Testing the Untestable – Testing Simulation Artefacts for Future Non-specific Re-use

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ABSTRACT

The UK has introduced a set of rules to govern UK Ministry of Defence's (MoD's) use of simulation across its programmes. The rules – the Defence Training and Education Coherence (DTEC) Ruleset - are designed to introduce efficiencies to MoD policy and acquisition, predominantly through actively encouraging re-use of simulation artefacts and consistency in architectural approaches in which the MoD has invested. To promote re-use, the MoD DTEC approach has started production of a DTEC Catalogue. The DTEC Catalogue is intended to inform the UK Defence community (MoD, Industry and Academia) of software, data and other artefacts that are available for re-use. The UK Defence Simulation Centre (DSC) capability has been established by the UK MoD to maintain the DTEC Ruleset and, in addition to other functions, to provide a central MoD capability to test simulation artefacts for inclusion in the DTEC Catalogue and to provide technical support to assist in their re-use. This paper discusses the rationale for developing the DTEC Ruleset and Catalogue and the approach employed by the DSC, which is currently in an interim DSC (iDSC) capability, in testing simulation artefacts for re-use, where the future specific use is not known at the time of testing, hence: Testing the Untestable.

ABOUT THE AUTHORS

Mrs. Liz Coad is the test and reference lead for the UK MoD interim Defence Simulation Centre (iDSC). Liz brings over 40 years' experience in the Defence sector to her current role. Over the last 12 years, Liz has gained extensive experience in the training and simulation domain including requirements capture, Validation and Verification (V&V) activities for Synthetic Environment terrain databases and Test and Acceptance (T&A) of QinetiQ produced software, for UK MoD Training systems.

Mr. Daran Crush is a skilled systems engineer, which has led to him working across a wide range of UK MoD programmes throughout his 25 year career at QinetiQ. Daran's expertise includes the application of simulation and modelling to training, experimentation, testing, battlespace architecture, secure networking and facility construction and operation. Currently Daran is a supporting a number of activities within the iDSC as well as being the technical lead for QinetiQ's contributions to the COTS and Enabling Technology Evaluation and Exploitation (CETEE) programme for the UK Defence Science and Technical Laboratory (Dstl).

Mr. Ian Page is an accomplished systems engineer who has worked primarily in the area of simulation, modelling and synthetic environments for QinetiQ and its former UK MoD organisations. Ian has extensive experience applying simulation technologies to the training, analysis, trials, assessment, experimentation and equipment acquisition fields. Ian has developed and led many programmes across the Defence Land, Sea, Air and Joint domains, frequently working with mixed industry and government teams.

Dr. Neil Smith has 17 years' experience in the modelling and simulation domain, providing consultancy, research and development roles for UK MoD programmes. Neil is a technical lead for the interim Defence Simulation Centre (iDSC), supporting the re-use of simulation content, testing approaches to software re-use and providing advice on Computer Generated Forces (CGF) Strategy. In addition, Neil technically leads QinetiQ's contributions to the Architecture, Interoperability and Management of Simulations (AIMS) and Simulation Composition and Representation of the Natural and Physical Environments (SCORE) projects for the UK's Dstl.

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INTRODUCTION

The United Kingdom (UK) Ministry of Defence (MoD) makes widespread use of simulation. Ensuring that simulation is employed in an efficient and effective manner, however, is a challenge due to its wide-scale use across the broader UK Defence domain. Purchase of simulation data, such as terrain databases and 3-Dimensional (3D) visual models, has previously been left to individual procurement teams resulting in the situation where the purchase of the same or similar data can occur. Exacerbating this scope for duplication, the application of simulation systems and tools, while typically compliant with international standards, can result in procurements that are incompatible at some level. Due to the ever changing demands of the military environment, resolving such incompatibilities can require significant effort later on in the simulation systems operational life to meet future interoperability requirements between such incompatible systems.

The focus of UK MoD procurement has typically been to deliver the most cost-effective systems. This approach is not necessarily the most efficient for MoD at a strategic level and has resulted in similar requirements being met by technically effective, but different solutions. The outcome across MoD programmes is a varied technical base that, while allowing for innovative approaches, has constrained the sharing of data, expertise and developments across the different simulation systems in use.

