

## Moving towards internal and external M&S distributed simulation interoperability – the UK approach

### Grant Bailey

Simulation Technical Authority - Defence Modelling & Simulation Coherence (DMaSC)  
Engineering Group, Safety & Environment, Quality & Technology Directorate,  
Defence Equipment & Support, MOD Abbey Wood, #4125, Elm 1a, Bristol, BS34 8JH  
UNITED KINGDOM  
[Grant.Bailey127@MOD.GOV.UK](mailto:Grant.Bailey127@MOD.GOV.UK)

### Michael Lewis

Joint Training & Simulation,  
Joint Forces Command Capability C4ISR,  
Joint Forces Command HQ, B.1.10 Building 410, Northwood, Middlesex  
UNITED KINGDOM  
[Michael.Lewis133@MOD.GOV.UK](mailto:Michael.Lewis133@MOD.GOV.UK)

### ABSTRACT

*The Armed Forces of the UK do not fight alone; this applies neither internally for each of the separate Front Line Commands across UK Defence, nor externally with Allied forces. This approach requires the ability for suitable collaborative or joint training both across the MoD and international borders.*

*The M&S systems' interoperability required to support the above goals for the UK calls for a top-down approach from NATO down to the training systems themselves. The UK's Defence Modelling and Simulation Coherence (DMaSC) approach and its supporting Defence Simulation Centre (DSC) therefore aims to align itself with NMSG direction and activities with the intent of providing optimum common resources.*

*This paper describes the experiences and challenges that continue to be faced, and how they are being tackled, as attempts are made to provide direction, guidance and resources for M&S based systems, no matter how they are used, across UK Defence.*

*The conclusion is that the benefits of distributed simulation are clear but the challenges faced are not to be dismissed lightly demanding great effort and resources from wherever they can be found.*

## 1.0 INTRODUCTION

### 1.1 Defence Policy

#### 1.1.1 Coherent Defence Capability

The UK MoD's Joint Service Publications (JSPs) are an authoritative set of rules and/or guidelines specific to Defence, material to Defence outputs and have pan-Departmental applicability. Each JSP must be owned by a relevant Defence Authority who is ultimately responsible for the publication.

One such publication is JSP 906: Defence Principles for Coherent Capability. The 2 documents that comprise JSP 906 contains 9 different Principles that have been declared to address known and systemic

issues and risks present in Defence. They serve to influence both decisions and behaviour regarding thinking and working for Defence, effectively promoting the acquisition of capability that is coherent through the application of what is known as the Systems of Systems Approach (SOSA). [1]

### 1.1.2 Defence Policy for M&S

Evolving and following the guidance that is provided in JSP 906, the UK has developed a Defence Policy for M&S that is now published in JSP 939, providing both direction and guidance. Underpinning and supporting this M&S policy by the Defence Modelling and Simulation Coherence (DMaSC) approach. DMaSC essentially ensures and assures for the technical coherence of all M&S internal to the MoD and with Allies, achieving this with the ultimate goal of providing Value for Money for M&S based systems at the Defence Enterprise Level without being too rigid that stifles innovation.

JSP 939 recognises that M&S is an enabler, it cannot deliver any form of Defence capability in its own right, it has to be used to do something.



**Figure 1-1 JSP 939 Defence Policy for M&S Parts 1&2**

## 1.2 DMaSC Aim

The aim of DMaSC is to provide a single direction for the development and management of all Defence M&S systems through a set of policies, technical procedures and common resources, providing and promoting and ensuring interoperability with the Front Line Commands and Allies. Figure 1-2 shows diagrammatically how the many uses of M&S can access such common resources and share them with deployed forces and Allies including the Five Eyes Community and NATO.

