RadView Software Whitepaper

Load Testing Web 2.0 Technologies

Ajax-RIA-SOA-Web Services

Web 2.0, RIA, AJAX and SOA are terms and abbreviations we hear and use on a daily basis. But do we know what they mean for us as professional performance testers?

This document provides an overview of the relevant Web2.0 terms and elaborates on how to run performance tests on these applications. The document targets the performance testing professional as well as the R&D manager looking for information on how to prepare for this new era.

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Overview

The internet world is evolving with new technologies and architecture models. Web2.0 is a major evolution of Internet applications and provides new options for internet application providers. Web2.0 enables improving the user experience, creating more efficient applications and increasing the productivity of the users and the enterprise.

People most often associate Web2.0 with user-generated content websites, typified by tagging content, blogging, wish lists, and RSS feeds. Some enterprise applications boast a recent Web 2.0 interface called "Enterprise 2.0", but, issues of performance, privacy and personalization are still blocking many enterprises from adopting this new internet trend. On the other hand technology enablers, such as the SOA system architecture and RIA's rich UI are likely to eventually converge with Web 2.0 concepts. The combination of different technologies, architectures and concepts will all create new dimensions of internet applications.
RadView, as a leading provider of performance testing software for Internet Applications, provides solutions and guidelines for testing Web2.0 applications. RadView's current and future product roadmap offers a high level solution enabling developers to secure the **Performance, Scalability and Reliability of their Internet Applications** in general and Web2.0 applications specifically.
This document provides an overview of the relevant Web2.0 terms and elaborates on how to run performance tests on these types of applications. The document targets the performance testing professional as well as the R&D manager looking for information on how to prepare for this new age.

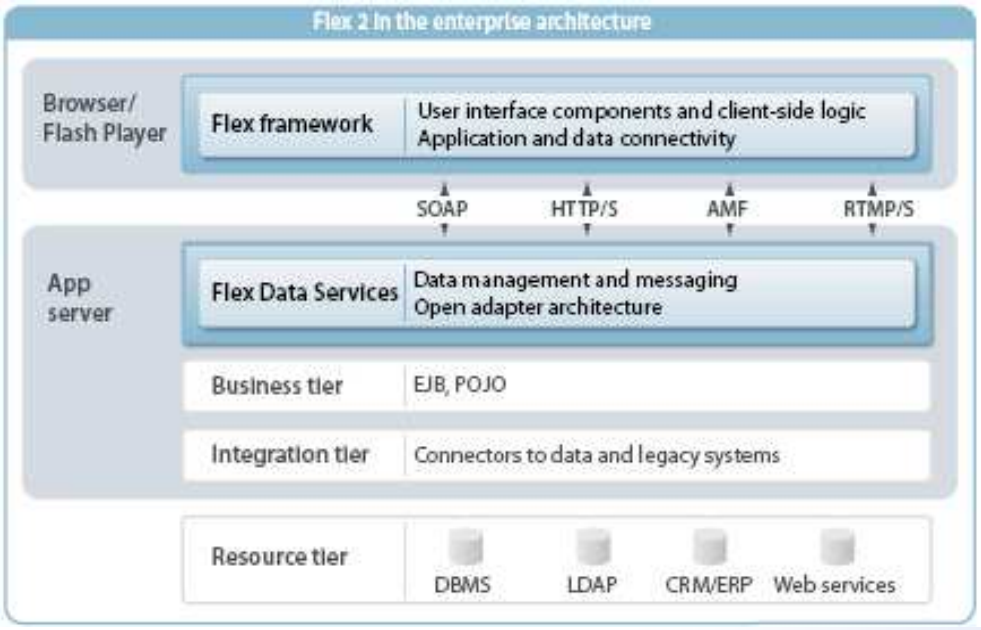
What is RIA?

Traditional desktop applications provide great functionality and a rich user experience but have always suffered from a higher cost of ownership due to software maintenance and deployment issues. Web applications, on the other hand are much more easily accessible and require no installation, but lack the rich user interface (UI). Rich Internet Applications (RIA) are a new type of web application that behave like traditional desktop applications and provide a more productive, responsive user interaction. RIAs provide several benefits for users:

- Easier access to application functionality enabled by a richer UI
- Fast response enabled by maintaining a good balance of application tasks between the client and server tiers.

Some RIAs also include asynchronous communication between the client and server, providing even better response to user requests and might eventually even provide an offline work mode.

RIA is not a technology by itself, so we can find many methods and techniques for its implementation. **JavaScript** combined with **DHTML** and **XMLHTTP Objects** (the building blocks for Ajax) are the basic elements for "do-it-yourself" type of RIA. By now, many companies have published some type of Ajax Frameworks, such as the Google toolkit, which helps developers tie the different pieces together. Adobe Macromedia, who actually coined the term RIA in 2002, offers a full development platform with Flash Player on the client side and **Flex Data Services** on the server side; both can be integrated with the Adobe streaming server for streaming video content. Flash applications run in the browser in a "sandbox" environment communicating with the server using web services or the Flex AMF protocol. The following diagram shows Adobe's Flex 2 in the enterprise architecture.



