

Analysis and Comparison of the Spring Framework, Struts Framework, Vaadin Framework, and Play Framework Performance, Used to Create Web Applications in Java

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Abstract: *In an era of continual technical growth, accompanied by an increase in the speed of computers and the Internet, it is also vital to create methodologies and programming languages, as well as other mechanisms that assist programmers in their job. As a result, frameworks, or skeleton applications, were developed to streamline program authoring and unify the structure of multiple applications. This article aims to analyze and evaluate the performance of four prominent frameworks used to create a server element of a Java online application, namely the Spring Framework, Struts Framework, Vaadin Framework, and Play Framework.*

Keywords: Spring Framework, Play Framework, Vaadin Framework, Struts Framework web Framework Java.

I. INTRODUCTION

Web frameworks are vital tools for Java developers who construct web applications. These frameworks provide a base of libraries, modules, and pre-built components that can assist expedite the development and simplify common tasks. Spring Framework, Struts Framework, Vaadin Framework, and Play Framework are among the most popular Java web frameworks. Each of these frameworks has advantages and disadvantages, and selecting the best one for a certain project takes careful analysis. In this post, we will compare various frameworks, highlighting their important features, benefits, and drawbacks. By the conclusion of this essay, you will have a better grasp of which framework is most suited for your web development needs.

II. ARCHITECTURE AND DESIGN

2.1 Spring Framework

The Spring Framework is a Java application framework that is open source and provides a full programming and configuration mechanism for developing enterprise-level applications. It is built on the Inversion of Control (IoC) design paradigm, which allows for flexible coupling of application components. The framework is organized into modules such as Core, Web, Data Access, and Integration, each of which provides unique features and capabilities. The Core module serves as the framework's base, containing the IoC container, Spring Expression Language (SpEL), and AOP (Aspect-Oriented Programming) support. The Web module includes MVC (Model-View-Controller) framework, RESTful web services, and WebSocket support for constructing online applications. The Data Access module allows you to communicate with databases, while the Integration module allows you to integrate Spring with other systems and frameworks.

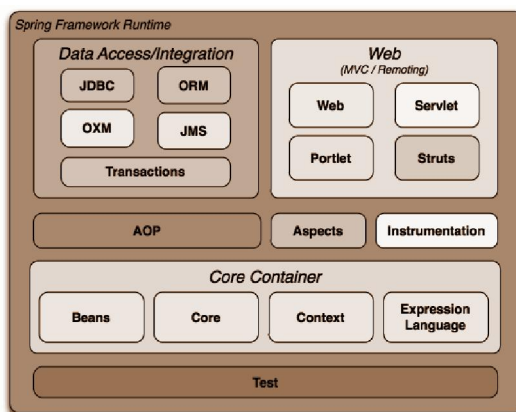


Figure 1 : Spring Framework[1]

2.2 Play Framework

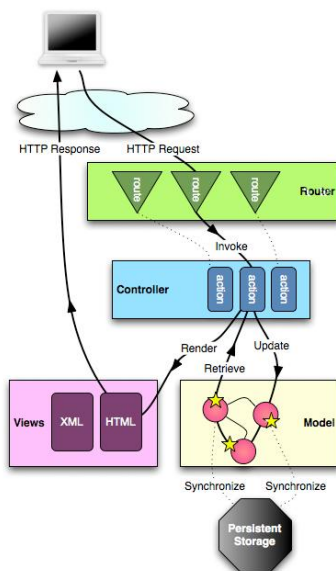


Figure 2: Play Framework [2]

The Play Framework is a web-friendly, lightweight Java and Scala application framework based on the Model-View-Controller (MVC) design paradigm. It is developed on top of the Akka toolkit, which provides an actor-based concurrency model and an event-driven architecture, and leverages a non-blocking, asynchronous programming style to achieve excellent scalability and speed.

The HTTP server, routing engine, controller, view template engine, and database access layer are among the framework's essential components. Incoming requests are handled by the HTTP server, while requests are routed to specified controllers by the routing engine. The view template engine produces HTML pages and view components while the controller evaluates the request and calls business logic to provide a response. Interacting with databases is supported via the database access layer.

2.3 Vaadin Framework

Vaadin is a web application framework that allows you to create business-oriented online apps. The Vaadin server-side framework and the Vaadin client-side framework are the two primary components of the framework.

The server-side framework is written in Java and is executed on the server. It offers a component approach for creating online user interfaces in the same manner as desktop UI frameworks do. Using Java code, developers may design UI components such as buttons, tables, and forms. A robust event system for handling user interactions like button clicks

and text input is also included in the server-side framework. The client-side framework, on the other hand, is responsible for rendering the server-side UI components. The user interface is built using web standards such as HTML, CSS, and JavaScript. The client-side framework is based on the Google Web Toolkit (GWT) and contains a collection of pre-built UI components and themes that can be customized using CSS.

