

NEMSIS v3 Web Services Guide

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Authors

Su Shaoyu - NEMSIS Lead Developer

N. Clay Mann – NEMSIS P.I.

Contributors

Grant Dittmer – Digital Innovations

Jerome Soller – Cognitech

Josh Legler – Utah Department of Health

EMSPIC Team – University of North Carolina-Chapel Hill

NEMSIS v3 Web Services Guide

Background

In NEMSIS V2, the dominant data submission mechanisms are ftp and web submission using Java Applet. Such procedures are manual and difficult to automate. The NEMSIS TAC has implemented a simple Web Services API for V2 data submission to the national EMS data warehouse. Although used only by a few states, it has proved to be an efficient alternative.

For software applications seeking V3 compliance, data submission via Web Services (WS) will be required. We hope the EMS software development community will take advantage of this mature technology and expand its usage to facilitate business workflow control and data exchange. If implemented properly, standardized NEMSIS WS API will provide the following advantages:

1. Fully automated electronic data exchange (including submission and retrieval) between the WS Consumer's system and the WS Provider's system. Human intervention could be minimized.

2. Better transaction management: The result of data submission / retrieval could be easily monitored without worrying about timeout. In NEMSIS systems, XML and business validation report could be available in real time, from the same communication channel.
3. Possibility to move to real-time / surveillance.
4. Some benefits are intrinsic characteristics of WS, such as vendor independence, scalability, and wide acceptance/adoption.

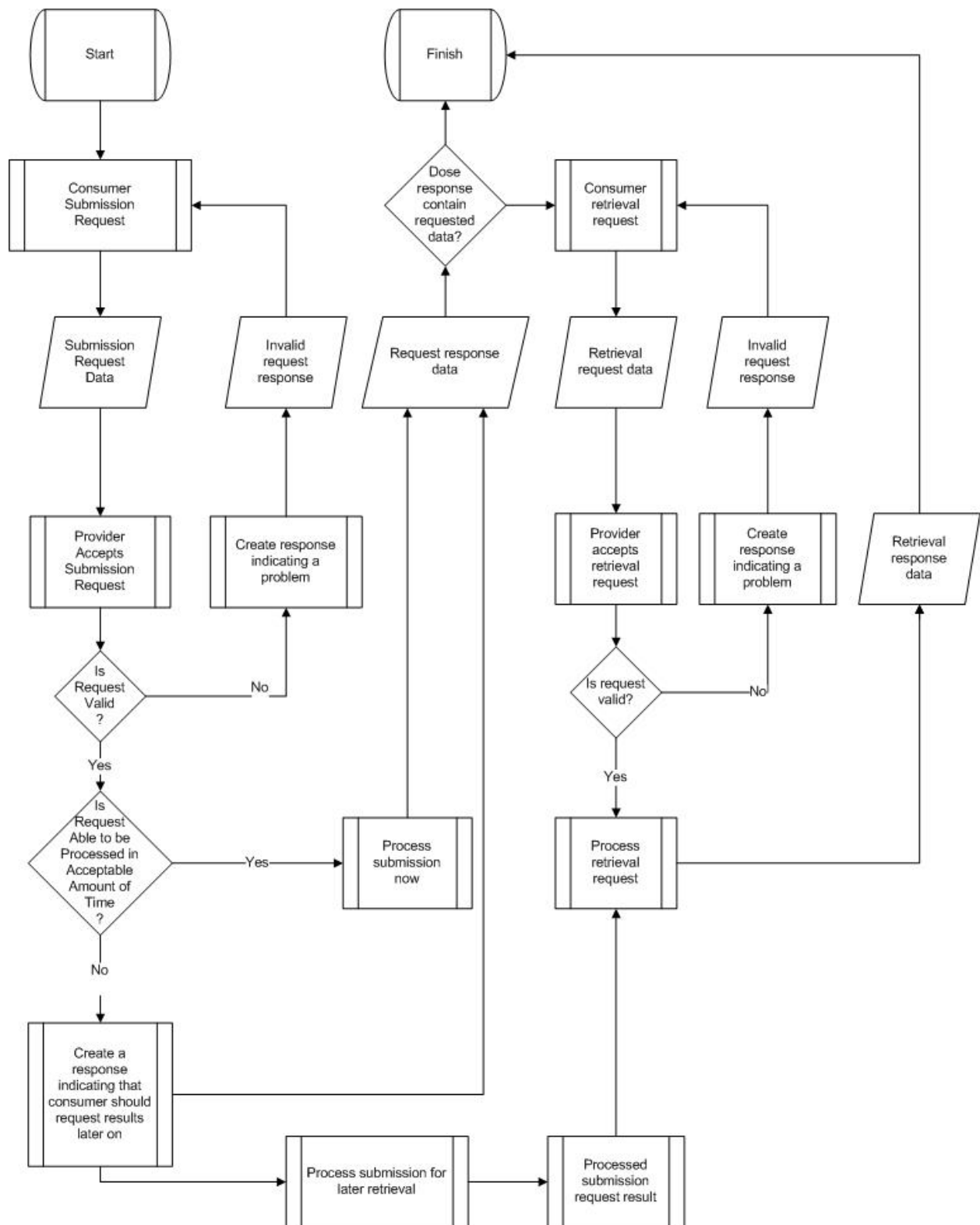
Purpose of NEMSIS v3 Web Services API

A unified interface to support data exchange between distributed NEMSIS v3 systems

Major design goals

1. Flexibility: no constraints on how to implement, which programming language to use, or what platform to deploy.
2. Efficiency: instant response, quick turn-around.
3. Unity: minimize confusion over information exchange.

Work Flow Diagram (Data Submission Request Only):



Detail Requirements

Protocol

1. SOAP Web Service is required
2. RESTful Web Services will continue to be supported for version 2 data submission to NEMESIS TAC.

Security

HTTPS is the required communication channel. WS messages might include sensitive information, such as login credentials and Protected Health Information (PHI). These types of data must be protected at the transport-level. Further discussion about security is included in a later section.

Status Codes

1. Common errors (defined by WSDL) should be included in the Response Data and use the appropriate Status Code as indicators. It is up to the vendor to decide whether to utilize the SOAP header for extra error information which is solely used for their own purpose.
2. NEMESIS WSDL defines a set of standard response codes. All WS response messages include a status code.
 - a. All error codes are negative integers.
 - b. All success codes are positive integers.
 - c. Integer "0" means that the requested action is not completed yet. The client should query the server later to retrieve final processing status.
 - d. States or vendors could design their own error codes, with integers smaller than -100. Similarly, custom success codes should use integers greater than 100. It is hard to distinguish state custom codes and vendor custom codes. There are many cases in which state and vendor means the same thing.
3. For data exchange, if a state/vendor uses codes from -100 to 100, it is required to adopt the definition from the NEMESIS WSDL. For example, it is invalid to use "-1" as a status code for "Failed import of a file, because of the [FATAL] level Schematron rule violation" since this has been defined in the WSDL as "Invalid username and/or password".

Important Common Objects

DataPayload

The Payload object, consisting of three data types (string, XML element, or Base64 encoded binary), is required for submitting data and returning reports. The table below gives an example of each payload.

PayloadOfString	<pre><DataPayload> <PayloadOfString> <encoding>text/xml</encoding> <payload><![CDATA[<?xml version="1.0" encoding="UTF-8"?> <product><name>pen</name></pre>
-----------------	--

	<pre> <price>\$1</price> </product>]]></payload> </PayloadOfString> </DataPayload> </pre>
PayloadOfBinary	<pre> <DataPayload> <PayloadOfBinary> <encoding>base64Binary</encoding> <compressed>>false</ compressed> <payload><![CDATA[67542893472937492]]></payload> </PayloadOfBinary> </DataPayload> </pre>
PayloadOfXmlElement	<pre> <DataPayload> <PayloadOfXmlElement> <encoding>xml</encoding> <product> <name>pen</name> <price>\$1</price> </product> </PayloadOfXmlElement> </DataPayload> </pre>

DataSchema and DataSchemaVersion

Four NEMSIS schemas are predefined. States/vendors could define custom schema used in data exchange. "NEMSIS EMS" and "NEMSIS Demographics" are required.

Combined with DataSchema, DataSchemaVersion helps to identify the exact schema used for the payload. For example, DataSchema="NEMSIS EMS" and DataSchemaVersion="2.2.1" is a valid combination. It points to current v2 schema. However, there is no version 2.5.6 for NEMSIS EMS data. So DataSchema="NEMSIS EMS" and DataSchemaVersion="2.5.6" is not a valid combination.

SubmitDataReport

SubmitDataReport is for the report of data submission processing. It should include at least one XmlValidationErrorResponse element for the XML validation report. The format implementation is as follows:

1. If the submission fails XML validation, SubmitDataReport is required to contain one XmlValidationErrorResponse. Since the submission is rejected at that step, SchematronReport must not be included.
2. If the submission passes XML validation, SubmitDataReport must contain
 - a. XmlValidationErrorResponse, with XmlValidationErrorResponse's TotalErrorCount set to zero.
 - b. SchematronReport, which contains either complete Schematron result file(s), or digested Schematron result file(s), or both of them. The decision is up to the state/vendor.
3. SubmitDataReport may include optional CustomReport element(s). It is designed to help the state/vendor handle their specific requirements.