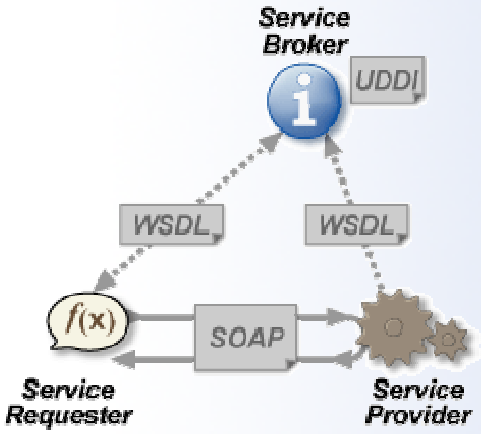
Microsoft has also introduced their RIA implementation in the form of what is now called **Microsoft Silverlight** and formally known as Windows Presentation Foundation (WPF) which provides a way to build single-platform applications with some similarities to RIAs using XAML and languages like C# and Visual Basic. In addition, Microsoft has announced Windows Presentation Foundation/Everywhere which may eventually provide a subset of WPF functionality on devices and other platforms.
As shown here in the Adobe Flex diagram above (as well as with other vendor frameworks), many RIA shells include a combination of data and multimedia content, making Video content a first class citizen in today's internet application. **Mixing data and video together in a single application requires special attention from testers. Streaming video uses different protocols than data, usually hitting a different streaming server, and uses different measurement counters for validations.**

ActiveX and Java applets have been around for a while but by their nature provide the same characteristics as other RIA technologies. Both need no

installation, and provide a desktop-like user interface running inside a sandbox in the web browser.

What is Ajax?

From Wikipedia, the free encyclopedia
Ajax, shorthand for *Asynchronous JavaScript and XML*, is a web development technique for creating interactive web applications. The intent is to make web pages feel more responsive by exchanging small amounts of data with the server behind the scenes, so that the entire web page does not have to be reloaded each time the user requests a change. This is meant to increase the web page's interactivity, speed, and usability.



The Ajax technique uses a combination of: XHTML (or HTML) and CSS, for marking up and styling information. The DOM is accessed with a client-side scripting language, especially ECMAScript implementations such as JavaScript and JScript, to dynamically display and interact with the information presented.

The XMLHTTP Object is used to exchange data asynchronously with the web server. In some Ajax frameworks and in certain situations, an IFrame object is used instead of the XMLHTTP Object to exchange data with the web server, and in other implementations, dynamically added <script> tags may be used.

XML is sometimes used as the format for transferring data between the server and client, although any format will work, including preformatted HTML, plain text, JSON and even EBML. These files may be created dynamically by some form of server-side scripting.
Like DHTML, LAMP and SPA, Ajax is not a technology in itself, but a term that refers to the use of a group of technologies.

As described in the section above, Ajax can be used for implementing RIA and SOA client side applications.
For more details on how to test Ajax Applications using WebLOAD please refer to "**Performance Testing for Ajax Applications**" on our community site (www.webload.org) in the community resources section.

What are Web Services?

From Wikipedia, the free encyclopedia:
The W3C defines a Web service as a software system designed to support interoperable Machine to Machine interaction over a network. Web services are frequently just Web APIs that can be accessed over a

network, such as the Internet, and executed on a remote system hosting the requested services.

The W3C Web service definition encompasses many different systems, but in common the usage of the term refers to clients and servers that communicate XML messages that follow the SOAP-standard. Common in both the field and the terminology is the assumption that there is also a machine readable description of the operations supported by the server, a description published in WSDL.

Styles of use

Web services are a set of tools that can be used in a number of ways. The three most common styles of use are RPC, SOA and REST.

Remote Procedure Calls

RPC Web services present a distributed function (or method) call interface that is familiar to many developers. Typically, the basic unit of RPC Web services is the WSDL operation. The first Web services tools were focused on RPC, and as a result this style is widely deployed and supported.

Service-oriented Architecture

Web services can also be used to implement architecture according to Service-oriented architecture (SOA) concepts, where the basic unit of communication is a message, rather than an operation. This is often referred to as "message-oriented" services.

SOA Web services are espoused by most major software vendors and industry analysts. Unlike RPC Web services, loose coupling is more likely, because the focus is on the "contract" that WSDL provides, rather than the underlying implementation details.

For more information on SOA, see the “What is SOA?” section, later in this document.

Representational State Transfer

Finally, RESTful Web services attempt to emulate HTTP and similar protocols by constraining the interface to a set of well-known, standard operations (e.g., GET, PUT and DELETE). Here, the focus is on interacting with stateful resources, rather than messages or operations.

RESTful Web services can use WSDL to describe SOAP messaging over HTTP, which defines the operations, or can be implemented as an abstraction purely on top of SOAP (e.g., WS-Transfer).

As shown above, Adobe Flex data services uses REST style between their flash player and web services server.

The different styles of use of web services are not just a semantic or a technological difference. Rather, each style represents a whole different view of the separation between the two acting parties (the service consumer and the service provider). As a result, the way we test these services will change accordingly.