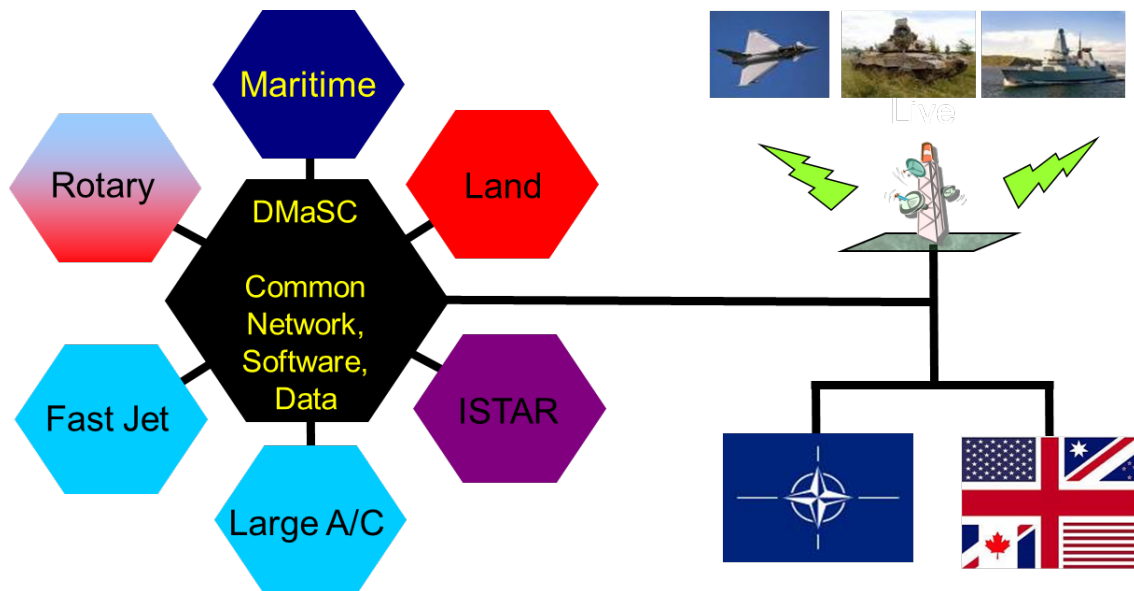


Figure 1-2 Common Resources Projected Out to Deployed Forces and Connectivity with Allies

It should be noted that DMaSC applies for all UK uses of M&S across Defence no matter its utility whether it is, for example, for the purposes of Training, Experimentation, or Acquisition.

A broad direction of travel is provided by a set of rules that act as constraints and provide direction. These have been developed to specify how individual projects are to achieve coherence in the acquisition and updates of M&S systems, thereby leading to improvements in efficiency and effectiveness for such capability. These rules promote the exploitation of assets, including research and official studies, through their sharing and re-use across Defence. To advertise and inform what is available, they have prompted the establishment of an early form of an approved M&S catalogue of resources which can be drawn upon and reused for all Defence M&S systems.

### 1.3 Scope

Figure 1-3 shows an interpretation of the hierarchy involved with M&S. In this diagram, the DMaSC scope covers all use of M&S across the MoD from the high end of the Engineering level, all the way up to the Strategic level. This reinforces the point that M&S is essentially an enabler and not a capability in its own right.

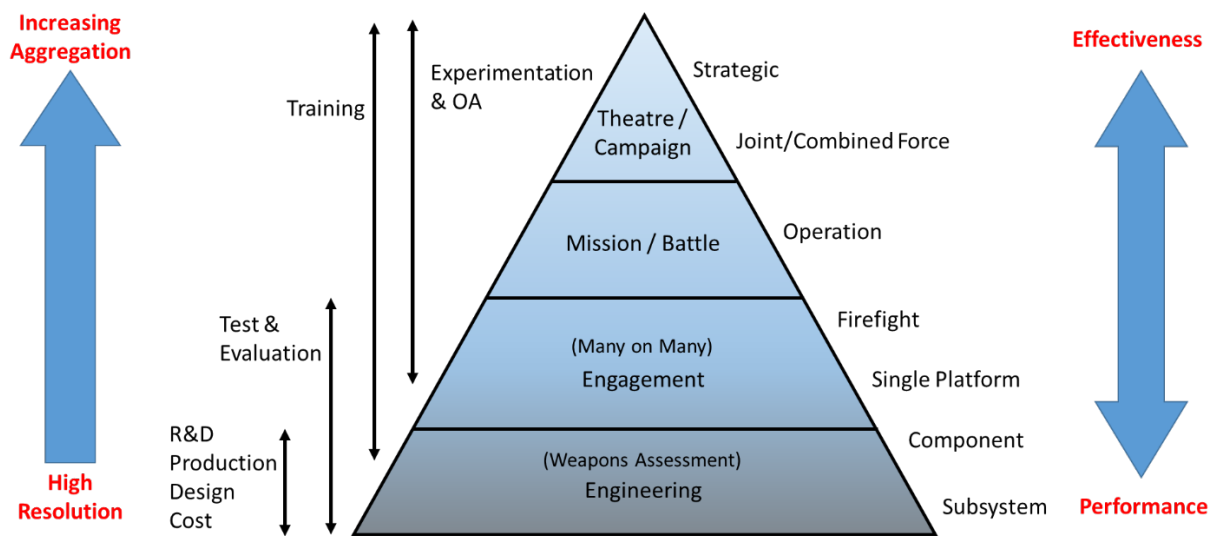


Figure 1-3 – Scope of M&S shown as a Hierarchy of Models (courtesy US Defense Systems Management College)

### 1.4 Emergence of UK Distributed Simulation Requirements

The UK already employs distributed simulation systems, primarily in the form of the Maritime Composite Training System<sup>1</sup> (MCTS) and the Distributed Synthetic Air Land Training<sup>2</sup> (DSALT). However, a requirement for further distributed training continues to grow primarily under the banner of Defence Operational Training Capability (DOTC).

DOTC(Air) is the most advanced of this suite of programmes that seeks to fill a demonstrated capability gap that prevents Air Force Elements (FE) training together as force packages, enables a Defence-wide requirement to download live training into a Synthetic Environment (SE), and will allow a rebalancing of live/synthetic training [5].

Land, Maritime and Joint implementations for DOTC are expected to appear in due course, with each fully interoperable with each other and with Allies’ complimentary and equivalent systems allowing richer and enhanced capabilities and international joint and collaborative training.

