NOGESI Case Study : A fresh approach to LVC simulation

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Table of Contents

Introduction

NADS key product, **Simware has reached a new milestone with the delivery of the NOGESI project**. NOGESI (NOdo GEnerico de SImulacion, Simulation Generic Node in Spanish) is a project for the Spanish MoD where Simware is the key element for creating a real time laboratory for distributed simulation. NOGESI puts together simulators and COTS in HLA and DIS approaching and probing the new SISO LSA (Layered Simulation Architecture) concept. **NOGESI project has meant the final testing and evolution of Simware Framework and Simware RTI towards Open Layered simulation architecture**.

The Quest for a simulation platform for System of systems

Since late 90s, there have been many projects trying to offer a seamless solution to the interoperability between different simulators on a network. Simulation community have developed many standards in order to try to provide better interoperable solutions but indeed **interoperability is still a great pain for lead users of distributed simulation like Us DoD and other NATO members**. These pains are very well documented in reports like LVC Architecture Roadmap (LVCAR)[1], sponsored by US M&S Coordination Office.

In last decade main simulation procurement agencies have invested many millions of dollars looking for a solution. Projects like MATREX[2] or LVC-IA[3] in USA, ITCS[4] in France and others have advanced a lot in the development of processes and tools to manage repositories and to guide the development of federations, but up now a full satisfactory solution to **improve reusability and runtime interoperability has not been achieved**. Runtime interoperability has been tried to be achieved by developing complex translation and gateways solutions; but performance and capabilities of this kind of solutions are still very poor. Up to now, agencies with large budgets, like Us DoD, have been able to achieve some successful results, investing much more money and resources than expected and suffering a lot of delays and finally having to accept down-graded solutions. In other NATO countries, agencies with bigger budgets like UK, France, Germany or

[1] http://msco.mil/LVC.html

[2] https://www.matrex.rdecom.army.mil/

[3] http://www.peostri.army.mil/PRODUCTS/LVCIA/ strategic requirements

[4] http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA425873

Sweden have achieved partial success, but countries with smaller budgets, like Spain, have advanced very few in distributed simulation, since the **required investment is high and the ROI is very uncertain**.

Because of that, **Spanish MoD have been looking from some disruption in distributed simulation since 2010**. Simulation is one of the key areas for improvement in its new Technology and Innovation Strategy for Defense (ETID)[5], delivered in 2010. ETID is the guide for R&D efforts in Spanish MoD and pilots the efforts of different R&D related bodies through specific technological goals.

The three Simulation objectives are:

1. improved interoperability,
2. enhanced modelization and simulation for battlefield representation, and
3. new M&S technologies for a cost effective, flexible, versatile and effective development of the future simulation systems.

In order to fulfill these requirements, **Sp MoD has been working with Simware platform since late 2010**. In this past two years, Sp MoD and NADS have been working together in two related projects in order to evolve Simware simulation framework as a **platform for open and interoperable distributed simulation, introducing some disruptive concepts like using DDS[6] as a simulation databus or open interfaces between simulation components**. These new concepts are right now the base of a new study group at SISO, LSA[7], trying to solve the main pains in LVC simulation.

