTP_REQUEST_HEADERS);
if (headers == null) {
    headers = new HashMap<String, List<String>>();
}
headers.put("Cookie", Arrays.asList(cookie));
ctxt.put(MessageContext.HTTP_REQUEST_HEADERS, headers);
```

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