

Machine Readable Enumerations For Improved Distributed Simulation Initialisation Interoperability

Peter Ross

Defence Science and Technology Organisation
peter.ross@dsto.defence.gov.au

Abstract. Prior to the conduct of a distributed simulation exercise, much human effort is spent configuring, and then verifying the configuration of, each participating simulator in accordance with the initialisation information agreed upon by the exercise stakeholders. This information includes the order of battle, entity starting positions and the communications plan. It must be consistent across all simulators to ensure a common understanding and fair fight. There is currently no standard and automated process for loading this information into a simulator. Manual entry is subject to human error, and is unnecessarily time consuming for large exercises. This paper examines the need for an initialisation interoperability standard for simulation enumerations.

1. INTRODUCTION

Interoperability is defined as the ability of two or more systems or components to exchange information and to use the information that has been exchanged [1]. In distributed simulations information is exchanged before, during and after simulation execution. Existing open standards for distributed simulation interoperability, such as *Distributed Interactive Simulation (DIS)*, *High Level Architecture (HLA)* and *Distributed Data Services* address the information exchange needs of the simulation execution phase. These standards, however, largely ignore the information exchange activities that occur before and after simulation execution.

Simulator maintenance staff have adopted manual practices to account for the lack of standards in this area [2]. An excellent example of a manual practice is the initialisation of simulation enumerations used for distributed simulation exercises. As simulation exercises become more frequent and increase in size, the before and after phases become a constraint on productivity, and a barrier to more responsive and even larger simulations. This paper defines the problem of initialisation interoperability, and proposes improvements to the current manual practice of exchanging simulation enumerations.

2. THE INITIALISATION PROBLEM

Initialisation data is used in a host of activities including network interface configuration, development of geospatial databases, and specification of the order of battle and entity starting positions. The exchange of this data is necessary, because either the execution phase depends on the data, or there are bandwidth savings to be realised by not exchanging it during execution. Regardless of the type of data, it must be consistent across all simulators to ensure that the output of the simulation is valid, or in other words, to ensure a fair fight.

When all simulators in an exercise are *identical*, or elements of the simulations are identical, the before phase is not typically onerous, as the initialisation data from one simulator can be directly loaded into other simulators. For example, this is true for terrain databases when compatible image generators are used. However, a far more common scenario is when the simulators participating in the exercise are *different*. In this case the initialisation phase must accommodate the different data requirements of each simulator, and the different semantics that may be applied to this data. There are few standards to which to refer to when performing the initialisation phase. The available standards are outlined in section three.

In lieu of interoperability standards for initialisation data, ad hoc approaches have been adopted. These vary depending on the type of simulation, the software being used, the time available, and the importance awarded to having consistent data. Documents and spreadsheets are typically created to describe the initialisation data, and these are distributed via e-mail or other means to the maintainers of each simulator. The maintainers are then responsible for interpreting and loading this data into each simulator. The lack of an interoperability standard means that many simulators provide only a human-machine interface to perform the loading function. Alternatively, where there is a machine interface, special procedures are required to import the data. These ad hoc approaches are often repeated for each exercise.

3. INTEROPERABILITY STANDARDS

The development of interoperability standards for initialisation data is the focus of many ongoing standardisation activities. These standards attempt to formalise existing practises, or are published by projects and vendors that have sought to promote their solutions to the problem. In addition to the most prominent standards, listed below, the literature provides examples of project-specific interchange formats [3],[4].

Military Scenario Definition Language (MSDL) is a scenario initialisation encoding standard that allows separation of the scenario design and scenario execution tools. This effort is led by creators of the OneSAF Objective System [5]. *Target Data Transfer Protocol (TDTP)* provides a standard interchange format for radar characteristics and performance data. The objective is to facilitate the exchange of data between those organisations that collect it, and those who use it in simulation models [6].

