“I can see clearly now” – deploying training simulators in a distributed heterogeneous cloud environment

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Abstract

This paper provides key insights and innovation into the issues of deploying next generation Simulated Training Equipment (STE) in an environment where most training is distributed; where constant upgrades are necessary for operational effectiveness, and in a contested and aggressive internet environment where there is a constant threat of interception and insertion by hostile actors. The paper describes the use of automated delivery and configuration for distributed and heterogeneous STE which will save the customer money and time, increase reliability and allow training professionals to concentrate on the job of training.

1 Introduction

This paper looks at the viability of taking the Modelling & Simulation as a Service (MSaaS) concept into addressing the needs of the customer for rapidly developed and deployed training devices.

Existing approaches are not capable of meeting customer requirements and so Thales as a leader in the research activities within the UK and in NATO is in the process of harnessing the benefits of MSaaS to provide a coherent end-user capability for developing and deploying of distributed collective training systems.

1.1 Trends in Simulation

In the past, STE systems procured by UK MOD and other governments were completely bespoke solutions produced using components sourced by the industry integrator. These components would be proprietary, Commercial Off The Shelf (COTS) or more commonly a mixture of both. COTS components have been growing in popularity to the extent that most training systems use them. However specialised integration skills have been needed to use them, and issues with licensing regimes and updates can occasionally be problematic for systems that are not connected to the internet in order to meet security accreditation requirements.

In addition the data that is needed to run simulations (Object model data, terrain data) is expensive to source and often requires government / end user assistance to procure. This has led to

governments around the world to produce catalogues and repositories of terrain and model data to encourage reuse and to mandate standards to ensure that components within a proprietary training solution can be partitioned to allow for easier and cheaper upgrade. In the UK this approach is known as Defence Modelling and Simulation Coherence (DMaSC), formerly known as Defence Training and Education Coherence (DTEC) with a series of rules embedded into acquisition requirements. [1]

1.2 'Fog of War'

With the ever changing world political environment, STE and modelling and simulation in general needs to be more flexible and agile to support rapidly changing requirements.

One example of this need is the recent case in Salisbury UK, where police and security service staff had to work in combination with military Chemical Biological Radiological and Nuclear (CBRN) expertise to handle the release of a sophisticated chemical nerve agent. Training and rehearsal for these types of unexpected events requires collective training systems to be rapidly adapted.

Providing a high level of agility in a traditional STE system is difficult, time consuming and costly. Introducing change in delivered systems generally requires substantial effort in time and labour in development, integration and testing. The costs involved are not necessarily understood by the end user leading to a widely differing expectation on pricing the change from customer and system integrator.

The work is even more challenging when the STE in question are heterogeneous in nature, or are distributed across multiple locations and connected to real equipment. This can lead to a 'fog of war' where change is too hard to be even considered and thus any new training objective is not delivered at all or delivered poorly with original equipment.

Current training requirements are increasingly based on the premise of using STE for distributed collective training, with flexibility of deployment on to different platforms, rapid adaption to new mission requirements, 'go-anywhere' connectivity, and re-use of data and models being key.

1.3 Next generation architectures

The Service Oriented Architecture (SOA) method, consisting of dynamically deployed modular components has been proposed as a method to overcome some of the issues relating to existing simulation systems; henceforth referred to as Modelling and Simulation as a Service (MSaaS).

The adoption of MSaaS could help the transition from large monolithic simulations into component architectures, providing opportunities for reusing these components across different simulation systems. The benefits of component architectures include;

- Reduced cost of procuring a capability as you can buy once and use many times;
- Reduced cost of maintaining a capability as only one piece of software has to undergo configuration control;
- Reduced skill requirement as only have to know about one piece of software;
- Bug fixes can be quickly propagated to wherever component is used.

The MSaaS concept provides a way of delivering software components as loosely coupled services.

