Towards a Synthetic Environment Ecosystem for Test & Evaluation

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Defence Test and Evaluation (T&E) is a critical enabler

- Motivations for Defence T&E include
  - to modernise operational capabilities
  - to enabling novel technologies to get into service at the pace of relevance
  - to verify next generation system-of-systems military capabilities
- Aspects of live T&E which are causing concern include but aren't limited to:
  - Systems of systems spanning multiple providers and organisations
  - Requirement for larger and larger range danger areas
  - Evaluating capabilities as complex and interconnected system of systems
  - Use operationally representative threats in cluttered / contested environment
  - Ability to collect, store and analyse the large amount of complex data
  - Enabling technology exploitation Implementing capability spiral development
  - Evaluating innovative & new technologies

Development of a MOD-wide Synthetic Environment (SE) Approach for T&E

- An increased use of SEs is viewed as essential in the proposal for overcoming challenges faced using purely live T&E
- Use of SEs will enable increased flexibility/agility/adaptability in T&E
- In order to achieve this aim, an SE ecosystem is required that is:
  - effective and affordable
  - promotes coherency and consistency
  - is, and allows components to be, sharable
  - reduces duplication of effort
  - easily accessible by MOD and its partners
  - trustworthy and credible

Timescales and Project Phases

- Phase 1 “Discovery Phase” (December 2022 – March 2023)
  - Initial discovery phase focusing on Synthetic Environments for T&E
  - **Focus of this briefing!**
- Phase 2 (April 2023 – Fall 2023)
  - Refinement, initial implementation of approaches identified in Phase 1
- Future Phases
  - Continued phases that will evolve from the completion of Phase 2 and will seek to generate further evidence as necessary

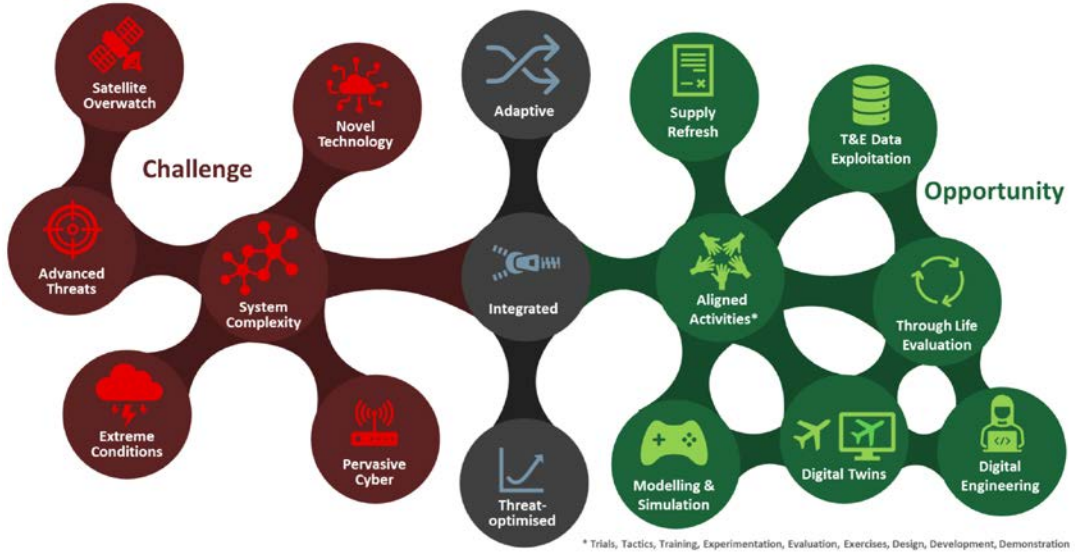
Phase 1 “Discovery Phase” in a Nutshell

1. Review of MOD policy and strategy documents
2. Align basic terminology and concepts
3. Identify specifics of T&E (e.g. as compared to training)
4. Identify related national/international approaches
5. Outline an architecture for SE ecosystem for T&E

1) Review of MOD policy and strategy documents

Reviewed documents include:

- Defence Capability Framework (DCF)
  - DCF defines guiding principles that will inform MOD's approach to investment decisions and military capability development over the next decade
- Integrated Operating Concept
- Digital Strategy for Defence
- Cloud Strategic Roadmap for Defence



