Comparative Evaluation of the Maintainability of RESTful and SOAP-WSDL Web Services

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Summary

1. Introduction
2. Theoretical Foundation
3. Experiment Carried Out
4. Results
5. Conclusions
**Historical context:**

1990 - A Controlled experiment comparing the maintainability of two functionally equivalent systems developed with object-oriented language and procedural language (Henry e Humphrey, 1990).

2007 - They studied the impact of maintainability between Aspect Oriented (AO) systems and Object Oriented systems (OO) (Kumar et al., 2007).

2011 - They performed a controlled experiment to assess the impact of coupling in maintaining Service-Oriented Software (Perepletchikov and Ryan, 2011).
1 - Introduction

**Objective:**

- To evaluate the maintainability of the approaches of REST-ful and SOAP-WSDL web services.

Thus, we developed an appropriated architecture and a whole set of web services.
2 - Theoretical Foundation

- Concepts of Web Services
- Experimental Software Engineering
- Maintainability
Service-Oriented Architecture (SOA)

A Service-Oriented Architecture (SOA) is a set of well-defined functionality in the form of services available through the network (Fraser and R. Woodcock, 2007).
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Web services are an emerging technology of Service Oriented Architecture (SOA).

Their main objective is to solve the problem of integrating heterogeneous applications (interoperability).

Its great popularity was due to the adoption of open standards and protocols, such as HTTP and XML.
2 - Theoretical Foundation

Client-Server Architecture

Web Service
Experimental Software Engineering

Experimentation is a systematic process consisting of phases and sub-products generated at the end of each phase.

It begins with the definition of the experiment, extending through the planning, operation, analysis and interpretation to the presentation and packaging.

These phases make up the experimental process illustrated as follows.
The experimental process and associated phases (Wohlin, 2000)
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2 - Theoretical Foundation

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Maintainability

- Maintainability is one of the characteristics of software quality, determining how easy it can be corrected or improved.

- A software with high maintainability requires less time and few people to be modified.
Stages of the Experiment

1. Definition and Planning Study
2. Selection of Subject
3. Preparing the Environment and Execution of Experiment
4. Analysis of Results and Evaluation of the Hypothesis
The study aims to identify characteristics poorly explored in the field of maintainability of service-oriented software.

The proposed hypotheses are not intended to be definitive, but to provide evidence on the issues addressed and may later be used as a reference for further studies in the area.
3 - Experiment Carried Out

The research questions

1. Are RESTful web services more maintainable than SOAP-WSDL web services on the server-side?
2. Are RESTful web services more maintainable than SOAP-WSDL web services on the client-side?
To evaluate the maintainability of RESTful and SOAP-WSDL web services, the following hypotheses were defined:

**Hypothesis 1**

**Null Hypothesis** ($H_0$): There is no difference in maintainability between RESTful and SOAP-WSDL web services on the server-side.

\[ H_0: \text{Maintainability}(RESTful) = \text{Maintainability}(SOAP - WSDL) \]

**Alternative Hypothesis** ($H_1$): There is a difference in maintainability between RESTful and SOAP-WSDL web services on the server-side.

\[ H_1: \text{Maintainability}(RESTful) \neq \text{Maintainability}(SOAP - WSDL) \]
Hypothesis 2

**Null Hypothesis** \( (H_0) \): There is no difference in maintainability between RESTful and SOAP-WSDL web services on the client-side.

\[ H_0: \text{Maintainability}(\text{RESTful}) = \text{Maintainability}(\text{SOAP – WSDL}) \]

**Alternative Hypothesis** \( (H_1) \): There is a difference in maintainability between RESTful and SOAP-WSDL web services on the client-side.

\[ H_1: \text{Maintainability}(\text{RESTful}) \neq \text{Maintainability}(\text{SOAP – WSDL}) \]

It is believed that the RESTful web services are more maintainable on both the server and the client-side of the web service the vice versa.
Experimental Tasks

- The first day of the course served as an introduction to the experiment, that was conducted on the second and third days of the course.

- There were 4 tasks provided to the students, 2 of them asking for make modifications on server-side and the other 2 asking for modifications on client-side web services.
The following **independent variables** were identified in this experiment:

1. Programming Language
2. RESTful web services server-side
3. RESTful web services client-side
4. SOAP-WSDL web services server-side
5. SOAP-WSDL web services client-side
6. Information on the subject: experience and training
7. Maintenance tasks
The dependent variables identified in this study are:

1 - The difference between the maintainability of RESTful web services and SOAP-WSDL web services on the server-side.