2 Overview of MSaaS

2.1 MSaaS Definition

The definition of MSaaS as described by the UK Defence and Science Technology Laboratory (Dstl) Architectures and Infrastructure in Modelling and Simulation (AIMS) project is [2]:

An Enterprise-level architecture that promotes modularity, loose coupling, agility and reusability of Modelling & Simulation resources from different suppliers by making them available on-demand to a large number of disparate users in order to reduce the cost and time for implementing Modelling & Simulation capability to improve operational effectiveness.

A more complete understanding of MSaaS is obtained by decomposing the AIMS definition into the four MSaaS principles:

- An on-demand fully transparent and integrated method of moving from an operational requirement to an executable simulation that can deliver that requirement;
- A semi-automated composition of simulations re-using existing capability where possible and integrating new if required;
- Deployment and execution of simulations decoupled from specific hardware and infrastructure to enable flexible and scalable use;
- Sharing of acquired capability, including hardware, software, services and infrastructure.

2.2 MSaaS Ecosystem

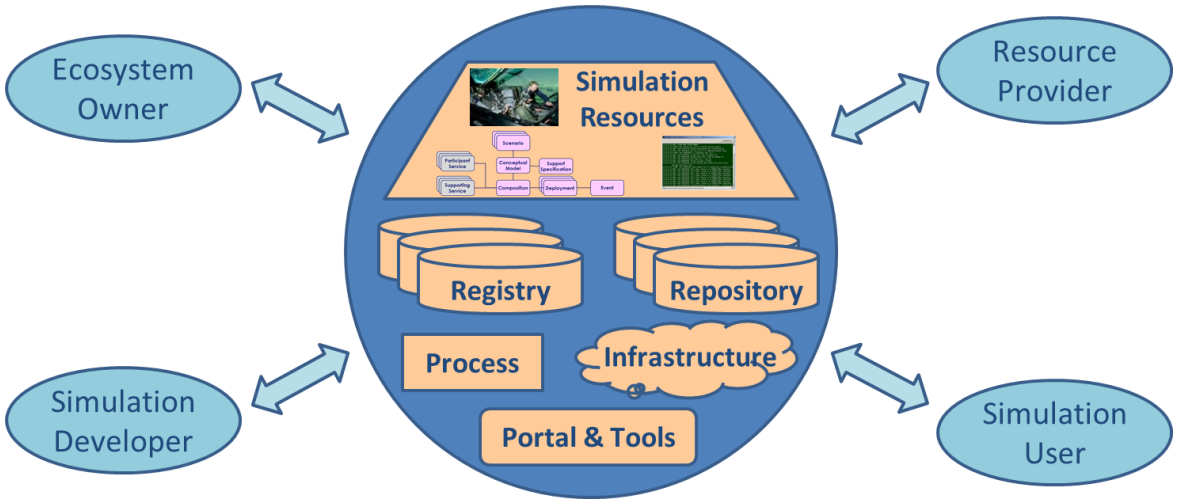

Figure 1 MSaaS Ecosystem and Stakeholders

. **Figure 1** shows the elements of the MSaaS ecosystem developed by AIMS and are more fully described in [2].

- Simulation Resources – comprises M&S Assets, M&S Services and M&S Blueprints[1];
- Registry – a structured, searchable database containing information about M&S Resources (analogous to an electronic, searchable catalogue);
- Repository – a store for reusable resources such as M&S Services and M&S Blueprints;
- Process – defines how services are Discovered, Composed, Deployed and Executed[2];
- Infrastructure – comprises the computing and network elements for executing the Simulation Environment;
- Portal & Tools – the Portal provides a single point of entry for accessing the toolset that supports the MSaaS process.

The MSaaS stakeholders are:

- Ecosystem Owner – responsible for setting-up and operating the MSaaS ecosystem by utilising maintenance functions;

[1] An M&S Blueprint specifies the registry objects associated with a simulation event including the Composition (defines the services used), Deployment (defines how the services are deployed on the infrastructure), Scenario (how the simulated entities, Event (captures details about the Event such as its objectives, responsibilities, location etc.