Within the Training and Education domain, the UK MoD is improving the efficiency of its use of simulation through increased re-use of simulation data and commonality of architecture across MoD simulation-based programmes. Defence Training and Education Coherence (DTEC) is an evolving approach now implemented within the UK MoD to help deliver these efficiencies. DTEC provides definition of the preferred standards to be used by simulations within the UK Defence domain and provides governance to direct procurements towards common approaches. Now integrated within the MoD Joint Service Publications (JSP) that define the overall UK Defence approach, DTEC has set out guidance, a rule set and governance for the procurement of simulation in the UK (UK MoD Joint Service Publications, 2016).

The UK Defence Simulation Centre

Endorsed by the UK MoD's Defence Authorities for Capability Coherence and Training, the 'Defence Policy for Simulation'[1] is paving the way for how simulation is procured in the UK for use in all areas, not just Training and Education. A key enabler within DTEC is the Defence Simulation Centre (DSC) capability. The DSC exists to support the UK MoD's DTEC approach in its goal to ensure Defence-wide coherence for whole force training, education and simulation systems to deliver a capability that allows the UK to train across the spectrum of force packages and conflict types. Having successfully passed through an initial piloting phase, the DSC is now in an interim (iDSC) phase to further identify the benefits of an enduring, user-focused hub for UK Defence simulation. Specifically, the iDSC is to:

- Inform the design of a permanent DSC;
- Contribute to the maintenance of the DTEC Ruleset;
- Provide advice and support to the Defence Community on Modelling and Simulation (M&S) matters;
- Support M&S common services;

[1] Internal UK MoD publication CDP/4/3/DCDS (MilCap)/15/Apr/34, April 2015

- Provide an accessible repository of M&S data, software and architecture for the benefit of MoD, Industry and Academia users;
- Provide a simulation reference library;
- Support simulation testing and evaluation.

The iDSC is not a training or experiment capability in itself, rather it provides a new capability to UK MoD to allow its users (including Industry and Academia contracted to the UK MoD) to support their simulation based activities. This breadth of scope to support all UK Defence simulation users is a unique service (and challenge!) for the DSC capability. The services provided include:

- Provision of simulation data such as terrain data and 3D visual models;
- Provision of enterprise-level simulation software;
- Technical advice;
- Use of a simulation facility and equipment to support simulation activities, e.g. training and experimentation;
- Test and reference services.

It should be noted that the iDSC does not currently create new terrain data or visual models, instead it maintains a repository of data created by UK MoD programmes and makes the data available to other UK MoD programmes to support consistency of approach and introduce savings to UK MoD through re-use. As the capability develops, the creation position may change.

Operational since summer 2012, the pilot and now interim DSC has delivered ever-growing and quantified benefits to UK MoD to the order of £25m over its near four years (at the time of writing) of operation (Figure 1). This benefit is calculated purely from the re-use of terrain data and 3D visual models for simulation use and does not take into account any of the other benefits provided by the capability. Terrain benefit is calculated using a UK MoD approved algorithm based on the area of the terrain data and the 3D visual model benefit is a function of the level of detail of the model. Running costs of the iDSC are a fraction of this benefit.

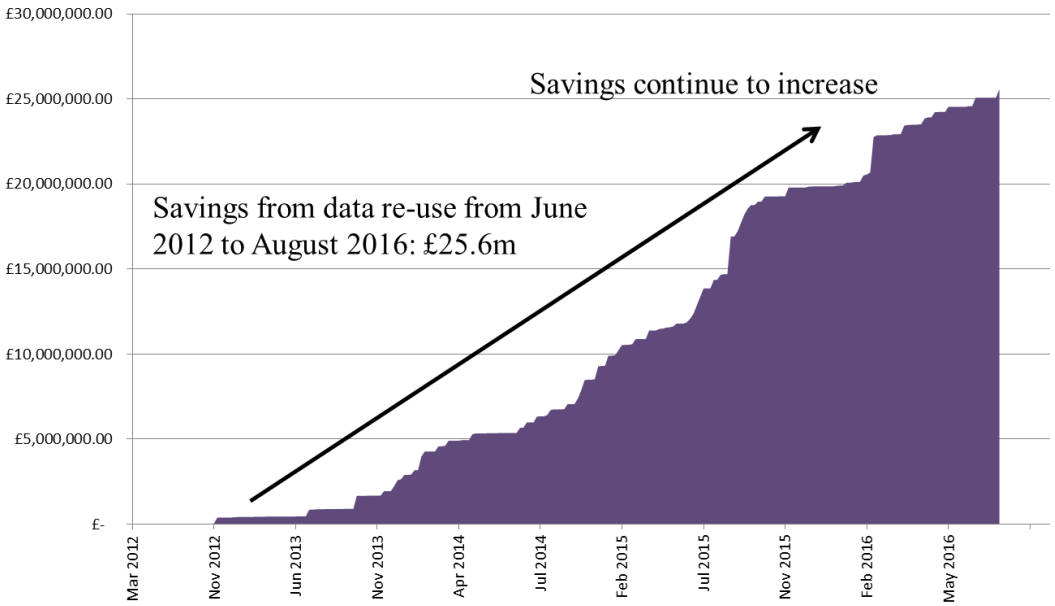

Figure 1: Increasing savings benefits to UK MoD through the re-use of terrain and 3D visual model data