<sup>1</sup> MCTS is a distributed warfare operator training solution, located at Portsmouth and Devonport which supports operational capability by ensuring that individuals and teams have the knowledge and confidence required to operate and fight their ships at sea. [3]

<sup>2</sup> DSALT provides virtual pre-deployment training to the British Armed Forces. It enables troops and aircrew to train alongside international partners in sophisticated simulated environments in real time. Speaking in 2014, Russ Cole, Flight Simulation and Synthetic Trainers Team Leader at MOD’s Defence Equipment and Support (DE&S), described DSALT as: "a vital, life-saving capability, essential to effective mission preparation." [4]

## 2.0 DEFENCE M&S COHERENCE AND GOVERNANCE

### 2.1 Horizontal Coherence

It is widely recognised across the MoD that effective governance for DMaSC is essential or individual projects, despite the direction and guidance provided by JSP 906 and JSP 939, will continue to only focus on what is best for them alone, regardless of the wider view, in a stove-pipe manner. SOSA is therefore employed to cut across all projects to deliver horizontal coherence as can be shown in Fig 2-1.

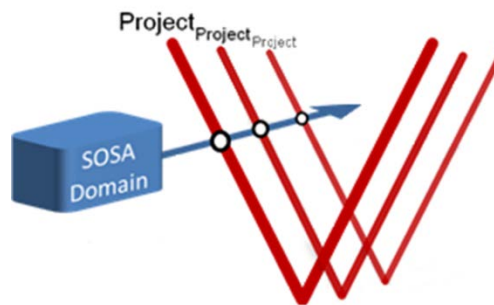


Figure 2-1 – SOSA Domains Interaction with Projects

In addressing this issue, a ‘*carrot and stick*’ approach is deemed to be appropriate, more carrot than stick but the stick has to be seen to be effective or it will be ignored. However, we remain in the position that until DMaSC governance is tested and seen to work, challenges are likely to be experienced. To help avoid this issue appearing, it is important that ample advice and guidance is made readily available. A recurring issue for DMaSC is communication, raising the awareness of DMaSC and its requirements, and that people are there to help.

### 2.2 Governance

As can be seen in Figure 2-2, the MOD’s Military Capability Board (MCB) helps develop advice on military capability. Chaired by Deputy Chief of Defence Staff (Finance and Military Capability) (DCDS (FinMilCap)), its main aims are to guide and inform strategic force development, balance investment and make sure people are clear on what is taking place and make recommendations to the Defence Board on carrying out investment decisions [2]. It therefore provides direction on capability coherence and ultimately arbitrates on technical coherence issues that cannot be resolved at the DMaSC TA level.

The DMaSC TA (supported by the SCTAs) provides the means to achieve DMaSC compliance via DMaSC Rules and supporting policies/procedures and common resources (See Section 4 for more details). The TA also very importantly provides Advice and Guidance that helps avoid any issues later in the assurance process.

The DSC Front Door manages the DMaSC Compliance process on behalf of the DMaSC TA liaising with individual project managers and work-streams. It regularly consults the SCTAs on technical issues to ensure that correct assessments are made.

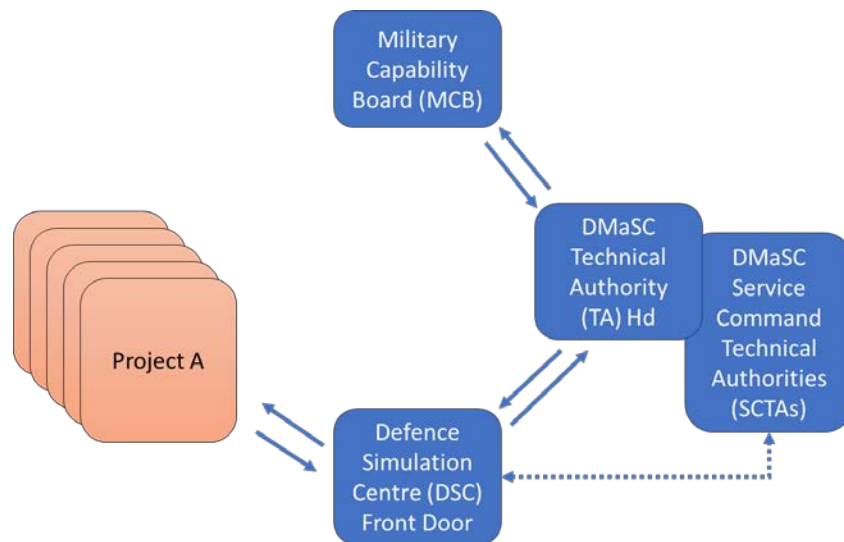


Figure 2-2 – DMaSC Applied M&S Governance

### 3.0 SUITABLY QUALIFIED AND EXPERIENCED PERSONNEL (SQEP)

M&S is a complicated engineering topic. MoD needs suitable staff to ensure that it obtains VFM when engaging with Industry and suppliers that can act as intelligent customers.

A number of M&S educational courses and modules are provided by Cranfield University on behalf of the MoD at its Defence Academy. These courses essentially cover the following (but more can be made available on request):

- *An Introduction to Defence Simulation (IDS)*; a one week full time course.
- *Simulation Employment Training (SimET)*; a five week full time course.
- *A Masters Degree (MSc) in Defence Simulation and Modelling (DSM)*; one year full time or up to 5 years part-time.