The problem of initialisation interoperability is not restricted to the military simulation domain. Faced with the desire to maintain presence across multiple Internet-based virtual worlds, such as Second Life and Metaverse, the private sector is investing in standards that promote interoperability between these different worlds [7]. Standards such as *COLLABorative Design Activity (COLLADA)*, a 3D visual asset standard, and *OpenID*, a digital identity management standard, are integral to this effort. Virtual worlds are increasingly promoted as media through which to conduct distributed training [8].

3.1 The Enumerations Document

Enumerated and Bit-encoded Values for Distributed Interactive Simulation, otherwise known as EBV-DOC [9], or simply the *enumerations document*, defines enumerated values of military and commercial equipment. It is a companion document to the DIS application protocol and HLA *Real-time Platform Reference Federation Object Model (RPR-FOM)* standards, and is used both to develop simulators, and to initialise them prior to simulation execution.

The enumerations document is published by the *Simulation Interoperability Standards Organisation (SISO)* on a yearly basis, and is maintained by a group of volunteers, led by an 'enumerations coordinator' appointed by the *SISO Standards Activity Committee (SAC)*. Members of the public can submit change requests to amend, delete or modify portions of the document. New change requests are posted to a public email reflector for comment. The standing rules are simple; if no one objects, the change will be accepted. Individual change requests are grouped together into change blocks by the coordinator, are issued quarterly, and then merged into the standard on a yearly basis. Due to the voluntary nature of the activity, this schedule is not always satisfied. The document was first released in 1992, with the latest revision, released in 2006, totalling 757 pages. At the time of writing there are approximately 400 outstanding change requests.

The *problem* with the enumerations document is that the content is stored in a Microsoft Word document. This content cannot be electronically loaded into simulators as it consists largely of free text, and the formatting is inconsistent; fit for humans, but unsuitable for machines. The document, or at least those elements relevant to a given exercise, must be manually entered into simulators by humans, typically involving many keystrokes, leading to data entry errors. This human

effort is repeated for each simulator in the exercise, and because the process, and humans, are known to be fallible, subsequent testing is required in each exercise to verify that the enumerations have been entered correctly.

4. MACHINE READABLE FORMAT

Within the volunteer community that supports the enumeration document, there have been at least five calls for a machine readable version of the enumerations document [10],[11],[12],[13],[14]. The introduction of a machine readable enumerations format offers four significant benefits.

Foremost, it allows enumerations to be loaded electronically into simulators and related tools. If a machine readable format was integrated into pre-simulation execution activities, it would ensure that all simulators had a common understanding of the required enumerations. This would significantly reduce the amount of human effort required to enter the enumerations document into a simulator, and would prevent the occurrence of data entry errors, therefore limiting the need for subsequent testing.

Secondly, it allows metadata to be associated with enumerated values, whereas at present only lines of free-text and footnotes can be associated. For example, currently the document indicates an enumerated value as deleted by embedding the text "*(Deleted)*" within the enumeration description. A machine readable format would annotate deleted enumerated values with an attribute indicating a Boolean deleted state. The introduction of metadata would allow all kinds of amplifying information, such as references to supporting documentation, points of contact and country of operation to be associated with enumeration values.

Thirdly, it allows for better revision control of the document. Currently this is managed using the in-built *track-changes* feature of Microsoft Word. However this feature does not scale well when there are large changes or formatting alterations. When change blocks are accepted by the enumerations coordinator, the track-changes history is lost. By separating the data and presentation elements of the document, ideally stored as in text rather than binary form, it will be possible to apply a revision control system to the document. Outstanding change requests could be stored in the revision control system, such that at any point in time, users could download an unofficial release of the document that incorporated all outstanding change requests. This would prevent the current situation where there is a backlog of outstanding changes.

Finally, the size the document makes it difficult to navigate, and to conduct meaningful queries. A machine readable format would allow intuitive views of the document, such as interactive web pages, to be generated, and context-aware queries to be performed.

4.1 Early Attempts

With compelling reasons for a machine-readable format, several solutions have been attempted.