In terms of the UK Defence community that the iDSC supports, Figure 2 shows the spread of users supported. This provides useful data to inform the UK MoD of the breadth of support being provided across the UK Defence community. To help improve re-use Figure 2 provides a useful indication as to where future promotional activities need to focus to increase awareness and therefore re-use. Figure 3 illustrates the relative type of support provided,

which helps inform UK MoD of the simulation areas best suited to re-use and so where best to focus efforts for future services.

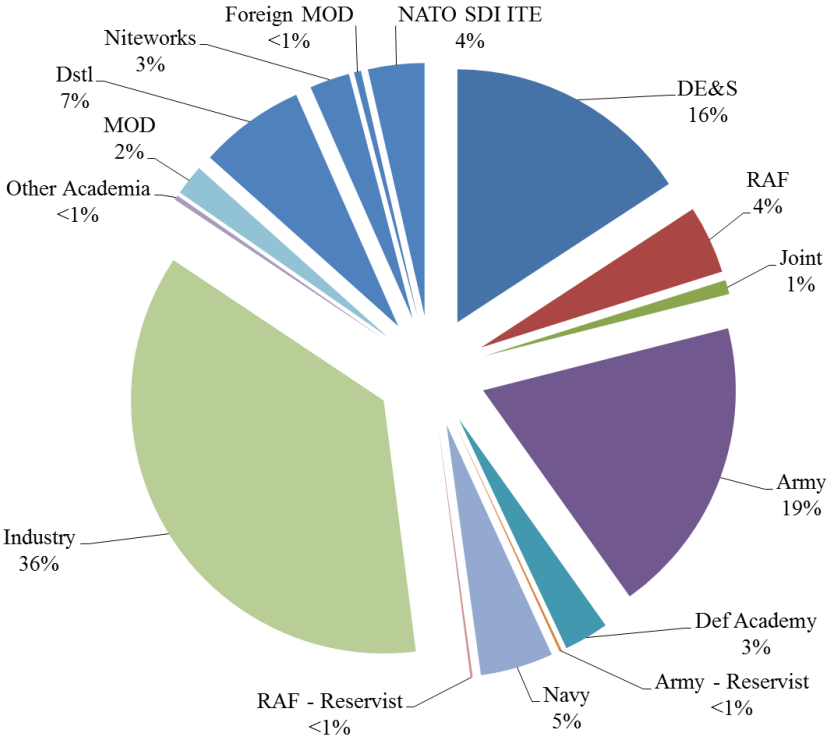

Figure 2: Recipients of iDSC services

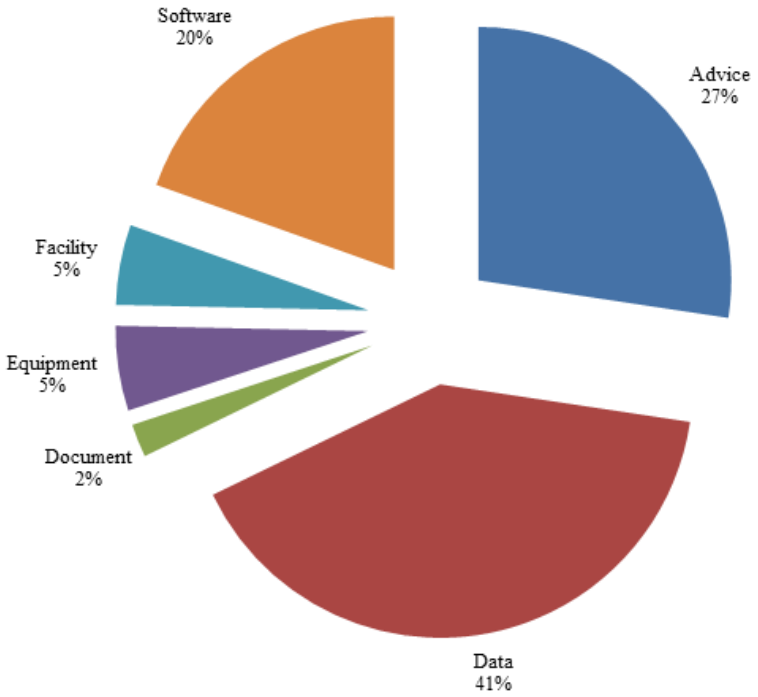

Figure 3: Relative proportion of types of enquiry

To continue to grow the value provided by DTEC and the iDSC, work is ongoing to develop a DTEC catalogue that describes reusable simulation artefacts available freely to MoD programmes. Still in its early days of development, the catalogue exists in an initial form describing simulation assets, terrains, 3D visual models and software available to the UK Defence community. The promotion of the DTEC catalogue is paramount to the wider success of delivering improved efficiencies in the use of simulation across MoD programmes.

As the starting point for many simulation users accessing the iDSC services, accuracy and confidence in the DTEC catalogue entries is essential. This paper discusses the challenges faced with testing candidates for inclusion in the catalogue. While the user base is the broad UK Defence domain, explicit understanding of how each catalogue artefact will be employed in the future is ultimately unknown. This places a challenge on testing candidates items for the catalogue, hence: testing the untestable.

CHALLENGES FOR RE-USE

Typically testing takes place as part of a systems engineering development cycle. For example, acceptance testing can take place at the end of a waterfall cycle. This testing is normally performed against a set of defined and well understood requirements, with a set of tests for identified use cases. When considering re-use within a DTEC context the scope and domain in which the simulation artefacts will be used are unknown. Simulation artefacts provided to the iDSC come from a variety of sources including national and international organisations. The simulation artefacts may have undergone significant testing or have been in use for a number of years, but information about their track record or from such testing may not be available and may have been performed for specific use cases.