Four levels of SQEP have been identified and these are described as follows:

- *Expert* – Educated to the MSc in DSM, having at least x years’ experience, writes papers and delivers presentations at international M&S conferences and workshops. Note: Only DMaSC TA Hd can formally acknowledge a DMaSC Expert.
- *Senior Practitioner* – Educated to the Assessed SimET level, has at least 2 separate posts in M&S.
- *Practitioner* – Educated to the Assessed SimET level, at least 3 years in a M&S post.
- *Awareness* – designed for those who need no more than a rudimentary understanding of M&S across Defence such as project managers and commercial staff. Must have attended the IDS course.

## 4.0 DMASC

### 4.1 Technical Coherence for M&S Across Defence

DMaSC is responsible for identifying and delivering M&S benefits that delivers VFM for Defence at the Enterprise level, even if this means a sub-optimal solution at the programme or project level. The benefits realised are not just cost savings but also the provision of enablers for increased and improved capability that otherwise would not be possible.

#### 4.1.1 The DMaSC Technical Authority (TA)

The DMaSC approach is supported by a virtual team that comprises Subject Matter Expert (SME) individuals (SQEP at the Expert Level) employed across the MoD acting as the DMaSC TA, with each individual known as a Service Command Technical Authority (SCTA).

The Operating Model for DMaSC is shown in Figure 4-1. In this diagram, it can be seen that MoD Head Office owns the Defence Policy for M&S (as published in JSP 939) and is therefore responsible for governance across UK Defence. Below this level, each of the Front Line Commands (FLCs) is responsible for its own M&S capability and M&S operation.

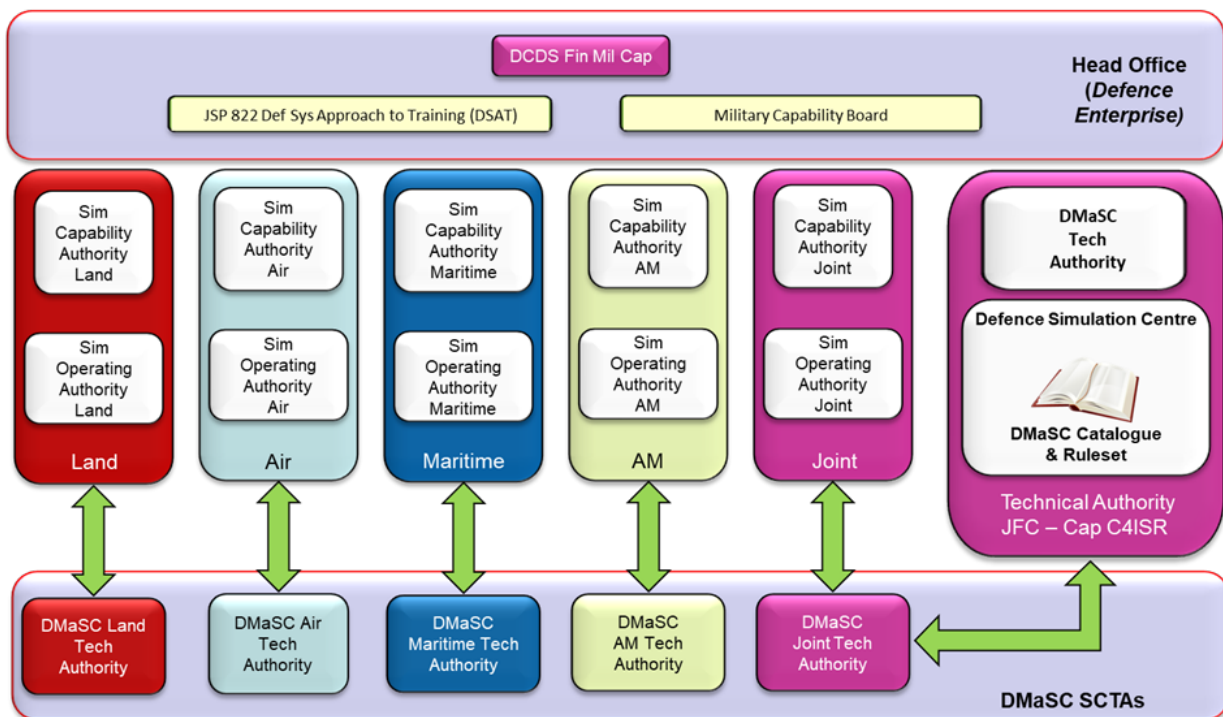


Figure 4-1 - DMaSC (Virtual) Operating Model

This DMaSC TA team is headed up by Joint Forces Command's C4ISR Capability Sponsor Deputy Head responsible for Simulation and Joint Training (JFC Cap C4ISR Dep Hd JTS). The DMaSC TA Head has been given full authority to act on behalf of DCDS (FinMilCap). Technical issues that cannot be resolved at the DMaSC TA level will be escalated to the MCB.