Entity-type enumerations account for a large portion of the enumerations document, and are presented using a hierarchical layout (see Listing 1 at the end of the paper). The author is aware of at least three programs written to extract entity types from the Word document, and then output these to comma- or tab-delimited text files, or *Structured Query Language* (SQL) statements for insertion into a database. These programs work by parsing each line of the document and counting the tabs and spaces to determine the entity type value and description (e.g. *1:3:13:6:1:2 = HMAS Arunta*). This approach often leads to inaccurate results, because tabs and spaces are used inconsistently throughout the document. However, no better alternative for parsing the document exists.

The enumerations document contains much more than entity-types, including several other distinctive categories of enumerations (see Listing 2 and 3). Some enumeration tables can be easily cut and paste from the document into another application, such as Microsoft Excel, and then saved to comma- or tab-delimited text. This is not the case for tables where there is either inconsistent formatting, or nested levels of information.

The *DIS Data Dictionary* was an early effort by the *Institute for Simulation and Training* to construct a database of entity-type enumerations and DIS message structures. The database is stored in *Microsoft Access* format and exploits the report and query tools provided by Microsoft Access and compatible database engines. A facility to export the database as *Hyper Text Markup Language* (HTML) is provided, and several organisations have published the human-readable HTML output on the Internet [15]. The database content has not been updated since 1996.

In an effort to focus existing attempts on a complete solution, the enumerations coordinator released a set of suggested requirements in 2005 [16], detailing what was considered to be the essential characteristics of a machine readable format. Shortly after this release, the enumerations coordinator issued a draft *Extensible Mark-up Language* (XML) schema named *XML encoding of DIS EBV (XoDIS)*, together with a partially populated XML data file containing entity-type and value-pair enumerations. The XoDIS received some initial interest from the enumerations user community, but the effort was abandoned following the 2006 release of the enumerations Word document.

Both the suggested requirements, summarised below, and XoDIS have served as foundation for an *improved machine readable format*.

1. Both a human readable document and at least one machine readable format are required;
2. there must be a process to convert between the human readable document and the machine readable format;

3. any conversion tools that support this process must be available at no-cost, and not be encumbered by restrictive licensing conditions;
4. any tools must not have a steep learning curve or require expert level knowledge to use; and
5. any tools must be available for Microsoft Windows.

4.2 Why It Has Not Yet Happened

Given the benefits outline above, one would expect a machine readable format to have eventuated. This has not been the case, despite the initial attempts detailed in section 4.1. The reasons for this are:

Incompleteness. Earlier attempts have focused on making entity-enumerations machine-readable, while neglecting the remaining tables of the enumerations document. It is difficult to justify retirement of the existing document without an adequate replacement. The machine readable format needs to be complete, or, consideration must be given to splitting the document into machine readable and human readable fragments.

Varying formats. There is no consensus on what underlying standard the machine readable format should be based on. Comma and tab-delimited text, SQL, Microsoft Access and XML have featured in earlier attempts. A working solution must support all of these, or at least provide a mechanism to accommodate these formats in the future.

Branding. The majority of tables within the enumerations document are not specific to the DIS standard, so the name of the machine readable format should in turn be protocol independent. Furthermore, XoDIS can be easily confused with another effort called DIS-XML [17], which serves an entirely different purpose, namely to create an XML encoding of the binary DIS application protocol.

Volunteer effort. The productivity improvement and cost saving of a machine readable format have never been measured, and so it is difficult to secure funding to support this work. It is therefore up to volunteers to develop a machine readable format. Volunteer efforts rarely adhere to schedule.

5. AN IMPROVED FORMAT

This author met with the enumerations coordinator and other members of the enumerations user community at the *2007 Fall Simulation Interoperability Workshop*, and discussed informally the future of a machine readable format. Whilst no consensus was reached on a particular way forward, there was much interest in revisiting the machine readable format. Using the existing materials, including XoDIS, the author set out to create an improved machine readable format that would ideally address the deficiencies described. The working title of this effort is *Machine Readable Enumerations and Bit-encoded Values*. It has involved six phases, described in each of the following six sections.

