



SOAP

simple object access protocol

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About the Tutorial

SOAP is an open-standard, XML-based messaging protocol for exchanging information among computers. This is a brief tutorial that introduces the readers to the fundamentals of SOAP before moving on to explain its various elements, encoding, and how SOAP is transported.

Audience

This tutorial has been prepared for beginners to help them understand the basics of SOAP and how to implement it in practice.

Prerequisites

As a reader of this tutorial, you should have a basic understanding of client/server environment, and knowledge of XML and XML namespace.

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1. WHAT IS SOAP?

SOAP is an acronym for Simple Object Access Protocol. It is an XML-based messaging protocol for exchanging information among computers. SOAP is an application of the XML specification.

Points to Note

- SOAP is a communication protocol designed to communicate via Internet.
- SOAP can extend HTTP for XML messaging.
- SOAP provides data transport for Web services.
- SOAP can exchange complete documents or call a remote procedure.
- SOAP can be used for broadcasting a message.
- SOAP is platform- and language-independent.
- SOAP is the XML way of defining what information is sent and how.
- SOAP enables client applications to easily connect to remote services and invoke remote methods.

Although SOAP can be used in a variety of messaging systems and can be delivered via a variety of transport protocols, the initial focus of SOAP is remote procedure calls transported via HTTP.

Other frameworks including CORBA, DCOM, and Java RMI provide similar functionality to SOAP, but SOAP messages are written entirely in XML and are therefore uniquely platform- and language-independent.

2. SOAP MESSAGES

A SOAP message is an ordinary XML document containing the following elements:

- **Envelope** : Defines the start and the end of the message. It is a mandatory element.
- **Header**: Contains any optional attributes of the message used in processing the message, either at an intermediary point or at the ultimate end-point. It is an optional element.
- **Body**: Contains the XML data comprising the message being sent. It is a mandatory element.
- **Fault**: An optional Fault element that provides information about errors that occur while processing the message.

All these elements are declared in the default namespace for the SOAP envelope:

<http://www.w3.org/2001/12/soap-envelope>

and the default namespace for SOAP encoding and data types is:

<http://www.w3.org/2001/12/soap-encoding>

NOTE: All these specifications are subject to change. So keep updating yourself with the latest specifications available on the W3 website.

SOAP Message Structure

The following block depicts the general structure of a SOAP message:

```
<?xml version="1.0"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">

  <SOAP-ENV:Header>
    ...
    ...
  </SOAP-ENV:Header>

  <SOAP-ENV:Body>
```

```
...  
...  
<SOAP-ENV:Fault>  
  ...  
  ...  
</SOAP-ENV:Fault>  
  
</SOAP-ENV:Body>  
  
</SOAP_ENV:Envelope>
```

3. SOAP ENVELOPE

The SOAP envelope indicates the start and the end of the message so that the receiver knows when an entire message has been received. The SOAP envelope solves the problem of knowing when you are done receiving a message and are ready to process it. The SOAP envelope is therefore basically a packaging mechanism.

Points to Note

- Every SOAP message has a root Envelope element.
- Envelope is a mandatory part of SOAP message.
- Every Envelope element must contain exactly one Body element.
- If an Envelope contains a Header element, it must contain no more than one, and it must appear as the first child of the Envelope, before the Body.
- The envelope changes when SOAP versions change.
- The SOAP envelope is specified using the *ENV* namespace prefix and the Envelope element.
- The optional SOAP encoding is also specified using a namespace name and the optional *encodingStyle* element, which could also point to an encoding style other than the SOAP one.
- A v1.1-compliant SOAP processor generates a fault upon receiving a message containing the v1.2 envelope namespace.
- A v1.2-compliant SOAP processor generates a *VersionMismatch* fault if it receives a message that does not include the v1.2 envelope namespace.

v1.2-Compliant SOAP Message

Given below is an example of v1.2-compliant SOAP message.

```
<?xml version="1.0"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
  ...
  Message information goes here
  ...
```



```
</SOAP-ENV:Envelope>
```

SOAP with HTTP POST

The following example illustrates the use of a SOAP message within an HTTP POST operation, which sends the message to the server. It shows the namespaces for the envelope schema definition and for the schema definition of the encoding rules. The *OrderEntry* reference in the HTTP header is the name of the program to be invoked at the tutorialspoint.com website.

```
POST /OrderEntry HTTP/1.1
Host: www.tutorialspoint.com
Content-Type: application/soap; charset="utf-8"
Content-Length: nnnn
<?xml version="1.0"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
    ...
    Message information goes here
    ...
</SOAP-ENV:Envelope>
```

NOTE: The HTTP binding specifies the location of the service.