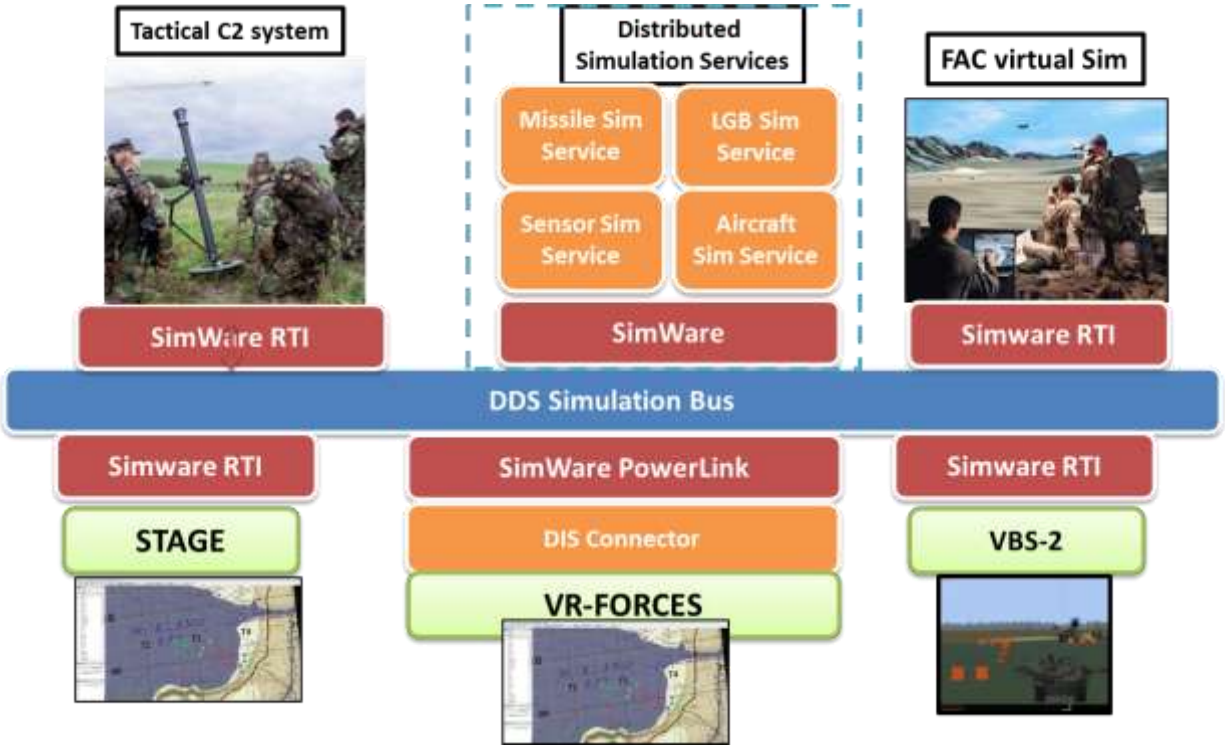
[5] http://www.tecnologiaeinnovacion.defensa.gob.es/en-us/Estrategia/Pages/Descripcion.aspx

[6] OMG DDS is one of the main data distribution technologies in use for operational systems. To know more about how can be used in simulation see http://www.Simware.es/index.php/resources-and-faq/Simware-presentations

[7] Layered Simulation Architecture is right now one the main iniciatives into SISO in order to improve interoperability in distributed simulation. See more at http://www.sisostds.org/StandardsActivities/StudyGroups/LayeredSimulationArchitectureLSASG.aspx

With a total investment of less than $1 million, Sp MoD has now a Distributed simulation lab, called NOGESI, which main capabilities are:

- Interoperability between simulated and operational systems using DDSI open wire protocol
- Development and maintenance of Simulation assets using MDA (Model Driven Architecture) paradigm.
- Deployment of simulation assets as services into an HLA federation.
- HLA interoperability to a wire protocol level.



NOGESI deployment demonstrates that using an open platform for interoperability allows also an easy integration of legacy simulators. In this case, a Forward Air Controller (FAC) virtual simulator, developed by Indra Sistemas for the Spanish Air Force in 2010, have been integrated into NOGESI supporting some advanced simulation services like ownership management. By using HLA Ownership services over DDSI wire protocol, FAC virtual simulator can interoperate in real-time with a simulation server in uses cases like *Close air Support* or *Call for Fire*. In this exercises, friendly forces simulated by VRForces or Stage can call for air support to a FAC that it is going to engage foes simulated by VBS2 with missiles or bombs that are been simulated by another HLA federate, the weapon server.

