

The background is a dark blue gradient with various digital and data-related graphics. On the left, there are several horizontal lines of varying lengths and colors (blue, purple, pink) that resemble data points or a bar chart. In the center, there is a large, semi-transparent gauge or dial with a needle and the number '80' visible. On the right, there is a prominent, glowing blue network mesh or data structure that looks like a stylized path or a complex network of nodes and connections. The overall aesthetic is futuristic and technological.

Harnessing  
the Digital Thread  
to Build a Valuable  
Through-Life  
Evidence Chain

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.

In a previous article, we looked at QinetiQ's vision for a defence digitally enabled T&E Enterprise. It described how the T&E enablers need to evolve to generate early confidence in emerging military capability, and sustain and enhance it through life to operate in dynamic and complex environments.

The way to realise this vision is to embrace the adoption of digital engineering, starting from the product 'concept' phase and progressing through life, capturing evaluation data as a shared single authoritative source of truth, known as the evaluation digital thread. Our vision is of a digitally enabled T&E enterprise that would enhance confidence in understanding of defence capabilities, through an integrated approach to Capability Generation and Assurance; reducing schedule time, risk and cost, and enhancing the war fighters' capability.

Globally defence budgets are facing huge pressure as nations struggle to keep pace with the unprecedented increase in threats. To counter these constantly evolving threats, defence platforms are becoming more complex and must be built and released into operational service quicker, with rapid and agile upgrades enabled. This must all occur against a background of shrinking defence budgets and a potential global recession.

The digital twin acts as a digital representation of the live platform. Evaluation data is gathered on the digital thread as design changes are made, augmenting the overall digital twin of the platform – evolving with the platform until it is released into service. As the design process evolves and iterative evaluation occurs, both live and model based, T&E data is gathered and the evaluation digital thread is built. This is then used to inform the many engineering review points which take the programme forward from concept through to final manufacture.

When implemented and shared effectively the digital thread transforms the evolution and manufacturing process, creating a single library of digital data that stretches from the initial design to the finished product and which can be accessed by anyone at any point in that chain for the purposes of evaluation as well as rapid manufacture. It ensures that at every stage, everyone involved has the digital data they need to perfect the product, pre-empt issues, respond rapidly to changes and deliver an end result that performs to expectations (or beyond) in every respect. The result is a better product in less time and at less expense. This approach has already enabled agility and cost reduction benefits in other industries such as vehicle manufacturing and automotive.

