Delivering Next Generation Simulation Today: Converging Virtual, Constructive and Gaming Through Cloud Technologies

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Abstract — Western military organizations are striving to bring together virtual, constructive and gaming training environments into single unified architectures. Similar requirements are emerging in the United States ("Synthetic Training Environment"), the United Kingdom ("Collective Training Transformation Programme") and Australia ("Land Simulation Core 2.0"). This paper examines the opportunities and challenges these requirements present to simulation developers and government defense organisations seeking to leverage game technologies in the cloud. Gaming technologies -- especially those that leverage the Cloud -- offer an unprecedented opportunity to scale simulation. For example, a cloud-enabled One World Terrain (OWT), a key requirement of the U.S. Army's Synthetic Training Environment (STE) initiative, will enable warfighters to conduct virtual training and complex simulations anywhere on a virtual representation of the Earth. The U.S. Army's STE will leverage cloud technologies to deliver training to the point of need, ensuring a common and high-fidelity whole-Earth terrain representation for a multitude of different simulation systems. This demanding requirement is beyond what most commercial video game engines provide out of the box, and this is just one example of the significant challenges that developers are working to address. This presentation will describe research and development efforts undertaken to accelerate simulation technology, including extensive use of industry-leading technologies from outside the military simulation domain. The presentation concludes with lessons learned related to the application of cutting-edge technologies to solving STE requirements.

1 Next Generation Simulation Technology Overview

Western military organizations are striving to bring together virtual, constructive and gaming training environments into single unified architectures. Similar requirements are emerging in the United States ("Synthetic Training Environment"), the United Kingdom ("Collective Training Transformation Programme") and Australia ("Land Simulation Core 2.0"). The stated goal of the U.S. Army's Synthetic Training Environment (STE) initiative is to "converge" virtual and constructive simulation, and deliver a holistic "one world terrain" to the point of need by leveraging Cloud technologies.[1] Similarly, as part of the Land Simulation Core 2.0, the Australian Army is seeking solutions to "enable a scalable and persistent Land Simulation System" and "common architecture" for virtual simulation and image generation.[2] In its efforts to evaluate the value of VR for simulation and training uses, the British Army has identified a need for simulation solutions providing "open architecture to enable the reuse of common systems," reconfigurability, and higher fidelity. [3]

Gaming technologies – especially those that leverage the Cloud – offer an unprecedented opportunity to scale simulation. In addition, the modular nature of game technology can help "future proof" future simulation deployments, reducing the cost of implementing best-of-breed technology in the future. However, Cloud technologies are relatively new to the military. While there is a desire among militaries to leverage game technology, there is a lack of understanding as to how to employ it.

This presentation will examine the opportunities and challenges that these requirements present to simulation developers and military and defense organizations and describe the efforts of the Bohemia Interactive Simulations (BISim) team to deliver against some of the common simulation modernization requirements and lessons learned.

2 Opportunities and Challenges

The vision of STE and other simulation modernization efforts is ambitious, aiming to address the limitations of the current "ad hoc" approach to simulation technology that is typical in all western military organizations, whereby bespoke simulation systems are procured to meet different requirements. This reduces the opportunity for huge cost savings through re-use of content, massively limits collective training as different simulation systems are not sufficiently correlated and, most importantly, creates very long lead times for setting up larger scale training exercises.

The unified architecture approach, however, would require all simulators to use a common IG, and stream terrain from a central server to ensure correlation (and removing the need to build runtime-specific terrains). All systems would be capable of being networked, expanding the possibilities for collective training, but also capable of operating stand-alone where network capability is not available.

Other opportunities include:

Common Terrain Representation - This would solve correlation issues between different simulation systems that presently contribute to training inefficiencies. For example, the U.S. Army SE Core program currently serves 47 runtime

engines and terrain production time can range from weeks to months depending on the complexity and size of the terrain.[4] OWT aims to serve correlated terrain to runtimes on-demand from a central location via APIs.

Connectivity to the Point of Need - Cloud technology should enable in-theatre forces to update terrain based on real-world changes, and those changes should be immediately available to forces training at home station.

Convergence of Virtual and Constructive - For the past few decades, interoperability has been achieved through connecting separate simulation systems by HLA or DIS, but programs like STE would effectively converge virtual and constructive, representing all aspects of Multi-Domain Operations (MDO). The obvious opportunity is to support tactical use cases within a much broader (Army Corps) level context, without needing significant overhead in terms of computing resources and admin staff.

Unprecedented Scale - Traditional constructive simulation supports tens to hundreds of thousands of individual entities, and aggregation is used to reduce the complexity of simulating Brigade level forces and higher. The use of cloud computing would dramatically scale up the number of intelligent entities in a simulation scenario into the millions.

Persistent Virtual World - Current simulation runs are scenario-specific, and the virtual world is "reset" at the end of training. Cloud-enabled simulation solutions offer the ability for changes in both the physical and human terrain to "persist" (if required). For example, tactical actions could have a strategic effect on the broader simulated population.

Aggregation of Performance Data and Machine Learning - Connecting all simulators through a common and open architecture offers a massive opportunity for automating the collection of performance data, providing valuable data sets that could be exploited by machine learning to further improve training vignettes or inform more realistic AI behaviors.

Of course, simulation modernization requirements present many challenges, including:

Upgrading Simulation Systems to Support a Common Architecture - The current "siloed" approach to military simulation will be expensive to change, with each simulator requiring a complex integration with the new technology (IG, network and potentially a hardware upgrade). Training scenarios will need rebuilding, and training methodology updated.

Traditional "Military Standards for Interoperability" Don't Readily Transfer to the Cloud - DIS (and other multicast protocols) were not designed for Wide Area Network (WAN) operation and HLA requires expert knowledge and expensive technology to work in the Cloud. STE should leverage "web-standard" technologies.

Cloud Technologies Are Relatively New to the Military - There are security concerns, bandwidth concerns and cost concerns (e.g. virtualization is not cheap), all of which need to be overcome to be deployed as envisaged.

Game Technology Does Not Readily Meet the Needs of Many Military Organizations - There is a strong desire among militaries to leverage commercial game technology (e.g. commercial game engines) but many required features, such as whole-earth terrain, don't exist in the baseline of most engines. There are also ownership concerns (underlying technology owned by potential adversaries) and challenges with licensing source code.

3 Lessons Learned

Modern web technology is enabling the acceleration of STE, as evidenced by the rapid progress of several development teams in prototyping relevant technologies. Lessons learned include:

1. Building a whole-earth engine capable of simulating the entire spectrum of MDO (from subterranean to space to cyber) is very challenging. Over five years of constant development effort underpins BISim STE technology.
2. The flexible contracting process behind STE facilitates innovation, enabling an agile development framework.
3. Web technology has moved far beyond military standards, offering new possibilities for interoperability that are more performant and cost-effective than military-specific standards such as DIS and HLA.
4. Cloud scalability can be leveraged *today* for dramatically increasing the number of simulated entities, and streaming whole-earth terrain data to the point of need. Broader deployment of cloud technology depends on available bandwidth at the point of need, and remains a significant challenge.

References

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[3] UK Ministry of Defence, Statement of Requirement - Virtual Reality in Land Training (2018)

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Author Biography

Pete Morrison is BISim's Chief Commercial Officer. Before BISim, Pete studied Computer Science and Management at the Australian Defence Force Academy and graduated with first class honors in 2001. He served as a Signals Corp Officer for several years, specializing in military simulation, and his final posting was to the Australian Defence Simulation Office (ADSO) as a Project Officer.