XmlElementInfo

This is used to identify the offending XML element reported in XML validation or Schematron validation. Line/column numbers, or XPATH location, could be used to identify the position of an XML element. Usually, DOM parsers (validators) report XPATH information and SAX/StAX parsers (validators) report line/column numbers. Some special XML processors, like SAXON EE/PE version, can report both. The design is to allow line/column numbers and XPATH location to be reported together: but it is not required to do so. The design also allows position information to be “unknown”.

XmlValidationError

There are two major types of XML validation errors. (For complete list of XML validation errors, check <http://svn.apache.org/viewvc/xerces/java/trunk/src/org/apache/xerces/impl/msg/>.) One could be pinpointed to a particular element: for example, if the element is defined as an integer but the value “ABC” is submitted. For this kind of error, use XmlElementInfo to report the offending element. Another type of error is not focused on one element: for example, if a CSV file is submitted for XML validation. In this case, use XmlGeneralErrorList to include a list of error messages.

Main Functions

Communication in Web Services is defined by the request message and response message. There are four required interfaces (functions): SubmitData, RetrieveStatus, and QueryLimit. Data structure for the request and response messages corresponding to these functions are defined.

Username, password, and organization are always required for any WS request. This information could be included in the request’s SOAP header, although we fail to find any advantage. For the proposed functions, values for element requestType are predefined. The state/vendor could develop other functions with a custom value for “requestType”. All functions also include an element of “additionalInfo” to allow for custom input.

NEMSIS WS response messages all include a status code (discussed above) and an echoing “requestType”, set to the same value as in the request. Except for the function of QueryLimit, they also include a unique identifier “requestHandle”: a system-assigned unique identifier at the server side for the transaction that takes place as a result of the request. In multiple query response situations, the “requestHandle” (or simply referred to as “handle”) is used as a common point of reference.

SubmitData

To submit data, the client needs to specify the data payload, data schema name, and schema version. As discussed above, the combination of schema name and version will decide the standard for the data submitted. After the data are submitted, it is subject to XML validation and Schematron rule checking. The submission is to be rejected due to:

1. XML validation fails
2. National Schematron rule(s) violated
3. Critical state/vendor Schematron rule(s) violated

4. Other critical business rule(s) violated

The response for data submission could be synchronous or asynchronous: in the synchronous situation, an object of “SubmitDataReport” is included in the response, together with status code, handle, and echoing requestType. In the asynchronous situation, the server is not able to process the submitted data in time. Then “SubmitDataReport” is not included in the response. The client should use the assigned requestHandle in the response message to query the server later.

RetrieveStatus

RetrieveStatus function is used to retrieve results from the previous submission. This is most important for an asynchronous response from the submission. However, even with a synchronous response, the server might save the submission processing status result for a limited time period. In this case, if the client needs to retrieve the result later, it can use the returned requestHandle.

The response to RetrieveStatus could be:

1. If the process is still not finished (pending), the server should return the same requestHandle and status code of pending (0).
2. If the process is completed and status is available, the server should return the same requestHandle, proper status code, and a SubmitDataReport, depending on the original request.
3. The server should return with proper status code if the status is not available because the status has expired, been deleted, or the requestHandle is not a valid identifier.

QueryLimit

Different web servers and WS implementations could apply a unique constraint on the size of the whole Web Service message. WS consumers can use this interface to query WS server's configuration for this limit.

The response to QueryLimit could be:

1. A positive integer to indicate the size limit on data payload, expressed in KB (1024 bytes).
2. A negative integer (-1) and an error status code.

Use cases:

Case 1 – Submit Data Request, Synchronous scenario

Step 1. Agency “Elmo” wants to send a set of EMS records to state “Sesame Street”. A Submit Request is sent with “Request Type” = “SubmitData”. The SOAP message looks like this:

SOAP Message 1

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/" xmlns:ws="http://ws.nemsis.org/">
  <soapenv:Header/>
  <soapenv:Body>
    <ws:SubmitDataRequest>
      <ws:username>sutest</ws:username>
      <ws:password>openthedoor</ws:password>
      <ws:organization>sesame</ws:organization>

      <ws:requestType>SubmitData</ws:requestType>
      <ws:SubmitPayload>
        <!--You have a CHOICE of the next 3 items at this level-->
        <!--
          <ws:PayloadOfString>
            <ws:encoding>text/xml</ws:encoding>
            <ws:payload?</ws:payload>
          </ws:PayloadOfString>
        -->
        <ws:PayloadOfBinary>
          <ws:encoding>base64Binary</ws:encoding>
          <ws:compressed>true</ws:compressed>
          <ws:payload>cid:103713444083</ws:payload>
        </ws:PayloadOfBinary>
        <!--
          <ws:PayloadOfXmlElement>
            <ws:encoding>xml</ws:encoding>-->
            <!--You may enter ANY elements at this point-->
          <!--
            </ws:PayloadOfXmlElement>
          -->
        </ws:SubmitPayload>
        <ws:requestDataSchema>bbbb</ws:requestDataSchema>
        <ws:schemaVersion>3456</ws:schemaVersion>
        <ws:additionalInfo>fun</ws:additionalInfo>
      </ws:SubmitDataRequest>
    </soapenv:Body>
  </soapenv:Envelope>
```

Step 2. The State receives the message and successfully processes it within a reasonable amount of time. It replies with a “requestHandle”, a system-assigned unique identifier for the transaction of handling Elmo’s WS request. Then the response message looks like this:

SOAP Message 2

```
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <SubmitDataResponse xmlns="http://ws.nemsis.org/">
      <requestType>SubmitData</requestType>
      <requestHandle>12345678</requestHandle>
      <statusCode>1</statusCode>
      <reports>
        <XmlValidationErrorReport>
          <TotalErrorCount>0</TotalErrorCount>
        </XmlValidationErrorReport>
        <SchematronReport>
          <CompleteSchematronReport>
            <CompleteReport>
              <PayloadOfString>
                <payload>test string payload. should be XML file content.</payload>
              </PayloadOfString>
            </CompleteReport>
          </CompleteSchematronReport>
        </SchematronReport>
      </reports>
    </SubmitDataResponse>
  </S:Body>
</S:Envelope>
```

Case 2. Submit Data Request, Asynchronous scenario

Step 1. Same as step 1 in case 1, Agency “Elmo” sends XML to state “Sesame Street”.

Step 2. The State receives the xml file. Because the system is too busy handling other agencies’ requests, the response message looks like this:

SOAP Message 3

```
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <SubmitDataResponse xmlns="http://ws.nemsis.org/">
      <requestType>SubmitData</requestType>
      <requestHandle>12345678</requestHandle>
      <statusCode>0</statusCode>
    </SubmitDataResponse>
  </S:Body>
</S:Envelope>
```

Step 3. RetrieveStatus Request for previous submission

After 15 minutes, as a responsible agent, Elmo thinks it has given the state system enough time to process the data. Using “requestHandle”, Elmo can query the state system to get the result of its previous WS request. The SOAP message for this kind of “RetrieveStatus” request looks like this:

SOAP Message 4

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/" xmlns:ws="http://ws.nemsis.org/">
  <soapenv:Header/>
  <soapenv:Body>
    <ws:RetrieveStatusRequest>
      <ws:username>sutest</ws:username>
      <ws:password>openthedoor</ws:password>
      <ws:organization>sesame</ws:organization>
      <ws:requestType>RetrieveStatus</ws:requestType>
      <ws:requestHandle>12345678</ws:requestHandle>
      <!--Optional:-->
      <ws:originalRequestType>SubmitData</ws:originalRequestType>
      <ws:additionalInfo>fun</ws:additionalInfo>
    </ws:RetrieveStatusRequest>
  </soapenv:Body>
</soapenv:Envelope>
```

Step 4. Response to Step 3’s Request

Output 1: If the state has finished processing the submission request, then the response message looks like “SOAP Message 2”.

Output 2: If the state still hasn’t finished processing the submission request, the response message looks like “SOAP Message 3”. So Elmo needs to come back later to check the status (repeat step 3).

Note: if for any reason Elmo forgets the status of his submission, even after he has received notification of a successful submission, Elmo should be able to send a “RetrieveStatus” request to the state again. As a good bookkeeper, the state should be able to response back with “SOAP Message 2”. Certainly, if the requestHandle is actually for a submission 10 years ago, it is very possible that the state will tell Elmo the status has expired.

Discussions:

1. Authentication/Security Implementation

- a. Some vendors might prefer to utilize the security element in the SOAP message's header. Web Service Security Specification, published by OASIS (<http://docs.oasis-open.org/wss/v1.1/wss-v1.1-spec-os-SOAPMessageSecurity.pdf>), provides a set of mechanisms to enforce message integrity and confidentiality. However, due to the vast differences among EMS vendors/deployments, the NEMSIS TAC will not specify a particular SOAP security header structure. It is very possible, and legitimate, that a vendor may choose to include the authentication information in the SOAP header. In such instances, both ends of the WS communication have to reach a mutual understanding about the underlining security mechanism (and ignore the username/password parameters in the proposed object nemsisV3WsRequest). For example, they can choose to use (a)symmetric keys to encrypt username/password.
- b. It was stated in the draft NEMSIS WS Guide that "passwords should never be sent as clear-text". We should revise this statement to be "passwords should never be sent as clear-text over a non-secured channel". Again, we require that all WS communications use HTTPS since we need to protect not only the header section, but also the embedded data payload. Hashing, or password digestion, is not more secure than a password in clear text, if it is not sent on a secure channel or token not encrypted. (See <http://www.oasis-open.org/committees/download.php/16782/wss-v1.1-spec-os-UsernameTokenProfile.pdf>, line 159-162. On 10/19/2011, some researchers demonstrated at the ACM conference how to break W3C standard XML encryption.)
- c. Password hashing might create unique challenges for implementation. For example, when using Microsoft Active Directory (AD) authentication, the WS recipient has to have a way to figure out the clear text password, then it can be sent to AD for authentication. OASIS documents have detailed discussions about other security concerns. (See references on page 27.)