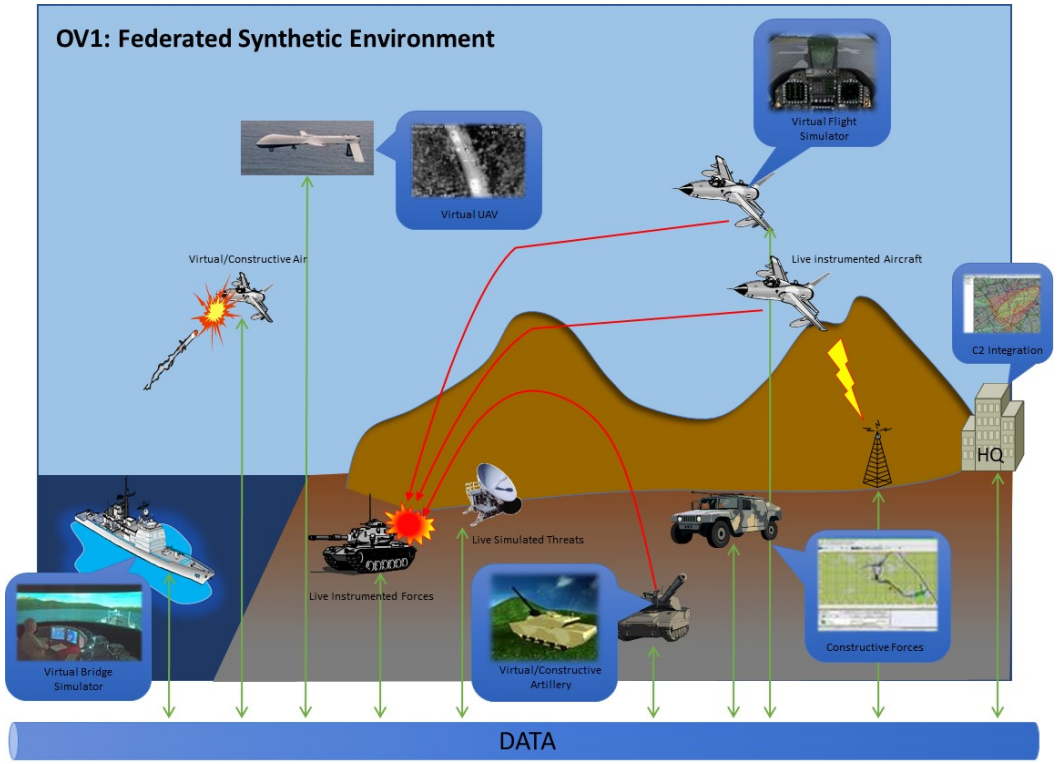
https://www.gov.uk/government/publications/the-defence-capability-framework