Each SCTA holds the rank of a S01 or equivalent and is appointed by the relevant Front Line Command (FLC) to act as the liaison with DMaSC as directed in the M&S Policy for Defence. Note that Joint



Helicopter Command (JHC) have also opted to nominate a SCTA due to the extensive level of M&S activity and expertise required for the rotary wing domain.

The DMAc TA provides Advice, Guidance and Assurance for all M&S matters and is supported by the DMAc Defence Simulation Centre (DSC) (see section 5).

#### 4.1.2 SCTAs Peer to Peer Knowledge

Each SCTA reports to the Head of the DMAc Technical Authority through the SCTA (Joint). Regular virtual and physical meetings are held by the SCTAs to ensure that collective knowledge and experience is maintained and enhanced and all are kept aware of activity.

### 4.2 Project DMAc Compliance

A specific mandated DMAc Compliance requirement included in every project’s User Requirements Document (URD) starts the process. But despite this mandation, making sure that Capability Sponsors are aware that this requirement is to be included in the URD is a challenge in itself.

This mandated requirement simply states that “The M&S based capability, system or service shall be Defence Modelling and Simulation Coherence (DMAc) compliant”.

To achieve DMAc Compliance, the capability change must demonstrate (with evidence) how it follows the 10 DMAc Rules that have been developed specifically for this purpose. Table 1 below describes these DMAc Rules.

**Table 1-1 - The DMAc Rules**

Rule	Description
1	Projects shall confirm if suitable existing systems are available to meet their requirement.
2	Any M&S standards selected for use by the training capability must be compliant with Def Stan 03-050.
3	Common M&S components, services and data as made available by the DMAc Catalogue must be used by the M&S capability.
4	Any new/modified/enhanced M&S components, services and data shall be made available for reuse via the DMAc Catalogue.
5	All M&S capability must be developed in accordance with the relevant Service Command’s technical architecture approach
6	Relevant enterprise rules from other domains acting as constraints must be adhered.
7	All new distributed simulation enumerations must comply with the DMAc Enumerations Policy and be registered with the DMAc TA.
8	Open interoperability documentation, to include Interface Control Documents, must be made available for all M&S Capability.
9	All M&S capability needs for terrain source data and 3D models that cannot be sourced via the DMAc Catalogue, are to be routed via the Defence Simulation Centre (DSC) Front Door.
10	All M&S related research and decision support activity is to be registered with the DSC.

Compliance against each of these rules is checked at project review points that are agreed between the project and the SCTA and recorded in a form known as the DMAc Capability Technical Assessment Report.



Any issues arising in these reviews are attempted to be resolved at the SCTA level but if necessary, the issue will be raised to the DMaSC TA Hd with arbitration sought by the MCB.

### 4.3 Alignment with Allies

UK Government Defence Policy stipulates alignment and interoperability with Allies wherever possible. For M&S this is primarily achieved through the engagement with the NATO M&S Group (NMSG) with which an active participation is taken where the UK currently Chairs the Modelling and Simulation Standards Subgroup (MS3).

International interoperability is fundamentally achieved largely via the common selection of open standards, hence the involvement with MS3 that is responsible for the NATO M&S Standards Profile (NMSSP) as published as Allied M&S Publication (AMSP) 01. As a subset and also a superset of the NMSSP, the UK maintains a DMaSC M&S Standards Profile (DMSP) that contains mandated and preferred M&S specific standards. To allow the DMSP to be used contractually, it is covered by Defence Standard (Def Stan) 03-050 that has been accepted by Industry and recently refreshed.

In an attempt to provide this technical coherence without stifling innovation (as mentioned previously), recourse to the DMSP by any M&S capability change is mandated and the selection of any M&S standard that is not included is prohibited without engagement with DMaSC and the issue of a waiver. Such capability change could be in the form of a project for a new system or a mid-life upgrade.

Where it is both commercially and technical feasible, the UK is keen to share M&S resources, especially as regards to data and 3D models. More about this to follow.

A common M&S glossary of terms is key for common understanding and so the UK continues to be involved in the NMSG work in this area with agreed and approved terms published in *NATOTerm*<sup>3</sup>.

### 5.0 DMASC DSC

The DSC acts a Focal Point for all UK M&S matters. It supports enquires and provides help to all UK M&S projects, Allies, Industry and other government departments. It has a Front Door (FD) that provides a Single Point of Access to all UK M&S Resources including data available for re-use, application licences, reference information and SMEs. We aspire to make the DSC a M&S Centre of Excellence.

Located within the Technology School at the UK's Defence Academy, the DSC's FD is manned by Civil (Crown) Servants primarily to ensure impartiality for all enquiries from Industry. It manages to an evolving M&S Catalogue, experimental facilities, repositories of data, etc. (more below in section 6). How the DSC is to be developed and initially developed can be seen pictorially in Figure 4-1.

