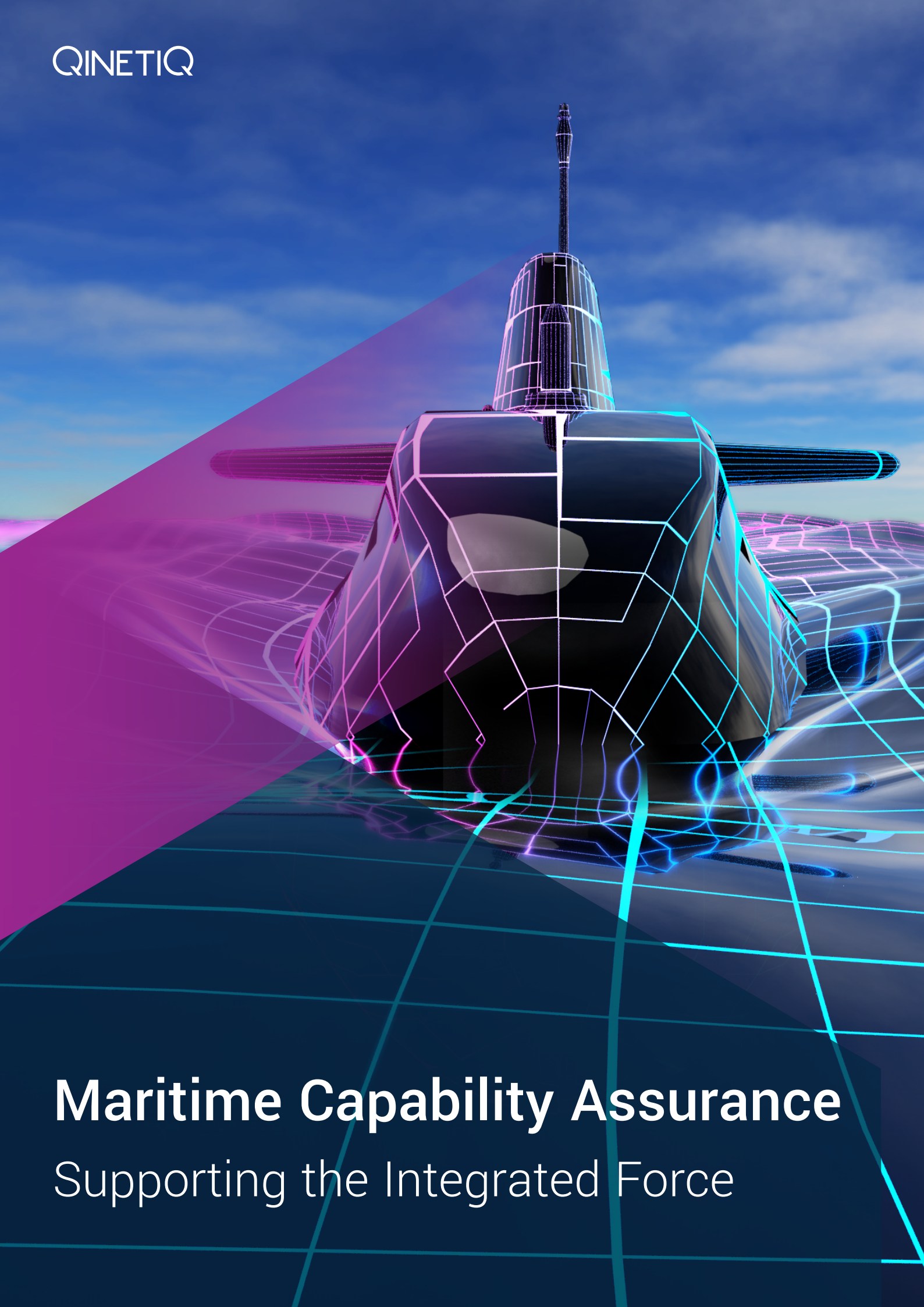
QINETIQ



Maritime Capability Assurance

Supporting the Integrated Force

Enhanced Capability Assurance

Advanced, independent test and evaluation (T&E) is fundamental to delivering the **capability assurance** underpinning a fully integrated and lethal Australian Defence Force (ADF). Conducting enterprise-wide T&E activities centred on Service, Joint, and Coalition outcomes will be vital to ensure the ADF operates effectively across the five domains, provides seamless performance during joint operations, and delivers enhanced and joined-up combat power.