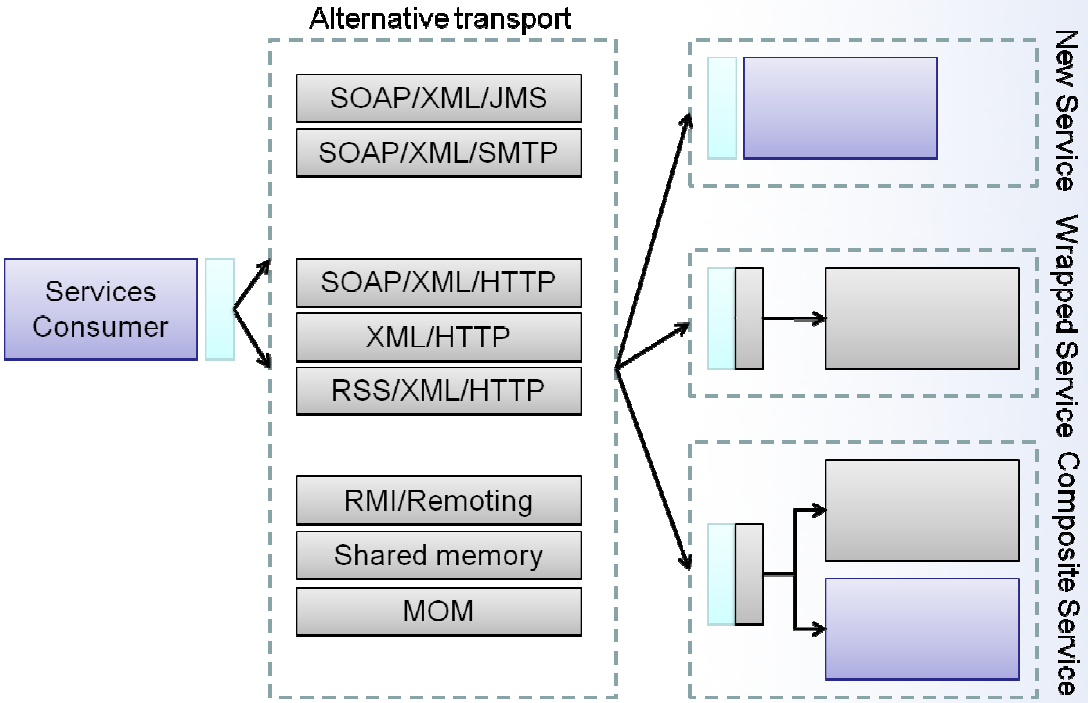
What is SOA?

From Wikipedia, the free encyclopedia:
There is no widely-agreed upon definition of **service-oriented architecture** other than its literal translation that it is an architecture that relies on service-orientation as its fundamental design principle. Service-orientation describes an architecture that uses loosely coupled services to support the requirements of business processes and users. Resources on a network in an SOA environment are made available as independent services that can be accessed without knowledge of their underlying platform implementation. These concepts can be applied to business, software and other types of producer/consumer systems.

It is not surprising that we can't agree on the definition of SOA. I once heard a Gartner analyst describing SOA as a term that is defined in the eye of the beholder:

- ✓ Programmers view SOA as means of invoking remote subroutines or a way to call remote functions that do some functionality for you, receive and return arguments.
- ✓ The Architect perspective on SOA is better manageability of outer layer software patterns by way of normalization and registered interfaces.
- ✓ Administrators view SOA based on their role in the software game, and for them it is heterogeneous distributed software.
- ✓ The Project leader refers to SOA as an improved engineering process which makes his life better and easier by splitting the management responsibilities between distinct teams.
- ✓ CIOs view SOA as a more affordable project by way of re-use. As shown later, SOA is all about re-usable services.
- ✓ The CEO's perspective on SOA is that it represents a more responsive IT, since SOA projects should finish on time and on budget by means of lowering the complexity and increasing the re-use.

So by looking at everyone's perspective on SOA we start to get an idea of what SOA is. It is about building remote services, which are registered with public interfaces and distributed in a heterogeneous environment. In the final analysis, SOA can be said to be composed of a set of services, usually web services, consumed from within the client application to provide some service to the organization. In reality we can find few a forms of services as shown in the diagram below.