---

<sup>3</sup> NATOTerm, the official NATO Terminology Database - <https://nso.nato.int/natoterm/content/nato/pages/home.html>

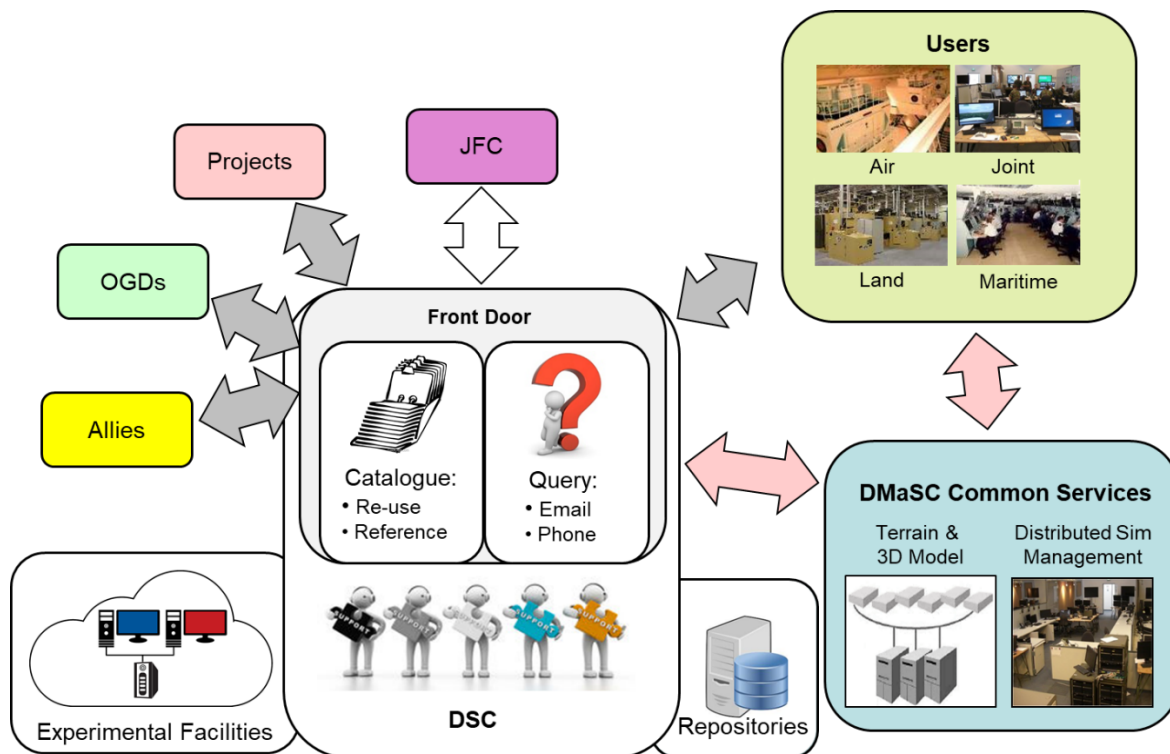


Figure 5-1 – The Defence Simulation Centre (To Be)

## 6.0 DMASC COMMON SERVICES

In line with wider MoD direction to provide capability as services where appropriate, and to ensure commonality and efficiency across Defence in accordance with the direction provided in JSP 906, DMaSC plans to deliver enterprise-wide common M&S services. These common services will initially include the following:

- An interactive M&S Catalogue (highest priority).
- A SE service (initially Terrain and 3D Models (with incorporated VV&A)).
- A Distributed Simulation Management Service (DSMS).
- A Computer Generated Forces (CGF) Service.

The delivery of these common services will inform and de-risk plans for Modelling & Simulation as a Service (MSaaS) for the UK, again aligned with Allies. More details on these intended common services are provided in the following paragraphs.

These common services would expect to be expanded and others added such as those to cover maritime warfare signatures, weather and weapons.

### 6.1 DMaSC M&S Catalogue

The highest priority of any of the DMaSC common services is the DMaSC M&S Catalogue. This will be an interactive, electronic catalogue that will act as a registry providing details of M&S resources that are

available. Underlying repositories will be provided as required but it is not the intent to store everything at the DSC.

Currently just a series of flat files that provide nothing more than simple listings with minimal metadata, the DMaSC Catalogue is split into 2 parts as follows:

- **Part 1 – Reuse**

- **The Data Repository** - that consists of the following elements, populated with items that the UK has re-use rights for and do not necessarily own:
  - **Virtual terrain processed source data** – this is terrain source data that has been edited (largely manually) to remove errors, improve correlation across the data layers and add features.
  - **Compiled virtual terrains (databases)** – small scale terrain data sets and models that have compiled specifically for popular simulations such as Virtual BattleSpace (VBS).
  - **3D models for which the MOD has reuse rights** – items such as models of platforms and specific environmental features.
- **Software Repository** – applications for which the UK has wide-spread licences allowing for re-use across the enterprise:
  - All M&S software resources available for reuse that includes computer generated forces, simulated communications, training need analysis and exercise management software.
- **Hardware Repository** – a list of hardware resources that are available on a loan basis:
  - All M&S related hardware resources available for reuse such as laptops, steering wheels, joysticks, etc.