Independent T&E is the essential and indispensable means through which unbiased, objective quality evidence (OQE) is established across the capability life cycle; from strategy and concept development, to operational deployment. It is the mechanism that unlocks the full operational potential of a capability. It guarantees the secure integration of new systems into current platforms while ensuring the attainment of the agreed-upon minimum viable capability. T&E must never be marginalised or relegated solely to the concluding phases of project delivery.

QinetiQ, a trusted technology and engineering company, provides independent, original equipment manufacturer (OEM) agnostic, cutting-edge T&E services worldwide. We employ advanced methodologies, tools, and expertise, aligned with model-based systems engineering (MBSE) practices, through a global team of seasoned professionals. Our extensive workforce and advanced capabilities inspire confidence in QinetiQ's support to defence, industry, and academic institutions.

QinetiQ's T&E services enable risk mitigation, optimise resource allocation, and provide support for decision-making at all stages of a capability's life cycle. Additionally, T&E ensures the protection of cost and schedule expectations, identifies design shortcomings and performance enhancements, informs the safe introduction of new and advanced technologies, and provides valuable insights for operational use.

QinetiQ's comprehensive life cycle-centric approach to T&E services is instrumental in supporting the defining of minimum viable capability for maritime platforms, combat systems, weapons, and new and emerging technologies. Our specialised maritime T&E expertise encompasses a diverse array of capabilities including system integration, signature hygiene, weapons testing, hydrodynamic design, survivability, environmental analysis, and more. As threats continue to evolve, the demand for rapid development, testing, evaluation, and implementation of new tactics, platforms, systems, and weapons, intensifies.

QinetiQ's maritime facilities, systems, experience, expertise, and life cycle-centric approach to T&E, provides Australia with an opportunity to rapidly accelerate building sovereign capacity for the delivery of genuine **capability assurance**.

Delivered Across the Life Cycle

The 2018 Defence Industrial Capability Plan introduced ten Sovereign Industrial Capability Priorities (SICP). These capabilities are deemed critical to Defence and were to be developed or supported by Australian industry to ensure Australia had access to, or control over the skills, technology, intellectual property, financial resources, and infrastructure that underpinned the Priorities. In 2020, the Test, Evaluation, Certification, and Systems Assurance (TESCA) SICP was released.

QinetiQ acknowledges the Government's directive on TESCA and emphasises the significance of our advanced, independent, OEM-agnostic, and comprehensive life cycle-centric approach to T&E services in fulfilling this. Only through specialised T&E delivered via dedicated facilities and systems, by expert staff observing across the entire life cycle at an enterprise level, can the **capability assurance** supporting the ADF's enhanced and joined-up combat power be developed. The essential role played by this approach in achieving the Integrated Force vision should not be undervalued.

QinetiQ's comprehensive life cycle-centric T&E model is a holistic enterprise-wide approach designed to identify a capability's characteristics from strategy and concepts, all the way to the in-service deployment as a part of the Integrated Force. It accommodates the demands of distributed and federated operations, prioritises interchangeability and interoperability, while emphasising the agile and rapid integration of cutting-edge technologies like artificial intelligence, machine learning, and remote and autonomous systems. This approach is pivotal in maintaining a competitive operational advantage. An exemplar life cycle-centric T&E model for a nuclear-powered submarine is at Figure 1.

This model's activities span strategy and concept development, design, production, acceptance, operations, capability evergreening, certification, operational effectiveness, surveillance, life-extension, re-purposing, operational analysis, tactics development, human factors engineering, disposal, and more. This ensures desired life cycle outcomes are achieved, and sets the shaping for future force design, structure, and posture on the correct path. This deliberate, long-term, enterprise-wide T&E model is designed specifically to prevent unforeseen capability silos from emerging within the Integrated Force.

During the **strategy and concept phase**, independent T&E evaluates and validates new ideas, technologies, and operational concepts. Analysis, simulations, and modelling are used to assess the feasibility and performance of proposed capabilities, offering decision-makers valuable insights, enabling informed choices, and identifying potential risks. An enterprise-wide capability life cycle-centric approach during this phase cannot be overstated. It is solely through this approach that the essential OQE required to set the ADF's future force structure on the correct course can be achieved.

In the **risk mitigation and requirements phase**, independent T&E is vital in ensuring that systems or equipment meets minimum viable capability and operational requirements, at Platform, Service, and Force levels. Prototypes, subsystems, and components undergo testing to validate their functionality, performance, and interoperability/interchangeability. Independent T&E helps identify design flaws, weaknesses, and areas that require improvement, enabling design refinements and optimisation. In this phase, adopting a forward-thinking, life cycle-centric T&E model becomes crucial to the smooth integration of future capabilities from the development pipeline. By doing this, integration is conducted with minimal disruptions to cost, schedule, and platform availability, all while maximising operational advantage and lethality outcomes.