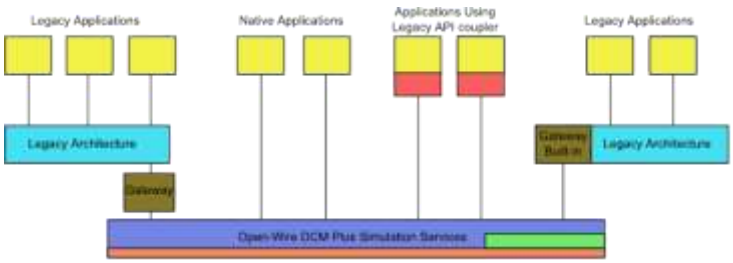
Why Nogesi is different

In a ***system of systems*** simulation project, like MATREX or ITCS, the **traditional approach has been to try to implement a simulation engineering methodology, like FEDEP or its evolution DSEEP[8], with a set of software tools and processes**. In this approach new developments are focused in the system engineering not in the deployment of the simulation. For the deployment, these projects propose some kind of wrapper or middleware that provides an abstraction of different simulation protocols like HLA, DIS or TENA. Translation code is generated to do gateways and bridges between the different types of simulators. There are not any innovations in the deployment of the simulations, using instead existing runtime infrastructures to run the exercises. The simulation services available for the federation are the basic services included in HLA or DIS, like entity and interaction management. Advanced simulation services like execution, ownership or time management are unavailable, even when some protocols like HLA support them.

In **NOGESI, main innovations are not in the development process but in the simulation technical architecture**. NOGESI is based on a pure distributed data-centric architecture. The use of DDS with its Quality of Se**r**vices (QoS) **allows avoiding** the main pains in HLA, like vendor's incompatibility and the difficulty of achieving scalability.

[8] http://www.sisostds.org/StandardsActivities/SupportGroups/DSEEPPSGDistributedSimulationEngineeringand.aspx

