

# Proposal for an XML API for the SCORM Run-time Environment

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## ***Abstract***

This paper proposes an XML message based API for communication between an LMS and Learning Object Provider in a run-time learning environment. It transforms the current SCORM Run-time Environment specification based on a JavaScript API implemented on the learner's browser to an XML API implemented as a SOAP web service on the LMS web server.

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## **The Problem**

The present SCORM 1.1 Run-Time specification specifies an API which facilitates the re-use of Learning Objects regardless of the platform used by the Learning Object Provider and the Learning Management System.

The SCORM specification is a JavaScript API executed by client side code on the user's web browser, which raises various issues.

The heavy reliance on client side functionality and JavaScript implies a highly coupled, device and platform dependent. The disadvantages are:

- ?? The client side environment is a fragile and error-prone platform not suited for critical business processes.
- ?? The client side environment raises security issues such as the lack of encryption of identifiers and interaction scores and the possibility of interference and spoofing by the user.
- ?? Dependence on client side software will require a high level of client software support.
- ?? The present API limits the application to one presentational platform, the web browser.
- ?? Future changes in software and scripting languages can make the present API redundant.

As well as the general disadvantages of the reliance on a client side environment, several specific development issues have been reported by developers implementing the SCORM 1.1 Run-Time Environment. These include cross frame scripting, cross browser differences in JavaScript execution and calling JavaScript from web page components and plugins such as Macromedia Flash and Shockwave movies.

## **The Solution**

We propose an XML message based API implemented as a SOAP web service on the LMS web server.

### **XML**

XML is a way of structuring and describing data for exchange over the Internet based on open standards. It is a recommendation of the independent standards body, the World Wide Web Consortium and has been adopted by all the major platform and software vendors.

XML is a truly cross platform technology. As XML messages are only text files, any system or platform, which can process text files and deliver data via HTTP can use XML to interact with other systems.

As XML is now an open standard, the increasing availability of third party software and tool support makes XML based software easy and inexpensive to implement compared to other networking and interop technologies.

## SOAP

SOAP is a specification (<http://msdn.microsoft.com/xml/general/soapspec.asp>) for the exchange of data using XML and HTTP, initiated and developed by Develop Mentor, IBM, Microsoft, Lotus and UserLand Software.

The SOAP 1.1 specification provides the following:

- ?? It defines a document definition (schema) for packaging XML data within an XML SOAP envelope.
- ?? It defines a protocol for the handling of SOAP messages. This includes the basic request / response framework, general message processing rules such as an error handling mechanism and message specific rules for validation and encoding of application specific data.

A SOAP web service is based on a very simple contract:

"If you send me a XML text message, formatted using an agreed schema and enclosed in a SOAP 'envelope', I will process that XML message and send you a correctly formatted XML response".

SOAP development tool support is widespread. Various toolkits are available which hide the low level processing and manipulation of XML messages and their transportation from the developer. This facilitates the development of SOAP web services and their clients.

## Advantages of an XML API

Use of an XML API for the SCORM Run-time Environment will ensure future interoperability, as it will be impervious to even radical changes in platform and software.

An API implemented on the web server will provide a more controlled and secure environment.

An XML API would decouple the critical application processes from the presentation platform and therefore provide a more robust, fault tolerant solution.

An XML API would allow greater freedom of implementation for a SCORM compliant learning system.

An XML API would remove the present restriction on presentation device inbuilt into the present web browser based environment.

## The API

### Data Model Representation

The following example shows an XML representation of the current SCORM Run-Time Environment Data Model.

Only fragments of this XML document will be used in any particular SOAP message depending on the data model elements required. The XML API will be subject to exactly the same requirements as the present SCORM API regarding the appropriate use of data elements in API calls.

Representing the data model as XML rather than the present dot notation (cmi.core.student\_id) will facilitate the parsing of data and allow strict validation against document definitions and schemas.