During the **acquisition phase**, independent T&E verifies that manufactured systems or equipment meet specified requirements and quality standards. Samples from production batches are tested to validate their performance, reliability, and compliance with contractual obligations. Independent T&E also ensures that manufacturing processes and supply chains are capable of consistently producing high-quality and reliable products. This is undertaken from subsystem to Force level, and includes equipment as disparate as components for nuclear-powered submarines, to advanced guided weapons manufactured by OEMs in Australia.

T&E activities continue during the **acceptance and introduction phase** when systems or equipment is delivered to end-users. This phase ensures that capability is properly installed, integrated, and configured to function as intended. T&E activities include acceptance testing, operational readiness evaluations, and interoperability assessments to confirm that the capability is fit for operational use.

Throughout the **in-service phase**, independent T&E supports the ongoing assessment of the capability's performance, effectiveness, and suitability for intended missions. Continuous monitoring, data collection, and analysis should be conducted to evaluate the capability's reliability, maintainability, and availability as well as performance against new and emerging threats. T&E also assists in identifying emerging issues, degradation, or potential risks that affect the capability's performance.

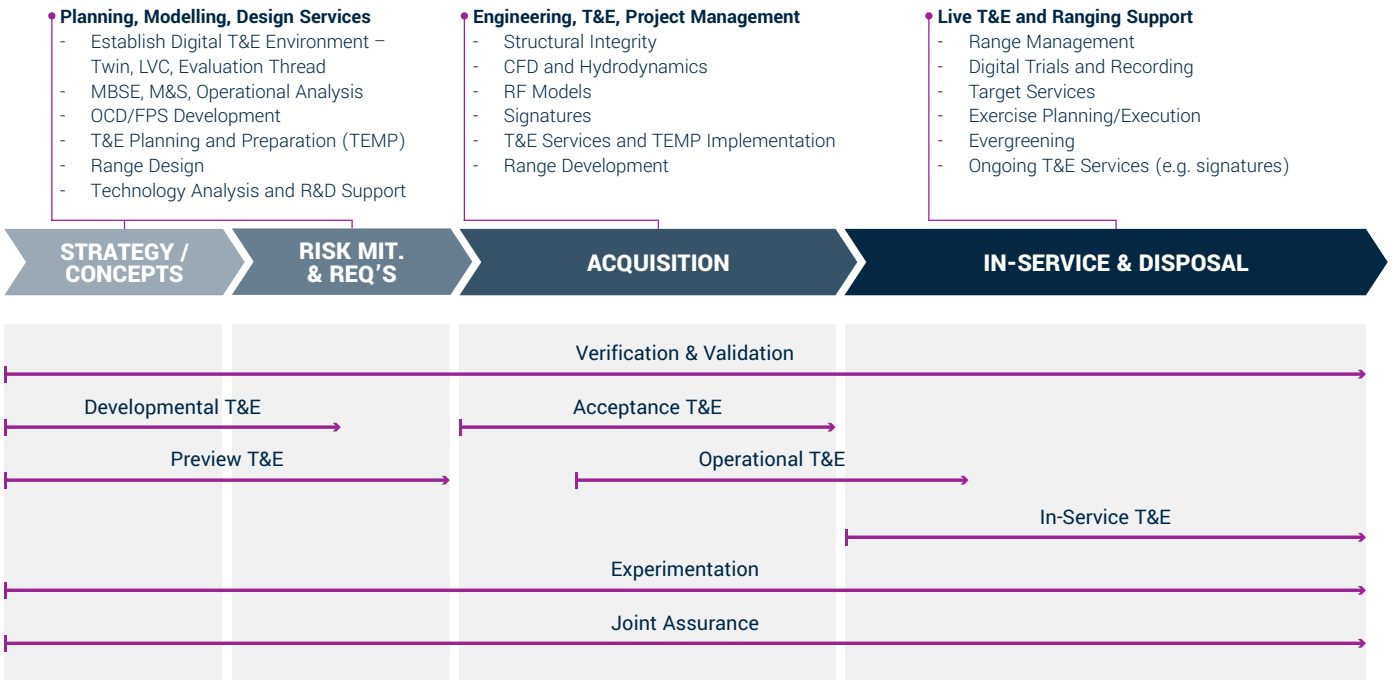


Figure 1: Exemplar Life Cycle-Centric T&E Model – Nuclear-Powered Submarine.