2. Web Services is not a perfect solution for transmitting large amounts of data in one WS message. Most web servers and WS implementations apply a limit on the size of one Web Service message. Oversized WS messages could be rejected by a web server, even before reaching the WS receiving codes. Also, due to performance considerations, WS recipients might prefer small WS messages. Researchers at IBM have published a study on this issue. (See reference 4 on page 27) We strongly encourage software vendors to develop appropriate strategies that fit their own software/hardware environments.

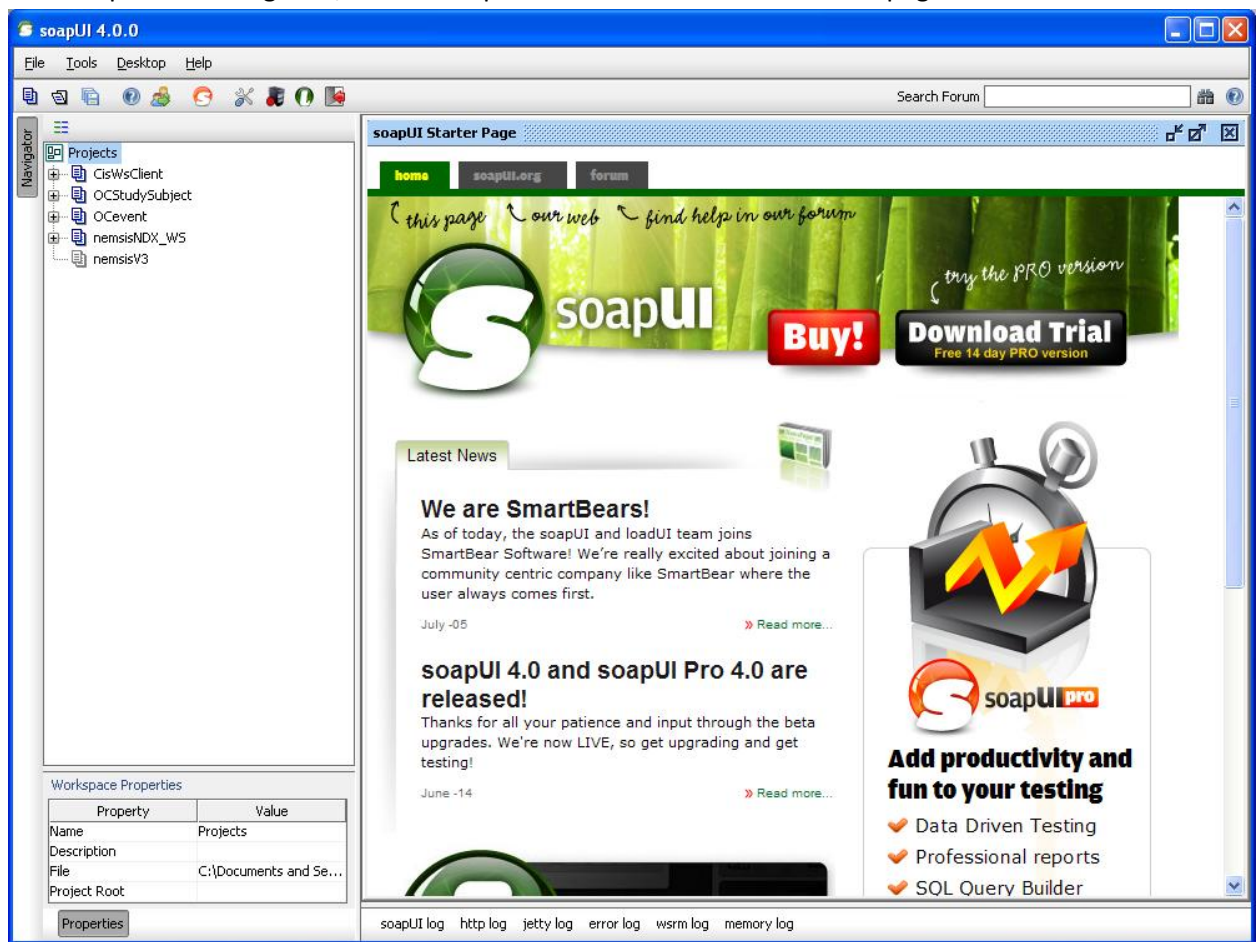
3. Unfortunately, it is hard to predict the size of one NEMSIS EMS record, especially when medical image files might be embedded. This is why the proposed interface "QueryLimit" should return the limit on the size of the string, instead of how many EMS records are contained.

4. Many web servers and web clients (like most web browsers) have built-in HTTP compression capability to facilitate faster transmission speeds. But, in the case where the WS client/server doesn't have HTTP compression built-in, it is necessary to consider compressing the NEMSIS XML File. In most cases, NEMSIS XML files could be compressed easily. We often see the compression rates of 30:1. So a 30MB NEMSIS file could be compressed to 1MB. After Base64 encoding, which increases the size of binary data by 33%, the final string to transmit is about 1.4MB.

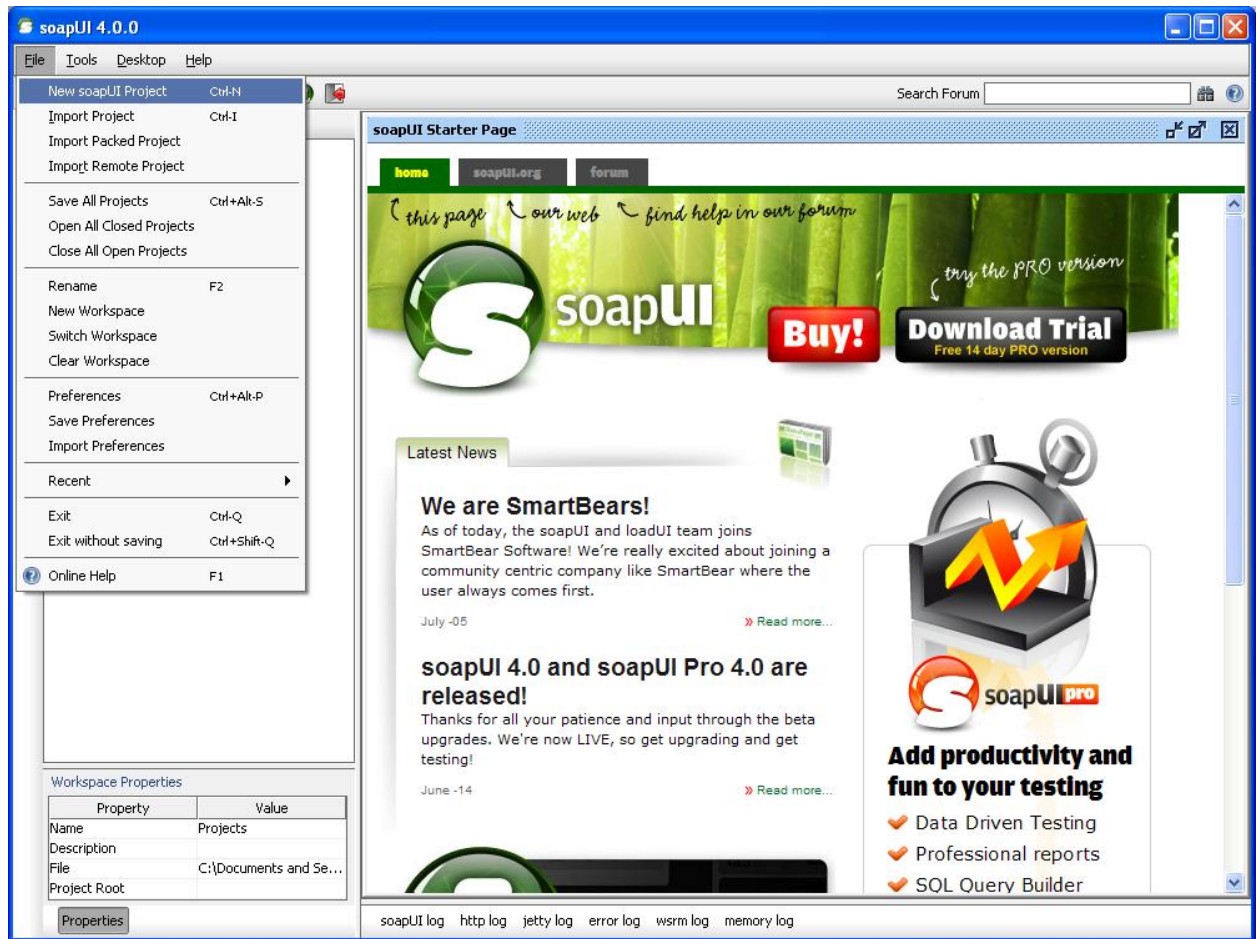
A Quick Guide for Using soapUI

This is just a simple guide to use soapUI, one of the most popular open source applications for testing Web Services. I believe that most readers are already familiar with it. Feel free to skip this section. The following is for Windows users. Check <http://www.soapui.org/Getting-Started/getting-started.html> for additional information.