DTEC has developed the DTEC M&S Standards Profile (DMSP) (UK MoD DTEC Publication, 2015) that identifies the DTEC approved M&S standards and specifies in detail any data models that are to be used to promote interoperability. The identification of these standards and data models offers an opportunity to develop a test strategy for each of the different types of simulation artefact.

The standards detailed by the DMSP cover a broad range of categories from M&S methodology, architecture, processes and guides to Synthetic Natural Environments (SNEs) data formats. The standards in each of these categories are maturing, some being international standards and others de facto standards. Some of these are readily testable and have or could have compliance tools developed, such as Common Image Generator Interface (CIGI), whereas testing methods of others are in development, such as the work being undertaken under the NATO MSG-134 programme that is developing compliance testing tools for the High Level Architecture (HLA) Evolved standard. Such international collaboration is essential to delivering interoperability benefit, both within the UK and in support of international activities. Effort by DTEC includes a focus to align the various international M&S Catalogues in development.

Testing under DTEC is complicated as the breadth of potential uses or re-uses for some of the simulation artefacts can also be varied, for example a Computer Generated Forces (CGF) system can have a wide range of uses from implementing a particular scenario to be run for multiple iterations in a Monte Carlo mode for generating operational analysis data to stimulating a Command and Control (C2) system for trainee familiarisation. Both of these would be tested in different ways, for example: testing functional requirements such as interfaces with different message types or non-functional requirements such as robustness testing across different exercise durations.

From these two examples it can be seen that a way to test for some uses would be to develop specific tests or design patterns, for example independently defining a scenario with a known or expected outcome than can be implemented within a Computer Generated Forces (CGF) system and used to test if the expected outcome is achieved. A number of standard test cases or design patterns can be built which can then be applied to the appropriate component types. Test cases and design patterns, however, will not be appropriate to all the categories of standard within the DMSP. Table 1 shows the standards categories and the testing methods that could be used to assess them; note columns 1 to 5 are taken from the DMSP.