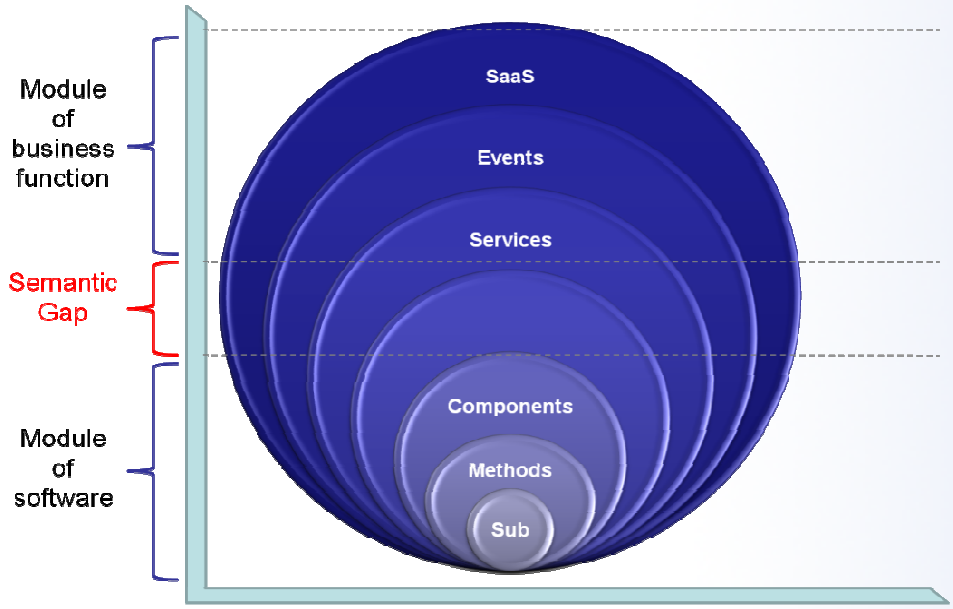


As shown in the diagram, all services are exposed as an interface; some encapsulate a brand new service including new functionality and new implementation. Obviously these ones are found in new applications and/or new organizations. Other services are **wrapped services** where the new interface wraps an existing implementation. In this case, all the service does is expose it through new protocols and through a registered interface repository. Lastly, the most complex service manifestations are composite services that encapsulate more than one service (existing or new), into one larger service.

The service consumer uses one of the different alternative transport protocols to call on the service. The "by the book" transport shall use SOAP and XML over HTTP protocol but other implementations might drop the SOAP definition and just use their own XML over HTTP. Some cases require messaging-type transports in which we see JMS (Java messaging system) and SMTP replacing the HTTP protocol.

SOA Semantic Gap

Regardless of implementation, most software architects and software modelers will see SOA as the next version of software modularity, starting with the use of subroutines, through the object oriented age, up to services, events and SaaS. With this in mind we have to note the semantic difference in this process. Subroutines and components are all modules of software while moving to a higher level as services and event based systems we start modeling business functions.



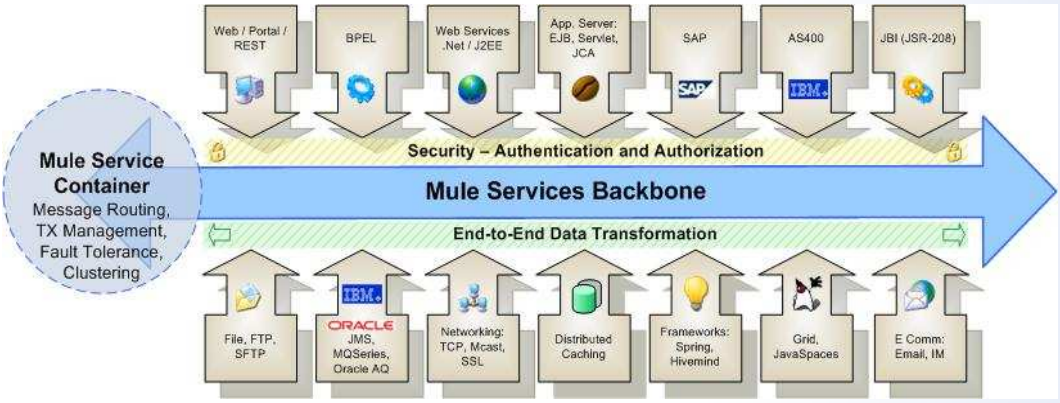
While this was all noted and published before by analysts like Gartner, it is important to note here that it affects the way we test these services. While testing the module of software is purely a developer's task, testing the service (the module of business function) involves both technical and business oriented people.

SOA and ESB

ESB or by its full name, Enterprise Service Bus, plays a key role in the evolution of systems based on service oriented architectures. While SOA is an architectural style rather than a product, several vendors offer products which can form the basis of, or enable SOA, particularly Enterprise Service Bus (ESB) products. ESBs provide infrastructure that can be purchased, implemented and leveraged for SOA-based systems. SOA relies heavily on metadata design and management. Metadata design and management products are also critical to implementing SOA architectures. ESB can be defined using the following characteristics:

- ✓ operating-system and programming-language agnostic.
- ✓ Uses XML as the standard communication language.
- ✓ Supports web-services standards.
- ✓ Supports messaging.
- ✓ Includes standards-based adapters for supporting integration with legacy systems.
- ✓ Includes support for service orchestration
- ✓ Includes intelligent content-based routing services.
- ✓ Includes a standardized security model.
- ✓ Includes transformation services (Often via XSLT) between the format of the sending application and the receiving application.
- ✓ Includes validation against schemes.

An example of a leading OSS provider is Mule:

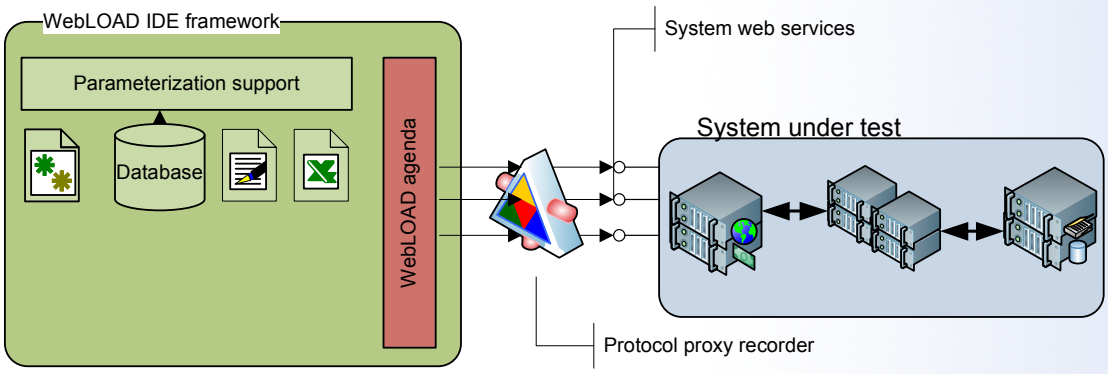


How to load test RIA?