The Digital Thread

The digital thread of performance evidence, or simply 'digital thread', refers to the concept of developing and maintaining a continuous, interconnected flow of digital information and data throughout the entire life cycle of a product or system, starting from its initial conceptualisation phase. This digital thread serves as a single, authoritative source of OQE for evaluating data related to the product or system. It allows for the seamless integration of data from various stages of development, testing, and operation, enabling a more comprehensive and efficient approach to capability generation and assurance. The digital thread is a means to enhance understanding, reduce schedule times, mitigate risks, lower costs, and improve the capabilities of defence systems.

Figure 2 below illustrates our model using a maritime example. It demonstrates the journey from strategy and concept, through to operation within a Task Group. Harnessing the digital thread will be crucial to delivering higher levels of military preparedness and accelerated capability development across the Defence enterprise, while meeting interchangeability and interoperability requirements with Partners and Allies.

Phase 1 – Subsystems Evaluation: Delivering independent T&E services to inform and validate the design and performance of the major subsystems of a platform, initiating the digital thread.

Phase 2 – Subsystems Integration: As the subsystems are integrated into the platform, independent T&E provides the expertise, digital tools, facilities, and ranges, to generate the OQE to assess the minimum viable capability of the platform, exploiting the digital thread at the Platform-level.

Phase 3 – Wider Capability Integration: The digital thread extends to the Integrated Force-level and beyond, encompassing an enterprise-wide view of the ADF, thereby ensuring the delivery of enhanced and joined-up combat power. Expanding the digital thread further provides insights into the anticipated level of interchangeability and interoperability with Partners and Allies.

While QinetiQ's digital thread capabilities are primarily centred at sites like Portsdown Technology Park (PTP), which includes the National Maritime Systems Centre (NMSC) land-based test site (LBTS) for surface combat systems, and the Haslar Marine Technology Park, delivering submarine **capability assurance**, the concept of the digital thread has been embraced with enthusiasm throughout the entire QinetiQ business and is actively used in our daily operations.

