Geospatial Layer Interoperability

Doug Stapleton, Executive IT Architect
IBM Australia
dougstap@au1.ibm.com

Abstract. Simulation is an area that requires the adoption of standards to allow the various simulation providers to interoperate. In particular, there have arisen a number of differing standards related to geospatial identification. Each of these standards has different benefits and different supporters among the industry vendors of simulation products. This has made it virtually impossible to agree and move to a single all-encompassing set of standards. Even if the hard work was done to obtain agreement to a single standard, the future is characterised by further rapid development in the digital arena, so the problem can be more accurately stated as how to build a conceptual model that allows disparate simulators to interoperate and allow for the introduction of new standards as they develop. This paper suggests an implementation model as to how that might be achieved.

1. INTRODUCTION

How is a particular physical location precisely defined? In an absolute sense, each place on earth is uniquely defined by its latitude and longitude coordinates, to a sufficient degree of precision. Of course this is further complicated by the concept of the objects height relative to the surface. The problem arises when various objects are placed onto the simulation landscape and slight inaccuracies lead to a misalignment of the object relative to the environment. This subject is generally discussed by Andreas Tolk (Tolk, 2012) and David Lashlee (Lashlee, 2012). These problems manifest themselves in the classic photo of a half-buried tank in a simulated environment.

Figure 1: Illustration of tank that is not aligned to its surrounding terrain[1]

So, an initial model would suggest that there is an absolute location, which is described by a particular standard, which is used by particular simulators; in a one to many set of relationships.

Figure 2: Relationship of Standards Used by Simulators to the Position Represented

Next, let's look at what can be present at the particular location described. We can think of this in two broad categories; the natural environment and man-made objects.

The natural environment can be illustrated as:

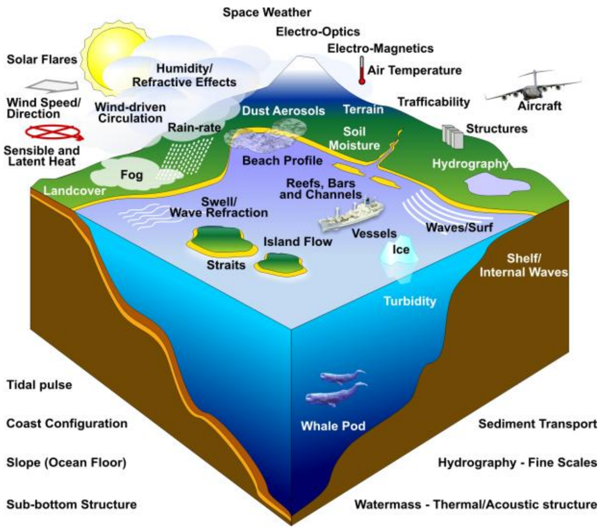

Figure 3: An Illustration of Components of the Natural Environment

As an example, the International Standard[2] ISO 18025:2005; *Information technology — Environmental Data Coding Specification (EDCS)* specifies environmental phenomena in categories that include, but are not limited to, the following:

a. abstract concepts (i.e. absolute latitude accuracy, geodetic azimuth);

b. airborne particulates and aerosols (i.e. cloud, dust, fog, snow);

c. animals (i.e. civilian, fish, human, whale pod);

d. atmosphere and atmospheric conditions (i.e. air temperature, humidity, rain rate, sensible and latent heat, wind speed and direction);

[1] Photo source: http://www.strangemilitary.com/content/item/144069.html

[2] http://standards.sedris.org/18025/

e. bathymetric physiography (i.e. bar, channel, continental shelf, guyot, reef, seamount, waterbody floor region);

f. electromagnetic and acoustic phenomena (i.e. acoustic noise, frequency, polarization, sound speed profile, surface reflectivity);

g. equipment (i.e. aircraft, spacecraft, tent, train, vessel);

h. extraterrestrial phenomena (i.e. asteroid, comet, planet);

i. hydrology (i.e. lake, rapids, river, swamp);

j. ice (i.e. iceberg, ice field, ice peak, ice shelf, glacier);

k. man-made structures and their interiors (i.e. bridge, building, hallway, road, room, tower);

l. ocean and littoral surface phenomena (i.e. beach profile, current, surf, tide, wave);

m. ocean floor (i.e. coral, rock, sand);

n. oceanographic conditions (i.e. luminescence, salinity, specific gravity, turbidity, water current speed);

o. physiography (i.e. cliff, gorge, island, mountain, reef, strait, valley region);

p. space (i.e. charged particle species, ionospheric scintillation, magnetic field, particle density, solar flares);

q. surface materials (i.e. concrete, metal, paint, soil); and

r. vegetation (i.e. crop land, forest, grass land, kelp bed, tree).

On the man-made scheme of things, we can overlay the natural environment with:

- The man-made civil environment, such as buildings, roads etc
- Simulation objects that can interact with the environment and can typically move, shoot, be damaged or destroyed.

Typically there is a list of simulation objects that can move and interact. This list will need to resolve the simulator that is responsible for that objects movements and interaction. So an object such as a tank may have a location at a point in time, but also has a direction and speed. Thus the simulation landscape is a calculated representation at a particular point in time.

Next we need to consider how a simulator represents four issues:

- The natural environment and static civil environment
- The list of simulation objects
- Changes to objects caused by their interaction resulting in damage or destruction
- Collateral damage to the natural environment and static civil environment and how that is updated and represented

<u>The natural environment and static civil environment</u>

These environmental representations are characterised by being relatively unchanging, so that they can be loaded at the beginning of a simulation exercise as the "Area of Operations" for each simulator. This suggests that the general process would be one of Defence maintaining the gold standard of the world, from which the static representation of the Area of Operations is defined and provided to the various simulators using the applicable standards required by each simulator. This would result in each simulator in an exercise being able to commence with a preloaded view of the static natural and civil environment. This progression is illustrated in Figure 4.

