

# WSHLA: Web Services-Based HLA Collaborative Simulation Framework

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**Abstract.** Collaborative simulation technology is an important factor in improving the efficiency of complex product design. Although High Level Architecture (HLA)-based simulation technology can meet the needs for simulation in product design, it's also marked by many deficiencies. In this paper, we focus on the introduction of web services into HLA simulation system and propose a Web Services-Based HLA Collaborative Simulation Framework (WSHLA). The framework uses web services to encapsulate the invocations of HLA services and then make simulation system more interoperable and reusable. Firstly, the overall structure of WSHLA and the proxy, which acts on behalf of a federate and interacts with Runtime Infrastructure (RTI), are presented. Then, the detailed design and implementation process of WSHLA are discussed. Experimental results show that, using web services, the framework can make up for the deficiencies in HLA simulation system and ensure WSHLA-based collaborative simulation goes smoothly at the expense of some time.

**Keywords:** web services, high level architecture, collaborative simulation framework, complex product design, run time infrastructure.

## 1 Introduction

Complex product design involves the consideration of many interdependent factors and variables, which are too complicated for the human mind to cope with. Simulation is a powerful tool that provides the capability and allows designers imagine new systems, conduct experiments to observe behavior, predict and evaluate the results of alternative decisions.

High Level Architecture (HLA) is an advanced distributed simulation architecture, which can effectively integrate sub-models in different domains together to form a complicated simulation system for simulation analysis. However, there exist some deficiencies in HLA simulation system<sup>[1]</sup>. For instance, due to the characteristics of platform-specific and programming language-specific of Runtime Infrastructure (RTI), the interoperability between different RTIs is poor; HLA is also not compatible with the standards and technologies in other domains; HLA-based simulation may be

blocked by firewall, which even makes simulation fail. The above deficiencies make it hard for HLA to get a deeper development in the field of collaborative simulation of complex product design. Therefore, HLA simulation system should adopt and assimilate related standards or technologies to achieve better development. Web services, using eXtensible Markup Language (XML) and HyperText Transportation Protocol (HTTP), represent a new distributed computing pattern, which allow applications to interact with each other in a platform-independent and programming language-independent manner. Introduction of web services can effectively make up for the deficiencies in HLA simulation system, greatly improve its interoperability, reusability, and then better support collaborative simulation of complex product design. However, web services and HLA are different standards for different purposes and domains, which makes the combination of the two difficult.

According to the characteristics of HLA simulation system and web services, we introduce web services into HLA simulation system and propose a Web Services-Based HLA Collaborative Simulation Framework (WSHLA). Firstly, we present the overall structure of WSHLA and a new object: proxy, which acts on behalf of a federate in interacting with RTI. Then, the detailed design and the implementation process of WSHLA are discussed in detail. Experimental results validate the framework and show that, using web services, the framework can make up for the deficiencies in HLA simulation system and ensure WSHLA-based collaborative simulation goes smoothly at the expense of some time.

The rest of paper is organized as follows: Section 2 presents some related works. Section 3 discusses the Web Services-Based HLA Collaborative Simulation Framework (WSHLA). Section 4 validates WSHLA through experiments and analyzes experimental results. Section 5 concludes the paper and gives the plan of future work.

## 2 Related Works

Andreas Wytzisk presents an initial solution that tries to bring HLA and web services together by creating a standard compliant bridging framework: “management federation”, which can make HLA federations controllable from the World Wide Web without needing to extend current standard<sup>[2]</sup>. Katherine L. Morse uses Web Enabled RTI (WE RTI) libraries instead of standard RTI libraries to build federation. The goal of WE RTI is to enable a simulation to communicate with HLA RTI through web-based services. The long-term goal is to be able to have multiple federates that are able to reside as web services on Wide Area Network, permitting an end-user to compose a federation from a browser<sup>[3]</sup>. Paul Gustavson explores how Services-Oriented Architecture and supportive technologies, such as XML, Web Service Definition Language and Base Object Model, can begin to be applied to provide a loose coupling and better support distributed simulation and how this concept is being applied to support aggregation<sup>[4]</sup>. Katherine L. Morse proposes an approach that uses web services as basis for sophisticated Interest Management in real time distributed simulation and presents a Web Services Internet Management architecture designed to achieve these capabilities in a way that is compatible with simulations using HLA<sup>[5]</sup>.