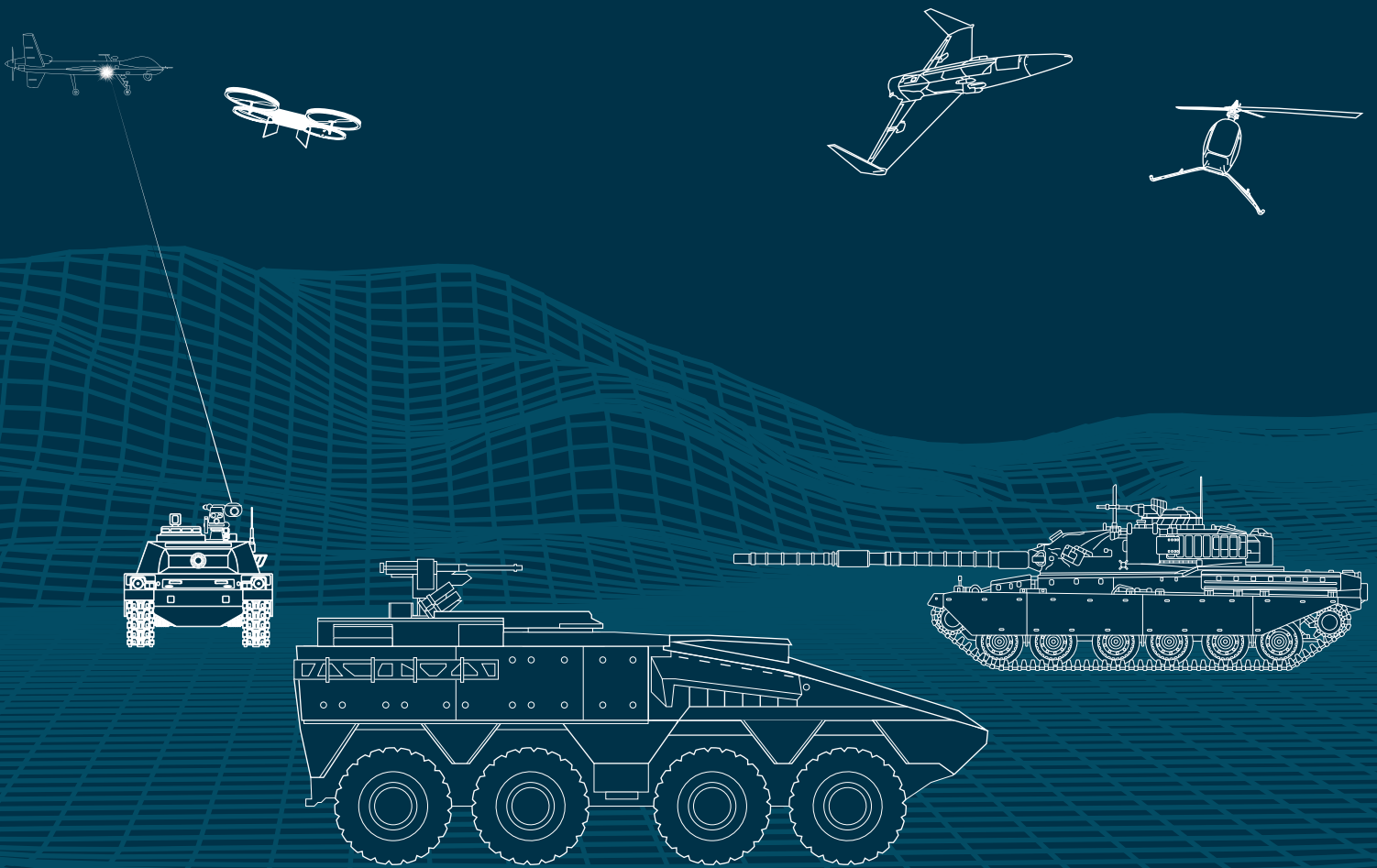
- **Stara:** Brazil-based tractor manufacturer Stara is using digital twins to modernize farming. By outfitting its tractors with Internet Of Things (IoT) sensors, the company can increase equipment performance. With real-time visibility into how its tractors operate, Stara can proactively prevent equipment malfunctions and improve asset uptime. The company has also leveraged digital twins to create new business models. With a wealth of IoT sensor data, Stara launched a profitable new service that provides farmers with real-time insight detailing the optimal conditions for planting crops and improving farm yield. It is claimed farmers have reduced seed use by 21% and fertilizer use by 19%.
- The **Maserati Ghibli** was designed & built with digital twins from the outset. It shortened the time to market by 30% (which included R&D) and gave a 3x increase in vehicle production.

Given these successes with the early adoption of digital twin and digital thread architectures why should this approach be more difficult in defence? The simple answer is – it cannot be!

Challenges faced by defence are not dissimilar to those faced in other highly regulated industries such as automotive or civil air where safety is a key factor in releasing products to the market. It is true that the unit cost, complexity and timeframe to develop a defence platform is hugely different from the more mass production automotive industry. But the principles remain the same and the cost and time savings could be arguably greater due to the scale of investment required to produce a new military platform versus that to produce a car.

To drive our vision of a digitally enabled defence T&E Enterprise and be able to capture and exploit the 'evaluation' digital thread, industry and government collaboration is paramount. Currently some key challenges exist which are preventing the realisation of through life benefits for defence:

- (i) Lack of a common agreement between defence industry and governments as to what data should reside on the evaluation digital thread and who should manage it.
- (ii) A common set of technical standards and a framework to enable ease of sharing of models inter-company at early concept and design phases for rapid experimentation
- (iii) Commercial sensitivities around Intellectual Property (IP) protection when collaborating inter-company.



QinetiQ is a global leader in T&E and is the strategic T&E provider for the UK MOD. Our experience in this area has led us to begin to address these barriers to delivering defence capability earlier and at reduced cost. We are examining the benefits of digital techniques applied to the T&E lifecycle such as model based systems engineering and Live Virtual & Constructive events, combined with the through life use of an evaluation digital thread.