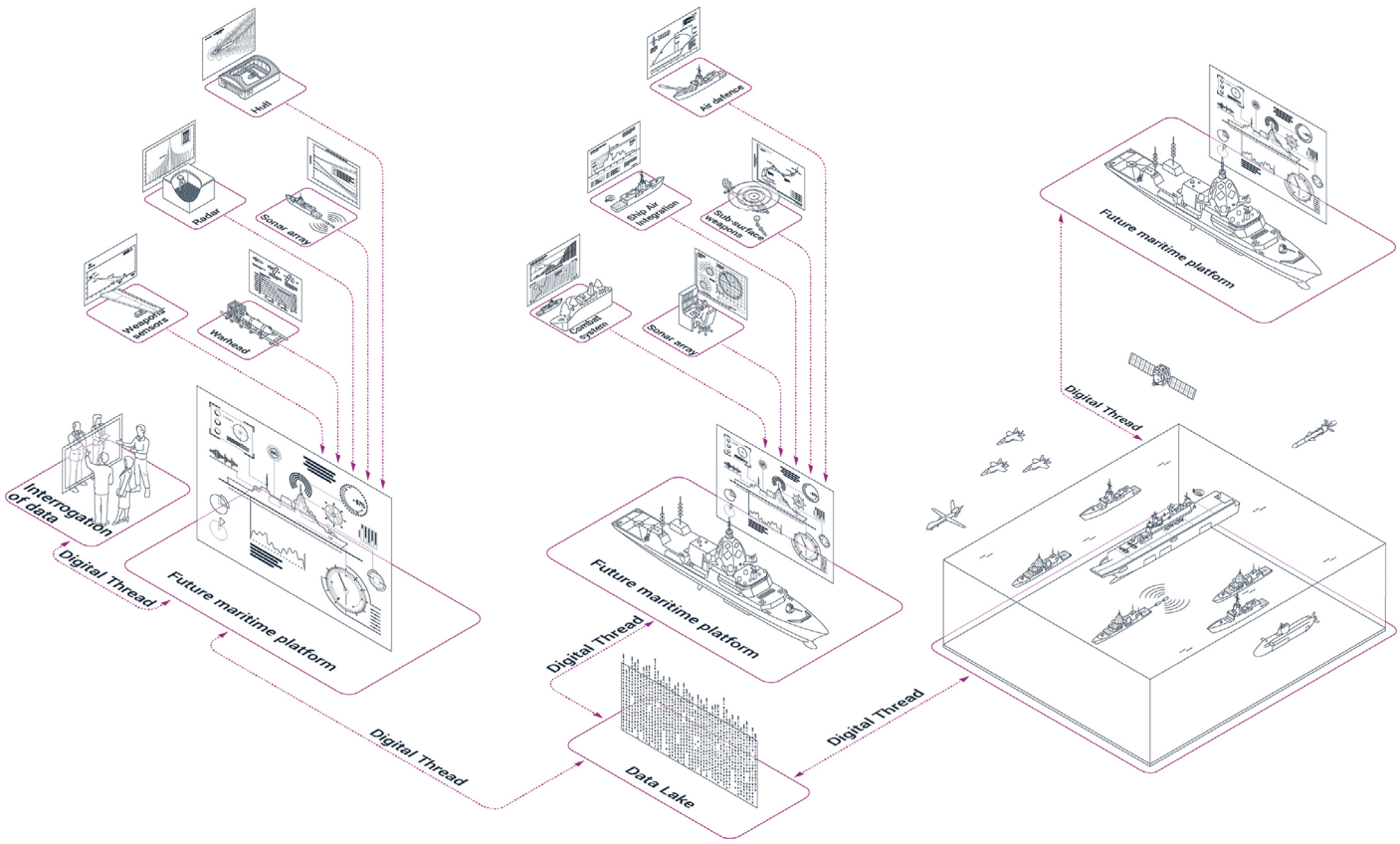


Figure 2: Integrating the Digital Thread from Concept to Integrated Force Operations.

Delivering Mission-Critical Capability in Submarines

Manoeuvring and control
Safe operating envelope and autopilot design

Materials
Selection, advice and in-service performance and assessment

Smart materials
Maximising platform performance

Submarine C4 and Information Management
Managing interoperability and provision of CIS

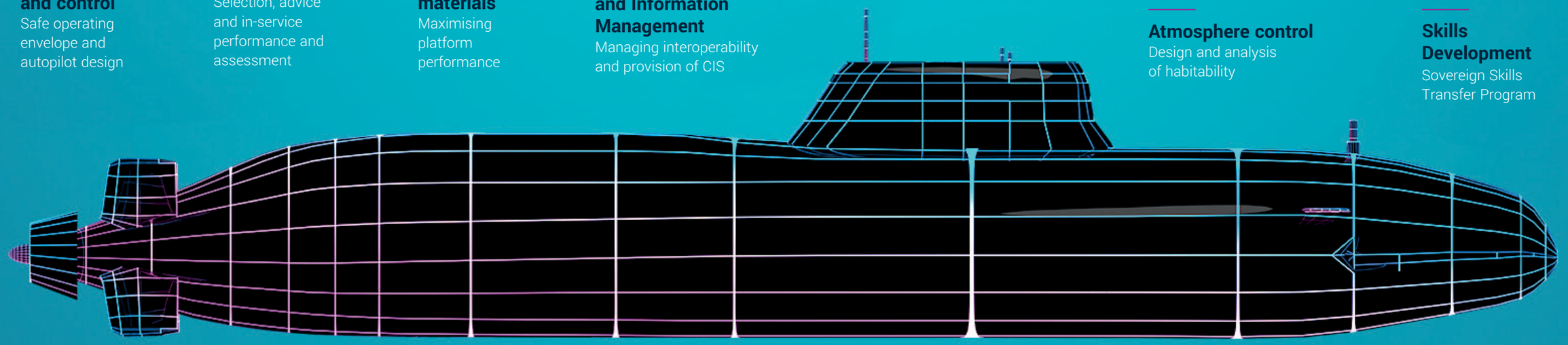
Escape and rescue
Design and analysis of escape and rescue systems. Hyperbaric medicine

Robotics and Autonomy
Including AI, and assurance and risk management

Weapons, torpedoes and targets
Capability analysis and delivery of underwater targets for crew training and picture compilation trials

Atmosphere control
Design and analysis of habitability

Skills Development
Sovereign Skills Transfer Program



Propulsor
Analysis of propulsors and propeller design

Susceptibility risk
Supporting continual improvement

Noise and vibration
Radiated acoustic noise assessment and management

Structures
Structural integrity, NDE advice, SM welding, corrosion and pressure hull collapse

Shock and Survivability
Physical testing and synthetic analysis

Signatures and Stealth
Ranging, testing and analysis, including provision of anechoic coatings

Hull form
Hull form design and analysis including dynamic stability and degraded conditions

Information assurance and Cyber
Cryptography, Secure Cloud, cyber survivability and susceptibility

From analysing manoeuverability to evaluating the stealth performance of submarines, our **capability assurance** model empowers us to support navies in delivering enhanced capability, safety, survivability, efficiency and fleet availability while minimising costs. This is achieved through the deep expertise of our people and the use of state-of-the-art facilities.