4. SOAP HEADER

The optional Header element offers a flexible framework for specifying additional application-level requirements. For example, the Header element can be used to specify a digital signature for password-protected services. Likewise, it can be used to specify an account number for pay-per-use SOAP services.

Points to Note

- It is an optional part of a SOAP message.
- Header elements can occur multiple times.
- Headers are intended to add new features and functionality.
- The SOAP header contains header entries defined in a namespace.
- The header is encoded as the first immediate child element of the SOAP envelope.
- When multiple headers are defined, all immediate child elements of the SOAP header are interpreted as SOAP header blocks.

SOAP Header Attributes

A SOAP Header can have the following two attributes:

Actor attribute

The SOAP protocol defines a message path as a list of SOAP service nodes. Each of these intermediate nodes can perform some processing and then forward the message to the next node in the chain. By setting the Actor attribute, the client can specify the recipient of the SOAP header.

MustUnderstand attribute

It indicates whether a Header element is optional or mandatory. If set to true, the recipient must understand and process the Header attribute according to its defined semantics, or return a fault.

The following example shows how to use a Header in a SOAP message.

```
<?xml version="1.0"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
<SOAP-ENV:Header>
```

```
<t:Transaction
xmlns:t="http://www.tutorialspoint.com/transaction/"
SOAP-ENV:mustUnderstand="true">5</t:Transaction>
</SOAP-ENV:Header>

...

...

</SOAP-ENV:Envelope>
```

5. SOAP BODY

The SOAP body is a mandatory element that contains the application-defined XML data being exchanged in the SOAP message. The body must be contained within the envelope and must follow any headers that might be defined for the message.

The body is defined as a child element of the envelope, and the semantics for the body are defined in the associated SOAP schema.

The body contains mandatory information intended for the ultimate receiver of the message. For example:

```
<?xml version="1.0"?>

<SOAP-ENV:Envelope>
.....

<SOAP-ENV:Body>
  <m:GetQuotation xmlns:m="http://www.tp.com/Quotation">
    <m:Item>Computers</m:Item>
  </m:GetQuotation>
</SOAP-ENV:Body>

</SOAP-ENV:Envelope>
```

The example above requests a quotation of computer sets. Note that the `m:GetQuotation` and the `Item` elements above are application-specific elements. They are not a part of the SOAP standard.

Here is the response to the above query:

```
<?xml version="1.0"?>

<SOAP-ENV:Envelope>
.....
```

```
<SOAP-ENV:Body>
  <m:GetQuotationResponse xmlns:m="http://www.tp.com/Quotation">
    <m:Quotation>This is Qutation</m:Quotation>
  </m:GetQuotationResponse>
</SOAP-ENV:Body>

</SOAP-ENV:Envelope>
```

Normally, the application also defines a schema to contain semantics associated with the request and response elements.

The *Quotation* service might be implemented using an EJB running in an application server; if so, the SOAP processor would be responsible for mapping the body information as parameters into and out of the EJB implementation of the *GetQuotationResponse* service. The SOAP processor could also be mapping the body information to a .NET object, a CORBA object, a COBOL program, and so on.

6. SOAP FAULT

If an error occurs during processing, the response to a SOAP message is a SOAP fault element in the body of the message, and the fault is returned to the sender of the SOAP message.

The SOAP fault mechanism returns specific information about the error, including a predefined code, a description, and the address of the SOAP processor that generated the fault.

Points to Note

- A SOAP message can carry only one fault block.
- Fault is an optional part of a SOAP message.
- For HTTP binding, a successful response is linked to the 200 to 299 range of status codes.
- SOAP Fault is linked to the 500 to 599 range of status codes.