1. Download soapUI from <http://www.soapui.org/>. (I prefer to download the standalone version.)
2. Install soapUI to your system, if you download the installer. If you download the standalone version, simply unzip it to your hard drive; then go into its bin folder, and run “soapui.bat” to start soapUI.
3. Start soapUI from Programs, or run “soapui.bat”. You should see a starter page like this:

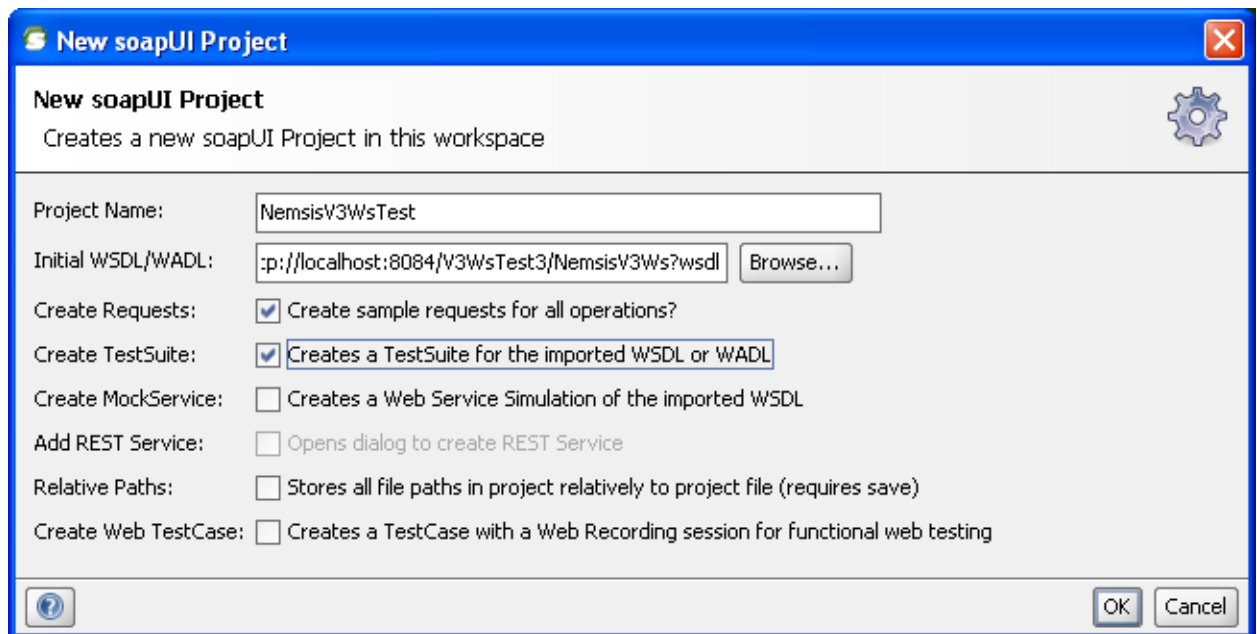


4. Click on File→"new soapUI Project" to start a new project.



5. Name your project. Since I deployed my NEMSIS WS on my developing desktop, the WSDL could be accessed at http://nemsis.org/v3/NEMSIS_V3_8.wsdl. Copy this to the text box next to "Initial WSDL/WADL". In many cases, you might save the published WSDL file to your hard drive – then you can use the Browse button to locate the WSDL file.
- It would be wise to investigate the WSDL file first: you have to make sure all referenced files are accessible. A funny thing about a WSDL file published by Spring Framework is that it usually doesn't include the full path in the SOAP address. For example, the line
- ```
<soap:address location=" http://nemsis.org/v3/NEMSIS_V3_8.wsdl " />
```
- could simply be
- ```
<soap:address location="/v3/NEMSIS_V3_8.wsdl" />
```
- In that case, you'd better save the WSDL and edit it. (You can also change the soapUI test property to force it point to the real server address.)

Remember to create TestSuite.



The 'New soapUI Project' dialog box is shown. It has a title bar with a question mark icon, the text 'New soapUI Project', and a close button. Below the title bar is a subtitle 'New soapUI Project' and a description 'Creates a new soapUI Project in this workspace' next to a gear icon. The main area contains several fields and checkboxes: 'Project Name:' with a text box containing 'NemsisV3WsTest'; 'Initial WSDL/WADL:' with a text box containing 'p://localhost:8084/V3WsTest3/NemsisV3Ws?wsdl' and a 'Browse...' button; 'Create Requests:' with a checked checkbox 'Create sample requests for all operations?'; 'Create TestSuite:' with a checked checkbox 'Creates a TestSuite for the imported WSDL or WADL'; 'Create MockService:' with an unchecked checkbox 'Creates a Web Service Simulation of the imported WSDL'; 'Add REST Service:' with an unchecked checkbox 'Opens dialog to create REST Service'; 'Relative Paths:' with an unchecked checkbox 'Stores all file paths in project relatively to project file (requires save)'; and 'Create Web TestCase:' with an unchecked checkbox 'Creates a TestCase with a Web Recording session for functional web testing'. At the bottom are a help icon, an 'OK' button, and a 'Cancel' button.

New soapUI Project
Creates a new soapUI Project in this workspace

Project Name:

Initial WSDL/WADL:

Create Requests: ☒ Create sample requests for all operations?

Create TestSuite: ☒ Creates a TestSuite for the imported WSDL or WADL

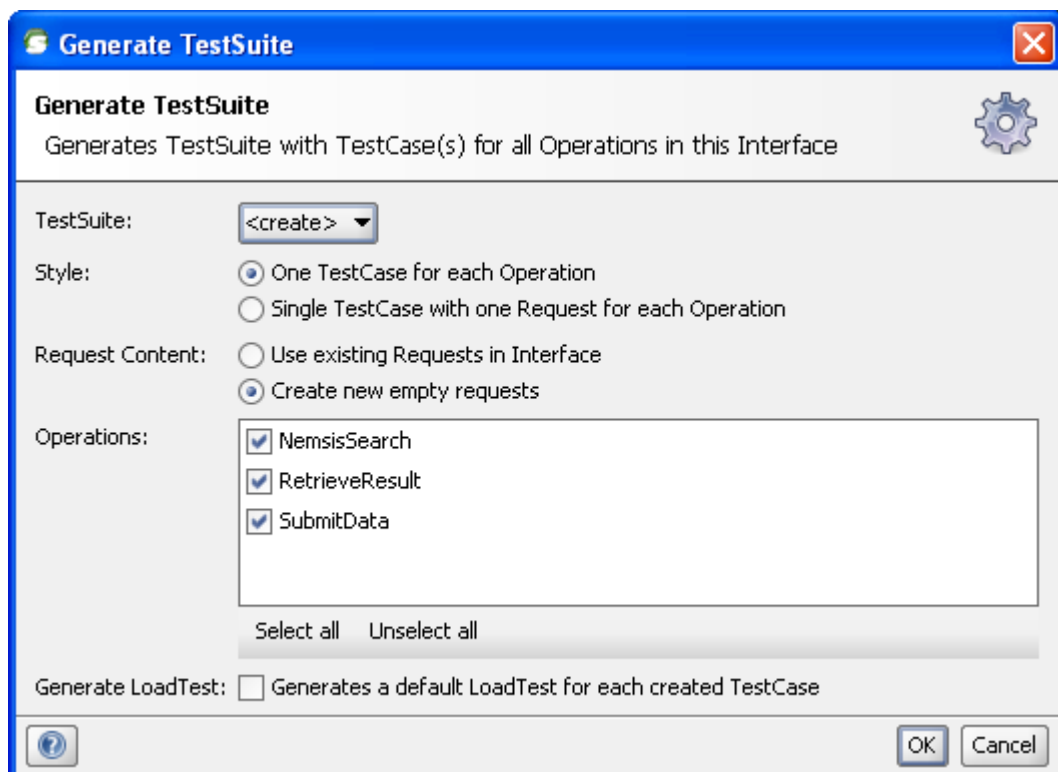
Create MockService: ☐ Creates a Web Service Simulation of the imported WSDL

Add REST Service: ☐ Opens dialog to create REST Service

Relative Paths: ☐ Stores all file paths in project relatively to project file (requires save)

Create Web TestCase: ☐ Creates a TestCase with a Web Recording session for functional web testing

6. Now, soapUI will parse the WSDL and generate TestSuite for all functions defined in WSDL file.



The 'Generate TestSuite' dialog box is shown. It has a title bar with a question mark icon, the text 'Generate TestSuite', and a close button. Below the title bar is a subtitle 'Generate TestSuite' and a description 'Generates TestSuite with TestCase(s) for all Operations in this Interface' next to a gear icon. The main area contains several fields and checkboxes: 'TestSuite:' with a dropdown menu showing '<create>'; 'Style:' with two radio buttons, 'One TestCase for each Operation' (selected) and 'Single TestCase with one Request for each Operation'; 'Request Content:' with two radio buttons, 'Use existing Requests in Interface' and 'Create new empty requests' (selected); 'Operations:' with a list box containing 'NemsisSearch', 'RetrieveResult', and 'SubmitData', each with a checked checkbox; 'Generate LoadTest:' with an unchecked checkbox 'Generates a default LoadTest for each created TestCase'. Below the list box are 'Select all' and 'Unselect all' buttons. At the bottom are a help icon, an 'OK' button, and a 'Cancel' button.