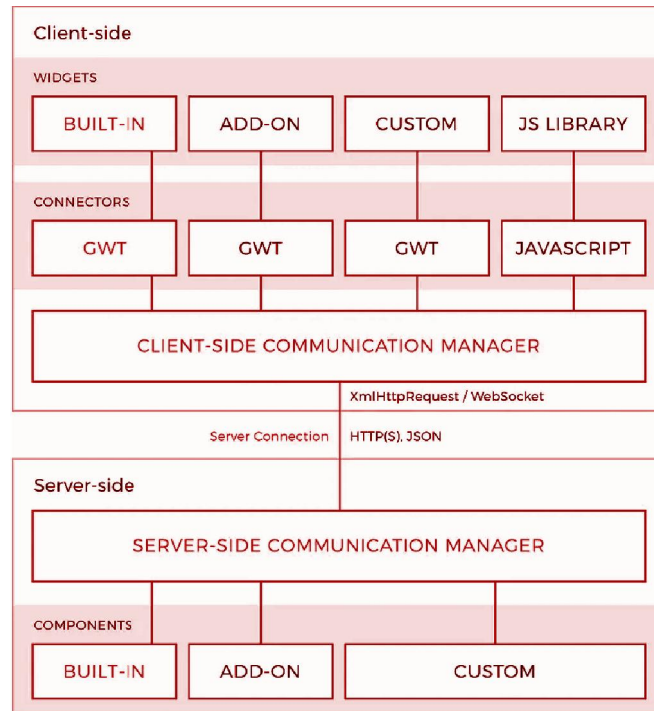


Figure 3: Vaadin Framework [3]

The architecture of Vaadin is meant to be easily integrated with other Java-based technologies and frameworks. It also supports data binding and data input validation, making it ideal for developing complicated data-driven web applications.

2.4 Struts Framework

Struts is an open-source web application framework used to create Java EE web applications. It is based on the Model-View-Controller (MVC) architectural pattern and provides a framework for developing an application's display layer. Struts implement the front controller design pattern and include a variety of components for managing the web request-response cycle.

The Struts Framework is made up of two key components: the ActionServlet and the Action class. The front controller is the ActionServlet, which is in charge of receiving incoming HTTP requests and dispatching them to the relevant Action class. The Action class contains the application's business logic and is in charge of receiving requests and providing responses.

To handle the request-response cycle, the Struts Framework also contains a number of additional components, such as the ActionForm class for handling form data, the ActionMapping class for mapping requests to actions, and the ActionForward class for specifying the next page to show.

In addition to the basic components, Struts has a variety of utility classes and tag libraries to help with web application development. It also allows you to utilize custom tags and JSP tag libraries.

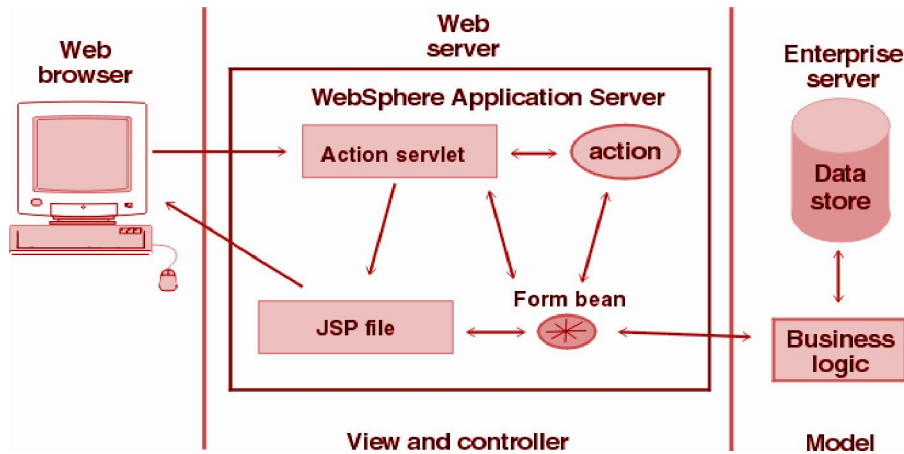


Figure 4 : Struts Framework model 2 [4]

III. COMPARISON BETWEEN SPRING FRAMEWORK, STRUTS FRAMEWORK, VAADIN FRAMEWORK, PLAY FRAMEWORK

| Keywords | Spring | struts | vaadin | play |
|---------------------|--|---|---|---|
| Key Features | Dependency injection AOP Data Access Web services | Request handling Validation Data binding Struts tag library for building UIs | Server-side data binding Testing tools Theming Theming and customization | Web sockets Hot reloading Asynchronous programming Support for caching |
| Performance | Fast and efficient performance due to modular design | Efficient performance due to its MVC architecture | Efficient client-server communication, data binding, lazy loading, caching, asynchronous updates, and integration with CDNs are the factors for performance | High efficient performance due to reactive and asynchronous architecture |
| Architecture | Traditional approach with server-generated HTML Pages | Traditional approach with server-generated HTML Pages | generate more dynamic pages with client-side JavaScript and AJAX calls | generate more dynamic pages with client-side JavaScript and AJAX calls |
| Mainly use | Developing web applications, REST APIs, and microservices | Developing web applications that require a high level of performance and scalability | developing business applications, content management systems, and dashboard applications | developing web applications that require real-time data processing, such as gaming and financial applications |
| Integration | Good integration with java technologies | Integrates well with other Apache projects | Integrates with various frameworks and libraries | Good integration with other Scala and java Technologies |