In the definition section we noted that RIA is not a technology by itself, but rather a term used to define a style of application. Yet there are a few characteristics which are worth highlighting when it comes to load testing RIA applications. We shall divide RIA testing into three different types of RIA implementations; Synced/A-synced Ajax based applications, proprietary protocol based applications and the push model. Each requires some specific consideration.

RIA as synchronous/asynchronous Ajax application

Generally speaking, the WebLOAD protocol level testing model allows built-in support for RIA-Ajax testing. When we record the agenda, we do not differentiate between a web request coming from the browser and a request issued by the page using the XMLHTTPObject. The only difference between different types of applications lies in the different data types and content types they use. If the application doesn't record as expected, you can always enable recording any unknown types by changing the default recording options so you can find out what your application is using. If you already know what it is, you can set a specific content type in WebLOAD's recording options and record your application.

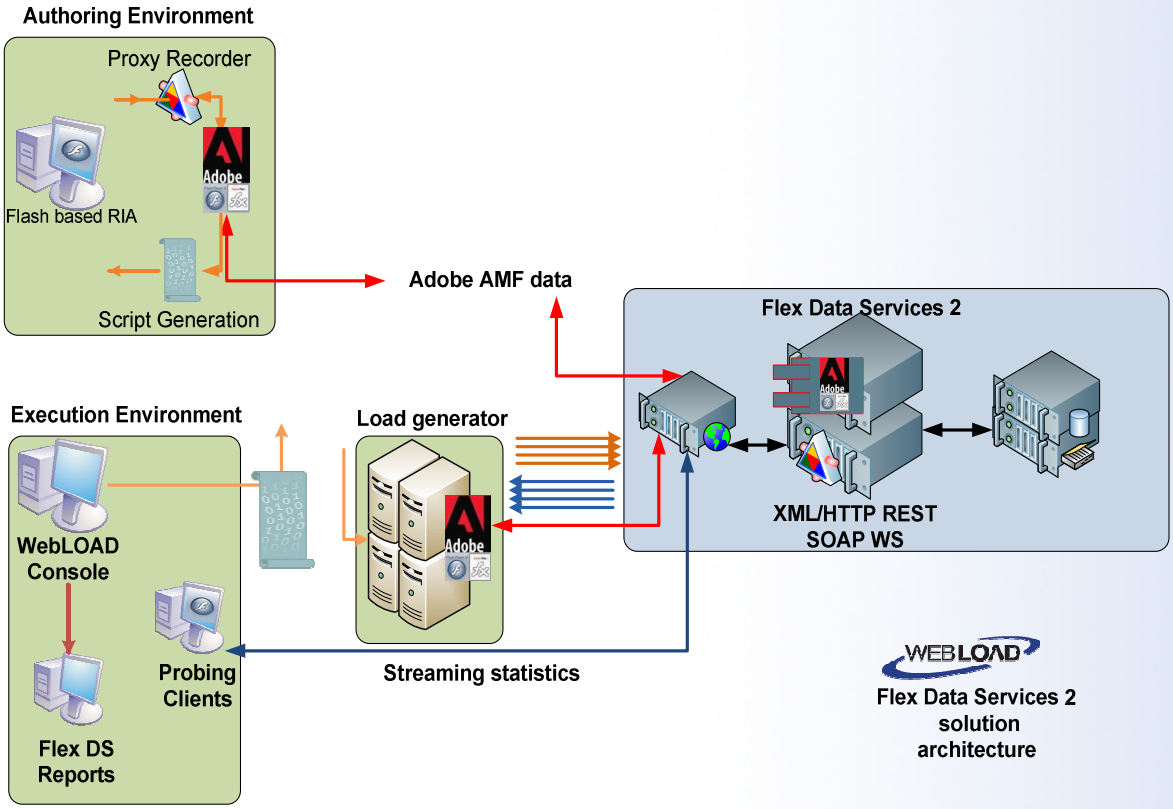


One thing worth remembering is that although your application might use asynchronous calls to the server, the agenda executes synchronously, meaning you will streamline your execution path.

For details on how to test Ajax Applications using WebLOAD please refer to "**Performance Testing for Ajax Applications**" on our community site (www.webload.org) in the community resources section.

RIA using proprietary protocols

Rich internet applications using a proprietary protocol to communicate between the client and the server require special support by the testing tools. For instance, Adobe flex data service uses a proprietary protocol named Adobe Messaging Format (AMF) to serialize and deserialize data objects passed to the REST web service interface or the Flex DS server. WebLOAD needs to "understand" this protocol (as would any other load testing tool), and generate a script that the load tester can read and edit; additionally, the load engine needs to create well formatted messages using the protocol definition, to be sent to the server.
During 2007 RadView is planning to release WebLOAD Professional with an Adobe Flex data services 2 add-on, providing a complete solution for load testing applications with Adobe based RIA.