- **Part 2 – Reference**

- **Assets** – The *Simulation Systems Asset Baseline* is a recording of the M&S assets that are operated by the MoD:
  - All the systems, sub-systems, software and data that is known to be in use across Defence.
- **Standards** - The *DMaSC M&S Standards Profile (DMSP)*:
  - The purpose of the DMSP is to identify DMaSC preferred M&S standards and to describe the importance of, and guidance in the selection of, such standards across defence. The DMSP is covered by Defence Standard 03-50.
- **Enumerations** - The *UK Simulation Enumeration Register*.
  - This is the list of current M&S interoperability enumerations administered by the DSC on behalf of DMaSC.
- **Expertise**
  - A listing of M&S Subject Matter Experts.
- **Research and Official Studies:**
  - A DMaSC listing of abstracts of M&S related research and other official studies that have been conducted on behalf of Defence.

Figure 6-1 shows how an electronic, interactive DMaSC Catalogue could be used to make available and enable M&S resources. Expected to be available via a web browser, access to the catalogue will be provided across the MOD, to Industry, Other Government Departments, Academia and Allies.

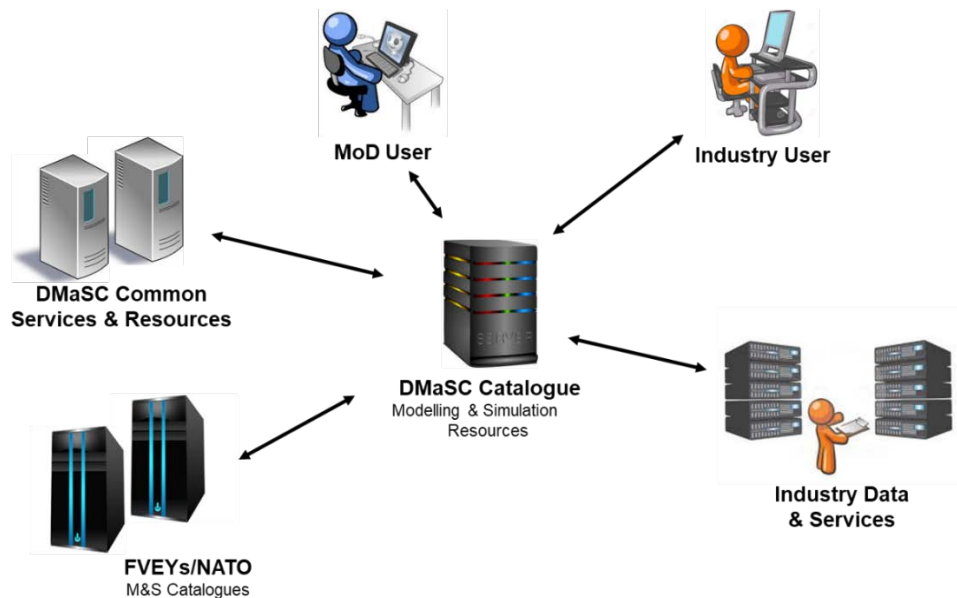


Figure 6-1 - The DMaSC M&S Catalogue

## 6.2 DMaSC SE Service

Beginning with Virtual Terrains (both compiled and source data), 3D Models and a VV&A service, this service is expected to be outsourced and competed with Industry. As regards to terrains, it should be noted that only compiled terrains of limited geographical sizes are likely to be held for reuse, such as those for VBS 3, as the physical sizes of larger terrains will be too challenging to manage and technology progresses to run from source data.

Consequently, focus will be on the management of processed source data where considerable manual effort has been expended to enhance the data, remove any errors and edit the data to overcome correlation issues, etc. This processed source data is of the highest value for Defence.

The location of the service is not of primary concern to DMaSC, but the asset is the data itself and how that data is managed and delivered will be fundamental to the selection of a preferred supplier.

The SE service be expanded in the fullness of time to include such common items as weather, hydrographics, etc.

An effective M&S Catalogue is fundamental to the success of such a service allowing a User to see in the repositories what is available, what data it contains and for what purpose it was created. It should also allow for the upload of any model/data for reuse.

### **6.3 DMaSC Distributed Simulation Management Service (DSMS)**

Albeit limited, UK experience with configuring and managing distributed simulation has revealed that it is very challenging to successfully achieve, but this challenge manifests itself more in terms of process rather than technically. As a result, a service to provide direct support distributed simulation is proposed to cover the example elements described in the following paragraphs. Using a service to fulfil this function will allow the building up of corporate knowledge providing efficiencies in terms of costs and time.

#### **6.3.1 Certification of HLA Federations**

Along with many Allies and in accordance with STANAG 4603, the UK has mandated the use of HLA but this demands great attention and management. In line with NMSG163: Evolution of NATO Standards for Federated Simulation, the UK intends to provide a HLA Federation Certification Service.

#### **6.3.2 Management of HLA RTI**

To ensure that any HLA RTI chosen runs effectively and efficiently, it will need regular optimisation and maintenance activity.

#### **6.3.3 Facilitate access to Appropriate Networks**

DMaSC will not be providing any network, nor will any project or capability, but the DSMS will be liaising with the Defence network providers in order to facilitate access to appropriate networks as required.

#### **6.3.4 Cross Domain Security (CDS)**

Early research and studies carried out indicate that an effective and accredited CDS solution will be more process than a technical challenge.