<u>The list of simulation objects</u>

This is typically the list of man-made objects, such as those in the Order of Battle, that are then represented in the simulation landscape.

<u>Changes to objects caused by their interaction resulting in damage or destruction</u>

As the simulation progresses and weapons are fired, this can result in varying degrees of damage or destruction. So the properties of these objects need to be updated and then shared with all the simulators in the scenario, not just the ones inflicting and receiving the damage.

<u>Collateral damage to the natural environment and static civil environment and how that is updated and represented</u>

One example of collateral damage to the natural environment and static civil environment might be a tank firing shells at an opponent. For those shells that miss their target, there is still an impact on the ground or vegetation at the point of impact (trees might fall down, for example). A shell might hit a bridge and make it unusable, an important point to the fidelity of the war game and an important point that must then be shared with all simulators in the scenario.

An interesting point to note is that we're reaching the point where the level of granularity of the geospatial data captured and maintained for the real world and that of the synthetic world are becoming the same. Simulators are today better able to cope with the complex computing required for accurate environmental representation in the real time display of the simulator. The implications are that perhaps we no longer need to synthesise the environment, we can use the real one in simulation and synthesis efforts shift to adding non-real world features we need for a simulation to a real world geospatial base

2. A PROPOSED IMPLEMENTATION MODEL

The issue of which standards apply to the environmental representation is one which has never been resolved to settle on one exclusive standard. And looking forward, it is unlikely to be settled in favour of one standard only. Even if it was, there is the issue of the inevitable updating of standards to cater for new and improved simulation outcomes.

The need for interoperability between environmental layers is particularly relevant for the Joint, Live, Virtual, and Constructive (JLVC) 2020 Technical Architecture which represents the next generation of cloud-enabled modular M&S services that will improve flexibility, accuracy and reusability.

We can restate this issue as the ongoing need for being able to run a scenario in which groups of simulators (connected via a version compatible run-time instance of HLA/DIS) can each work with a particular version of environmental standards and yet share this information between the players in real time.

The Enterprise Service Bus supporting the Synthetic Backbone is a way to accomplish this. Each execution group of simulators is connected to the ESB and passes events to the backbone, such as damage to the environment or movement of objects in the simulation landscape. The backbone then mediates between each group of simulators and passes the event, in the right standard format to each group of simulators so that the objects move or reflect damage to them. In this way, a tank firing a shell at a bridge can have that damage reflected in other simulators that are not part of that action and may use a different environmental representation standard. That concept is illustrated below:

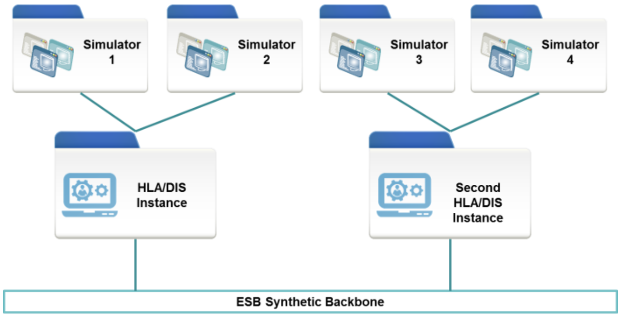

Figure 4: Interoperability of Environmental Elements

We can think of this as having a gold master for the world, from which is derived the specific exercise area of operations with that AoO being shared between the various simulator instances. The message events sent to the synthetic backbone enable each version of the AoO to be kept up to date as the action progresses in the game.

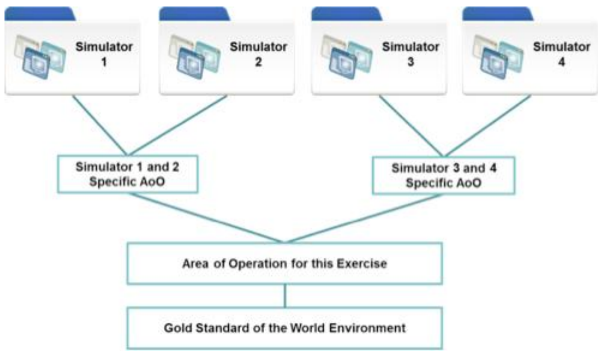

Figure 5: Deriving the Area of Operations

3. BENEFITS

The implementation approach outlined above allows for new versions of particular standards to be linked into to the synthetic backbone and 'subscribe' to a particular exercise. The results of using new standards can be monitored and compared with the results obtained in the current production version of the game, without impacting on the outcome of the production version of the game.

Thus simulators may be in view only mode, subscribing to the appropriate data feed and receiving that data in the standard that they understand for display to the operator. The operator can see the result in the production version of the game and compare it in real time to the fidelity obtained by the new simulator. This approach provides a comprehensive way to test new standards while maintaining the production quality of existing versions prior to their deprecation and subsequent retirement. This will allow future standards as they develop to be mixed into existing simulation standards. It further provides flexibility to the hosting Defence force to ensure that all simulators can be accommodated with a broad range of supported environmental standards.

4. REFERENCES

Tolk, A. (2012) Chapter 7 Modeling the Environment page 113, *Engineering Principles of Combat Modelling and Distributed Simulated.* Edited by Andreas Tolk. New Jersey USA: John Wiley & Sons.

Lashlee, D. Bricio, J. Holcomb, R. & Richards, W T. (2012) Chapter 23 GIS Data for Combat Modeling page 511, *Engineering Principles of Combat Modelling and Distributed Simulated.* Edited by Andreas Tolk. New Jersey USA: John Wiley & Sons.