5.1 Which Methodology?

There are two fundamentally different ways in which to achieve a machine readable format. These diverge with respect to how the master enumerations document is managed.

The first method is an extension of the earlier attempts, involving programs that extract information from the enumerations document to output a machine readable format. This would involve retaining the existing human readable document as the master, and then providing software tools, or even macros embedded within the document, to perform the extraction. In order to be successful, this method would require some clean-up of the existing document to ensure that the output of the extraction programs was accurate. Following this clean-up, any subsequent document changes made through the change request process would need to be performed with extreme care to ensure that the Word document could be parsed by the extraction programs.

The second method would see the machine readable format become the master document. Transformation software would then be used to convert the machine readable document into a human readable form. The existing change request process would continue, but instead of changing the document, the machine readable document would be altered. This method involves considerably more effort, because there is the initial task of creating the machine readable format. However, this only needs to be performed once, and once achieved it opens the possibility of transforming the document not only into a human readable format, but also into alternative machine readable formats.

The latter method was chosen on the grounds that, while the solution requires more effort, the end result will be more flexible than that offered by the former.

5.2 Technology Selection

Any decision that involves the selection of one piece of technology over another is going to incite a heated debate between technologists. An important decision in this effort is the selection of the underlying technology that forms the basis of the machine readable format. Comma- and tab-delimited text, SQL, Microsoft Access and XML technologies have been applied in earlier attempts. In addition, the *Lightweight Directory Access Protocol* (LDAP) and the *Web Ontology Language* (OWL) [18] have been suggested as suitable candidates.

A decision was made to base the machine readable format on XML, on the grounds that of the technologies mentioned, XML is widely practiced, is devoid of proprietary extensions and can be edited with nothing more than a text editor. There is also a large and diverse market of commercial and free tools that support the use of the standard. XML can store hierarchical data structures, whereas delimited text cannot. There are different dialects of SQL to accommodate, both SQL and LDAP require server or processing software to operate, and Microsoft Access is a proprietary format.

XML has also been recommended specifically as a data interchange format for simulation [19].

Extensible Style-sheet Language Transformations (XSLT) is a language for transforming XML documents into other XML or plain text documents. It grew out of the need to add styling information to data-driven websites and, like XML, XSLT is a *World Wide Web Consortium Recommendation (W3C REC)* [20]. XSLT is relevant to this effort because it provides a standardised and vendor-neutral approach to transforming the machine readable format into a human readable document. Whilst other programming languages could be used to perform transformations, XSLT is especially suited for manipulating XML data.

An *XSLT Processor* is required to perform XSLT transformations. The processor is responsible for reading the master XML document, executing the XSLT transform and then outputting the resulting document. There are many open-source and commercial processors available, and most web browsers provide a built-in processor.

5.3 Information Schema Design

The purpose of this phase was to determine which aspects of the existing enumerations document were relevant to a machine readable format, and then construct an information schema to capture the structure and semantics of the content.

The enumerations document includes a number of preliminaries such as a title page, table of contents, and introductory errata. These aspects of the document are all for the benefit of human readers and are irrelevant to machines. For the remainder of the document, however, there is a consistent and clearly visible structure.

The enumerations document specifies a total of 279 tables, where each table lists enumerated values for the various *DIS Protocol Data Unit* (PDU) fields and RPR-FOM attributes and parameters. These tables are grouped together and arranged into sections. There are sections for each of the DIS PDU families, such as entity interaction, emissions regeneration, and simulation management. Further sub-sectioning is used to group the enumeration tables based on the PDU type (or RPR-FOM object and interaction name), followed by record type (or RPR-FOM class) grouping and so on until each table is assigned a dedicated section. Each dedicated section begins with a brief description of the table, followed by the table itself.