Generate TestSuite
Generates TestSuite with TestCase(s) for all Operations in this Interface

TestSuite:

Style: ☒ One TestCase for each Operation
☐ Single TestCase with one Request for each Operation

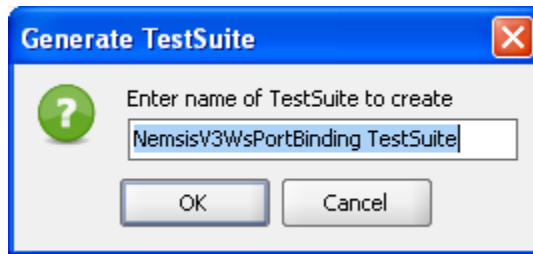
Request Content: ☐ Use existing Requests in Interface
☒ Create new empty requests

Operations: ☒ NemsisSearch
☒ RetrieveResult
☒ SubmitData

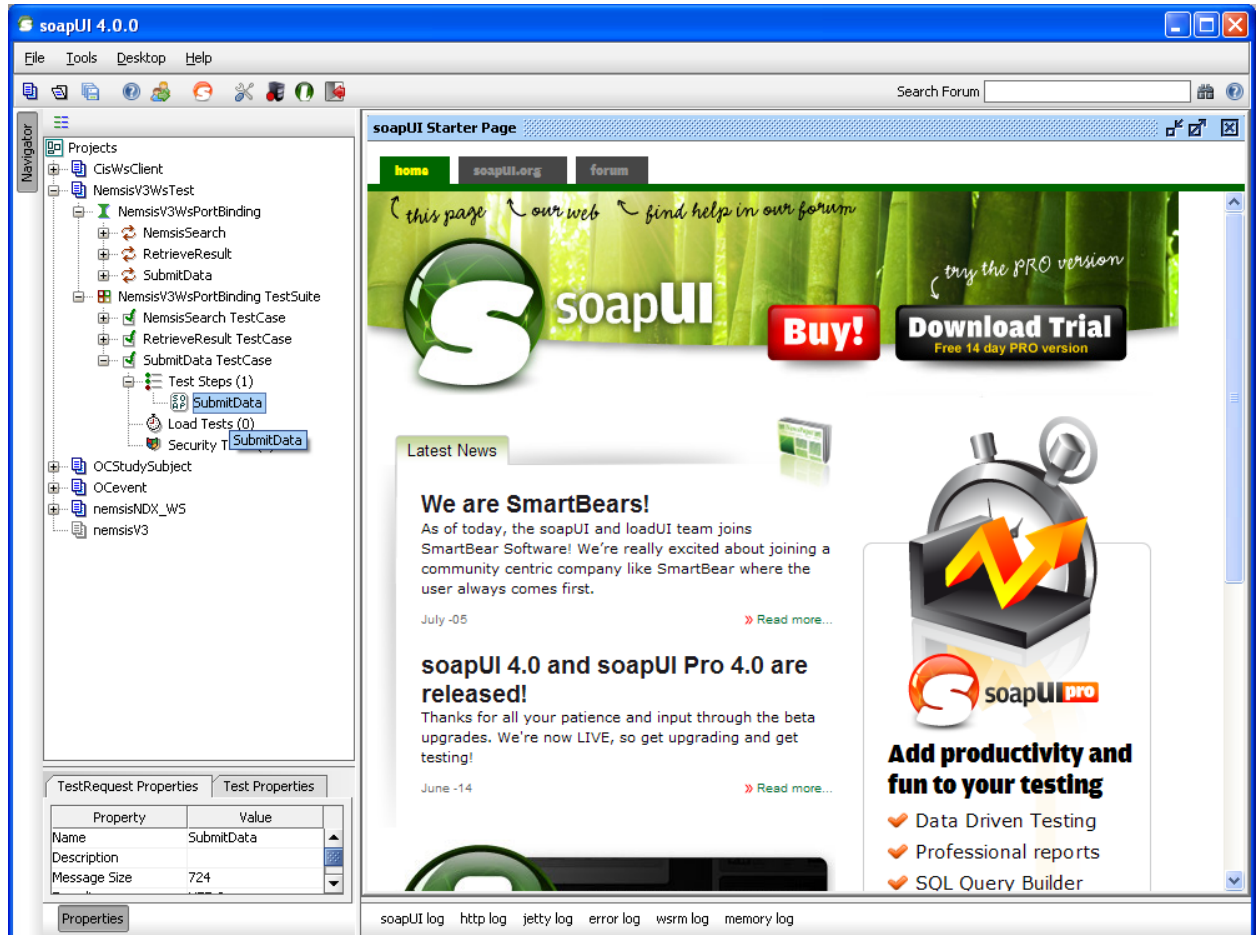
Select all Unselect all

