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Next Generation Test & Evaluation

The generation and assurance of defence capability has never been more critical. Governments must plan, resource, test and train for highly complex operational environments

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In this series of articles, QinetiQ experts outline how a modern Test & Evaluation (T&E) enterprise allows military customers to rapidly and safely experiment with new technologies and processes. This, in turn, enables them to evolve and create new defence capabilities to counter emerging new threats and get new technology and systems into the hands of war-fighters faster.

Introduction

Our militaries are experiencing an unprecedented increase in threats, from unsophisticated swarming unmanned systems to new and novel weapons and hypersonic weapons. In response to this challenge, significant funding is being invested in next generation air, land and maritime capabilities. Increasing system inter-operability is vital between a nation's own ships, aircraft unmanned air platforms and C4ISTAR assets; and between nations in a coalition scenario.

In order to achieve the necessary assurance in this complex and rapidly developing environment, Test & Evaluation (T&E) needs to adapt. T&E enablers need to evolve to enhance confidence in defence capabilities, through an integrated approach to capability generation and assurance; reducing schedule, risk and cost and enhancing the war fighters capability. This requires a clear strategy. How the broad breadth of defence capability should be verified, validated and optimised, from individual systems to entire complex force units. In response to the continuously changing threat, this validation, verification and optimisation needs to be undertaken in a perpetual cycle, to enable defence capability to evolve through rapid technology insertion, to get relevant technology into the hands of war fighters quicker and maximise defence capability utility in operation. In essence, the challenge is to ensure Defence Capability fitness pre-deployment and maximise sustainment whilst deployed in an increasingly cost effective way.

The Right T & E Enablers

Critical to addressing this challenge is having the right T&E enablers which must include people, processes, tools and data. This combination will ensure the delivery of appropriate, cost effective and efficient end-to-end assurance of the efficacy of individual defence systems and force units. This requires a fundamental change from the past, where T&E enablers have generally been implemented with a narrow focus of introducing new defence platforms into service, often continuing unchanged until they become obsolete or the platform is disposed of.

The future vision should be of a T&E enterprise that is optimised across the end-to-end capability generation cycle and integrated through-life, supporting information re-use to maximise both the capability and availability of operationally deployed defence assets. The capability generation cycle should cover;

1. Experimentation to understand the potential of future technology
2. Developmental testing
3. Certification and qualification
4. Upgrades

Additionally, against the highly dynamic threat environment, T&E enablers can enhance training output, through using fully instrumented T&E capabilities to provide a much greater level of insight and help to optimise operational tactics, techniques and procedures. This enables defence capability to evolve much faster.

Digital Twin and Digital Thread

Embracing the Fourth Industrial Revolution and the breakthrough of Digital Engineering opens up the opportunity to create a digitally enabled T&E enterprise that more closely links the management and capture of evidence with the capability generation cycle. This enables faster access to information and so accelerates the pace of decision making. The defence industry is rapidly realising the transformative effects of digital technologies on the cost and 'time to market' of increasingly-complex platforms. Hence, the next-generation of systems will benefit from the use of Digital Twins and Digital Threads. T&E should now evolve, to embrace these techniques and build on the advances being made, learning from the civil sector where similarly highly regulated industries (e.g. automotive and civil air) have embraced digital engineering technology. This would be achieved through two complimentary approaches:

Firstly, the validity and pace of decision-making could be increased through establishing an evaluation digital thread, a single assured version of the truth, which supports information re-use. This digital thread would be used to establish a through-life T&E plan, built and accessed in collaboration between industry, assessors, regulators and end users. This plan would span all T&E activities undertaken throughout the life of the defence capability covering experimentation, concept development and refinement, developmental testing, certification and qualification, training and the evaluation of operational tactics and upgrades.

Data, from all the T&E activities undertaken would populate the evaluation digital thread. The digital thread would start with model based design evidence, underpinned by critical live T&E where needed, with results fed back to validate the models. Modelling and live data would progressively populate the digital thread. Whilst the data would remain the property of the owning organisation, an independent curator would understand what data is available and facilitate mining to enable timely decision making. The digital thread would be accessible collaboratively by developers, assessors, regulators and end users. The collaboration, coupled with utilising the increasing power of data analytical tools, would enable coherent information to be provided simultaneously on equipment performance, training and tactics. It would also inform capability evolution requirements. This would enable the rapid and incremental assurance and hence fielding of defence capability and improve the understanding of overall warfighting effectiveness.

