CORE REQUIREMENTS FOR A COMMON DYNAMIC SYNTHETIC ENVIRONMENT

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ABSTRACT  Simulation in aviation has been around for a very long time indeed, and is the most mature application of M&S. “Virtual air” has come a long way, from the early 1900’s where “human actuators” induced motion cues for the trainee pilot to contend with, to the first computer based flight simulators with the advent analogue computing. However things really took off as it were with the advent of digital computing technology in the late 1950’s resulting in huge advances in M&S technology and capability to the zero-flight time trainers delivered by CAE today such as the C-130J Full Flight and Mission Simulator currently used by the RAAF at Richmond in NSW.

The architectures of our M&S based systems evolved over time as well – building on a platform centric core to progressively add-on elements of a “wrap-around” synthetic environment within which the platforms operate. However they fundamentally remain “platform centric” in their design. Three key aspects are today driving a fundamental shift in our M&S systems architectures - the ever increasing pace of technological change, the need for better interoperability and need for agility of reconfigurability of simulations. The pace of technologic change is closing the performance limitations gap of the past that forced the development of propriety/closed architectures. In fact technology is now enabling a shift towards open / computing platform agnostic architectures. In parallel, users of complex simulations are starting to demand more of their solutions – specifically for interoperability and agility of re-configurability of simulations with particular regard to the synthetic environment.

This presentation examines the context of the shifting paradigm to propose a core set of requirements for a future virtual world within which simulations of various platforms could operate effectively and efficiently, facilitating greater interoperability and ease of reconfigurability.

CAE was competitively selected in 2004 by the US Army Special Forces to develop and deploy the Army Special Operations Training and Rehearsal System (ASTARS), a state-of-the-art mission rehearsal system funded by the US Special Operations Command for the 160th Special Operations Aviation Regiment. The System involves multiple weapons platform simulators, as well as an advanced computer network system-of-systems replicating weather, enemy threats, and highly realistic and current terrain. A major technological breakthrough was required in the development of ASTARS: the US Special Forces missions demanded very high performance interoperating simulators, but more importantly, the mission demanded that the synthetic environment, i.e. the world ‘outside’ the simulator, be as realistic and current as possible in all aspects. There was a requirement for the terrain, the buildings, the vegetation, the friendly and enemy order-of-battle to represent as close to as possible the current situation in theater, based on the most recently available and highest quality intelligence and surveillance, so as to allow for effective Mission Rehearsal. Equally important to the visual simulation, there was the need also for completely correlated high fidelity representations in Radar, Night-Vision, infra-red, and other spectra.

CAE realized early in the program that the legacy approach and architectures would not suit or meet the ASTARS requirements, both from a fidelity as well as from a timely perspective. A new approach and architecture was needed. The new development that resulted was named the Common Database (or CDB) by CAE. CDB is an open specification high fidelity data model that makes it possible to develop and deploy high fidelity synthetic environments in the timeline necessary to support the rehearsal of critical missions. The ASTARS system, employing the CDB represents very effective current capabilities for enhancing combat effectiveness.

The effectiveness of a M&S System for Mission Rehearsal is directly related to two key requirements - how well Systems interoperable with other Systems, and the ease or agility with which a System allows for changes to its configuration.

Interoperability is defined as the ability to interconnect and communicate information between systems and for this information to be correctly interpreted by the receiving System in the same sense as intended by the transmitting System. For M&S based training systems, interoperability can be partitioned out into two key aspects –
- the sharing of position and state data of the simulated entities as they move around, and
- the synthetic environment within which they operate.

There are established standards for the first – such as DIS, HLA and TENA, however there is in fact no such established standard for a common / shared synthetic environment! It was this challenge that CAE had to overcome on the ASTARS program, and the solution required a re-think of legacy simulation architectures.

Historically, we started by simulating individual weapons platforms, specifically aircraft. As we got better at replicating the behavior of the complicated machine, and as technology evolved, we began to build environments to wrap around the simulated platforms to replicate the world in which they operated. As we got better at replicating the external wrap-around environments, we discovered we could begin to simulate the mission beyond the operation of individual aircraft and other platforms. Today, we are able to integrate multiple simulations and simulators into networks that provide capabilities that are used not only for training, but also in support of operations from mission planning, to course of action analysis, mission rehearsal, and after-action reviews, all of which can be shown to contribute directly to improve combat effectiveness. However, simulation architectures are rooted in our original concept of wrapping an environment around an individual simulator. When we integrate multiple simulators and simulations today, we are forced to integrate, and attempt to interoperate, with multiple, purpose-built “wrap-around” synthetic environments. And herein lies the problem – even when separate simulations have synthetic environments that replicate a common location, as they use different source files and different technologies, they do not provide for a true common synthetic environment. There are always differences in fidelity and resolution of the synthetic environment that consequently provide the humans in each of the simulators with non-identical cues.

Today’s computer generated synthetic environment is both better to look at and it offers benefits that are perhaps not obvious at first sight. They support sensors such as Radar and FLIR, and Computer-Generated Forces, and sometimes planning, mapping, and command-and-control simulations. We now expect a modern synthetic environment to provide coverage over large areas – ultimately the planet – and to support use at different levels-of-detail. The underlying database must contain all the data, attributes, and 3D content needed for high-fidelity real-time simulation at any level-of-detail.

To enhance combat readiness, the **synthetic environment must support scalability of content and dynamics** to support simulations for individual units, weapons platforms and soldiers, up to large, sophisticated joint and multi-national simulation federations and operations.

Current synthetic environments take too much time and money to develop and integrate, and they consume considerably more time and money to maintain their currency and relevance. An important side effect of this is that they are always “behind” the state of the real-world. **Our future Synthetic environments must maintain their currency and relevance.**

If we wish to further extend the effectiveness, efficiency, and utilization of simulators, and broader M&S technologies, we need better interoperability, better standards - a technology eco-system within which multiple simulations can co-exist and interact. **We need to make connectivity easy.**

“Fair fight” issues arise when only some of the participants have access to the latest data across a large-scale federation of networked simulators. **Visual simulations need to be correlated** with very high performance Radar and electro-optical sensors, and with computer generated forces used to generate both enemy and friendly “players” in the environment.

Most synthetic environment today are paged from a ‘static’ database. A relatively small number of ‘moving models’ and other entities can move and display changes over time, but this paradigm has severe limits at scale, and requires all the participants to essentially agree in advance what changes might happen and where they might happen so they can be enumerated and articulated over a simulation network. **Our future synthetic environments must support dynamics with persistent, correlated simulation representations at scale in a federation.**

At the simplest level, a Synthetic Environment that complies with the key requirements noted above will facilitate having the most recent intelligence and surveillance data represented in the synthetic environment. At a more complex level, this capability enables time variant datasets resulting from individual simulations and even live sensors to be made persistent and externally available to larger scale federations. With the right protocols, full-scale inter-connected environment simulations could expand over time to include large-scale
weather, hydrology, ocean conditions, as well as a vast array of simulated players all interacting with – and modifying – the environment in which they live.

Each of these key requirements highlights a specific need that must be addressed in a no-compromise synthetic environment solution. The resulting database would permit open interchange and interoperability at a whole different scale, where database content is fully decoupled from the capacities of the consumer of that content – the real-time “clients”.

**Future Virtual World – Core Requirements**

- Currency
- Ease of connectivity
- Scalability
- Correlation
- Persistence
- Dynamics