Submarine Test & Evaluation

QinetiQ is one of few companies in Australia that possesses extensive access to vital nuclear-powered submarine T&E expertise and facilities in the United Kingdom (UK). This enables the provision of advanced underwater T&E services informed by experienced practitioners. Governments, navies, shipbuilders, and regulators trust us as their adviser for mission-critical submarine solutions. QinetiQ, as a preferred partner for the UK's Submarine Delivery Agency (SDA), ensures underwater operational advantage, and the safe delivery of nuclear-powered submarines. From hydrodynamic facilities and underwater signature ranges, to propulsor design and marine structures, we assure the performance of equipment and deliver innovative solutions, creating the OQE that underpins the submarine digital thread. Our integration of advanced T&E capabilities, extensive knowledge, and continuous innovation solidifies our position as a trusted partner in this domain.

The ability to accurately test and evaluate a submarine's stealth characteristics, and therefore its ability to avoid detection by the adversary, is a critical factor in submarine design and through-life mission performance. Delivering the **capability assurance** necessary prior to the operational deployment of nuclear-powered submarines is only achieved through the provision of specialised underwater T&E services, supported by dedicated facilities, systems, and expert staff.

QinetiQ's renewed ten-year Maritime Strategic Capability Agreement (MSCA) contract with the SDA plays a pivotal role in designing the SSN-AUKUS nuclear-powered submarine. Drawing on a team of over 700 maritime experts, we address submarine challenges, and support the Continuous At-Sea Deterrent (CASD). Our expertise spans physics, physiology, acoustics, atmospheres, structures, survivability, and more, providing long-term project support, innovative system solutions, and rapid operational response. We sustain present and future nuclear-powered submarines through areas like manoeuvrability, propulsor design, stealth assessment, shock testing, and atmosphere modelling. QinetiQ T&E practitioners conduct sea trials, safety assessments, clinical and operational diving support, and contribute to safety cases and forensic investigations. Our state-of-the-art facilities, and wide range of tools and capabilities shown below at Figure 3, ensure optimal and cost-effective delivery of T&E in support of nuclear-powered submarines and the SDA.

QinetiQ's operation of the UK Ministry of Defence's (MoD) British Underwater Test and Evaluation Centre (BUTEC) under a 25-year contract underscores the UK Government's confidence in our expertise. BUTEC is a specialised facility dedicated to the T&E of underwater systems and technologies.

BUTEC offers a controlled environment for conducting trials and assessments, including underwater tracking, magnetic and acoustic signature measurement and analysis, and torpedo testing. This facility plays an essential role in establishing a submarine's safe operating envelope (SOE), advancing underwater warfare capabilities, including Unmanned Underwater Vehicles (UUVs), and ensuring the optimal performance of naval systems in real-world underwater conditions.