2 - The difference between the maintainability of RESTful web services and SOAP-WSDL web services on the client-side.
1 - In the first day of the course a questionarie was given to the students.
2 - In the second day of the course data were collected. Every student of Group A received a copy of RESTful web service on the server-side. Every student of Group B received a copy of SOAP-WSDL web service on the server-side.
3 - In the third day of the course more data were collected.
Results on the Server-Side

We gathered a lot of results. As shown in the following table 1.

First T-Test Student

Table: $T$-Test First Server-Side Task

<table>
<thead>
<tr>
<th>Information</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$</td>
<td>-21,543</td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>8</td>
</tr>
<tr>
<td>$P$-value</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Average in group 1:</td>
<td>1,062</td>
</tr>
<tr>
<td>Average in group 2:</td>
<td>1,708</td>
</tr>
<tr>
<td>Sample standard deviation of group 1:</td>
<td>0,042</td>
</tr>
<tr>
<td>Sample standard deviation of group 2:</td>
<td>0,051</td>
</tr>
<tr>
<td>Pooled standard deviation:</td>
<td>0,047</td>
</tr>
<tr>
<td>Alternative Hypothesis: Unlike</td>
<td>0</td>
</tr>
<tr>
<td>Confidence Interval</td>
<td>95%</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>-0,715</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>-0,577</td>
</tr>
</tbody>
</table>
Analysis of the data with the parametric Student $t$-test for matched pairs revealed a significant change ($p < 0.05$).

Therefore, the alternative experimental hypothesis $H_1$ was accepted and it was concluded that RESTful web services are more maintainable in terms of evolutionarily maintenance than SOAP-WSDL web services on the server-side.
Second T-Test Student

Table: T-Test Second Server-Side Task

<table>
<thead>
<tr>
<th>information</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$</td>
<td>-4.973</td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>8</td>
</tr>
<tr>
<td>$P$-value</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Average in group 1:</td>
<td>0.076</td>
</tr>
<tr>
<td>Average in group 2:</td>
<td>0.085</td>
</tr>
<tr>
<td>Sample standard deviation of group 1:</td>
<td>0.003</td>
</tr>
<tr>
<td>Sample standard deviation of group 2:</td>
<td>0.002</td>
</tr>
<tr>
<td>Pooled standard deviation:</td>
<td>0.002</td>
</tr>
<tr>
<td>Alternative Hypothesis: Unlike</td>
<td>0</td>
</tr>
<tr>
<td>Confidence Interval</td>
<td>95%</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>-0.013</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>-0.004</td>
</tr>
</tbody>
</table>
The result of the $t$-test for matched pairs from the two groups indicates a significant variation ($p < 0.05$).

The alternative hypothesis $H_1$ was therefore accepted, and it was concluded that, as measured by the modifiability metric MC, RESTful web services are more maintainable in terms of adaptive maintenance than SOAP-WSDL web services.
**Third T-Test Student**

**Table: T-Test of a Client-side Task**

<table>
<thead>
<tr>
<th>Information</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$</td>
<td>5.608</td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>8</td>
</tr>
<tr>
<td>$P$-value</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Average in group 1:</td>
<td>0.368</td>
</tr>
<tr>
<td>Average in group 2:</td>
<td>0.126</td>
</tr>
<tr>
<td>Standard Deviation sample Group 1:</td>
<td>0.084</td>
</tr>
<tr>
<td>Deviation standard sample Group 2:</td>
<td>0.045</td>
</tr>
<tr>
<td>Pooled standard deviation:</td>
<td>0.068</td>
</tr>
<tr>
<td>Alternative Hypothesis: Unlike</td>
<td>0</td>
</tr>
<tr>
<td>Confidence Interval</td>
<td>95%</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>0.142</td>
</tr>
<tr>
<td>Upper Limit</td>
<td>0.340</td>
</tr>
</tbody>
</table>
The results of the Student $t$-test for from the two sets of samples revealed a significant variation ($p < 0.05$) in all the groups examined.

The alternative hypothesis $H_1$ was therefore accepted and it was concluded that SOAP-WSDL web services are more maintainable in terms of **adaptive maintenance** than REST-ful web services on the client-side.
This paper presented the results of a controlled experiment examining the relationship between the maintainability of RESTful and SOAP-WSDL web services.

Our experimental results indicate that RESTful web services are more maintainable on the server-side than SOAP-WSDL web services, which are more maintainable on the client-side.
However, with the controlled experiment is not possible to reach overall conclusions about the technology of SOAP-WSDL and RESTful web services.

For this, a more detailed study should be carried out with different types of applications and with greater complexity, and other metrics and more experienced programmers.
Thank you.
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