There are four distinctive table categories used in the document, namely entity-type enumerations (see Listing 1), object-type enumerations (similar to entity-type enumerations, but not as deeply nested), standard name-value pairs (Listing 2) and bit-masks describing the layout of bit-fields (Listing 3). The document also specifies data record structures, which are specific to the DIS protocol. It is recognised amongst users that data record structures do not belong in the enumerations document and a separate document has been proposed

by the enumerations coordinator to store such records. Similarly there are a number of sections of the enumerations document that outline requirements for the DIS application protocol. These are to be incorporated into the next revision of the DIS standard.

For the improved machine readable format, the structural and semantic information has been expressed as an *XML Schema Definition (XSD)* file. This file mirrors much of that defined in the XoDIS draft, however there are some notable differences. The XoDIS draft incorporated the notions of section hierarchy into its information schema, and proposed unique XML tags for each enumeration table. This is considered to be poor design. Section hierarchies are a presentation issue. Every time a new enumerations table is added to the document, it will need to be revised to incorporate new XML tags. Consequently any software using the schema will need to be updated.

Not all of the enumerations document content fits neatly into an information schema. Some tables are context sensitive. For example, for radio communications, different detailed modulation enumeration tables take effect depending on the major modulation selected. These dependencies are not explicitly captured by the improved format, as they are expressed elsewhere in the DIS application protocol and RPR-FOM standards.

5.4 Data File Population

With the design work complete, it was necessary to undertake the laborious task of extracting all the machine-relevant data from the Word document and storing it in an XML data file in accordance with the information schema.

An existing parser tool was used to extract entity enumerations from the Word document. The parser was modified to output XML in the format defined by the schema. The remaining tables in the document were manually cut and pasted into Microsoft Excel, and saved to an interim comma-delimited format, before being converted to XML mark-up using custom shell scripts.

The extraction process is known to be unreliable, so it is necessary to formally validate the final machine readable document. Formal validation has not been performed as it is a considerable undertaking, requiring a large number of volunteers to verify that the content of the XML data file is equivalent to that of the original Word document. Validation should not be attempted until there is consensus amongst the enumerations user community that the machine readable format is an adequate replacement for the current Word document.

5.5 Transformations

As discussed earlier, XSLT provides a mechanism to transform the machine readable format into other XML and plain-text documents. Three prototype transforms have been created to demonstrate the potential of the

machine readable format. The transformation workflow is shown in Figure 1.

An initial transform was written to output only the entity-type enumerations into tab delimited text. This was used to perform rudimentary validation of the XML data file, as the output of this transformation could be compared to that generated by existing extraction programs. The comparison provided confidence that the transformation workflow was functioning correctly.

Following this, a transformation was written to construct a human readable document from the machine readable format. The objective was to make the resulting document appear as close to the original word document as possible. *DocBook* is a presentation-neutral mark-up language for creating technical documents and is a standard of the *Organization for the Advancement of Structured Information Standards (OASIS)*. This was chosen as an interim output format. There are both commercial and open-source tools available for compiling DocBook content into presentation formats, such as the *HTML*, *Portable Document Format (PDF)* and *Rich Text Format (RTF)*.

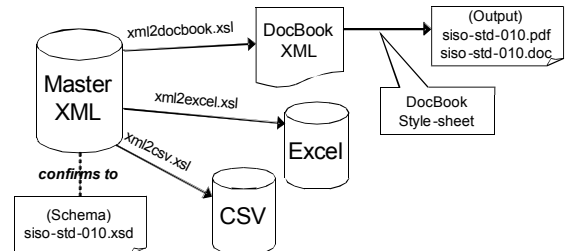


Figure 1: The transformation process.

To demonstrate the use of alternative human readable formats, a transform was created to output the enumerations in the form of a Microsoft Excel workbook. Spreadsheets within the workbook were used to list the enumerated values of each enumeration table. Spreadsheets offer an environment from which it is very easy to cut and paste, and having enumerations expressed in this format allows statistics to be calculated.

Many other types of transformations are possible, and the scope is really only limited by one's imagination. It is possible to output HTML documents, perhaps not unlike the original *DIS Data Dictionary*, for display on a website. Translators could also be written to output to simulator-specific formats. It is also possible to transform the document into a series of SQL statements, or to C header files or Java classes for use in simulator development. The existing prototype translators will serve as a foundation to develop future translators.