[2] NATO MSG-136 has produced an overlay for the Distributed Simulation Engineering & Execution Process (DSEEP) [4]

- Resource Provider - produces and maintains simulation resources that can be exploited by other users;
- Simulation Developer: uses the M&S Resources for developing Simulation Environments;
- Simulation User: Indirectly uses M&S Resources by interacting with a Simulation Environment.

2.3 Why MSaaS?

MSaaS has become a very 'hot' topic with dedicated sessions being organised at most simulation conferences. The reason for this is it that the output from the research provided by AIMS and MSG-136 shows that it provides several benefits to the way simulation capability can be delivered in future. These include;

- Efficient use of Simulation Resources;

  MSaaS encourages a culture of 'buy/develop once, use many times'. In the past, large enterprises have bought the same or similar capability many times over as people were not aware of what resources were already available to them. By having a registry that provides an efficient search capability, simulation developers can discover simulation resources they were not previously aware of.

- Saves time creating and deploying simulations;

  Reusing simulation resources that already exist in a repository enables simulation environments to be created much quicker. Even if the simulation resource doesn't exactly meet a user's needs, it is much quicker to modify something than start from scratch.

- Reduces technical expertise required for creating/deploying simulations;

  By reusing previously generated Deployments, non-technical users are able to discover and deploy previously created simulation environments. MSaaS facilitates the future automation of creating Compositions and Deployments.

- Capitalises on the benefits of recent IT developments;

  The provision of M&S Services using virtual machines, containers and web services enables the execution of simulations to be decoupled from specific hardware and infrastructure to enable flexible and resilient use. Cloud computing provides an efficient use of hardware resources as the simulation services to support a specific event are only deployed when needed, which frees it up for other uses.

- Enables simulations to be generated and executed anywhere/anytime;

By enabling the MSaaS tools to be always online and accessed remotely, they are available 24/7 from anywhere in the world.

- Resolution of interoperability issues and the ‘fair fight’ problem.

  Instead of using conventional ‘bottom up’ approaches (using physical and syntactical standards); tackling the interoperability problem using SOA techniques to make composable systems may be a more productive way forward. Dr. Andreas Tolk’s quote “Interoperability enables fair fights, composability ensures fair fights” [3] summarises his paper which detailed the fundamental mathematical barriers to conventional approaches which do not take into account the need for conceptual alignment.

- Potential for automatic generation of simulation compositions and deployments from user requirements;

  The MSaaS ecosystem provides the framework for providing the long-term vision for MSaaS of producing simulation environments from operational requirements with minimal human involvement.

- Different Business models;

  MSaaS opens up the possibility of having different business models such as ‘Pay As You Go’. It also enables SMEs (Small/Medium Enterprises) to provide smaller services, which will increase competition.

3 MSaaS Challenges

The research that has been conducted has provided compelling evidence that MSaaS has potential; nevertheless there are many issues that need to be resolved such as:

- Service Definitions;

  Not much research has been performed into determining the appropriate granularity for providing services. There is a cross-over between having a lot of small services that cost a lot to maintain, and having fewer larger services, which will have less chance to be reused. Once the functionality for a service has been agreed, the interface needs to be defined.

- Cloud Latency

  Associated with service definitions is where services are likely to be executed. Small services, such as ‘coordinate transformations’ may be called many times a second. If these are running in a remote cloud, the latency may impact the operation of the overall simulation. Research is required to determine those services that can be run remotely and

those which have to run locally. A similar consideration has to be applied to graphic intensive applications.

- Integration of heterogeneous systems;

  Although the integration of complex distributed simulations environments is becoming easier with better tool support, it is still a time consuming and error prone process. In the past, if a simulation environment had to be recreated, it would take almost as long to implement again. Whilst still challenging to perform the initial integration of heterogeneous systems, once its operation has been validated, MSaaS provides the ability to capture the design and deployment of the simulation environment so that it can be quickly recreated.

  Also, MSaaS provides a way of simplifying the integration problem by capturing which services work together to provide a particular function such as exercise control. This reduces the number of interfaces to be taken into account.