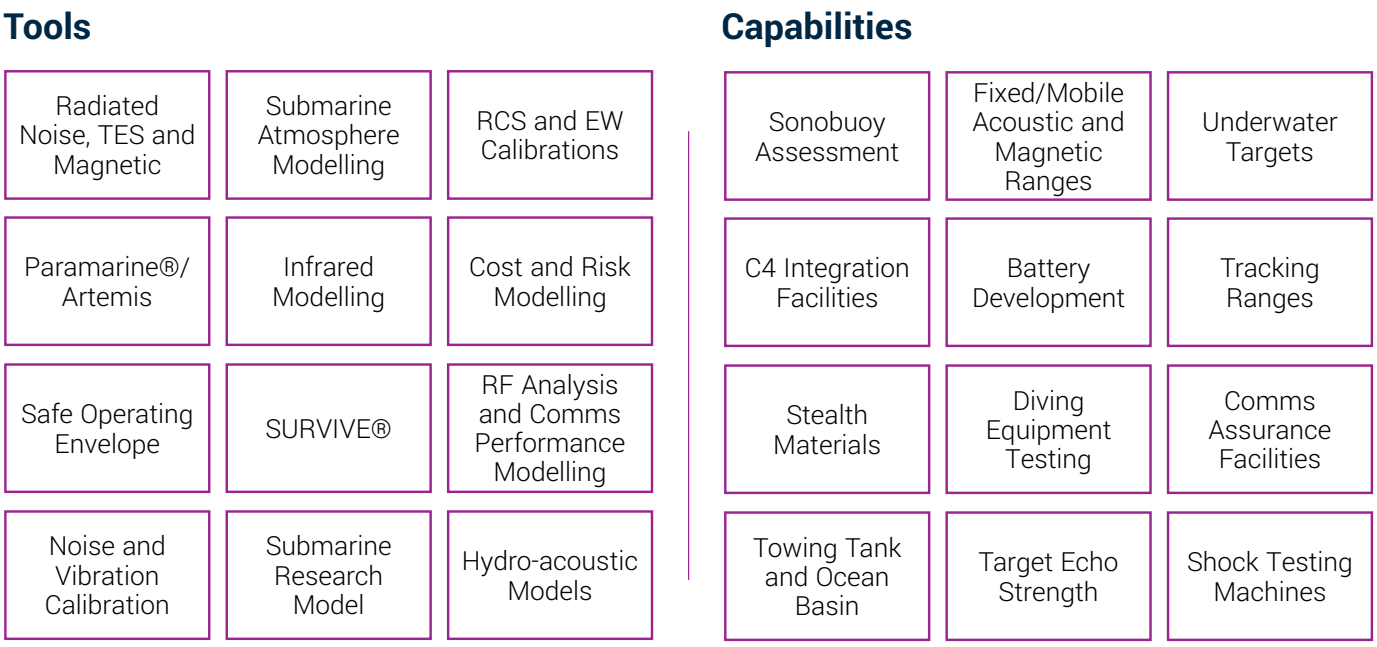


Figure 3: QinetiQ Tools and Capabilities in Support of Nuclear-Powered Submarines and the SDA.

Surface Ship Test & Evaluation

Through the Naval Combat Systems Integration Support Service (NCSISS) contract, QinetiQ works in collaboration with BAE and the UK MoD Defence Equipment & Support (DE&S) body to provide comprehensive T&E support to surface ships. The NCSISS provides expertise in areas such as combat system integration, naval architecture, crew training, and operational evaluation. Leveraging the digital thread, we conduct evaluations, trials, and testing to optimise performance at the agreed minimum viable capability, ensure safety, and enhance operational effectiveness.

This capability is at QinetiQ's NMSC LBTS where our team of specialists undertake the design, integration, test, evaluation, and frontline support of the complex, software-intensive systems that deliver the Royal Navy's (RN) fighting capability. Moreover, this capability enables the coordination of distributed and federated activities, and operational analysis involving ships, LBTS, and weapons ranges, through events such as Exercise Formidable Shield. Additionally, the NMSC LBTS features an Innovation and Collaboration Hub (ICH) aimed at fostering partnerships between QinetiQ, other tenants, and small and medium-sized enterprises (SMEs) to accelerate the advancement of cutting-edge capabilities.

QinetiQ's well-established global reachback to advanced levels of expertise, along with long-term secondments for Australian QinetiQ staff (and potentially Defence), will be instrumental in ensuring the successful delivery of a fully integrated and more capable ADF described as the Integrated Force. Within this framework, RAN combat systems will serve as integral nodes inside complex enterprise-wide sensor-to-shooter networks, including the enhanced, all-domain, integrated air and missile defence capability, land-based maritime strike, and a fully enabled, integrated amphibious-capable combined-arms land system. In due course, AI-powered kill-webs will harness inputs from various maritime, air, land, and space-based assets. To meet these requirements, it is vital to incorporate the enterprise-wide digital thread concept into the design and testing of present and future RAN combat systems.

QinetiQ has developed substantial expertise and experience in delivering **capability assurance** through its management and operation of the NMSC LBTS. This presents a significant opportunity to acquire lessons-learned and valuable insights for the RAN as it establishes its own Maritime Combat System Integration Centre (MCSIC) LBTS.

C6ISR Test & Evaluation

Testing, design, integration, and support services for C6ISR (Command, Control, Communications, Computers, Cyber Defence, Combat Systems, and Intelligence, Surveillance, and Reconnaissance) are crucial for maintaining the safe and efficient operation of complex enterprise-wide systems in rapidly changing environments.

QinetiQ's independent T&E services provides solutions across the full C6ISR life cycle, including radar and electro-optic sensing systems, command and control centres, secure and resilient infrastructures, and simulation and training. C6ISR systems are developed and tested at our purpose-built LBTS facility, in a secure environment that allows unencumbered radio frequency (RF) transmissions while protecting intellectual property.

System Operation Performance: At our NMSC LBTS, we provide essential support for the operational performance of C6ISR systems integrated into naval combat systems. Leveraging our specialised expertise, we ensure that the systems meet the operational requirements of in-service naval platforms. This encompasses tasks such as enabling and ensuring secure networking and interoperability, fine-tuning sensors, optimising combat system performance, assisting in fault-finding activities, and delivering operational performance training.

Our efforts result in the enhancement of C6ISR systems, optimising their operational performance and effectively managing system evolution, upgrades, and future-proofing measures.