The re-balance between live and model-based evidence

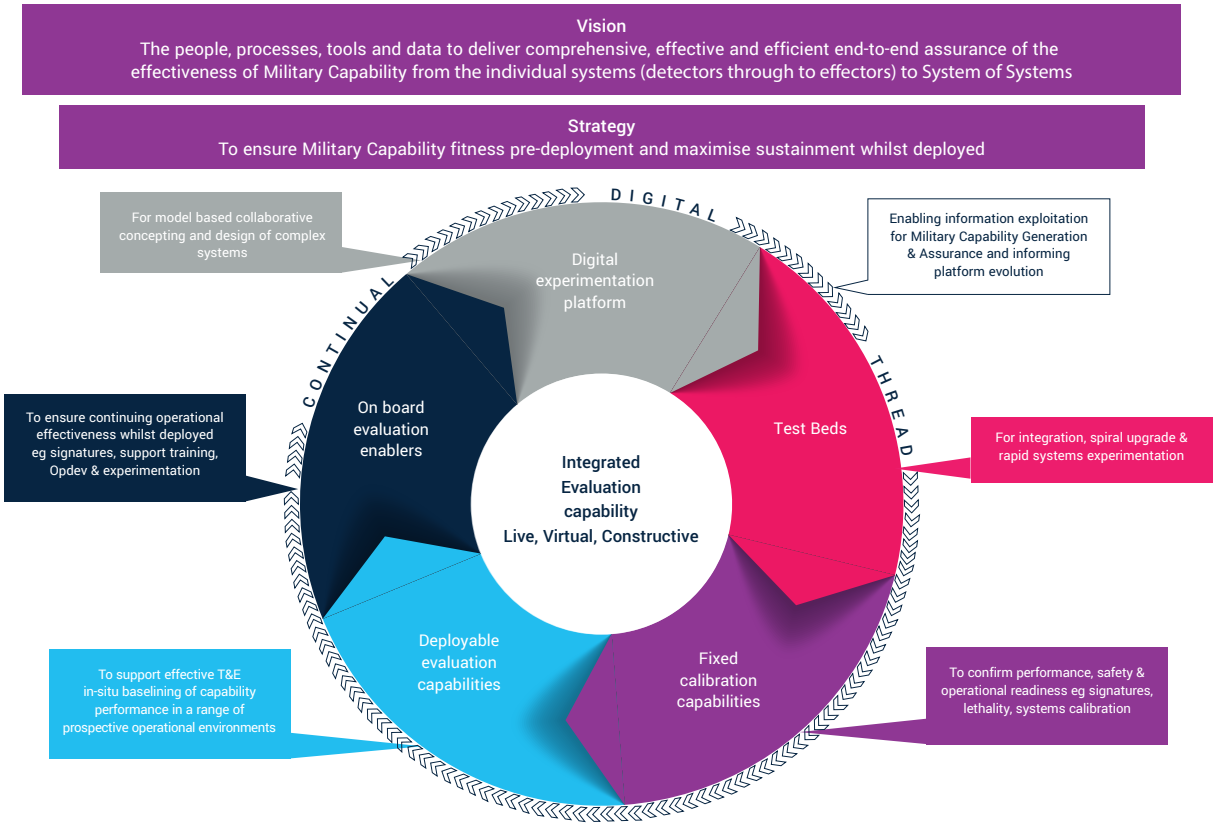
As confidence in the performance of military systems comes increasingly from virtual means, the second shift for T&E should be a fundamental rebalancing between live and model derived evidence. This would enable faster, more cost effective decision-making, accelerating capability to the front line. Secondly, a clear understanding should be established of which elements within a T&E event need to be live and which synthetic to provide the correct stimulus. Where live, there should be a rebalancing from fixed to mobile evaluation whereby the evaluation capability is with, or taken to, the platform, reducing the length of time platforms need to be taken out of service for upgrades or testing and maximising their availability on the frontline. Integrating live and model derived evidence, coupled with a 'systems of systems' approach to building an aggregated assessment, would also enable evaluation to be conducted in a secure way, unobserved by hostile agencies. Such an approach would provide the vehicle through which emerging technologies, systems and operational experimentation can be undertaken, enabling safe 'minimum viable product' capability to be provided to the war fighter earlier.