- Business Models/Licencing;

  MSaaS opens up the possibility for offering different licencing models when procuring simulation capability such as 'Pay As You Go'. This means that although there may be a higher charge for a service, it is only being paid when the service is being used. For core simulation services, the concept of a gold licence may still be applicable. More work is required to determine the cost of generating and maintaining different services so that the customer gets value for money and industry can still remain in business.

- Risk

  In future, if the MOD wants to promote reuse by insisting that Government Furnished Equipment (GFE) is utilised when procuring new simulation capability, the issue of who owns the risk when it is integrated with the new capability needs to be addressed. The functionality provided by a service and any limitations needs to be clearly specified.

- Standards;

  For MSaaS to be successful, internationally agreed standards need to be developed for M&S Services and M&S Blueprints (which capture the design and deployment of a simulation environment). The best forum for this is through the Simulation Interoperability Standards Organization (SISO).

- Cyber and Security

  MSaaS encourages the geographic distribution and sharing of M&S resources. This makes the ecosystem vulnerable from cyber-attack. As a lot of work into cyber security is taking place outside the simulation domain, most MSaaS research has not addressed this subject.

It is thought that the solutions being developed for cyber security will be directly applicable to MSaaS. Although not specific to MSaaS, the issue of cross-domain security needs to be addressed when networking simulators with different levels of protective marking.

- MSaaS Business Case

  An analysis needs to be performed to determine the cost for setting-up and running the MSaaS ecosystem. Similarly, the potential cost savings that can be made so that a coherent business case can be made by an organisation to allow future deployment and support continual investment.

4 "I can see clearly now"

The concept of MSaaS will only be realised if it can be turned into a system that someone without a deep technical knowledge can use effectively on a day to day basis.

Focussing on the customer and end-user is vital if the concept is to be turned into anything more than a research dream. The customer and end-user needs reconfigurable STE delivered at the 'press of a button'.

Thales, as a leader in providing STE systems and a key contributor to the AIMS project and NATO MSG-136 task group has resolved to introduce MSaaS techniques into its STE systems. Substantial internal development activity has allowed it to provide useful technology to solve some of the challenges mentioned above and to provide insight into developing a complete overarching solution for 21st century modelling and simulation applications.

4.1 Characteristics of a useful MSaaS implementation

Based on all the preceding comment, it is possible to describe what an MSaaS implementation that is useful a customer for running a training service might look like. The implementation would include the following:

- Registry services, linkable to internal or customer registries
- Repository services, linkable to internal or customer repositories
- Deployment and Execution components allowing complete redeployment in minutes
- After Action Review and Analysis support
- Component tools such as scenario development, communication, sharing, visualisation and monitoring
- Support for security accreditations

- Support to handle ‘Quality of Service’ requirements
- Support for COTS and legacy components
- Support for multiple cloud computing providers and web based components
- Capability for Metering, monitoring and charging
- Full support of the UK DTEC/DMASC rules and international equivalents including the use of a standards based approach to infrastructure and module services
- Simple unified user interface that customers can learn quickly

5 Conclusions

Thales’ work in the area of MSaaS is with the aim of introducing the benefits of the new approach to the user community at an early stage and to exploit the benefits of research as they appear. MSaaS is a revolutionary approach which will require patterns of behaviour within the STE industry to change:

- ‘Stove-piped’ training systems will die out being replaced with dynamic composable structures which may be changed in a matter of minutes;
- Components and infrastructure in the same STE systems may be sourced from multiple organisations that compete with each other;
- Users will be able to rapidly generate novel scenarios using available modules and services without extensive support from system integrators;
- Components will be paid for on an ‘as-used’ basis rather than purchased outright;
- Components may be physically located in the cloud and not locally;
- Simulation system hardware will be repurposed dynamically rather than being used with the same application all the time.

Changing behaviours from customers and suppliers will need to be worked out carefully to ensure that both sides benefit from the radical change and disruption that MSaaS will bring to the STE industry.

6 References

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