#### Run-Time Data Model as XML

```
<?xml version="1.0" encoding="UTF-8"?>
<cmi>
  <_version>3.4</_version>
  <core>
    <_children>student_id,student_name,lesson_location,credit,lesson_status,entry,score,total_time,
exit,session_time</_children>
    <student_id>OCF10987</student_id>
    <student_name>Cain, Doug</student_name>
    <lesson_location>LO198/5</lesson_location>
    <credit>no_credit</credit>
    <lesson_status>completed</lesson_status>
    <entry>ab-initio</entry>
    <score>
      <_children>raw,min,max</_children>
      <raw>77.5</raw>
      <max>100</max>
      <min>0</min>
    </score>
    <total_time>01:29:57.8</total_time>
    <lesson_mode>normal</lesson_mode>
    <exit>normal</exit>
    <session_time>00:13:12</session_time>
  </core>
  <suspend_data>flash-state=563</suspend_data>
  <launch_data>stylesheet=http://www.mylms.com/stylesheets/mylms.xslt</launch_data>
  <comments>This is too hard for me!</comments>
  <comments_from_lms>Remember to read the questions carefully.</comments_from_lms>
  <objectives>
    <_children>id,score,status</_children>
    <_count>2</_count>
    <objective index="0">
      <id>OBJ423</id>
      <score>
        <_children>raw,min,max</_children>
        <raw>23.5</raw>
```

```

        <max>50</max>
        <min>0</min>
    </score>
    <status>failed</status>
</objective>
<objective index="1">
    <id>OBJ81</id>
    <score>
        <_children>raw,min,max</_children>
        <raw>65</raw>
        <max>100</max>
        <min>0</min>
    </score>
    <status>passed</status>
</objective>
</objectives>
<student_data>
    <_children>mastery_score,time_limit_action,max_time_allowed</_children>
    <mastery_score>75</mastery_score>
    <max_time_allowed>45:00:00</max_time_allowed>
    <time_limit_action>exit-message</time_limit_action>
</student_data>
<student_preference>
    <_children>audio,language, speed,text</_children>
    <audio>80</audio>
    <language>English</language>
    <speed>0</speed>
    <text>0</text>
</student_preference>
<interactions>
    <_children>id,time,type,correct_responses,student_response</_children>
    <_count>2</_count>
    <interaction index="0">
        <id>INT001</id>
        <objectives>
            <_count>2</_count>
            <objective index="0">
                <id>OBJ001</id>
            </objective>
            <objective index="1">
                <id>OBJ002</id>
            </objective>
        </objectives>
        <time>18:05:37</time>
        <type>true-false</type>
        <correct_responses>
            <_count>3</_count>
            <correct_response index="0">
                <pattern>1</pattern>
            </correct_response>
            <correct_response index="1">
                <pattern>1</pattern>
            </correct_response>
            <correct_response index="2">
                <pattern>0</pattern>
            </correct_response>
        </correct_responses>
        <weighting>0.66</weighting>
        <student_response>1</student_response>
        <result>correct</result>
        <latency>10:00:00</latency>
    </interaction>
    <interaction index="1">
        <id>INT002</id>

```

```

<objectives>
  <_count>1</_count>
  <objective index="0">
    <id>OBJ003</id>
  </objective>
</objectives>
<time>18:32:02</time>
<type>true-false</type>
<correct_responses>
  <_count>2</_count>
  <correct_response index="0">
    <pattern>0</pattern>
  </correct_response>
  <correct_response index="1">
    <pattern>1</pattern>
  </correct_response>
</correct_responses>
<weighting>.75</weighting>
<student_response>0</student_response>
<result>correct</result>
<latency>15:00:00</latency>
</interaction>
</interactions>
</cmi>

```

## API Functions

The XML API is defined in the following SOAP message examples. This section should be read with reference to the API specification outlined in SCORM 1.1.

### LMSInitialize

The following message initialises the learning session:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Body>
    <LMSInitialize xmlns="http://www.adlnet.org/api">
      <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
        <initialize/>
      </cmi>
    </LMSInitialize>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