Table 1. Standards category vs testing method

Category	*Standard*	*Status*	*Type*	*Description*	*Testing method*
M&S methodology, architecture, processes and guides:					
Systems Engineering processes	DSEEP	Mature	Open	Distributed simulation engineering process	*Inspection of artefacts generated by the DSEEP process*
	DMAO	Mature	Open	Multi-architecture overlay, part of DSEEP	*Inspection of artefacts generated by the DSEEP process*
	FEAT	Mature	Open	Federation engineering template	*Inspection of artefacts generated by the federation agreement process*
Verification and Validation	SISO-GUIDE-001-2013 GM-VV	Mature	Official	V&V Guidance	*Inspection of artefacts generated as part of the V&V activities*
Conceptual modelling and scenarios	MSDL	Mature	Open	Scenario definition language	*Schema validation and enumerations tests*
M&S interoperability	HLA Evolved	Mature	Open	IEEE Standard – STANAG 4603	*Compliance tools, Network monitors tests* *NATO MSG-134 is developing HLA compliance testing tools*
Live simulation	UCATT	Emerging	Open	See SISO UCATT products	*Compliance tools, Network monitors tests* *Could be developed as the standard matures*
Information exchange data model	NETN FOM	Mature	Open	Based on SISO RPR FOM	*Compliance tools, Network monitors tests ('well formed-ness')*
	C-BML	Emerging	Open	Battle Management Language	*Enumerations tests, specific use case interoperability tests (complex test systems)*
	SISO-REF-010-2015 Enumerations	Mature	Open	SISO Co-ordination of model IDs	*Enumerations tests, specific use case interoperability tests (complex test systems)*
Synthetic Natural Environments (SNEs):					
Processed data sources and formats	Shapefile	Mature	De facto	Esri standard for vector, culture data	*Source data tests*
	DTED	Mature	Official	Digital terrain	*Source data tests*
	GeoTIFF	Mature	Official	Aerial imagery and elevation models	*Source data tests such as extent testing*
	JPEG2000	Mature	Open	Aerial imagery	*Source data tests such as extent testing*
3D models	OpenFlight	Mature	De facto	Presagis standard for 3D models	*Source data tests* *Final database tests (coverage, completeness, layer interference e.g. buildings on roads)*
Production processes Visualisation	RIEDP	Emerging	Open	Data preparation process	*Potential production tool set with test suite*
	CIGI	Mature	Official	Image Generator Interfacing	*CIGI compliance tools*
Simulation analysis and evaluation	DDCA	Emerging	Open	Used for AAR	*Bespoke toolset needs to be developed*
General	SEDRIS EDCS	Mature	Open	Feature data coding – STANAG 4662	*Potential compliance tools*
	SEDRIS SRM	Mature	Open	Spatial reference model – STANAG 4663	*Potential compliance tools*
	CDB	Mature	Open	OGC Best Practice	*Potential compliance tools*

The list of standards included within the DMSP is expected to evolve as other standards emerge and mature. The iDSC has been supporting this with an investigation into 3D model formats (Smith & Harris, 2015). Additionally, it is expected that a greater amount of automated support will be developed to aid and speed up the testing.

Each of the simulation artefacts is described by a set of metadata. The metadata collected for each type of artefact is described within the DTEC Catalogue Definition Document (Smith, 2015). Using this metadata it should therefore be possible to select the most appropriate methods of testing.

APPROACH

The approach adopted by the iDSC for evaluating simulation artefacts for potential inclusion in the DTEC Catalogue includes assessing metadata, checking for compliance with the standards specified in the DMSP and developing testing strategies appropriate to the artefact being evaluated.

Different categories of simulation artefact require different metadata to be assessed; however, there is a core set of 'global' metadata common to all entries. These relate to UK MoD usage rights and constraints or conditions on the release of the artefacts to third parties, which if not satisfied mean the item is unsuitable for inclusion in the DTEC Catalogue. This 'global' metadata has been determined from discussions within the UK Defence simulation community, however, it is thought that international peer review would be useful particularly from those allies who already have mature catalogue systems.

As described in the introduction, in its current state of development, the DTEC Catalogue contains simulation assets, terrains, 3D visual models and software available to the UK Defence community for re-use. The simulation asset section of the DTEC Catalogue contains information on training systems currently in service along with descriptions of the components they include. The information held was obtained by canvassing all areas of UK MoD relating to training and simulation with a request to answer a standard set of questions. This allowed the creation of a training and simulation asset baseline, which captures all of the in-service systems in use across the UK MoD. The items in this baseline are not necessarily reusable in other contexts, but this baseline does provide support to the DTEC rule set by identifying any capabilities already existing across the three services that may support a new, or emerging, need. As such, no testing of these assets is directly required, however, simulation artefacts contained within the assets may need to be tested if considered for re-use. The test approaches adopted for 3D models, terrains and software are explored in the following sections.

Models

The test approach for 3D models relies heavily on the collection of metadata. Both 3D cultural models within the virtual terrain, (models of point objects, specific buildings, etc.) and 3D platform models operating in the virtual environment, (models of vehicles, personnel, etc.) can be described using the same metadata. The DTEC Catalogue holds the metadata as shown in Table 2 for 3D models (Smith, 2015).