Sub-elements of Fault

The SOAP Fault has the following sub-elements:

Sub-element	Description
<faultCode>	It is a text code used to indicate a class of errors. See the next Table for a listing of predefined fault codes.
<faultString>	It is a text message explaining the error.
<faultActor>	It is a text string indicating who caused the fault. It is useful if the SOAP message travels through several nodes in the SOAP message path, and the client needs to know which node caused the error. A node that does not act as the ultimate destination must include a <i>faultActor</i> element.
<detail>	It is an element used to carry application-specific error messages. The detail element can contain child elements called detail entries.

SOAP Fault Codes

The faultCode values defined below must be used in the *faultcode* element while describing faults.

Error	Description
SOAP-ENV:VersionMismatch	Found an invalid namespace for the SOAP Envelope element.
SOAP-ENV:MustUnderstand	An immediate child element of the Header element, with the mustUnderstand attribute set to "1", was not understood.
SOAP-ENV:Client	The message was incorrectly formed or contained incorrect information.
SOAP-ENV:Server	There was a problem with the server, so the message could not proceed.

SOAP Fault Example

The following code is a sample Fault. The client has requested a method named *ValidateCreditCard*, but the service does not support such a method. This represents a client request error, and the server returns the following SOAP response:

```
<?xml version='1.0' encoding='UTF-8'?>

<SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/1999/XMLSchema">
  <SOAP-ENV:Body>
    <SOAP-ENV:Fault>
      <faultcode xsi:type="xsd:string">SOAP-ENV:Client</faultcode>
      <faultstring xsi:type="xsd:string">
        Failed to locate method (ValidateCreditCard) in class
        (examplesCreditCard) at /usr/local/ActivePerl-5.6/lib/
        site_perl/5.6.0/SOAP/Lite.pm line 1555.
      </faultstring>
    </SOAP-ENV:Fault>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

```
</faultstring>  
  
</SOAP-ENV:Fault>  
</SOAP-ENV:Body>  
</SOAP-ENV:Envelope>
```


7. SOAP ENCODING

SOAP includes a built-in set of rules for encoding data types. It enables the SOAP message to indicate specific data types, such as integers, floats, doubles, or arrays.

- SOAP data types are divided into two broad categories: scalar types and compound types.
- Scalar types contain exactly one value such as a last name, price, or product description.
- Compound types contain multiple values such as a purchase order or a list of stock quotes.
- Compound types are further subdivided into arrays and structs.
- The encoding style for a SOAP message is set via the *SOAP-ENV:encodingStyle* attribute.
- To use SOAP 1.1 encoding, use the value <http://schemas.xmlsoap.org/soap/encoding/>.
- To use SOAP 1.2 encoding, use the value <http://www.w3.org/2001/12/soap-encoding>.
- Latest SOAP specification adopts all the built-in types defined by XML Schema. Still, SOAP maintains its own convention for defining constructs not standardized by XML Schema, such as arrays and references.

Scalar Types

For scalar types, SOAP adopts all the built-in simple types specified by the XML Schema specification. This includes strings, floats, doubles, and integers.

The following table lists the main simple types, excerpted from the XML Schema Part 0: Primer

<http://www.w3.org/TR/2000/WD-xmlschema-0-20000407/>

Simple Types Built-In to XML Schema	
Simple Type	Example(s)
string	Confirm this is electric.
boolean	true, false, 1, 0.

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float	-INF, -1E4, -0, 0, 12.78E-2, 12, INF, NaN.
double	-INF, -1E4, -0, 0, 12.78E-2, 12, INF, NaN.
decimal	-1.23, 0, 123.4, 1000.00.
binary	100010
integer	-126789, -1, 0, 1, 126789.
nonPositiveInteger	-126789, -1, 0.
negativeInteger	-126789, -1.
long	-1, 12678967543233
int	-1, 126789675
short	-1, 12678
byte	-1, 126
nonNegativeInteger	0, 1, 126789
unsignedLong	0, 12678967543233
unsignedInt	0, 1267896754
unsignedShort	0, 12678
unsignedByte	0, 126
positiveInteger	1, 126789.
date	1999-05-31, ---05.
time	13:20:00.000, 13:20:00.000-05:00.

For example, here is a SOAP response with a double data type:

```
<?xml version='1.0' encoding='UTF-8'?*gt;
<SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <SOAP-ENV:Body>
    <ns1:getPriceResponse
      xmlns:ns1="urn:examples:priceservice"
      SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
      <return xsi:type="xsd:double">54.99</return>
    </ns1:getPriceResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Compound Types

SOAP arrays have a very specific set of rules, which require that you specify both the element type and array size. SOAP also supports multidimensional arrays, but not all SOAP implementations support multidimensional functionality.

To create an array, you must specify it as an *xsi:type* of array. The array must also include an *arrayType* attribute. This attribute is required to specify the data type for the contained elements and the dimension(s) of the array.

For example, the following attribute specifies an array of 10 double values:

```
arrayType="xsd:double[10]"
```

In contrast, the following attribute specifies a two-dimensional array of strings:

```
arrayType="xsd:string[5,5]"
```

Here is a sample SOAP response with an array of double values:

```
<?xml version='1.0' encoding='UTF-8'?>
<SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
```

```

<SOAP-ENV:Body>
  <ns1:getPriceListResponse
    xmlns:ns1="urn:examples:pricelist-service"
    SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
    <return
      xmlns:ns2="http://www.w3.org/2001/09/soap-encoding"
      xsi:type="ns2:Array" ns2:arrayType="xsd:double[2]">
      <item xsi:type="xsd:double">54.99</item>
      <item xsi:type="xsd:double">19.99</item>
    </return>
    </ns1:getPriceListResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Structs contain multiple values, but each element is specified with a unique accessor element. For example, consider an item within a product catalog. In this case, the struct might contain a product SKU, product name, description, and price. Here is how such a struct would be represented in a SOAP message:

```

<?xml version='1.0' encoding='UTF-8'?>
<SOAP-ENV:Envelope
  xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <SOAP-ENV:Body>
    <ns1:getProductResponse
      xmlns:ns1="urn:examples:product-service"
      SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
      <return xmlns:ns2="urn:examples" xsi:type="ns2:product">
        <name xsi:type="xsd:string">Red Hat Linux</name>
        <price xsi:type="xsd:double">54.99</price>
        <description xsi:type="xsd:string">
          Red Hat Linux Operating System
        </description>
        <SKU xsi:type="xsd:string">A358185</SKU>
      </return>
    </SOAP-ENV:Body>
  </SOAP-ENV:Envelope>

```

```
</ns1:getProductResponse>  
</SOAP-ENV:Body>  
</SOAP-ENV:Envelope>
```

NOTE: Please take care of proper indentation while you write your SOAP code. Each element in a struct is specified with a unique accessor name. For example, the message above includes four accessor elements: name, price, description, and SKU. Each element can have its own data type. For example, name is specified as a string, whereas price is specified as double.

8. SOAP TRANSPORT

SOAP is not tied to any transport protocol. SOAP can be transported via SMTP, FTP, IBM's MQSeries, or Microsoft Message Queuing (MSMQ).

SOAP specification includes details on HTTP only. HTTP remains the most popular SOAP transport protocol.

SOAP via HTTP

Quite logically, SOAP requests are sent via an HTTP request and SOAP responses are returned within the content of the HTTP response. While SOAP requests can be sent via an HTTP GET, the specification includes details on HTTP POST only.

Additionally, both HTTP requests and responses are required to set their content type to text/xml.

The SOAP specification mandates that the client must provide a *SOAPAction* header, but the actual value of the SOAPAction header is dependent on the SOAP server implementation.

For example, to access the AltaVista BabelFish Translation service, hosted by XMethods, you must specify the following as a SOAPAction header.