The following response message indicates the success of the initialisation process:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Body>
    <LMSInitializeResponse xmlns="http://www.adlnet.org/api">
      <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
        <initialize status="0"/>
      </cmi>
    </LMSInitializeResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

```

    </LMSInitializeResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Note the status attribute on the initialize node which indicates success.

The following response message indicates the failure of the initialisation process:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Body>
    <LMSInitializeResponse xmlns="http://www.adlnet.org/api">
      <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
        <initialize status="501"/>
      </cmi>
    </LMSInitializeResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Note the value of the status attribute on the initialize node which indicates failure with error code 501 (Initialization failed).

## LMSFinish

The following message terminates the learning session:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Body>
    <LMSFinish xmlns="http://www.adlnet.org/api">
      <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
        <finish/>
      </cmi>
    </LMSFinish>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

The following response message indicates the success of the termination process:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
  <SOAP-ENV:Body>
    <LMSFinishResponse xmlns="http://www.adlnet.org/api">
      <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
        <finish status="0"/>
      </cmi>
    </LMSFinishResponse>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Note the status attribute on the finish node which indicates success.

The following response message indicates the failure of the termination process:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"

```

```

        SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" >
    <SOAP-ENV:Body>
        <LMSFinishResponse xmlns="http://www.adlnet.org/api">
            <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
                <finish status="502"/>
            </cmi>
        </LMSFinishResponse>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Note the value of the status attribute on the initialize node which indicates failure with error code 502 (Finish failed).

## LMSGetValue

The following message queries the LMS system for multiple data model element values:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
    SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" >
    <SOAP-ENV:Body>
        <LMSGetValue xmlns="http://www.adlnet.org/api">
            <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
                <_version/>
                <core>
                    <student_id/>
                    <student_name/>
                    <credit/>
                    <lesson_mode/>
                </core>
                <launch_data/>
                <objectives>
                    <objective index="0">
                        <id/>
                    </objective>
                </objectives>
            </cmi>
        </LMSGetValue>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Note that an empty data element node signifies a request for the data for that element.

The following response message returns the requested values:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/" SOAP-
ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" >
    <SOAP-ENV:Body>
        <LMSGetValueResponse xmlns="http://www.adlnet.org/api">
            <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
                <_version status="0">3.4</_version>
                <core>
                    <student_id status="0">STU28934</student_id>
                    <student_name status="0">Cain, Doug</student_name>
                    <credit status="0">credit</credit>
                    <lesson_mode status="401">
                        <error>Not implemented error</error>
                    </lesson_mode>
                </core>
            </cmi>
        </LMSGetValueResponse>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

```

        </lesson_mode>
    </core>
    <launch_data status="0">
        stylesheet=http://www.my_lms.com/stylesheets/my_lms.xslt
    </launch_data>
    <objectives>
        <objective index="0">
            <id status="0">OBJ824</id>
        </objective>
    </objectives>
</cmi>
</LMSGetValueResponse>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

Note that each data model element node returns with a status attribute. The value of the status attribute conforms to the present SCORM API error codes (0 – No error, 401 – Not implemented error etc.). An error message can accompany any data node which return an error status.

## LMSSetValue

The following message sends multiple data model element values to the LMS system:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
    SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
    <SOAP-ENV:Body>
        <LMSSetValue xmlns="http://www.adlnet.org/api">
            <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
                <comments>This lesson is very interesting.</comments>
                <student_preference>
                    <audio>-1</audio>
                </student_preference>
            </cmi>
        </LMSSetValue>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

The following response message returns status information about the update:

```

<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
    SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
    <SOAP-ENV:Body>
        <LMSSetValueResponse xmlns="http://www.adlnet.org/api">
            <cmi session-id="1D269790-C38D-4F51-9300DE661C7DF885">
                <comments status="0"/>
                <student_preference>
                    <audio status="401">
                        <error>Not implemented error</error>
                    </audio>
                </student_preference>
            </cmi>
        </LMSSetValueResponse>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

```

### **LMSCommit**

This API call has been omitted from the XML API. It is used in the JavaScript API to flush client side data to the LMS server. As the XML API Interface is located on the LMS web server, this API call is not appropriate.

### **LMSGetLastError**

This API call has been omitted from the XML API. Error codes are returned in the XML response messages to the LMSGetValue and LMSSetValue API calls.

### **LMSGetErrorString**

This API call has been omitted from the XML API. Error descriptions are returned in the XML response messages to the LMSGetValue and LMSSetValue API calls.

### **LMSGetDiagnostic**

This API call has been omitted from the XML API. Vendor specific error descriptions can be returned in the XML response messages to the LMSGetValue and LMSSetValue API calls.