Cloud Based Simulation in Europe
## UK S&T Perspective

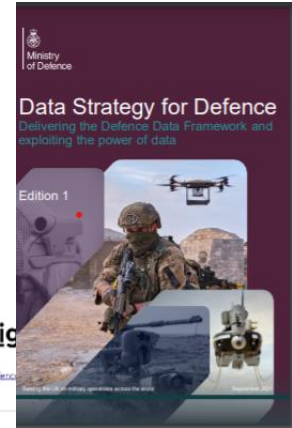Bharat Patel

Fellow

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- The full value of models, simulations and synthetic environments is only realised when they are **readily accessed and used across domains, government and with allies.**

- **Vision: an ecosystem that rapidly acquires, composes and executes the required synthetic environment to the point of need**.

- **Cloud Computing** seen as **core to an ecosystem**
  - Not unique for M&S needs or its application, but across defence – **MOD Cloud, D-Cloud**
  - As an enabler to M&S to be more responsive and more affordable – **Cloud as a Platform**
  - A range of approaches including **on premises, hybrid, and public and private cloud services**.
  - **'Bill shock',** where you are billed in arrears for usage remains a risk for all cloud computing projects.

- On-line, on-demand M&S as a Services approach enabled by associated technologies comprising of:
  - Modelling, Simulation, and Data Services
  - Discover, Compose and Execute Services
  - Verification and Validation Services
  - Application Services
  - **Infrastructure Services** – secure cloud/edge processing and networks services
  - Business Services – governance, business sustainment, secure access, service level agreements, licensing and pricing models (Apps, pay-per-use, monthly/yearly subscription, on-line contracting).
  - **Security & Resilience** – multi-level/cross domain national and commercial security, and resilience to faults and cyber attacks.

MSaaS Ecosystem

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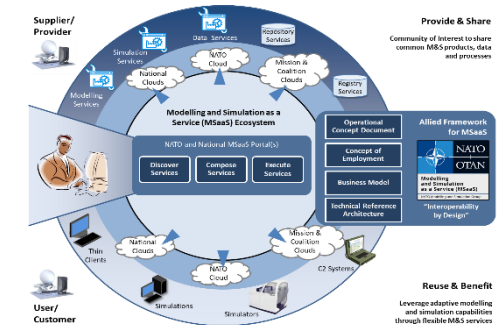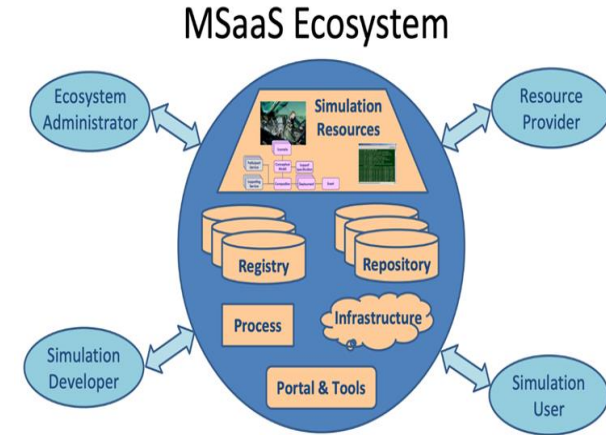
- **MOD Cloud** offers a range of secure services being shaped by current capability projects, with each project generating a 'leave behind' capability for the next.

- **D-Cloud** is used for secure communications and data-driven research and analysis by Dstl.

- **Cloud orchestration and novel simulation frameworks.**
  - Pairing M&S resources with cloud computing.
  - Examples include but not limited to: Improbable's SpatialOS, Hadean's Aether and MAK's Legion.

- **Costs of public cloud.** Scant data. Small scale use may not be cost-effective over an on-site solution.

- **Use of the cloud is not a panacea.** Standalone computers/servers or edge infrastructure (**hybrid approach**) will play a part in the ecosystem.

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Eight principles to establish and sustain an ecosystem:

- **On-line On-Demand Ecosystem** - Established by national and international suppliers and users

- **Discover, Compose and Execute Services**. Find; select and compose; deploy and execute for purpose

- **Fitness for Purpose**. assessed through verification and validation

- **Adaptive Procurement**. Various licensing and payment methods: from App store to on-line contracting.

- **Service-Oriented Architecture**. Open standards, modular/scalable

- **Cloud-Based Design.** SoS design with 'centralised' and/or 'edge' processing

- **Agile Software Access and Development**. Freedom to develop and offer software.

- **Data Centric Security**. Adopt data centric security with zero trust.

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