As shown in the figure above, the Adobe Flex DS 2 Add-on includes a proxy recorder which understands and translates the AMF protocol into an editable script format. The load engine contains a player enabled to generate AMF requests to the target Flex DS server.
As highlighted before, many rich internet application shells mix rich data content with multimedia content. WebLOAD supports mixed protocol testing in a single agenda which enables testing HTTP, AMF and streaming in the same agenda. WebLOAD also supports the different statistical measurements relevant to each protocol, capturing transactions per

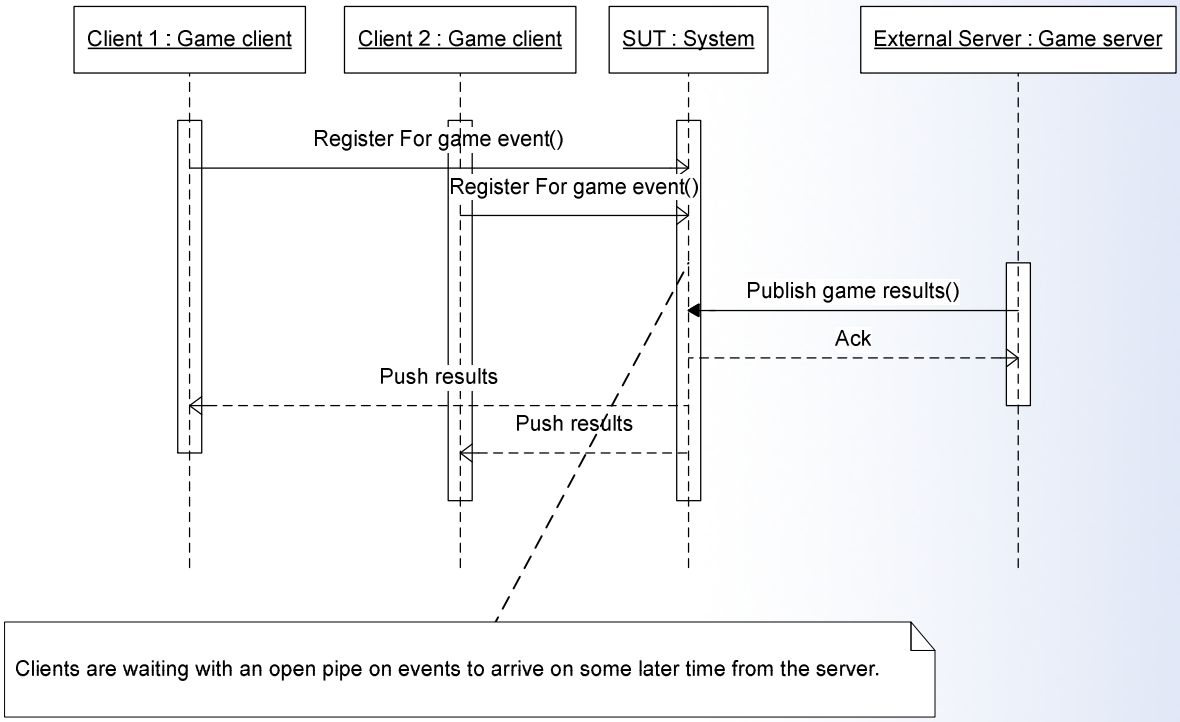
second as a relevant counter for HTTP requests and bit-Rate as a separate counter for streaming content.

RIA using push model

RIA is not just about new user interfaces and sync/asynchronous web services calls. Advanced use of RIA will include different types of push models also known as messaging/pub-sub/real-time type of scenarios. When it comes to performance testing we must define the SUT boundaries before we define the solution. The boundaries have not changed - it is still the whole server as a black box. This means that when approaching load testing, we must disregard any activities happening inside the server and simulate/test activities received by the server and sent by it.

Let's take a sample NBC game notification scenario where a few clients register for an event on a specific game and wait idly for data to arrive. Once the game starts an outside entity sends an update request to the server which later triggers an event to be sent to all users.

The following diagram illustrates the sequence of events and calls between the system and the clients.



Note that I am still referring to the SUT as a single unit assuming all requests are coming from an outside source.

How would we load test such an application?

We need to run two agendas for this system. One represents the client's registration and is waiting for the notifications and the other represents the external server sending the game results.
These two agenda need to be synched. For example, the game server will not publish the game results before all clients have registered. Lastly, the

client's agenda needs to wait for the events to arrive. For this to happen we need a protocol which supports such a scenario. HTTP by itself does not support it so it can't be done with standard HTTP support, but in the future we assume such applications will evolve using such protocols as Adobe Flash and with them the ability to wait for events inside WebLOAD. In the meantime, you can use your own client proxy implementation written in Java or COM and call it from within your agenda.

How to load test Ajax applications?

For details on how to test Ajax Applications using WebLOAD please refer to "**Performance Testing for Ajax Applications**" on our community site (www.webload.org) in the community resources section.

How to load test Web Services?

There is no one good approach for load testing Web Services. Based on your Styles of use, your testing requirements might vary.