### **6.4 CGF Service**

Although this proposed service is in its pre-concept phase; when delivered it would enable the acquisition, delivery and management of an optimal number of selected Off-The-Shelf CGFs to meet Defence's M&S requirements. The CGF Service would provide semi-autonomous representation of civilian population (e.g. crowd behaviours), red forces (threat generation) and blue forces (flanking and non-player unit representation), and other patterns of life. It would exhibit behaviours that are representative of the associated unit, grouping or individual and can be controlled either individually or as an aggregate.

Research conducted by the MOD's Defence Science & Technology Laboratory (Dstl) predicts a longer-term composable CGF capability based on a modular set of behavioural components and services, moving away from deploying CGF systems through the traditional CGF approach. However, this approach is seen as too technically immature at this stage and therefore DMaSC is likely to concentrate on the approach dictated by SOSA in minimising diversity but reducing the number of CGFs, although that will probably result in a small number of solutions, and making every effort to share and reuse data.

## **7.0 INTERACTION WITH OTHER M&S SERVICES WITHIN DEFENCE**

Other Defence projects and programmes may also deliver M&S services but specifically only for them and their domain. For example, the Defence Operational Training Capability (Air) (DOTC(A)) programme has a separate project known as Common Systems and Services (CS&S) that has been established to deliver and operate as the 'Air Hub', the necessary simulation and network functions required to allow the linking of current and future air simulation capabilities and enable them to regularly operate together in a single

coherent synthetic training environment.

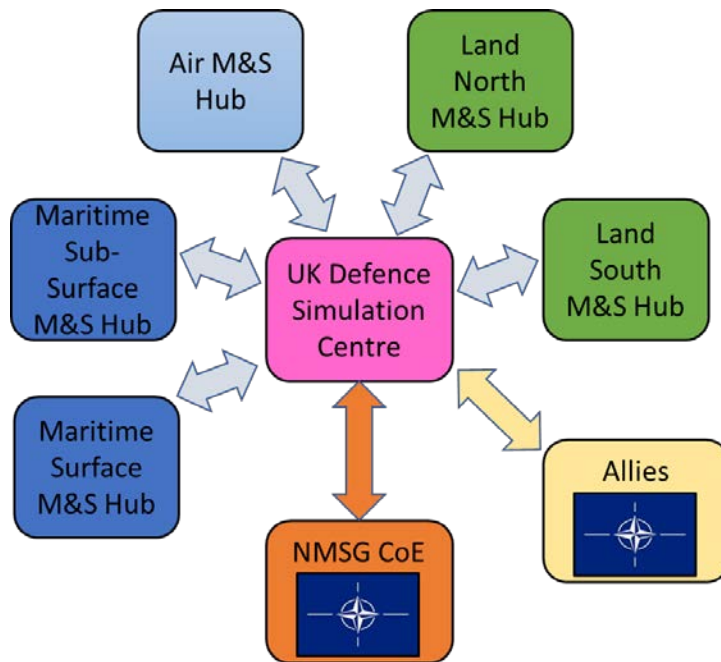


Figure 7-1 – Co-ordination Common M&S Services Internally and with Allies

Clearly there is the potential that both DMaSC, through its DSC, and CS&S will overlap and possibly duplicate services and therefore care and co-ordination must be taken to avoid this risk. The same applies to other M&S services that Land or Maritime, for example, may provide. For this reason, efforts are being made to ensure that suitable architecture work is conducted to ensure, at least internally to UK Defence, that we understand what is being by whom and how interactions should take place.

## 8.0 CONCLUSION

The benefits of DMaSC's co-ordinated and coherent approach to an Enterprise wide management and usage of M&S are clear in terms of cost savings and improved capability. This high-level approach can result in a sub-optimal solution at the project or programme level but it delivers VFM for the taxpayer.

Notwithstanding the above, care is taken to ensure that alternative proposals are not automatically dismissed and innovation is not stifled. But the VFM point will always apply.

An added benefit of such an approach provided by DMaSC is the improved interoperability internally to the UK and through engagement and alignment with NATO, externally with Allies. Such interoperability underpins the ability to be able to deliver successful distributed simulation capability.

In order for such an approach to function, effective governance is key and this is provided for the UK MoD by the Defence Policy for M&S as published in JSP 939.

## 9.0 REFERENCES

- [1] <http://www.integrated-ea.com/wp-content/uploads/2014/08/Jon-Cook.pdf> - Integrated-EA.com – 5 March 2013
- [2] [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/484941/20151208HowDefenceWorksV4\\_2.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/484941/20151208HowDefenceWorksV4_2.pdf) - How Defence Works – 1 December 2015
- [3] <https://www.naval-technology.com/features/featuremcts-the-royal-navys-next-gen-training-revolution/> - NavalTechnology.com – 26 February 2012
- [4] <https://www.qinetiq.com/News/2015/12/QinetiQs-DSALT-virtual-training-programme-scoops-IET-Innovation-Award> - QinetiQ Web Site - 2 December 2015
- [5] <https://www.contracts.mod.uk/announcements/dotca-core-system-and-services-industry-engagement-event/> - MOD Contracts web site - ND