```
urn:xmethodsBabelFish#BabelFish
```

Even if the server does not require a full SOAPAction header, the client must specify an empty string ("") or a null value. For example:

```
SOAPAction: ""  
SOAPAction:
```

Here is a sample request sent via HTTP to the XMethods BabelFish Translation service:

```
POST /perl/soaplite.cgi HTTP/1.0  
Host: services.xmethods.com  
Content-Type: text/xml; charset=utf-8  
Content-Length: 538  
SOAPAction: "urn:xmethodsBabelFish#BabelFish"  
  
<?xml version='1.0' encoding='UTF-8'?>  
<SOAP-ENV:Envelope
```

```
xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"

xmlns:xsd="http://www.w3.org/1999/XMLSchema">
<SOAP-ENV:Body>
<ns1:BabelFish
xmlns:ns1="urn:xmethodsBabelFish"
SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
<translationmode xsi:type="xsd:string">en_fr</translationmode>
<sourcedata xsi:type="xsd:string">Hello, world!</sourcedata>
</ns1:BabelFish>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Note the content type and the SOAPAction header. Also note that the BabelFish method requires two String parameters. The translation mode en_fr translates from English to French.

Here is the response from XMethods:

```
HTTP/1.1 200 OK
Date: Sat, 09 Jun 2001 15:01:55 GMT
Server: Apache/1.3.14 (Unix) tomcat/1.0 PHP/4.0.1p12
SOAPServer: SOAP::Lite/Perl/0.50
Cache-Control: s-maxage=60, proxy-revalidate
Content-Length: 539
Content-Type: text/xml

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:xsd="http://www.w3.org/1999/XMLSchema">
<SOAP-ENV:Body>
<namesp1:BabelFishResponse xmlns:namesp1="urn:xmethodsBabelFish">
```

```
<return xsi:type="xsd:string">Bonjour, monde!</return>  
</namespace1:BabelFishResponse>  
  
</SOAP-ENV:Body>  
</SOAP-ENV:Envelope>
```

SOAP responses delivered via HTTP are required to follow the same HTTP status codes. For example, a status code of 200 OK indicates a successful response. A status code of 500 Internal Server Error indicates that there is a server error and that the SOAP response includes a Fault element.

9. SOAP EXAMPLE

In the example below, a *GetQuotation* request is sent to a SOAP Server over HTTP. The request has a *QuotationName* parameter, and a Quotation will be returned in the response.

The namespace for the function is defined in "http://www.xyz.org/quotation" address.

Here is the SOAP request:

```
POST /Quotation HTTP/1.0
Host: www.xyz.org
Content-Type: text/xml; charset=utf-8
Content-Length: nnn

<?xml version="1.0"?>
<SOAP-ENV:Envelope
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">

  <SOAP-ENV:Body xmlns:m="http://www.xyz.org/quotations">
    <m:GetQuotation>
      <m:QuotationsName>MicroSoft</m:QuotationsName>
    </m:GetQuotation>
  </SOAP-ENV:Body>

</SOAP-ENV:Envelope>
```

A corresponding SOAP response looks like:

```
HTTP/1.0 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: nnn

<?xml version="1.0"?>
<SOAP-ENV:Envelope
```

```
xmlns:SOAP-ENV="http://www.w3.org/2001/12/soap-envelope"  
SOAP-ENV:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
```

```
<SOAP-ENV:Body xmlns:m="http://www.xyz.org/quotation">  
  <m:GetQuotationResponse>  
    <m:Quotation>Here is the quotation</m:Quotation>  
  </m:GetQuotationResponse>  
</SOAP-ENV:Body>  
  
</SOAP-ENV:Envelope>
```

10. SOAP STANDARDS

SOAP 1.1 was originally submitted to the W3C in May 2000. Official submitters included large companies such as Microsoft, IBM, and Ariba, and smaller companies such as UserLand Software and DevelopMentor.

In July 2001, the XML Protocol Working Group released a "working draft" of SOAP 1.2. Within the W3C, this document is officially a work in progress, meaning that the document is likely to be updated many times before it is finalized.

SOAP Version 1.1 is available online at <http://www.w3.org/TR/SOAP/>

The working draft of SOAP Version 1.2 is available at <http://www.w3.org/TR/soap12/>

Note that the W3C also hosts a submission for "SOAP Messages with Attachments", which separates from the core SOAP specification. This specification enables SOAP messages to include binary attachments such as images and sound files. For full details, see the W3C Note at <http://www.w3.org/TR/SOAP-attachments>.