Remote Procedure Calls

Remote procedure calls procedures or functions, as their name suggests, and they have to be tested as such, using the Unit test approach. With WebLOAD built-in support for protocol level recording you can use your web service client proxy and trigger the web service. The result would be an agenda with the different parameters used to call on the service. This basic agenda can now be parameterized and be used as part of any regression testing of your application. Keep in mind that we are not aiming for a complete test of the application, only for a test of the specific procedure. Once we have every procedure working as expected we can move on to the system level testing.

This approach can be further extended to build your own performance testing framework using WebLOAD. This will allow you to test your system on the API level.

Service-oriented Architecture

Web services used in SOA are message oriented and heavily rely on the WSDL contract. This means that the tester should focus on testing the web service based on the WSDL and not on a specific consuming client. This will ensure the service adheres to the contract definition regardless of any specific usage of the service. For more details on SOA testing see section 0.

Representational State Transfer

There are two common approaches for load testing your server. We can aim for maximum transactions per second, regardless of the number of real users and with no think-time between transactions. Alternately, we can use a more realistic approach and have as many virtual users as we need with reasonable think time between transactions. As described

above, the REST usage style is about passing the state to a stateful resource. With this in mind we have to make sure we use the virtual client model and think-time appropriately. Since the server has reserved some stateful resources associated with each user, testing for maximum transaction per second will divert the results.

Using WebLOAD for load testing of Web Services

With WebLOAD you can load test your web services on any of the following levels: **As part of the system test**, as **individual computing units**, and as part of your **performance testing framework**. Testing Web Services as part of the system tests means we want to run our client application which is usually hosted in the browser and run through given scenarios. Some may just use standard web browsing and others may involve back-end web service calls using Ajax. For any of them, we would like to get a script which can be read and later be parameterized and used for load testing the application.

WebLOAD provides all of this, since it records the interaction on the protocol level and generates the different calls whether they are for loading the page or for following a link or if they are triggered by an XMLHTTPObject calling a Web Service returning XML or a JSON object.

The following sample, taken from (http://ajax.asp.net/docs/Samples/Sys.Net.CallWebServiceMethods/cs/CallWebServiceMethods.aspx), shows how web page load requests and web services calls are all the same for WebLOAD tester.

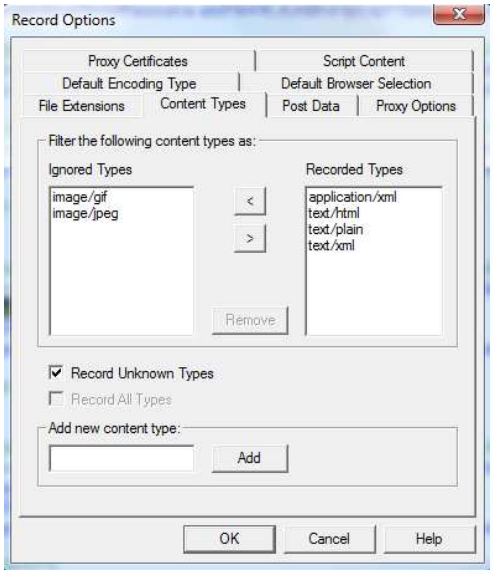
```
wlGlobals.GetFrames = false
wlGlobals.SaveSource = true
//This is just a regular page get request loading the sample page.
wlHttp.Get("http://ajax.asp.net/docs/Samples/Sys.Net.CallWebServiceMethods/cs/CallWebServiceMethods.aspx")

//We clicked on the GET XML botton which caused a back-end call to the web service returning XML.
wlHttp.Header["Referer"] =
"http://ajax.asp.net/docs/Samples/Sys.Net.CallWebServiceMethods/cs/CallWebServiceMethods.aspx"
wlHttp.Data["Type"] = "application/json; charset=utf-8"
wlHttp.Data["Value"] = ""
wlHttp.Post("http://ajax.asp.net/docs/Samples/Sys.Net.CallWebServiceMethods/cs/WebService.asmx/GetXmlDocument")
// document.wlSource contains the XML returned from the server. in this sample we only print it.
InfoMessage(document.wlSource)
```

Now, let's look at how WebLOAD supports other levels of testing. The **individual computing unit** level means we treat each Web Service as an atomic application which is tested separately. As explained above, the right way to test these types of services is by building the agenda using the service client proxy. WebLOAD supports most common data types, content types and file extensions out of the box without any modification but it also provides a way to add your own types to the recorder options and make WebLOAD "understand" your data types. Not only can you add

your own types, you can discover which types are used by your application. Once you found out which types you actually need you can add them to the default list which makes them available for future runs even after you close WebLOAD.

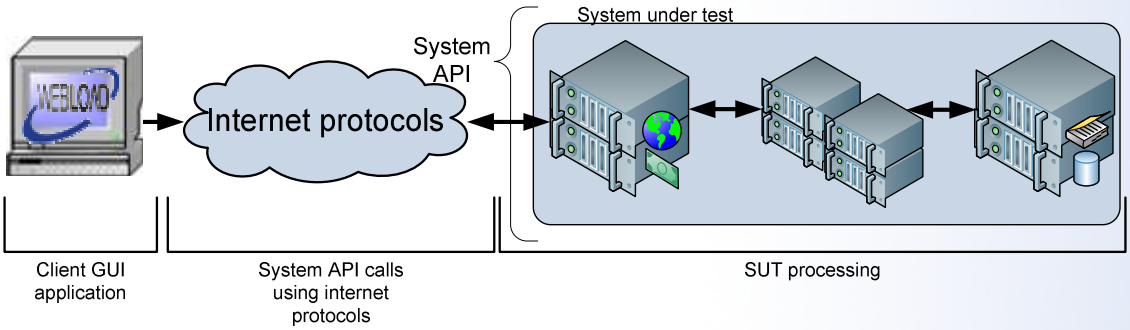
Setting content type options

If you don't know exactly what content type your application uses, the best way to start recording is by turning on the "***Record Unknown types***" in the record options.