Table 2. 3D Model Metadata

Metadata	***Comments***
Description	*Textual description of the equipment – should include MoD standard name.*
Picture	*One or more pictures of the 3D model.*
Format	*Should be one of the DMSP approved formats*
Levels of detail	*May be multiple at different ranges*
Polygon counts	*May vary by level of detail*
Damage states	*May include several different damage models*
Camouflage	*For example desert, green, etc.*
Articulated parts	*Static, moving, attached*
Lights	*On platform illumination*
Material classification	*e.g. IR or radar reflectivity codes present*
Limitations On Public Access	*Terms and conditions of source data release ability to third parties*
Use Constraints	*IP/usage rights of data*

The iDSC holds numerous 3D models in its M&S data repository. These models are collected from a number of UK MoD programmes and are in a number of different formats. The models are currently stored 'as received' with no formal test or assessment activity to determine their suitability for re-use within the UK Defence community. Visual testing of individual models is carried out by the iDSC and the model is then catalogued along with notes of any issues found. This is a subjective process that may differ without a defined testing procedure. Given the time consuming nature of this process, especially with large batches of models, the possibility of automated testing is being investigated.

Initial investigations have identified that there is a lack of industry software used specifically for automated testing of 3D models. This is thought to be due to the qualitative nature of assessing many aspects of a 3D model, for example, textures, appearance, etc. that are subjective and specific to customer requirements and the specification in use. That being said, elements such as texture size, number of polygons, etc. can be measured and scripted for automation. This would then simply need a human to view the model for final validation and would reduce the time taken to open and check each and every texture, Level of Detail (LOD), etc. Development of a draft approach for DTEC to test models has been developed, but further investigations are required before this test process is adopted.

Terrains

As with the 3D models the test approach for terrain data is currently based largely on the collection of metadata. The iDSC holds both terrain datasets (a set of geospatial source information that has been processed for use in a Training and Education (T&E) application to make it suitable for use in a simulated environment); and terrain databases (terrain datasets that have been compiled into formats that can be directly reused in simulation applications).

The metadata held by the iDSC for terrain datasets follow the Defence Geographic Centre mandated UK MoD Geospatial Metadata Profile (MGMP). To ensure coherence with the wider geospatial community in UK MoD and thus facilitate integration with data across the defence enterprise, it is important that these metadata elements are recorded in exact compliance with the MGMP.

When the iDSC receives a processed source dataset, e.g. a dataset where colour corrections across the imagery have been applied or alignment between feature and imagery data, there is often no quality information supplied with it. The datasets supplied are often 'raw' and can need significant work to be used in a T&E application. Datasets are also often composed of multiple data types with different coverage. In addition, 'post-processed' data in the form of terrain databases that are specific to a particular simulation or image generation system, e.g. Bohemia Interactive's Virtual Battlespace (VBS) or the Common Data Base (CDB) format, are held. The iDSC focuses on re-use of both processed terrain datasets and post-processed databases as these yield the best cost benefit savings due to their potential for wide re-use while saving development effort by users to integrate these products.

In addition, the use of semi-automated testing of these datasets is being investigated to ascertain whether it can provide a useful indication of quality. A number of different types of semi-automated terrain testing are available, for example:

Correlation testing:

- 2D feature correlation analysis can correlate any type of feature (point, linear and areal) with any other. For example, a point-to-point analysis would be used to analyse tree correlation and a linear-to-areal correlation analysis would be used to correlate a CGF linear road network with a visual polygonal road network.
- 3D correlation analysis is used to test the correlation of features in the Z (elevation) dimension. It is typically used to assess the correlation between terrain skins or feature types that exist in 3D space (e.g. roads in a visual database and CGF database). For example the vertices in two road features could have the same (X,Y) positions but different (Z) values.
- Vector vs Digital Elevation Model (DEM) correlation test is used to assess the correlation between a vector (feature) terrain representation (e.g. an OpenFlight™ terrain) and a raster-based DEM terrain representation (e.g. a DTED or Grid ASCII file). It compares the elevation value of each vertex of each feature in the feature layer and compares it to the elevation value of the corresponding "pixel" in the raster grid.