We have been working with UK Defence Industry Prime contractors to examine the optimum composition of the evaluation digital thread to make it useful to defence through life. We are starting to build some examples of how this would work in practice; comparing digital processes against existing manual process in place today to prove the benefits.

## How could use of the Digital Thread benefit Defence?

QinetiQ is exploring three key areas with our global customers to look at how the introduction of an evaluation digital thread and digital twins can benefit through life T&E. We are focussing on driving cost and time out of new and upgrade programmes and improving war fighting ability for the front line.

### 1. Rapid prototyping at the concept and design stages.

As modern defence systems increasingly comprise a deeply integrated set of complex sub systems, the 'systems of systems' evaluation process is an essential requirement for success. The ability to explore concepts early in the product life cycle and progressively ensure the performance of the overall suite of integrated systems is key to delivering rapid military capability into service. The evaluation data collected at every stage of this iterative design process informs key design decisions and evolves the end 'system' more rapidly.

QinetiQ is investing in proof of concept technology platforms to demonstrate the benefits of an enduring environment supporting the federated sharing of models inter-company. This approach aims to address the three challenges to Industry/government collaboration described above, allowing industry to digitally test models of systems and subsystems together on demand without models leaving the owning organisation. This provides assurances around the protection of IP and supports rapid concept spiral development, flushing out errors earlier in the process and reducing the need for engineers to travel to other subsystem manufacturers sites to share and test models. Thus a reduction in travelling cost and time between companies for model to model testing purposes can be achieved.

## **2. Model based certification and a transformed progressive certification approach**

Model based systems engineering (MBSE) is increasingly becoming the norm in defence for the development of new platforms and capability.

The evaluation digital thread can now be populated with key data at relevant stages in the design and engineering lifecycle to record the evidence chain necessary for qualification, certification and acceptance into service.

By collecting the evidence as it is generated and collecting much of this from model based testing, the qualification and certification process for defence capability can occur progressively. Less actual live testing will be required as much of the evidence will come from model based sources. The result is a much faster time to deployment as the acceptance process is not 'back-end' loaded but has occurred throughout the engineering life cycle with the defence authorities gaining progressive confidence in the safety and suitability for operational service as progression through the engineering process occurs. By looking to shift the balance of live and digital testing, QinetiQ is currently building a transformed certification system for our air domain customers which supports this approach and by working with the defence regulators, we are seeking to reduce cost and speed up time to operational acceptance.

## **3. Enriched operationally relevant capability dashboards**

The large volume of evidence data generated during development and acceptance provides a high fidelity baseline of a military platform prior to operational deployment. This data, residing on a through life evaluation digital thread, provides a baseline capability status at a snapshot in time. As the platform is deployed additional mission specific or platform status data may become available that, when combined with the earlier data, gives a more dynamic and operationally relevant view of the military platform or capability. In addition, once a defence platform is operational, the digital Twin can be used to interpret operational data from the live platform and model the impact of any changes in near real time without impacting performance or safety, populating the digital thread with updated evaluation evidence. By way of an example, in a maritime environment data from the digital thread could be used to provide a dynamic feed to an on-board ship capability dashboard prior to entry into conflict. This could apply at a single platform level or at a fleet/task force level. In an earlier article we described our vision for a through-life T&E eco-system populating a digital thread. QinetiQ is investigating how in this maritime context, high fidelity test data from instrumented fixed ranges could be combined with data from potential low cost on-board T&E measurement devices, and integrated with geographical data. This augmented data could then feed a capability dashboard which would provide a more relevant and timely view to the ship or task group commander of critical aspects of their operational capability at that new point in time.

It is clear to see from the short examples described, that the ability to correlate all of the test and evaluation data, from the full spectrum of modern design environments through to live/synthetic testing and training, into a shareable single source of truth could help accelerate the development, acceptance and through-life optimisation of military capability.

This approach would ensure military capability can be delivered faster and cheaper whilst not compromising assurance. The end result in all cases is a more agile warfighting capability.

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. If you would like to hear more, please sign up for our Webinar in July where our Global Director for T&E will host a deeper discussion around the topics discussed in this article.