Embracing these two complimentary approaches to T&E would enable enhanced defence capability to be accelerated to the front line, delivering operational advantage and maximising platform availability.

This requires that the total breadth of T&E enablers need to be architected and integrated to provide a cost effective, flexible and agile capability, as depicted in the diagram below. These comprise:

- Digital experimentation to provide evidence to inform design decision.
- Test beds to enable integration, spiral upgrade and experimentation.
- Fixed ranges to confirm performance, safety and operational readiness.
- Deployable capabilities to support effective T&E in-situ baselining of capability performance in a range of prospective operational environments.
- On-board evaluation capabilities to ensure continuing operational effectiveness whilst deployed.

The T&E enablers and activities would be informed by a rigorous understanding of the information required and the uncertainties and risk that can be tolerated. This focus would drive the balance between live and synthetic enablers. Each element would include credible but cost effective threat representations, comprising live and virtual components, to provide an LVC (Live, Virtual, Constructive) capability to enable realistic evaluation and training. Each element, whether live or virtual, would feed the digital thread, providing information and evidence to support decision-making.



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The digitally enabled T&E Enterprise

To deliver this digitally enabled T&E enterprise, a number of key enablers must be established. Firstly, the necessary digital infrastructure, tools and processes to create, share, use and manage knowledge and information across the entire T&E enterprise, harnessing the benefits of Big Data capture and analytical techniques to provide near real time, coherent information. The digital infrastructure and tools should enable federated experimentation across government & suppliers and have an enduring ability to be able to rapidly augment Live T&E capability with Virtual and Constructive elements.

Secondly, an endorsed taxonomy for T&E should be established, as the basis for setting clear through-life T&E requirements, encompassing both acceptance and in-service needs. This would be based on a rigorous understanding of what information, evidence and data are required. This would enable the coherent specification and management of T&E capability across defence organisations hence improving value for money.

Thirdly, and fundamental to success is the need to rapidly develop a skilled workforce across all players in the enterprise covering:

- Model Based Engineering to derive cost and risk balanced testing strategies from evaluation needs, requiring a deep understanding of the evidence required to meet defence standards and how this can be compiled progressively through-life and increasingly from models. This needs to be coupled with an ability to consider and recommend alternative methodologies for the capture of evidence;
- Experimental design, data evaluation and data analytics facilitating the broader use of deeper data analysis techniques;
- Integration and exploitation of synthetic tools and techniques through understanding the standards and approaches needed to know how to integrate models and simulations both together and into live components;
- Digital and IT engineering to bring pace and agility to projects through deeper digital integration of geographically separate virtual and live components;
- Safety to understand how to deliver in a safe manner evaluation of new defence systems, such as Directed Energy Weapons and hypersonic weapons and complex exercises.

Summary

In summary, the breakthrough of digital engineering opens up the opportunity to create a digitally enabled T&E enterprise that more closely links the management and capture of evidence with the system development lifecycle, enabling faster access to information and so accelerating the pace of decision making. This would deliver a number of benefits but fundamentally would improve and accelerate warfighting capability through increasing the pace of system development, certification & upgrades and platform availability.

QinetiQ is a company founded upon innovation, defence specific research and development, and T&E forms the core of our business. The breadth and depth of our people's technology and domain expertise, and our investment in their continued development, enables QinetiQ to deliver valuable advice, innovative solutions and managed services globally. We work collaboratively with Government, Industry and Academia to deliver complex services and innovative technology solutions to our customers.

QinetiQ plays a central role in delivering capability assurance for our defence customers, as evidenced in the UK through our Long Term Partnering Agreement (LTPA), which is at the heart of our strategy in modernising T&E in our home markets.

QinetiQ is investing in services and solutions in all of these areas in conjunction with Industry and the military both in the UK and Internationally.

To hear more, please join us for our live Webinar in June where Cathy O'Carroll, Global Director, Test & Evaluation will host a deeper discussion around the topics discussed in this article.