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**Statement of Requirement for the R-Cloud Above Water Systems Strategic Capability**

**Introduction:**

The Defence Science and Technology Laboratory (Dstl), which is part of the UK Ministry of Defence (MOD), is refreshing its commercial agreement for Science and Technology (S&T) research contracts, known as R-Cloud (Research Cloud).
MOD places extensive fundamental, experimental and applied research with industry and academic suppliers and wants to broaden access for this supply base, reducing the cost of trading with MOD and enabling agile contracting. R-Cloud complements MOD's other contracting mechanisms and academic and industry suppliers of S&T research are now invited to apply to join MOD's research supplier community within the Above Water Systems Strategic Capability.

This statement of requirement relates to suppliers joining R-Cloud within the Above Water Systems capability area. R-Cloud provides a low barrier to entry for potential suppliers and offers direct access to MOD's current and future research requirements. Academic and industrial suppliers of Above Water Systems research are invited to apply to R-Cloud if you are a supplier of Science and Technology Research in this area.

Above Water Systems encompasses a broad range of technical areas, these are summarised here:


| STRATEGIC CAPABILITIES | CAPABILITY ELEMENTS | DEFINITIONS |
|---|---|---|
| Systems | | The Systems capability focuses on the application of systems engineering approaches to major platforms and complex systems, enabling the provision of advice and the necessary evidence base to support decision making and includes highly specialist services in subjects including SQEP expertise, for example advice on airworthiness matters. In addition, this capability supports the planning, analysis, organisation and integration of Defence and Security capabilities for existing and new systems into a system of systems capability. |
| | Systems Integration | S&T required to physically integrate technologies, systems (mission systems, combat systems etc.), propulsion systems and weapon integration onto platforms. Includes specifying the requirements for systems to be integrated and release to service support (e.g. test, evaluation, risk assessment and certification) of integrated systems on the platform, as a system of systems. |
| | Concepts and Design | S&T to establish the requirement for a platform, the required specifications, concept design and design finalisation. Includes aerodynamics and fluid dynamics and other fundamental S&T to support platform design. Includes development of generic platform concepts of operations and concepts of use. Includes S&T to integrate the platform into force structures and any supporting infrastructure requirements. |
| | Performance and Optimisation | S&T to understand, test and evaluate the performance of platforms and to optimise platform performance for specific or multiple roles, including in an operational context. Includes the development and application of effectiveness metrics and the means to simulate and measure these for platforms. Identifies concepts, restraints and trade-offs to provide platform performance options. |


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|---|---|---|
| | Information Architectures and Connectivity | Systems engineering that enables platform systems to communicate and perform as a system of systems. Includes the development and implementation of common information architectures, and implementation of machine-machine and human-machine interfaces. Includes S&T to support safety cases and certification for platform software. Includes mission system architectures. |
| | Abovewater Systems | Abovewater Systems delivers the capabilities for the development, evaluation and demonstration of systems and concepts in the Abovewater domain. It links the broader S&T and systems capabilities to the Abovewater domain by providing the expertise to ensure the S&T is exploitable and relevant to this environment. |


**Statement of Requirement:**

**All of our systems Strategic Capabilities should consider Cross-Cutting, Underpinning Approaches**

## SYSTEMS APPROACHES

MOD applies Systems Approaches across the breadth of its S&T activity and a recent and continuing trend is for the analysis of organisations that are involved with the development of military capability, as well as the processes they use. For example, Dstl is leading research into the formulation of requirements which will be embodied into best practice on the MOD Acquisition Operating Framework (AOF). MOD also anticipates more work on enterprise architecting in connection with the SOSA and a continued interest in Open Systems as part of a package of measures to reduce the cost of defence. The capability sought is that of experienced systems practitioners who are responsive, flexible and capable of working at the systems and system-of-systems level.

MOD uses the term System Approaches to cover the totality of concepts including Systems Engineering, Systems Thinking and Systems Analysis. At the generic level (i.e. including organisations, processes and capability engineering), the following themes are in scope for R-Cloud:

- Open and modular systems;
- Defence standards including interoperability;
- Requirement setting;
- Requirement management;
- Requirement engineering (also referred to as requirement analysis);
- Systems thinking methodologies:
  - Quantitative;
  - Qualitative; and
  - Semi-quantitative.
- Systems engineering foundations:
  - Systems science;
  - Complexity theory; and
  - Network theory.

MOD also uses the term Systems of Systems Approach (SOSA) to cover the acquisition and management of capability at the enterprise level. It is underpinned by many of the SE principles for which additional research has been described already. Additional research themes appertaining to SOSA are:

- Portfolio, Programme and Project Management (P3M);
- Change management;
- Risk;
- Defence Lines of Development (DLoD) coherence; and
- Enterprise architecting.

Additional systems related issues which are enablers for platform systems include:

- System reliability and maintainability;
- System health monitoring;
- Safety systems;


- Security systems;
- Asset management and usage monitoring; and
- Energy and power sources and management.