This setting is sufficient for most known applications. If you still don't see your Ajax calls recorded in your application, check the "***Record Unknown Extensions***" in the File Extensions tab.

Last but not least is using WebLOAD to build your performance testing framework. If we look closely at the load testing architecture we can divide the system into three parts. The **client GUI application**, usually implemented as a browser application using static HTML or rich internet applications such as Ajax applications. The second part is the **internet protocol** available to access the system under test. This is usually HTTP/HTTPS but may also include multimedia protocols such as RTP/RTSP or "Web 2.0" protocols such as SOAP/XML or RSS over HTTP. The last part is the **system under test** (SUT), which is the subject of our load testing effort.



With the growing adoption of service oriented architecture (SOA), there is a new layer that is worth mentioning here in this context, the system API. In the SOA world the system API are the set of services offered by different sub-systems and consumed by the client application, usually in the form of web services. System APIs are not limited to SOA web services implementations. Any reasonably stable system has some form of separation between the GUI and the business logic functions, which can be accessed via a stable System API. Since these APIs are considered more stable than the trendy GUI application consuming them, a method of load testing is required which is not affected by the ever changing GUI application. This is where the **LOAD testing framework** comes into play. The load testing framework allows you to build new load test agendas without recording a new script, thus eliminating the effect of changes in the UI. It uses the pre-defined system API calls like any other callable object within your JavaScript code. The agenda accesses external resources to get your parameters for each of the calls.

For details on how to build your performance testing framework using WebLOAD please refer to "**Building a Performance Framework**" on our community site (www.webload.org), in the community resources section.

How to load test SOA based applications?

SOA based applications are built using some form of Web Services as described in section 0. This section describes a few unique requirements worth noting, regarding load testing of SOA based applications.

SOA closing the gap between functional & performance testing

There are different offerings on the tools market for functional testing and performance testing. This worked well for most web applications to date, since functional testing required user interface manipulation while performance testing did not involve the client side and concentrated on sending smart load requests to the back-end server. While performance testing always required a specialized tool for automation, it had always been possible to complete functional testing by adding manual efforts.

With the new evolution of Service Oriented Architecture (SOA) the rules of the game have changed. Service oriented architecture is all about immutable interfaces and reusable services.

Immutable interfaces

SOA is not another form of object oriented design. It is an evolution of OOP and the three tier architecture where one of the key factors for making an implementation successful, are the immutable interfaces. The services interface must be well defined and as immutable as possible. Otherwise, external users (outside of the scope of the monolithic application) will not be able to keep up-to-date with interface changes. This fact by itself makes testing automation worthwhile! The key obstacle for testing automation are frequent changes that result in frequent updates to the testing script. Now, with SOA immutable interfaces, the testing client is just another client of the service.

Reusable service

Gartner claims that a good reusability matrix is 30%, meaning that if 30% of your services in the organization are being used by other applications then you are in a good shape. SOA preaches for re-usability and is the key argument for pursuading the CIO: SOA means more affordable IT due to reusability. This fact makes testing of SOA applications important than ever. An unstable service compromises not just the integrity of its monolithic application but also of all the other applications relying on this service.

So how does this change the rules?

The rules have changed because now it is very hard to differentiate between the functional testing and performance testing of the service. They are both done using the same technology (mostly by calling the SOAP method over HTTP). We can write the same call and validate the result for functional testing and later use the same call to load the server and validate the performance. We are not claiming that a good testing design will definitely use the same script for both functions but it will definitely use the same tool and technology and provide higher productivity for the testing engineer.
WebLOAD native support for Java Script and XML makes it very easy for you to consume a web service, trigger different operations and validate their results. You can load your XML response into the XML parser and validate it or use JavaScript ***eval*** function to convert your JSON response into an object and manipulate it in your agenda.

Testing of SOA and ESB applications

With standard autonomous applications, we knew who the client and the server were and how they interacted with each other, which made testing straight forward. SOA added a second level of complexity when the applications are not an island but rather a mix of services consumed by a mix of clients. We resolved that complexity by separating the services testing from the consuming client testing as suggested in this document. Integrating SOA with ESB makes testing even harder, since we now have to think about the chain reaction of a service call (or message sent) to the ESB. This raises a few questions on how to approach testing for such systems, or collection of systems: What are the boundaries of your tested application? How should the required throughput of my application be analyzed when the input is driven not by user interaction but from ESB raised events? Will we face a new term named “Enterprise level testing” following the traditional system testing?

These are all important questions, yet to be answered. With the evolution of such systems and adoption of the underlying technologies you can surely expect RadView with WebLOAD to be leading the way.

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