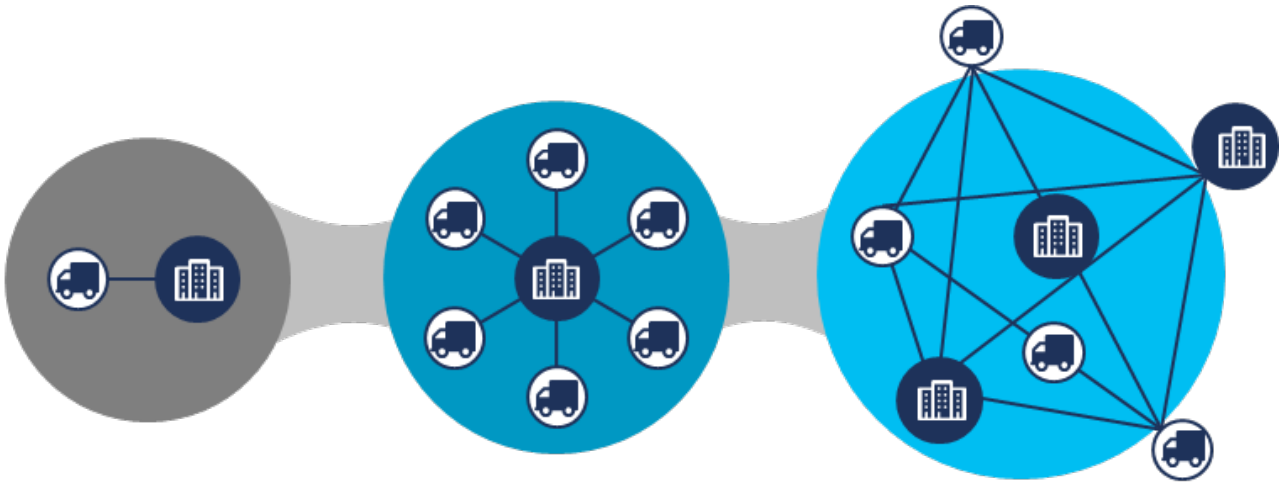
2) Align basic terminology and concepts

- Synthetic Environment (SE)
  - computer-generated simulations of real or imagined physical environments that can be used for training, research, or analysis
- Federated Synthetic Environment (FSE)
  - “A Federated Synthetic Environment is a federation of M&S services, data services, tools etc. that is used to stimulate the System under Test and to collect, store, analyse, visualize T&E data.” (developed by Study Team)
- System under Test (SUT)
  - The SUT is the actual system that is to be tested and/or evaluated.
  - In many cases, the SUT may be treated as a “black box”.
  - It is important to note that (data exchange) interfaces are usually dictated by the SUT, as the aim is to stimulate the SUT via its original interfaces. In other words, in general it cannot be assumed that an SUT has an interface that is usually common within synthetic environments, e.g., HLA or DIS

Moving from singular FSEs to an SE ecosystem

Rather than developing a small number of rigid, widely used FSEs, the desired step change in T&E demands a new approach for generating, deploying and using multiple FSEs to test and evaluate against emerging requirements.





Past
1:1
Relationship

Today
1:n
Relationship

Future
n:n
Relationship

3) Identify specifics of T&E

Study Team identified the following high-level requirements for FSEs for T&E and the SE ecosystem approach:

- Maximise the range of potential SUTs, and combinations of them, that can be tested
- Maximise the range of potential environments, and combinations of them, in which SUTs can be tested
- Provide quality-assured, value-for-money test and evaluation
- Maximise the number of users of (and hence beneficiaries of) the SE ecosystem for T&E

Simulation for T&E is different from Training !

Characteristic	Training	T&E
Nature of the application domain	Often aimed at recurring iterations.	Often focussed on single scientific or experimental goals.
Human involvement	Training will always involve humans (at least one human participant as the subject of the training).	T&E may not include humans but only system-to-system interaction. Humans likely needed to run and control the tests but not necessarily be part of the tests.
System level	Training typically occurs at system (or sub-system) level upwards.	T&E will cover all levels from component through to Systems of Systems.
Types of simulation and data analytics tools used	All sorts of simulation used (live, virtual, constructive). Data analytics often constrained to After Action Review.	Often constructive, faster-than-real-time simulations are preferred to allow high numbers of repetitions. Sophisticated statistical analysis and data visualization used. Usually more scientific and critical in their analysis.
Models (and fidelity)	'Realistic enough' models to achieve training objectives.	T&E will often incorporate detailed physics-based models. Also, models may have to be formally verified and validated if used for certification of a SUT.
Complexity	Varies significantly depending on training purpose, but usually restricted to minimum required to achieve training objectives.	More varied and complex in nature.
Determinism	Exact repeatability usually not required.	Often repeatable and deterministic behaviour is required. Larger scale runs may be required for statistical validity.
User community	Predominantly soldiers in warfighting activities.	Large cross-section of users including scientists, academics, engineers (structural, electronic, chemical etc), designers, strategists etc.
Safety concerns		Safety will be more complex with T&E SEs when performing hardware in the loop testing, e.g., laser safety rooms, EM radiation exclusion areas. Physical safety measures will undoubtably be incorporated but there may also be safety features within the SE.