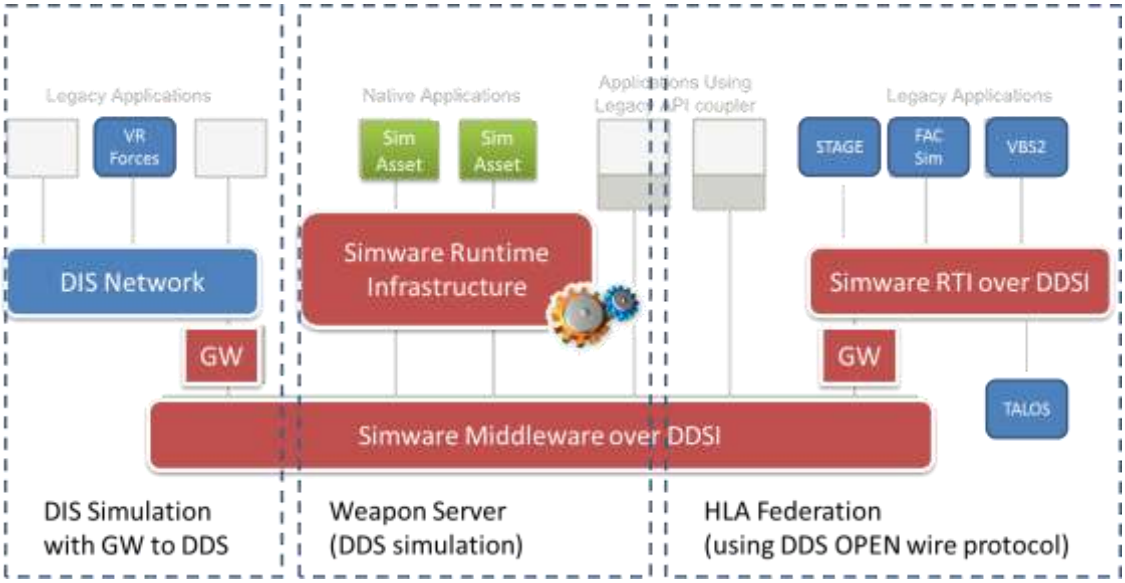
Architecture of the solution



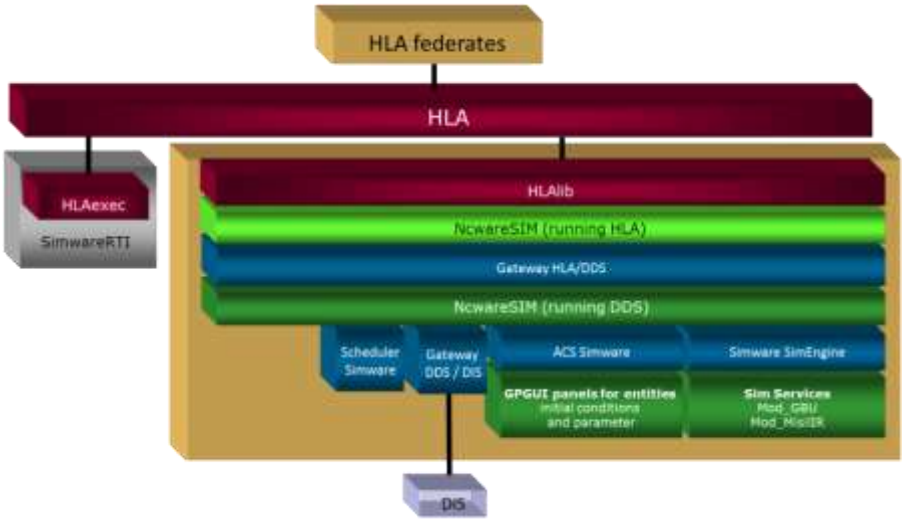
NOGESI is a very good example of how SISO LSA could perform. **NOGESI architecture is based on LSA architectural concept**, showed in figure

NOGESI is federating native applications made with Simware with legacy DIS and HLA simulations. Native Simware applications are working directly on top of a Data-Centric simulation middleware based on DDS. Native simulations are integrated into a Weapon Server, which is deploying a set of simulation services as another HLA federate. HLA federation is using Simware RTI, which is a HLA 1516.2000 implementation on top of DDSI. For DIS interoperability a gateway between DIS and DDS data models is made using PowerLink tool that it is provided into Simware portfolio.

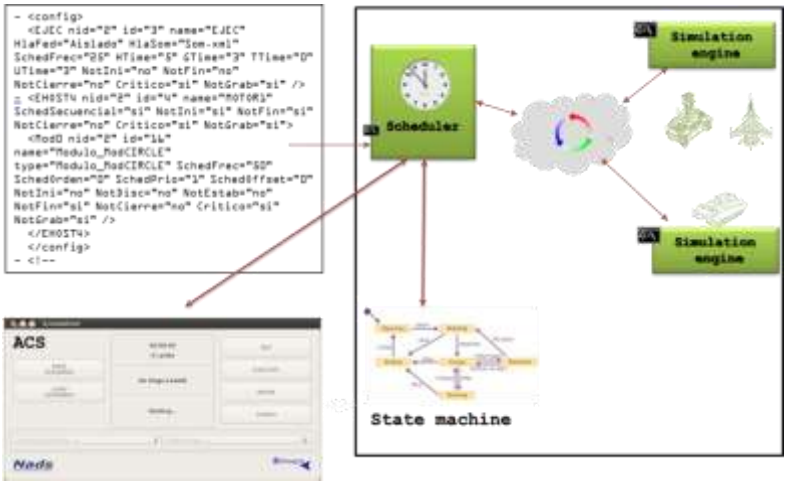
NOGESI, therefore, is using a fully open layered architecture as LSA proposes.