Generate LoadTest: ☐ Generates a default LoadTest for each created TestCase

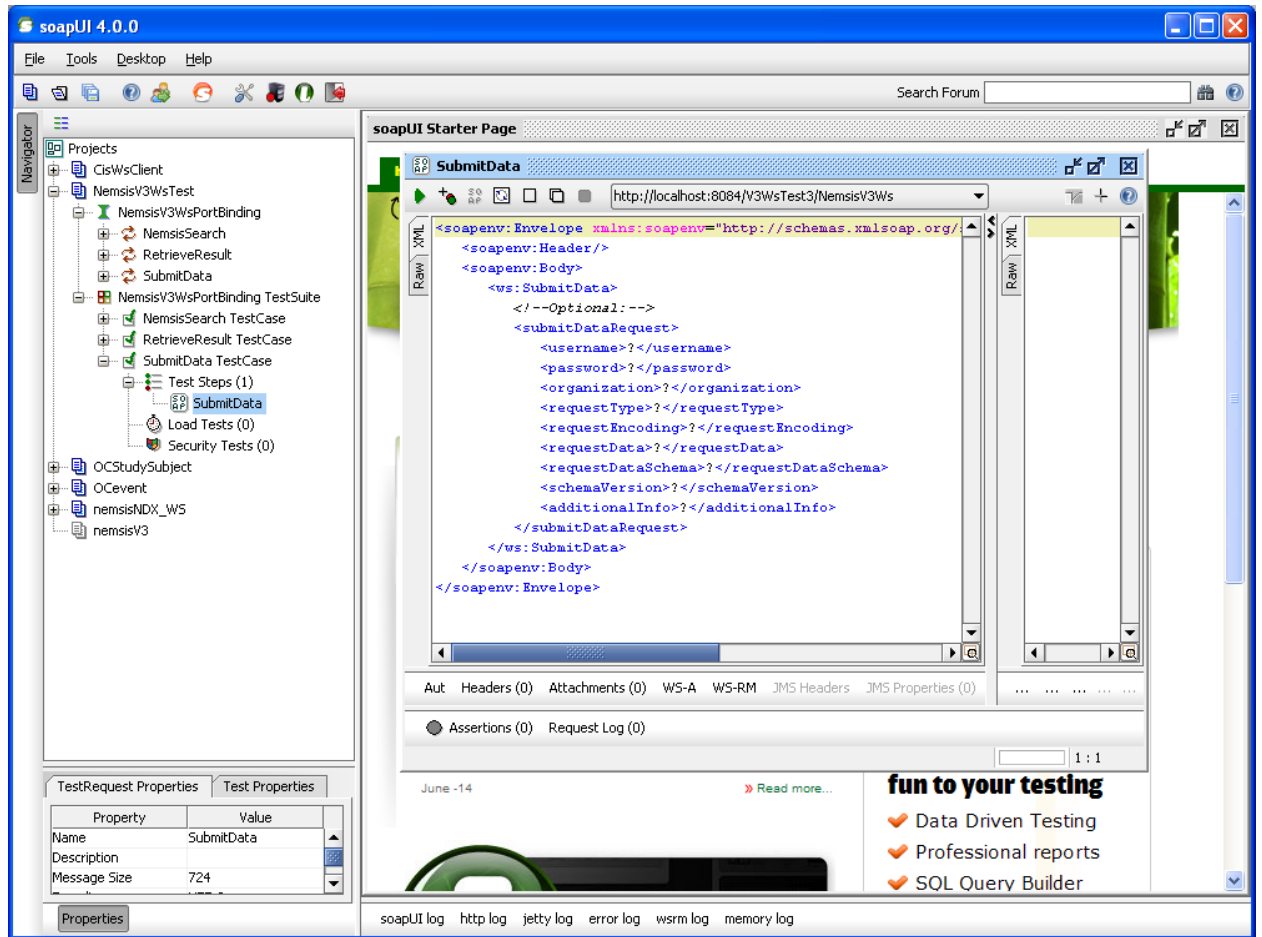
7. Give the TestSuite a name



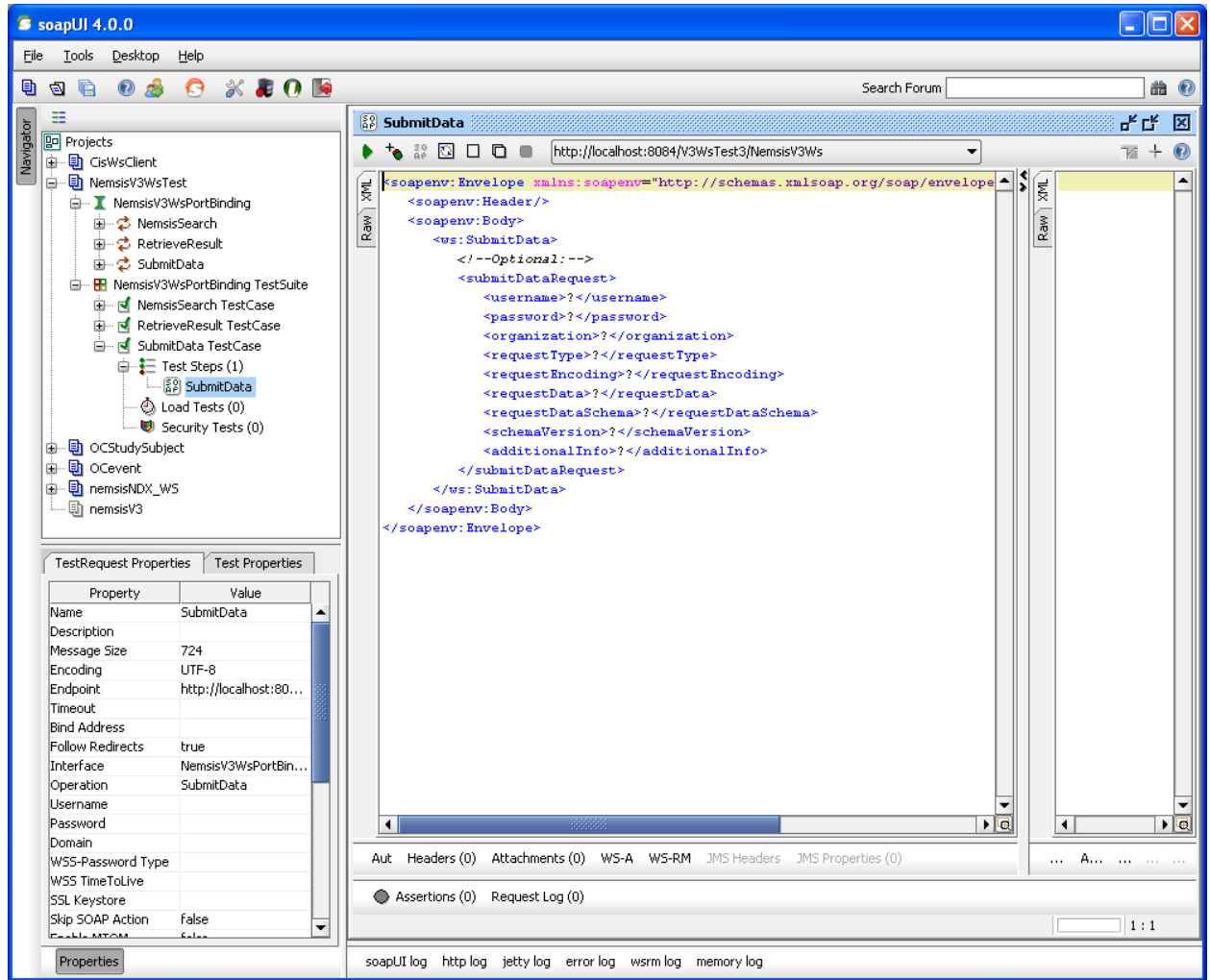
8. In project NemsisV3WsTest, go into “NemsisV3WsPortBinding TestSuite”, “SubmitData TestCase”, “Test Steps(1)”, “SubmitData”:



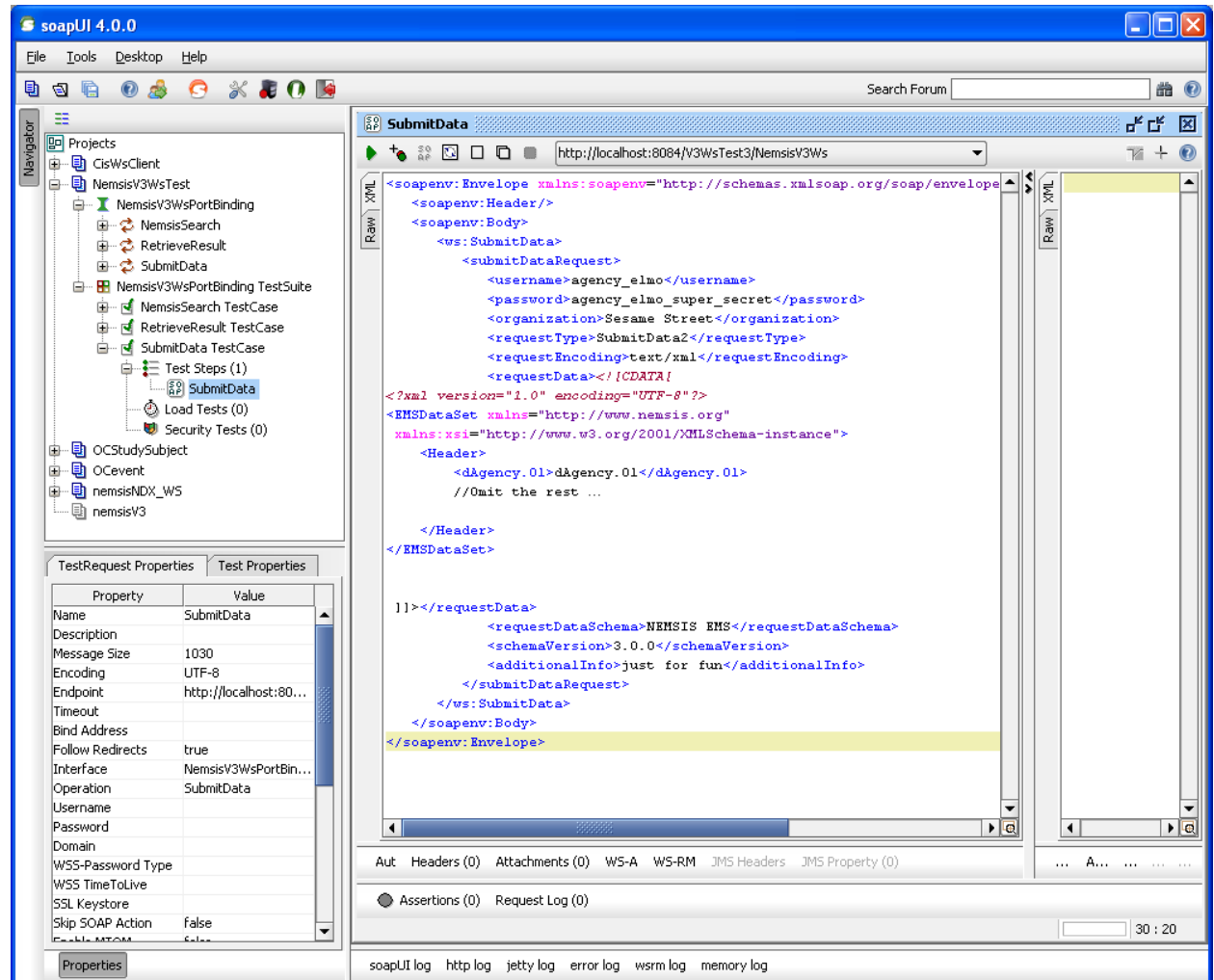
Double click on “SubmitData”,



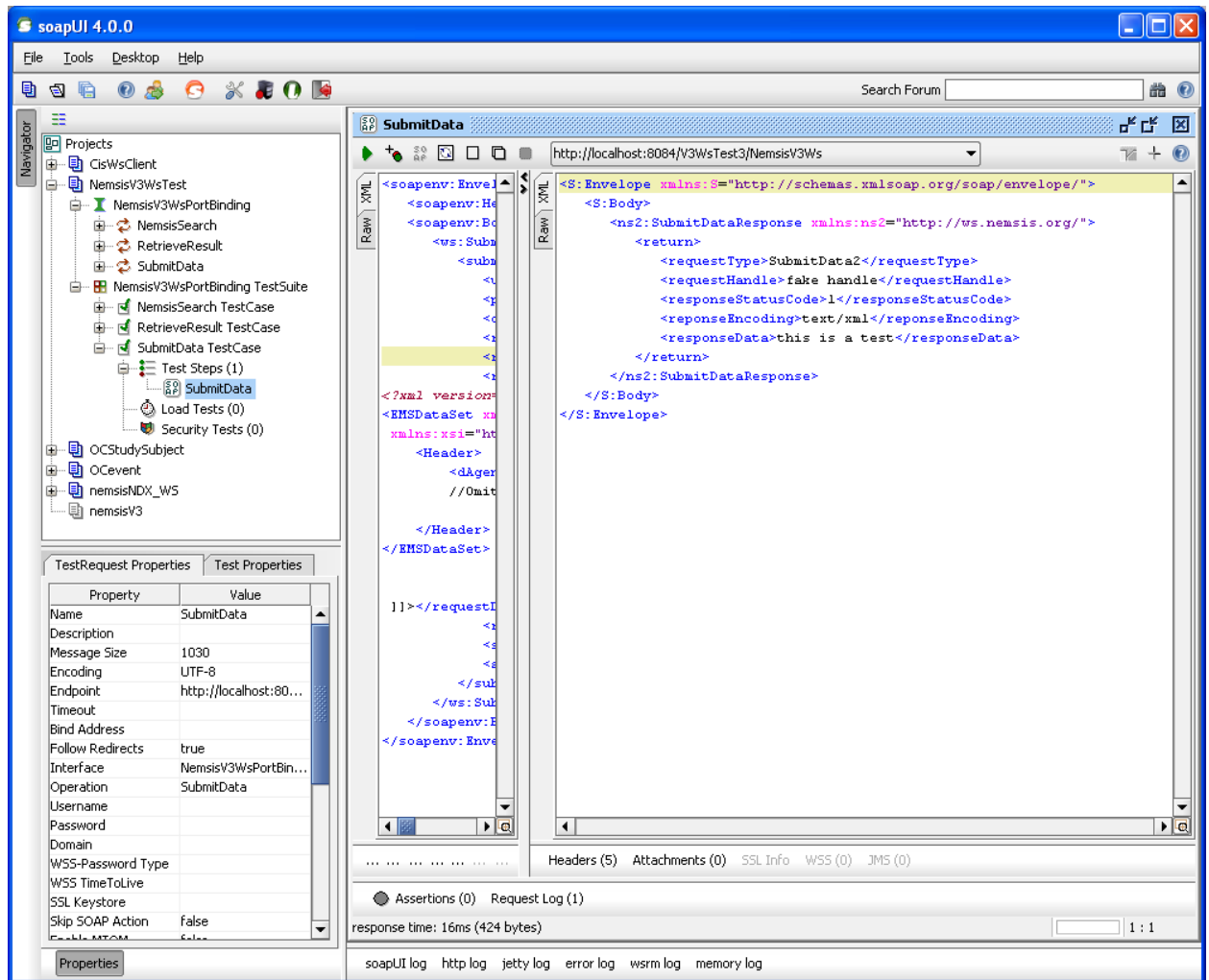
Now is a good time to close “Starter Page” and maximize the new “SubmitData” window.