5.6 Status And Trial Usage

A draft of the machine readable format was posted to the enumerations email reflector in December 2007 [21]. The release included the schema, machine readable document, translators for DocBook, Microsoft Excel and precompiled PDF, RTF and Excel outputs. Feedback has been received, including corrections to

errors within the machine readable document that were not captured by the rudimentary validation step.

Support for the machine readable format presented in this paper has been added to an experimental build of an interoperability test suite that is used by Air Operations Division of DSTO. This software is used to evaluate the DIS implementations in the acceptance phase of government simulator acquisitions, and, until recently, has relied on a series of tab-delimited text files to provide enumerations. Trial integration with fielded training simulators (such as [22]) was initially proposed under this effort, but is best deferred until the machine readable format matures.

6. CONCLUSION AND FURTHER WORK

An approach to constructing a machine readable format has been presented that is intended to improve the current manual practice of exchanging simulation enumerations in word document format. The format has been presented to the enumerations user community as a viable replacement for the enumerations document.

Further work is required to transition this effort from a prototype to an actual replacement for the current enumerations document. The information schema needs to be finalised and promoted as a standard, as this will encourage users to adopt it. Formal validation of the document is required, and the community of enumerations users will be called upon to take part in the validation effort. Finally, the machine readable format transformations need to be completed.

REFERENCES

- Institute of Electrical and Electronics Engineers, (1990) IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries, standard no. IEEE 610-1990, ISBN 1-55937-079-3.
- P.D. Clark (2007) "Coalition Fleet Synthetic Training". Proceedings of the Langkawi International Maritime and Aerospace (LIMA07) Maritime Conference, Langkawi, Malaysia, 2-3 December 2007.
- Lacy, L.W., King, D. & Burnett, K., (2001) "Equipment Characteristics and Performance Data Interchange for Simulations using XML," *Spring Simulation Interoperability Workshop*, Orlando, FL, USA, 25-30 Mar, paper 01S-SIW-023.
- Carlton, B., Scudder, R.O., Black, C.A & Hopkins, M. (2004), "Initialization of C4I Systems and Simulation Federations Today and in the Future," *Fall Simulation Interoperability Workshop*, Orlando, FL, USA, 19-24 Sep, paper 04F-SIW-089.
- Prochnow, D., Fogus, M., Vintilescu, J. & Borum, B. (2005), "Initialization of Distributed Simulations: A Better Way?," *Fall Simulation Interoperability Workshop*, Orlando, Florida, USA, 18-23 Sep, paper 05F-SIW-073
- A.G. Stove, (2007) A Protocol for Exchanging Radar Target Data, document no. D6117/07/0003, 16 Feb, viewed 12 Nov 2007, <http://www.thertdc.com/TargetDataStd/radar_target_data_protocol_1.doc>
- IBM Press Release, (2007), IBM and Linden Lab Launch Collaboration to Further Advance the 3D Internet, San Jose, California, USA, 10 Oct, viewed 19 Oct 2007, <<http://www-03.ibm.com/press/us/en/pressrelease/22428.wss>>
- David K, (2008) "Make Your Very Own Virtual World with OLIVE," *IEEE Spectrum Magazine*, January 2008, viewed 18 Feb 2008, <<http://origin.www.spectrum.ieee.org/jan08/5838/2>>
- Simulation Interoperability Standards Organisation (2006). Enumeration and Bit Encoded Values for use with Protocols for Distributed Interactive Simulation Applications, document no. SISO-REF-010-2006, 12 May.
- Sauerborn, G. (1997), E-mail posting to enumerations e-mail reflector: "non WORD version?," 22 Oct 1997, viewed 27 Sep 2007, <<http://discussions.sisostds.org/default.asp?action=9&read=14433&fid=162&boardid=2>>
- DeCarlo, T. (1999), E-mail posting to enumerations e-mail reflector: "Looking for enum doc in MS Access format," 12 Jan 1999, viewed 27 Sep 2007, <<http://discussions.sisostds.org/default.asp?action=9&read=14488&fid=163&boardid=2>>