4) Related national/international approaches

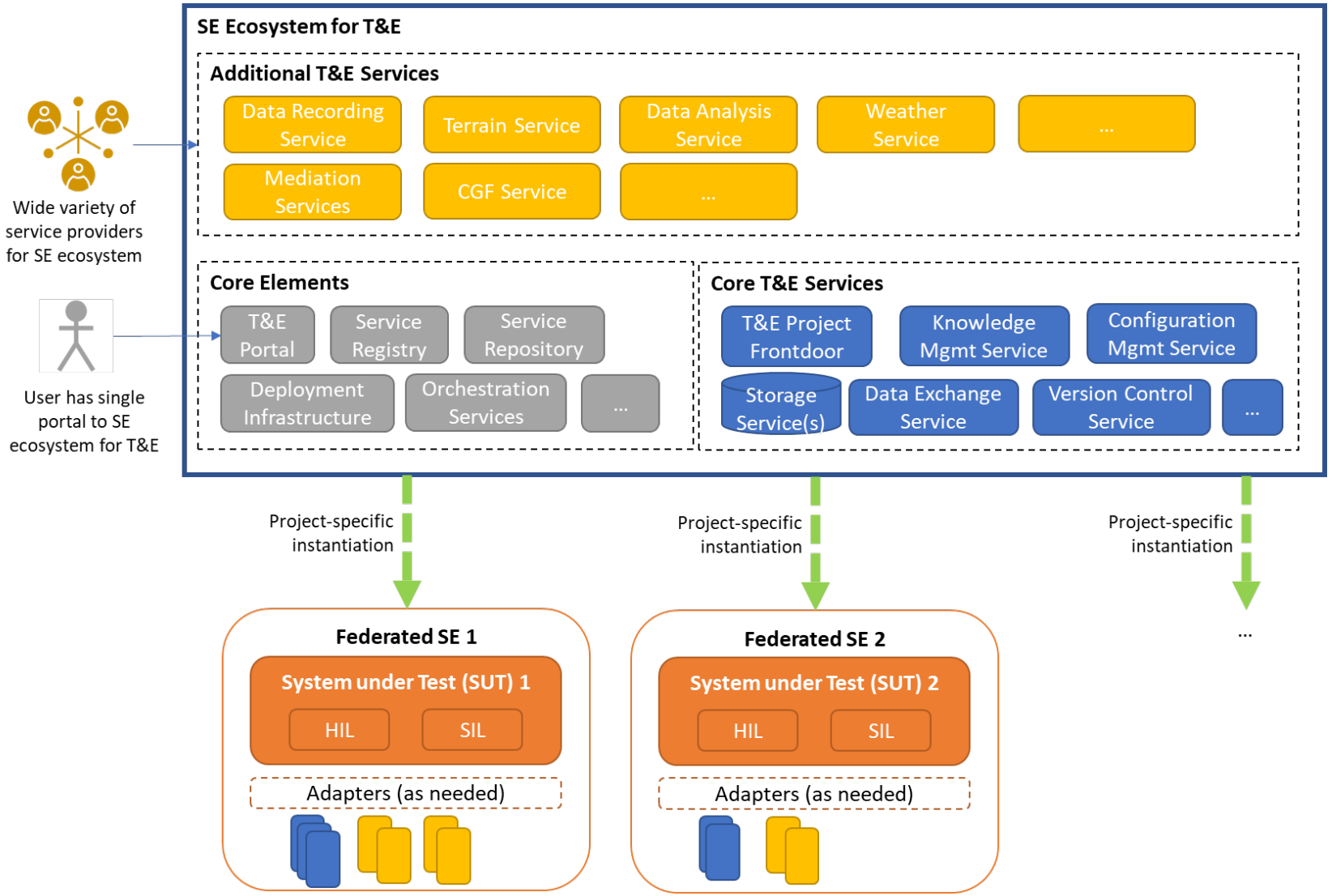
UK Defence national efforts include:

- Defence Synthetic Enablers (DSEn)
  - Aims to provide Defence-wide access to common M&S resources
  - Should include catalogue, synthetic environment service etc.
- Defence Synthetic Environments Platform (DSEP)
  - Might provide tooling and runtime elements of a future T&E SE ecosystem

International efforts include:

- NMSG's MSaaS activities

5) Architecture for SE ecosystem for T&E



Conclusions and Outlook

- Demand for establishing an MSaaS Ecosystem is growing
  - MSaaS concepts are being adopted by various communities, e.g. training and exercises, data farming / decision support
  - Remember: MSaaS is not a single technology, but a toolbox!
- Growing political demand for multi-national collaboration (e.g., next generation aircrafts, or the European Sky Shield Initiative) also drives T&E to a more internationally agreed approach (and a T&E ecosystem)
- Agreed approach (all stakeholders!) required to establish MSaaS Ecosystem
  - Future T&E ecosystem must integrate seamlessly with Digital Twins
  - Move from singular events to continuous T&E

Thank you

For further information and inquires, please feel free to reach out.

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