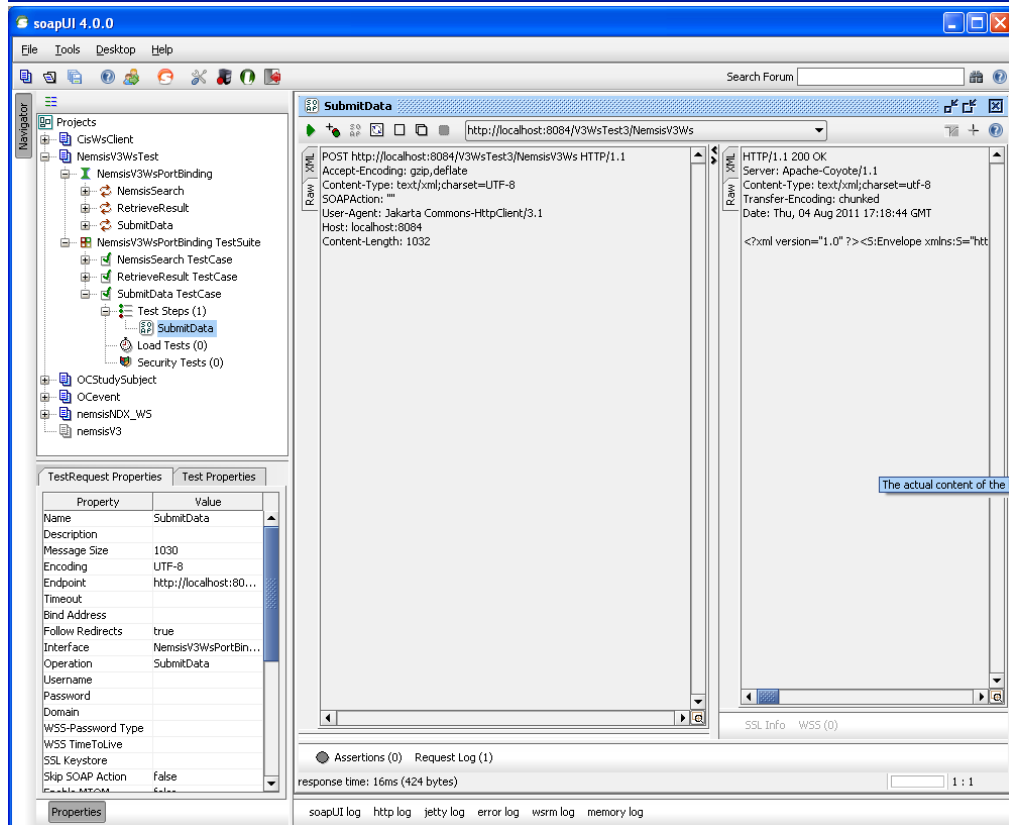
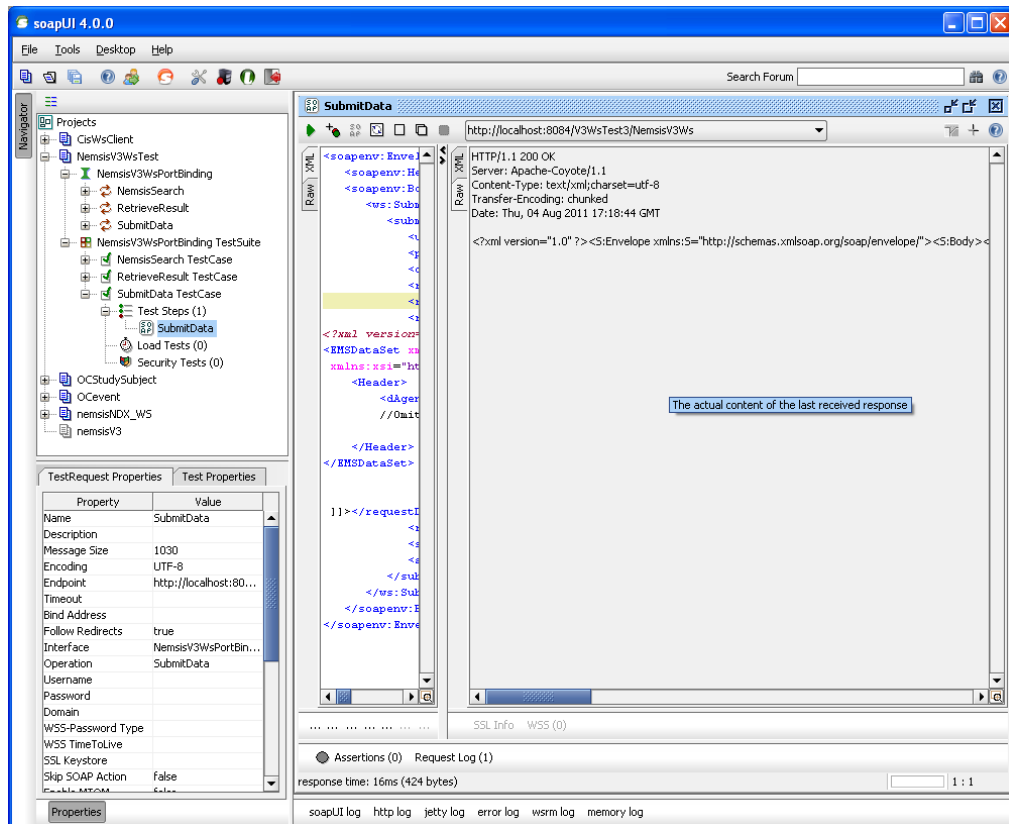
9. SoapUI has already created a template for you to fill in real data. You can copy and paste the content of “SOAP Message 1” in this file’s “User Cases” section.