Layered architecture with Simware is better understood if you look into the detail of the weapon server architecture. Dynamical simulation of the weapon services is managed by **Simware runtime infrastructure**, which is a fully compliant **DDS distributed infrastructure**, composed by four main components



- Scheduler. It is a real time scheduler which manages the execution of the simulation and the state machine during runtime. All the configuration is based on a XML configuration file.
- SimEngine. Manages cyclical execution of the simulation assets during runtime. In a fully distributed architecture, like Simware, a SimEngine instance is required in each node that it is running simulation assets.
- ACS. Tool to manage weapon server and its instances. Allows interacting with instances of the simulation services on runtime.
- Simulation Assets. Dynamical models of simulated entities. In NOGESI deployment there are simulation models for infrared missile, sensor, aircrafts and LGB

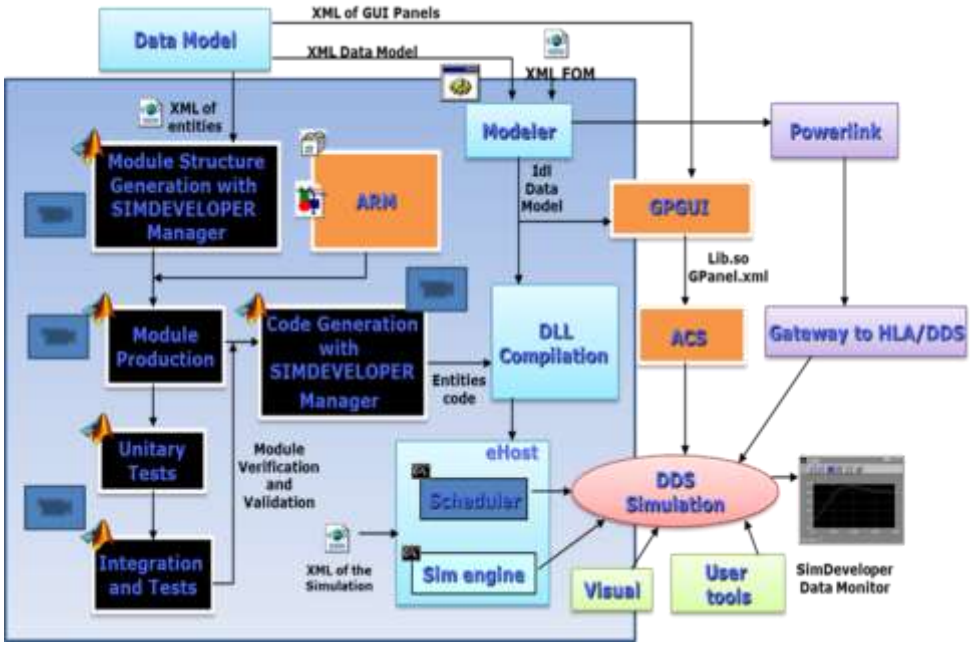


One important feature of Simware runtime infrastructure is that **every data to control the simulation is managed using a DDS topic, using a DDS compliant control datamodel to manage the simulation**. Having an open data model to manage simulation assets is currently a topic of discussion in LSA forums, because it has been considered essential to improve the interoperability to an asset level.

Even though the main innovation in NOGESI is its technical architecture, a **quite innovative approach has been also made in order to improve interoperability and reusability of simulation assets**. In NOGESI simulation services deployed in the weapon server are from a **repository of simulation models made with SimDeveloper, that is the M&S development environment of Simware**, based on Simulink from Mathworks.

