Modernization of Simulators through Modularity

"We need to do a better job of ensuring that our designs are modular – and that the [US] government is in a position to control all the relevant interfaces…"

US DoD Better Buying Power 3.0 Implementation Directive (April 2015)

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1 PROBLEM STATEMENT

The defense ministries around the world are taking significant cost cutting initiatives across their militaries in order to cope with their reduced financial resources. Governments worldwide, especially those on NATO are doing a continuous effort to increase the productivity, efficiency and effectiveness of their many acquisitions, technology and logistic efforts. These efforts are affecting the way the systems are designed, developed and supported along their full life cycle. Simulation & Training (S&T) systems is an example of systems that must evolve in order to reducing its life cycle costs and improving the ability to quickly respond to the demand of the services. One way to do it is by adopting a modular approach in the engineering, manufacturing and sustainment of the simulation systems. This whitepaper analyzes how modularity helps to have better simulation systems with a lower total cost of ownership and proposes a riskless way to do it.

2 REASONS TO ADOPT MODULARITY

Modularity approaches are already well known in many commercial sectors for years. Modularity has proven useful in reducing life cycle costs and improving the ability to adapt quickly to new market demands or requirements. Military systems are already starting also to adopt modularity approaches not only for new weapon systems but also to modernize existing ones. As an example, US Marine Corps and the US Navy talks about a holistic Modular approach (HMA) to provide the services with "holistically modular systems" that are adaptable, scalable and interoperable (see 2015 USMC PEO LS Advanced Technology Investment Plan). HMA concept is not just a technology concept or a development strategy for new systems; it also provides a methodology for modernizing existing systems. The concept relies on a set of standard interfaces, a key component of modular design that provides an opportunity to obtain required future capabilities in a cost-effective manner. HMA provides a mean of meeting existing requirements while establishing the foundation needed to meet changes in the requirements in the future

A modular design enables a system to be expanded or functionally reconfigured by incorporating new modules or replacing others with greater functionalities or differing functions. A computer system is a good example of a modular design: we can add new software and hardware to the basic configuration in order to incorporate new capabilities to our system.

Modularity not only provides many technical and maintenance advantages but also enables the creation of ecosystems in the industry, fostering competition, avoiding vendor lock-in and allowing open innovation.

The use of modularity is very common in products we use every day, as the smartphones, computers, cars, airplanes, etc. The most basic example of a modular approach are LEGO toys sets, which are composed of blocks of different sizes and shapes that can be linked together through a common structural interface. In the military systems, modularity is broadly used in air platforms (not only for the airframe but also for the avionics) and naval platforms and it is increasingly adopted in land systems (a good example is the Generic Vehicle Architecture or GVA adopted by UK Mod for its land systems).

3 APPLYING MODULARITY TO THE SIMULATION SYSTEMS.

Even when the use of modular designs has been a trending topic in the S&T industry for years, the simulation systems are still very coupled, especially in their software components. It is true that COTS has been introduced in the simulation systems in a massive way especially for the hardware components of a simulator; but they are not so common in the software components. Moreover, when they are used, normally they are integrated in a proprietary and much coupled software architecture that avoids its easy replacement or update in the future.

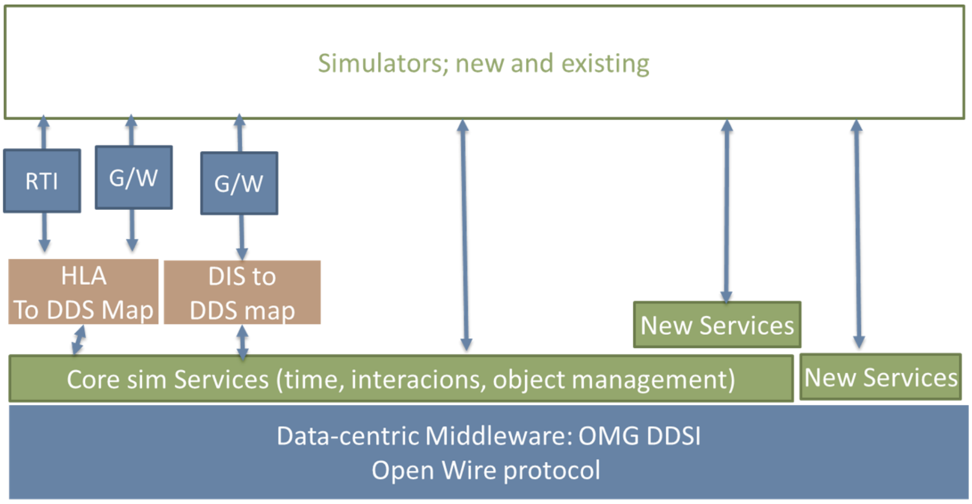
This lack of software modularity in the simulator is one of the main stoppers that are avoiding a significant reduction in its acquisition and support costs. There are two main challenges to solve before software modularity can be a reality for the simulations systems:

1. Simulators are developed with proprietary architectures without support for standard interfaces. When some standard is used, typically HLA or DIS, they are not supported as part of the architecture but only added as a gateway, that translate the proprietary protocols and datamodels used internally to the HLA or DIS std.
2. There is not only one standard interface to integrate COTS and reusable components. Only the data interface between an image generator and the host of a simulator is standardized by SISO, this is the CIGI standard; but we are lacking standard interfaces to connect other type of components as synthetic scenarios, instructor stations, cockpit displays, motion platforms, etc. In the case of synthetic scenarios, sometimes standards as HLA or DIS are used to do the integration; but here we have and additional restriction to the gateway architecture explained above: datamodels supported by COTS in HLA or DIS are only compliant with the RPR-FOM data-model (another SISO std) and this model is best designed to connect full systems or devices on the network, not to exchange data between the different components of a simulator.

Solution to these challenges is to adopt open, modular and layered architectures as the foundation to design a simulator. Without an open architecture, the software integration of a simulation system can be a real nightmare, compromising any deadline and budget. This is a big problem for the manufacturer of the simulator, eroding its benefits and blocking important resources that could be employed to generate new business opportunities and revenues for the company. But it is also a huge problem for the customer, normally the military services, because they need very big budgets to acquire the systems and to support them during its life cycle. Moreover, the lack of modular and open architectures into the simulators impedes the easy evolution of the system to meet future demands by the users. Many times the evolution of the system is not possible even when a big budget is available, because the proprietary architecture avoids the upgrade of the system, forcing to its replacement for a new simulator.

4 LEVERAGING OPEN ARCHITECTURES TO HAVE MODULAR SIMULATORS

Therefore, the best solution to increase the modularity of simulators seems to be the adoption of open architectures, but the question is: which is the right architecture to use? One candidate could be HLA, a SISO and NATO standard, well known standard in the market for distributed simulation, but it is not an architecture designed for real time performance, very needed for any virtual or live simulator; it is not completely open because of the lack of an open wire protocol and its architecture is very coupled. We need an integrated architecture, modular, layered and open at the same time. We are working already with SISO community to have it. At SISO, we are creating the first open integrated architecture for simulation: Layered Simulation Architecture or LSA. Right now, LSA is a nominating standard at SISO, already completed its viability stage in the LSA Study Group, started at sept 2012 and finished at late 2014.



LSA provides convergence of simulation standards into a Data-Centric platform, using OMG DDS standard as the foundation to converge the different simulation standards as HLA, DIS, CIGI and many others. The cohabitation of multiple standards into one architecture makes LSA the first architecture that can be considered an open integrated platform for any kind of simulation. It is the first standard developed specifically for the S&T domain with a full Network-Centric and Systems of Systems (SoS) approach.

LSA is designed to meet the requirements of any type of simulation system : Live, Virtual or Constructive. LSA provides a data-centric real time architecture focused on integration of COTS and existing components in a modular, uncoupled and layered software architecture. LSA enables the application of the Holistic Modular approach to the simulation systems, building the system as the integration of different modules and components. In this way, LSA can realize the dream to have simulators systems that are scalable, adaptable and interoperable.

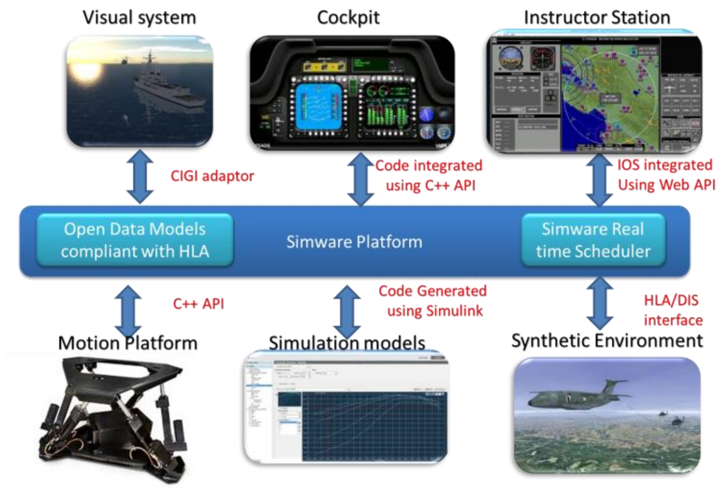
5 APPLYING LSA IN YOUR SIMULATORS.