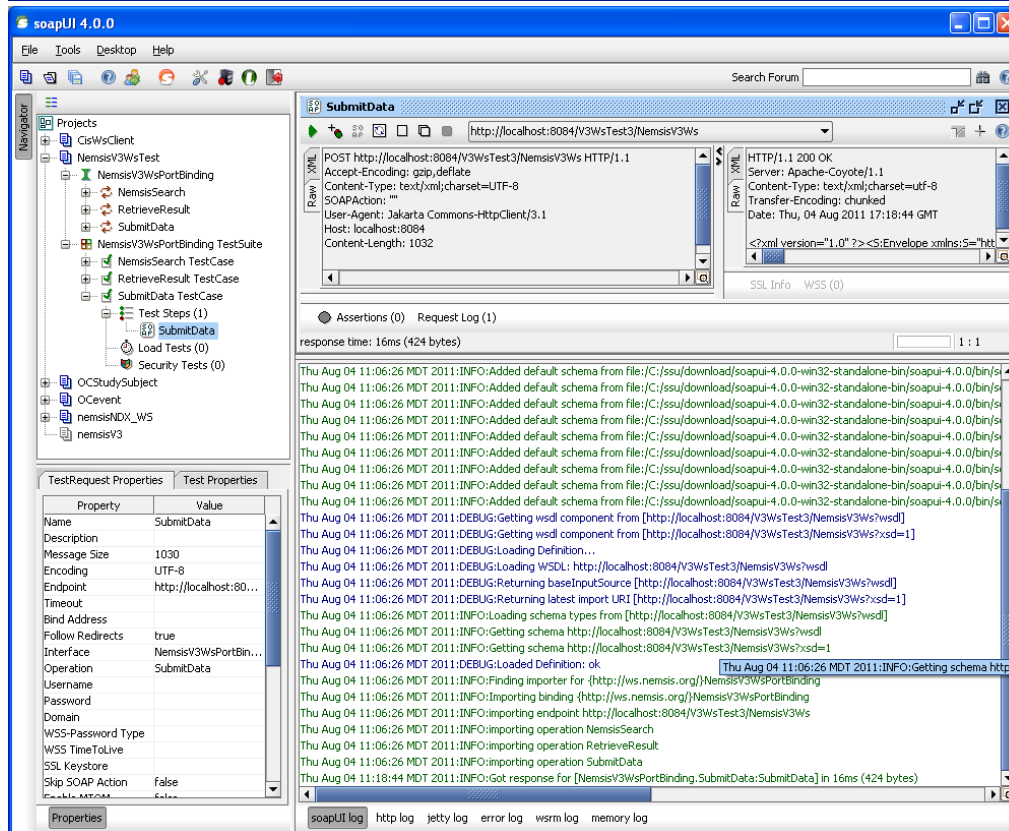
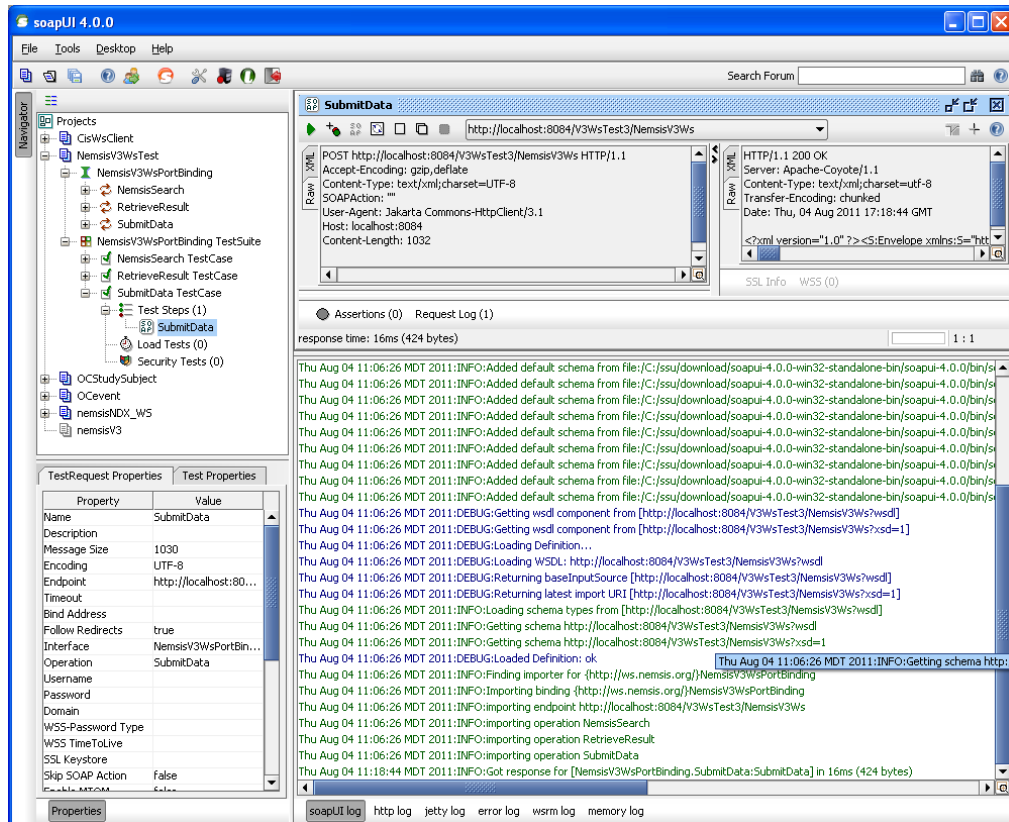


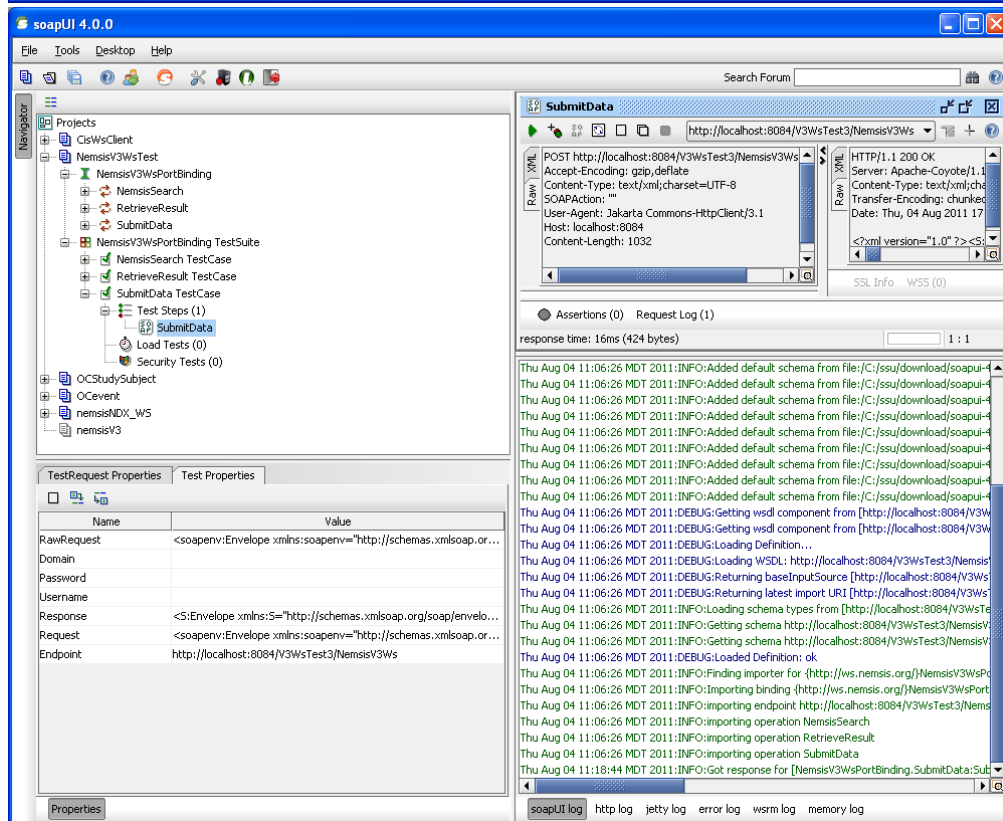
10. Magic moment: click on the green triangle button in left-upper corner of the “SubmitData” window. This will submit the SOAP message to the designated WS server (in Web Services terms, this is the “endpoint”. Make sure your WS server is up and running!). You can see the result in the right panel: since we are testing, my super-simple WS server returns a super-simple message.

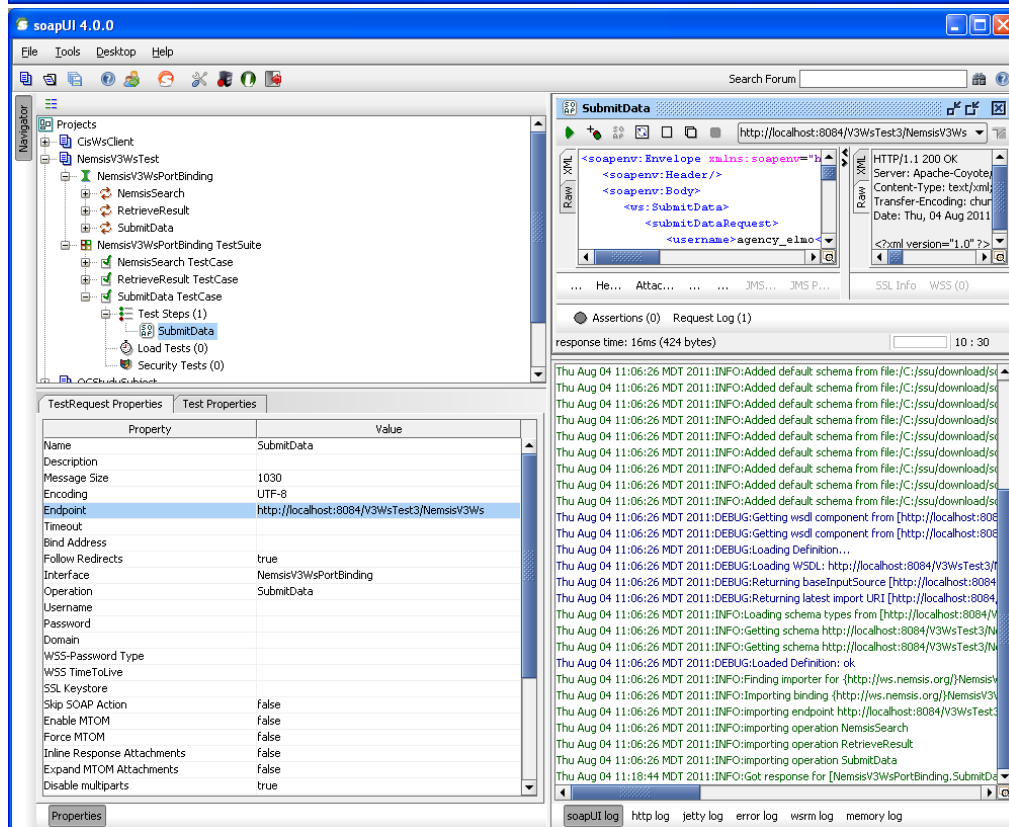


11. SoapUI provides a wide range of functionalities to help you debug a WS application. For example, you can check the raw request/response message, error log, http log. And you can change your endpoint, set up security, attach documents, etc. I attached some snapshots to provide further guidance. To explore the full power of soapUI, read its online document and the forum.









Reference:

1. WS-SecurityPolicy 1.2. OASIS Standard, 1 July 2007. <http://docs.oasis-open.org/ws-sx/ws-securitypolicy/200702/ws-securitypolicy-1.2-spec-os.pdf>
2. Web Services Security: SOAP Message Security 1.1. OASIS Standard Specification, 1 February 2006. <http://docs.oasis-open.org/wss/v1.1/wss-v1.1-spec-os-SOAPMessageSecurity.pdf>
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