IV. ADVANTAGES AND DISADVANTAGES BETWEEN SPRING FRAMEWORK, STRUTS FRAMEWORK, VAADIN FRAMEWORK, PLAY FRAMEWORK

| Frameworks | Advantages | Disadvantages |
|--------------------------|---|---|
| Spring Frameworks | <p>Comprehensive framework with many features</p> <p>Good integration with other java technologies</p> <p>Large and active community with many resources and documentation available</p> <p>It is used for building complex enterprise applications</p> <p>Good performance and scalability</p> <p>It is a lightweight</p> | <p>Steep learning curve due to its comprehensive features and configurations requirements</p> <p>Can be overwhelming for small or simple applications</p> <p>Requires a lot of XML for developing the application</p> |
| Struts Framework | <p>Good support for building MVC-based web applications</p> <p>well-integrated with other Apache projects</p> <p>A large number of extensions and plugins are available</p> <p>Mature and stable framework</p> | <p>Steep learning curve due to its configuration requirements.</p> <p>tightly -coupled architecture can make maintenance challenging</p> <p>May require additional libraries or tools for certain functionalities</p> <p>No exceptions are allowed if there are any errors</p> <p>Not suitable for smaller application</p> |
| Vaadin Framework | <p>Easy to learn and use</p> <p>Good performance and scalability</p> <p>Provides pre-built UI components that can be easily customized</p> <p>The server-side architecture allows for responsive and interactive user interfaces</p> <p>Good support and documentation are available</p> | <p>Not flexible as other frameworks</p> <p>Limited community support as compared to other frameworks</p> <p>Finding resources can be more challenging.</p> <p>Focused more on business. We cant create any fancy website using vaadin</p> |
| Play Framework | <p>Fast and scalable framework</p> <p>Designed for high-performance and reactive applications</p> <p>Good support for web sockets, hot reloading, and asynchronous programming</p> <p>Good integration with other Scala and java technologies</p> <p>Easy to learn and use</p> <p>Testing the application is very easy and testing provides authentic results</p> | <p>Not suitable for building enterprise applications.</p> <p>Limited community support compared to other frameworks.</p> <p>The learning curve for scala, if not familiar with the language.</p> <p>Requires a strong understanding of reactive programming principles.</p> <p>It does not offer backward compatibility. Play 2 is not compatible with Play 1</p> |

V. RELATED WORK

Cloud Computing:-Cloud computing is an approach to computing that involves accessing and using computing resources (such as servers, storage, and applications) over the internet, rather than relying on local hardware or infrastructure.

Spring applications can be easily deployed to cloud platforms like AWS Elastic Beanstalk, Azure Spring Cloud, and Google Cloud Run. Similarly, Struts applications can be deployed to cloud platforms like AWS Elastic Beanstalk and Azure App Service. Vaadin applications can be deployed to cloud platforms like AWS Elastic Beanstalk and GCP App Engine. Play Framework applications can be deployed to cloud platforms like AWS Elastic Beanstalk and Azure App Service.

HTML 5 supports:-HTML5 is a web standard that offers a comprehensive set of functionality for developing modern online applications. HTML5 is supported by all of the frameworks you listed, and developers may utilize HTML5 elements and APIs to build interactive user interfaces, multimedia content, offline support, and other sophisticated capabilities.

Spring Framework provides built-in support for HTML5 through its Spring MVC module, which allows developers to create HTML5-based views using technologies such as JSP, Thymeleaf, and FreeMarker.

Similarly, Struts 2 Framework provides support for HTML5 through its tag library, which includes HTML5 form controls, validation, and other features.

Vaadin is a web framework that abstracts HTML5 and other web technologies at a high level. It enables developers to create web applications using Java-based APIs while automatically producing HTML, CSS, and JavaScript for the user interface. Advanced HTML5 capabilities such as Web Components, Service Workers, and WebSockets are also supported by Vaadin.

Play Framework is a web framework with built-in HTML5 support via its template engine, allowing developers to construct HTML5-based views utilizing technologies like Twirl and Scala HTML. Server-sent events, WebSockets, and other HTML5 capabilities are also supported by Play.

C. Debugging:- Debugging is an important aspect of the software development process, and all of these frameworks offer a variety of tools and approaches to help developers debug their programs.

Comparison Table

| Keywords | Spring | struts | vaadin | play |
|-----------------|--------|--------|--------|------|
| Cloud Computing | yes | yes | yes | yes |
| HTML 5 Support | yes | yes | yes | yes |
| Debugging | yes | yes | yes | yes |

VI. CONCLUSION

Spring, Struts, Vaadin, and Play Framework are all prominent Java-based web application development frameworks, each with its own set of features and advantages. Which one to select is determined by the project's unique requirements. Developers should assess each framework's strengths and limitations to determine which one best meets their requirements. Finally, all of these frameworks are designed to make web application development simpler and more efficient.

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