But LSA is not only a nominating standard at SISO, still to be developed and tested by the market. LSA is already a mature architecture, fielded in many simulation solutions. LSA is the bedrock of our Simware platform. Simware leverages LSA to offer the first commercial open simulation to the S&T market.

Simware adds many advantages to the development of a simulator, here you have the main ones:

- Software architecture is very comprehensible because of it is data and network-centric.
- Modules and components can be easily replaced; because of the pure data-centric interfaces, based on standards.
- Work division is possible without all the participants knowing the complete system. This feature is very important in complex projects, in which industrial or security regulations impedes to share the full architecture of the system, between companies or even between governments.
- Uncoupled and layered architecture allow doing changes to one part with minimal effects in the rest of the simulator.
- Many different configurations are possible. For example, you can have a basic configuration for individual training and an advanced one for mission rehearsal. Second one adding terrain and advanced weapon effects servers to the basic configuration.
- Vendor lock-in is prevented due to standardization
- Open innovation, enabling innovative inputs from different entities without risking the whole system.

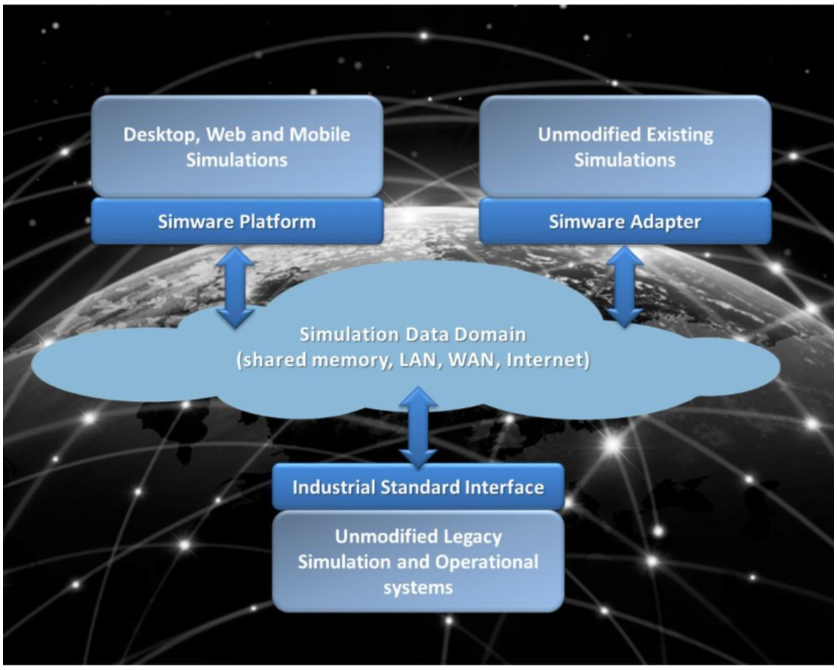
Simware leverages LSA to converge the main standards in simulation and operational systems into one and only common real time simulation platform. Compliance with operational standards as DDS or JAUS enables also the easy connectivity of real equipment as components of the simulator.



6 ABOUT SIMWARE AND NADS

Simware is the first Simulation platform compliant with the new Layered Simulation Architecture or LSA. You can find more information about our portfolio of products and solutions at www.simware.es

Our platform is the first commercial product available to build and federate simulations in compliance with initiatives at SISO and NATO related to the use of Simulations assets as Services in the Network. Simware platform provides, out-of-the-box, seamless interoperability of SISO simulation standards like HLA, DIS, CIGI or CBML with the OMG DDS standard. Multi-standard compliance makes affordable to any budget the development and deployment of LVC simulations over any kind of network.



Beyond our products, our commitment is with standards, actual and future; because of that, we are working at SISO and NATO to develop the future standards and technical architectures for distributed simulation and for the use of M&S as Services (MSaaS concept).

Simware is the technological company of NADS. NADS is a simulation company, leveraging radical innovations to make affordable the use of simulation solutions for anyone, anywhere and anytime.