Integrity testing:

- Network analysis can validate various aspects of a transport 'network'. The network connectivity test is particularly difficult to implement because it is hard to determine whether two features should or should not be connected.
- Feature conflict analysis searches for features in two layers that intersect or overlap when they should not do so.
- Feature slope analysis looks at each feature in a layer and calculates the slope (maximum gradient) of intersecting features in a second layer (usually a terrain skin). For example it is unlikely that a building would be located on an extremely steep cliff.
- Extreme slope analysis test checks for features with Z values whose slope (maximum gradient) exceeds a specified amount. This is useful for finding 'broken' features (e.g. road or river polygons with extremely steep gradients often indicate incorrectly modelled sections of a terrain database).
- Terrain hole analysis can identify missing polygons in a terrain surface. It only works with a continuous surface consisting of 3- or 4-sided polygons and relies on the fact that no polygons overlap or are duplicated.
- Uphill flow analysis checks for rivers which flow 'uphill' (i.e. their elevation profile is not continually downhill).

In order to produce a quality assessment of a terrain dataset, once the desired tests have been executed, the next stage is to analyse the results. This is a vital step as some errors may actually be legitimate (conversely not all actual errors may be identified by the test). The specific tests employed can impact on the level of human analysis required. For example the feature confliction test is straightforward (features conflict or they do not) so in this instance all errors identified will represent true anomalies. Other tests require an element of interpretation. For example the extreme slope test might identify a road polygon with a steep gradient value. It must be determined whether this is a true anomaly or a legitimate road feature (usually by visualising the area in 3D). Similarly if the network connectivity test has highlighted a road feature as potentially unconnected it is advisable to manually verify this.

As with model testing mentioned earlier, the iDSC does not currently test terrains – they are treated 'as received'; although (as with models) a draft test process has been developed, but not yet adopted.

Software

To date, testing in support of DTEC has concentrated on software artefacts. The test process for simulation software held in the iDSC software repository comprises four stages, see Figure 4.

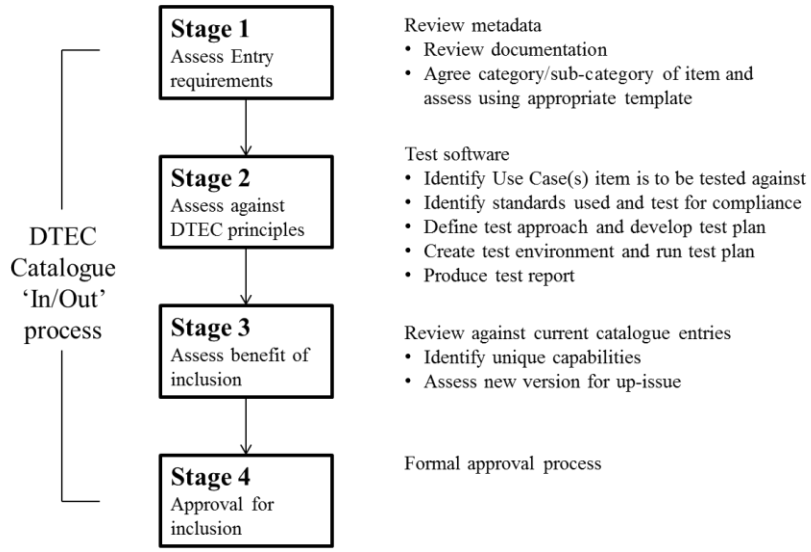

Figure 4. iDSC software repository test process

In the first stage, the initial assessment of entry requirements, the available documentation including release notes, user guides and test reports are reviewed and an assessment made using a standard set of criteria. If evidence is found that the software does not meet the specified criteria in any one of the areas assessed then it will not be included in the DTEC Catalogue. The eight areas assessed are:

- Commercial and Intellectual Property Rights (IPR) conditions;
- Release conditions;
- Security assessment;
- Infrastructure requirements;
- Standards;
- Documentation assessment;
- Compatibility with previous versions;
- Level of Validation and Verification.

In the second stage, assessment against DTEC principles, a specific test approach is defined. Any known specific re-use requirements are taken into consideration together with the requirements and use cases that have been developed for each of the software subcategories defined in the DTEC Catalogue.

A test report is created that states the requirements being tested against and describes the use case(s). A detailed test plan is developed with a compliance matrix that relates the test steps back to the requirements including testing for compliance with the appropriate standards as specified in the DMSP. The test steps are then run and an assessment made of whether the requirements have been met with any significant shortfalls highlighted.

In the third stage an assessment is made of the benefit of including the application under test into the DTEC Catalogue by reviewing it against current entries. The recommendation for inclusion or not is based on the following:

- Does the application have the potential for re-use;
- Does the application provide a new and unique capability;
- If assessing a new version of a current entry, does the application both:
    - Retain previous capability, and
    - Provide additional capability.