- Clay, B. (2003), E-mail posting to enumerations e-mail reflector: "DIS enumerations list", 17 Nov 2003, viewed 27 Sep 2007, <<http://discussions.sisostds.org/default.asp?action=9&read=14915&fid=167&BoardID=2>>
- Shanks, G. (2005), E-mail posting to enumerations e-mail reflector: "Machine readable DIS Enumerations", 10 Jan 2005, viewed 27 Sep 2007, <<http://discussions.sisostds.org/default.asp?action=9&read=15143&fid=31&BoardID=2>>
- Brutzman, D. (2005), E-mail posting to enumerations e-mail reflector: "DIS Enumeration Database and XML," 7 Feb 2005, viewed 27 Sep 2007, <<http://discussions.sisostds.org/default.asp?action=9&read=15188&fid=31&BoardID=2>>
- DIS Data Dictionary (On-line version), accessed 12 Nov 2007, <<http://siso.sc.ist.ucf.edu/djs-dd>>
- Shanks, G. (2005), "Machine Readable Enumerations - DIS Product Development Group Meeting," *Fall Simulation Interoperability Workshop*, Orlando, Florida, USA, 18-23 Sep, presentation 05F-SIW-212.
- McGregor, D., Brutzman, D., Arnold, A. & Blais, C. L., "DIS-XML: Moving DIS to Open Data Exchange Standards," *Spring Simulation Interoperability Workshop*, Huntsville, AL, USA, 2-7 Apr, paper 06S-SIW-132.
- Lacy, L.W. & Gerber, W. (2004), "Potential Modeling and Simulation Applications of the Web Ontology Language - OWL," *Proceedings of the 2004 Winter Simulation Conference (WSC'04)*, vol. 1, Washington, D.C., USA, 4-7 Dec, pp. 257-262.
- Tang, K & Au, A. (2003), "Supporting Reuse for Distributed Simulations Using XML," *Proceedings of the Simulation Technology and Training Conference (SimTecT)*, Adelaide, 26-29 May.
- World Wide Web Consortium, (1999), W3C Recommendation - XSL Transformations (XSLT) - Version 1.0, 16, document no. REC-xslt-19991116.
- P. Ross, (2007), E-mail posting to enumerations e-mail reflector: "Machine Readable EBV, draft 1," 20 Dec 2007, viewed 20 Dec 2007, <<http://discussions.sisostds.org/default.asp?action=9&read=43525&fid=31&BoardID=2>>
- Zalcman, L.B, (2005), "The Royal Australian Air Force Air Defence Ground Environment Simulator," *Proceedings of the Inter-service/Industry Training, Simulation & Education Conference (IITSEC)*, 28 Nov - 1 Dec, Orlando, FL, USA, paper no. 2028.

Kind	Domain	Country	Cat	Subcat	Specific
1	3	13		6	Guided Missile Frigate (FFG)
				0	Other
				1	ANZAC Class (Meko 200)
				1	FFH 150 Anzac
				2	FFH 151 Arunta

Listing 1: Entity-type enumerations

Field Value	Function Description
1	Multi-function
2	Early Warning/Surveillance
3	Height Finding

Listing 2: Value-pair enumerations

Name	Bits	Purpose
Damage	3 - 4	Damaged appearance of an air entity
		0 - No damage
		1 - Slight damage
		2 - Moderate damage
		3 - Destroyed

Listing 3: Bit-mask enumerations

```

<EntityState>
  <CountryCodes>
    <Country ID="99" Description="India" />
  </CountryCodes>
</EntityState>
<enum length="16" id="es.type.country" name="Country"
  source="4.2.2">
  <enumrow id="99" description="India"/>
</enumrow>

```

Listing 4: XoDIS schema (above), versus improved schema (below)