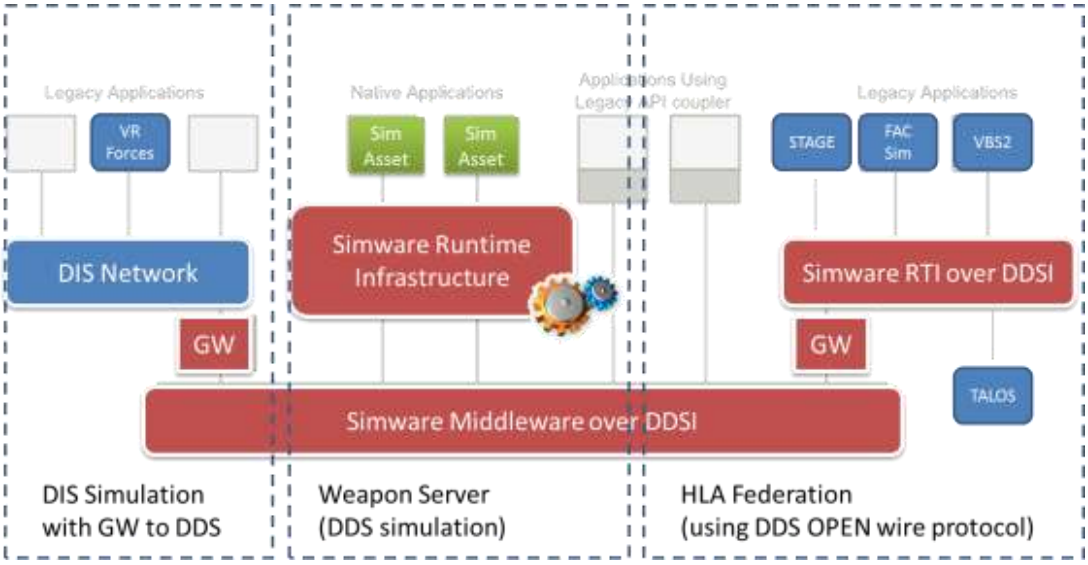
SimDeveloper have its own M&S development process automatized into Simulink. In this way a simulation engineer can do the complete development cycle of a simulation model into Simulink, including unitary and integration testing. Automatic generation of code, compliant with Simware runtime infrastructure is provided just out of the box by the tool. Using Simdeveloper blocksets and toolboxes is quite straightforward to have a repository of simulation models available to be deployed like HLA, DIS or DDS compliant services.

When every middleware, tool and API in Simware portfolio is put together you have a complete ecosystem to design, develop, test and deploy your distributed simulation with an open and Layered architecture.



Summary

NOGESI project with the Sp MoD has demonstrated that one of the proposals made at LVCAR for **improve interoperability in LVC simulations**, converging existing architectures with a new one, it is possible to be **achieved with a low budget and low technical risk** by the simulation community by following an **open innovation model like Simware**. Taking advantage of **new data exchange technologies, like DDS**, successfully applied in many others domains, into a **new architecture, structured by layers and based on open interfaces**, is a very good solution to the many pains that exist right now in the simulation industry.



About Simware

Simware is the **first commercial off-the-shelf platform to do distributed simulation with an open architecture**. Simware proposes a new way to integrate and interoperate simulation systems, with **an open layered architecture based on OMG DDS standard for distribution of data**. Compliance with others simulation standards, like HLA or DIS, is guaranteed with Simware, allowing interoperability between legacy simulations and new simulations made with Simware. Our latest commercial release, Simware V, available since July 2013, bring new exciting features to the simulation community, like

- New data exchange architecture, supporting latest version of DDS open wire protocol : DDSIv1.2
- Full support of HLA specification in our own RTI.
- Support of simulation services.
- Improved support for multiple instances of simulation objects and interactions.
- Improved compatibility between HLA data models and DDS models, to automatically generate gateways.
- Generation of gateways DIS, adding mapping between DDS and PDUs models defined in the IEEE 1278.1A-1998.

About SISO LSA

Layered Simulation Architecture (LSA) study group was established in September 2012 at SISO Fall SIW.

The objective of this new group is to investigate the use of OMG standard DDS, for helping in the convergence of the different simulation architectures. **LSA is based on the idea of evolution of legacy simulation architectures to an evolved architecture which uses a common wire protocol**.

More information about SISO LSA study group can be found at http://www.sisostds.org/StandardsActivities/StudyGroups/LayeredSimulationArchitectureLSASG.aspx

More information about relationship between Simware and LSA can be found at http://www.Simware.es/index.php/use-cases/lsa-sg-and-Simware