The final decision on what is included in the DTEC Catalogue rests with the UK MoD, informed by the iDSC test outputs. If an application is deemed suitable for inclusion a summary of the test report will be included in the DTEC Catalogue entry and the full report will be held by the iDSC and made available to potential users to help the reuse assessment.

SUMMARY

Conclusions

The DTEC approved M&S standards listed within the DMSP are expected to evolve and mature for each type of simulation artefact held in the iDSC repository. These maturing standards will aid the construction of an efficient and robust testing strategy for each type of artefact.

Testing for future non-specific re-use does not allow testing against clearly defined requirements as would be available or indeed mandated, in a regular development cycle. However, a well-developed test approach can add confidence and reduce risk for potential re-users.

It is important to take a pragmatic approach to this testing and to focus on the most likely re-use purposes as the amount of testing that is done is constrained by the cost benefit trade off.

There are a wide range of T&E simulation artefacts that are under consideration for re-use, the iDSC have initially focused on developing a testing strategy for software in order to assess whether individual applications should be included in the DTEC Catalogue. Strategies for testing 3D models and terrain data are currently being developed.

Testing activities to date have successfully informed the content of the DTEC Catalogue. Currently, the software section of the DTEC Catalogue contains eight entries encompassing several software types, with testing on-going for three further applications. The 3D model and terrain data sections of the DTEC Catalogue list what is available in the iDSC repository; these entries have information on UK MoD usage rights and some further metadata associated with them but have not undergone structured testing.

Way ahead

In the near term, the way ahead for the iDSC testing of UK MoD T&E simulation artefacts for re-use will proceed in the following areas:

- Software – continue applying the test process that has been developed to additional software items both in the categories that currently have entries in the DTEC Catalogue and of those yet to be assessed. Use the lessons learned from applying the process to evolve and refine it.
- 3D models and terrains – this is the next area of focus for testing and assurance. A test approach has been developed and investigations into the feasibility and usefulness of automated and semi-automated systems for testing these types of data initiated.
- Information packs – development of structure and content of supporting information packs for potential re-users.

In the longer term, the iDSC will investigate increasing the use of automation where possible in the simulation artefact testing process. In addition, the iDSC plans to widen the scope of re-use testing to cover the broader categories in the DTEC Catalogue. This includes standards, where for example, the leverage of HLAe federation testing from NATO MSG 134 will be investigated and scenarios, where work will build on an initial study recently commissioned by the iDSC (Gorton, 2016) in to the identification of scenario exploitable products.

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ACRONYMS

AAR	After Action Review
C2	Command and Control
C-BML	Coalition Battle Management Language
CDB	Common Data Base
CGF	Computer Generated Forces
CIGI	Common Image Generator Interface
DDCA	Distributed Debrief Control Architecture
DE&S	UK Defence Equipment and Support
DEM	Digital Elevation Model
DMAO	DSEEP Multi Architecture Overlay
DMSP	DTEC Modelling and Simulation Standards Profile
DSEEP	Distributed Simulation Engineering and Execution Process
Dstl	UK Defence Science and Technology Laboratory
DTEC	Defence Training and Education Coherence
DTED	Digital Terrain Elevation Data
EDCS	Environmental Data Coding Specification`
FEAT	Federation Engineering Agreements Template
GeoTIFF	Geographic Tagged Image File Format
HLA	High Level Architecture
HLAe	High Level Architecture Evolved
IEEE	Institute of Electrical and Electronics Engineers
JPEG2000	Joint Photographic Experts Group
JSP	Joint Service Publication
M&S	Modelling and Simulation
MoD	UK Ministry of Defence
MSDL	Military Scenario Definition Language
NATO SDI ITE	North Atlantic Treaty Organisation Smart Defence Initiative Immersive Training Environment
NETN FOM	NATO Education Training Network Federation Object Model
Niteworks	A UK MOD-Industry partnership organisation
OGC	Open Geospatial Consortium
RAF	UK Royal Air Force
REIDP	Reuse and Interoperation of Environmental Data and Processes
RPR FOM	Real-time Platform Reference Federation Object Model
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
SISO	Simulation Interoperability Standards Organization
SNE	Synthetic Natural Environment
SRM	Spatial Reference Model
STANAG	NATO Standardization Agreement
T&E	Training and Education
UCATT	Urban Combat Advanced Training Technology
UK	United Kingdom
V&V	Verification and Validation
VBS	Bohemia Interactive's Virtual Battlespace