System Concept Development: We reduce procurement costs and timescales in the development, definition of requirements, and design of new, secure C6ISR systems. From tender development during the acquisition phase, through to design assessment and integration, we resolve technical system issues using the deep knowledge accumulated over many years of supporting concept development efforts.

In close collaboration with navies, we formulate the conceptual design architecture essential for the procurement, integration, and delivery of fit-for-purpose C6ISR systems. Our capabilities extend beyond existing systems, to encompass the development, design, and demonstration of concepts for future naval systems with a view to interchangeability and interoperability demands with Partners and Allies' systems (e.g. NATO).

System Integration: We support the integration, installation, commissioning, and acceptance of C6ISR systems. We understand that integrating systems can be a more time-consuming and costly activity than anticipated – especially if the system architecture and design is not managed and evaluated holistically.

Drawing on our deep knowledge, experience, specialist tools, and facilities, we reduce the risk of cost escalation by delivering secure and resilient system architecture design and development, advice and guidance on systems integration, end-to-end system validation, and integration of emergent technology throughout the capability's life cycle (evergreening).

System Evaluation: Selecting C6ISR systems that meet the needs of frontline users requires the ability to make decisions, based on the OQE of a system's functionality, performance, and capability.

Utilising the digital thread, we rigorously assess overall performance, and highlight novel concepts and designs for C6ISR systems. Our assessments, advice, and guidance supply navies with OQE-driven evaluations, enabling the development of secure and capable naval combat systems.

Australia has a valuable opportunity to draw upon QinetiQ's experience gained as the RN's partner responsible for ensuring the **capability assurance** of C6ISR systems. This knowledge provides insights not only into what to do but also into the 'know-how' and 'know-why,' as well as what to avoid.

Enhancing Australian Capabilities

QinetiQ Australia is proud to be a trusted sovereign industry partner of the ADF. Our collaborative, OEM-agnostic approach assures the delivery of tailored, optimised solutions without bias. With independence at our core, we supply niche skills to other industry partners through our Integrated Engineering Services (IES) contract to deliver cutting-edge solutions for Defence. We do this by embedding within customer sites to design, build, deliver, and assure critical T&E capabilities.

As our sovereign T&E workforce continues to expand, we take pride in advancing Australia's T&E capability. We achieve this by tapping into our vast global expertise and upskilling our local workforce in various T&E domains, including maritime, land, and air range operations, guided weapon and explosive ordnance, trials design, and data analytics. Our tailored skills development program, part of our T&E Sovereign Skills Program (TESSP) initiative, focuses on building Australian T&E skills through training, mentoring, and coaching Australian QinetiQ staff. This program leverages our extensive experience through dedicated secondments with T&E expert practitioners, access to sophisticated T&E tools and processes, and placements at advanced and well-established T&E facilities such as BUTEC, Haslar, and the NMSC LBTS.

Commitment to Success

Outpacing the adversary through a comprehensive life cycle-centric T&E model delivering independent **capability assurance** will be a complex undertaking given the ever-increasing speed of change in platforms, systems, and weapons. Further complexity will be introduced through distributed and federated architectures, the need to contribute to combined and allied operations, while being interchangeable and interoperable with Partners and Allies – particularly our AUKUS Partners.

Ensuring confidence to meet these challenges necessitates swiftly accessing the expertise of experienced T&E practitioners through innovative commercial models emphasising agility and speed. Rapidly capitalising on QinetiQ's knowledge, established T&E tools, and facilities like those at BUTEC, Haslar, and the NMSC LBTS, while embracing cutting-edge concepts like the digital thread and life cycle-centric strategies for T&E, will be essential if the ADF is to deliver the Integrated Force.

Crucially, as the RAN continues to be transformed with nuclear-powered submarines and an enhanced lethality surface combatant fleet, the experience of the UK MoD highlights the need to establish more advanced and deployable T&E capabilities, akin to those used by the RN and SDA. The capabilities, expertise, and experience described here provide meaningful insights into the complexity and lengthy delivery schedules incumbent when delivering new and sophisticated T&E capabilities. Acquisition programs for T&E facilities supporting major maritime acquisitions must commence soon to ensure commissioning prior to the arrival of platforms such as nuclear-powered submarines.

QinetiQ stands ready to offer unwavering support to Defence in the formation of a comprehensive life cycle-centric T&E model, establishing new T&E facilities, developing a skilled T&E workforce, and delivering independent and cutting-edge **capability assurance**.

Delivering the
capability assurance
underpinning a fully integrated
and lethal ADF

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