## DEFENCE ARCHITECTURES

Defence architectures undertake the development of operational, system and technical architectures to advance enterprise-wide interoperability. They provide:

- Enterprise architecture methods and tools;
- Information systems interoperability advice;
- Enterprise architecture;
- Solution architecture;
- Information architecture; and
- Business architecture and process modelling.

## INFORMATION & INTELLIGENCE SYSTEMS ENGINEERING

System Engineering skills need to be applied to both MOD's initial thinking about new capabilities as well as upgrading current capabilities. These capabilities are increasingly based on new and legacy systems to form an ever evolving system of systems or enterprise. Specific areas of interest are covered below (from the INCOSE Handbook):

- Systems Thinking:
  - Systems Concepts;
  - Super-system Capability Issues; and
  - Enterprise and Technology Environment.
- Holistic Lifecycle view:
  - Determine and Manage Stakeholder Requirements;
  - System Design:
    - Architectural Design;
    - Concept Generation;
    - Design for operation;
    - Functional Analysis;
    - Interface Management;
    - Maintaining Design Integrity;
    - Modelling and Simulation;
    - Select Preferred Solution; and
    - System Robustness.
  - Systems Integration and Verification;
  - Validation; and
  - Transition to Operations.
- Systems Engineering Management:
  - Concurrent Engineering;
  - Enterprise Integration;
  - Integration of Specialisms;
  - Lifecycle Process Definition; and
  - Planning, Monitoring and Controlling.


## SOFTWARE SYSTEMS ENGINEERING

Software and Systems Dependability provides cross-domain through-life expertise to MOD on the engineering and assurance of dependable, software-intensive, military systems and whole life-cycle technical support to acquisition projects. The current portfolio of multi-platform support across Air, Land and Sea domains is expected to continue with the addition of targeted support to the Successor nuclear submarine programme as a holistic enterprise. Additionally the requirement for Suitably Qualified and Experienced Personnel (SQEP) software specialists (including practitioners) is expected to increase across the whole portfolio, starting in the Airworthiness domain. It provides:

- Safety policy development and advice;
- Military air regulation and certification;
- Safety case development and assessment;
- Systems safety assessments focussing on the software contribution;
- Software assurance; and
- High integrity hardware and software research and development.

## NAVIGATION SYSTEMS

To enable fundamental research, advice, experimentation, trials, modelling and simulation to support the development of both satellite and non-satellite based navigation systems. Focusing on the on the following areas:

- Antenna technology including innovative design for challenging platform and system integration;
- Platform and system specific systems integration;
- Alternatives to satellite based navigation, for example:
  - Visual navigation;
  - Quantum technology;
  - Signals of opportunity;
  - Optical flow;
  - IMUs; and
  - Non GNSS satellite navigation.
- Advanced Multi-sensor navigation system integration;
- Development of multi-frequency navigation receiver technology;
- Low Size, Weight and Power (SWaP) design solutions for navigation systems;
- Re-use of existing platform and system sensors (for example Radar Warning Receivers) to augment primary navigation system.

## MARITIME SYSTEMS ENGINEERING & INTEGRATION

Due to the specialised nature of many aspects of Maritime Systems Engineering and Integration, Research and Project Support activities will be serviced generally by a range of specialised contractual frameworks. However, this may be supplemented by the R-Cloud requirements as set out in the themes below:

- Maritime Trials Support;
- Sonar Systems;
- Mine Warfare Systems;
- Maritime Geospatial Intelligence;
- Maritime Combat Systems, Situation Awareness and Decision Aids;
- Diving Technology;


- In-water Weapons;
- Maritime Unmanned Vehicle Systems; and
- Marine Engineering and Sea-Based Platforms.

## MARITIME TRIALS SUPPORT

- Provision, operation and maintenance of small craft for trials, (both surface and Underwater (UW) craft, manned and unmanned);
- Instrumentation of small surface craft for trials, (weapons trials, Radar Cross Section (RCS) measurements); and
- Configuration of small surface craft as unmanned vessel for trials.

## SONAR SYSTEMS

- System Design;
- Transducer design;
- Vector sensor design;
- New transducers for mine countermeasures;
- Diver systems, (e.g. hand held sonar) for mine countermeasures;
- Sonar waveforms and data processing;
- Thin flank array processing;
- Submarine sonar 2D processing;
- Very high data rate processing, (e.g. MFBSA);
- Sonobuoy system design;
- Dipping sonar target detection classification and tracking;
- Next Generation towed arrays;
- Next generation hull arrays; and
- UUV hull arrays.

## MINE WARFARE SYSTEMS

- Develop and validate novel and advanced mine sweeping system concepts and technologies;
- Development and demonstration of mine countermeasures concepts and techniques, (e.g. use of unmanned systems); and
- Software Model development and maintenance to support assessment of UK capability against the developing mine threat.

## MARITIME GEOSPATIAL INTELLIGENCE

- Requirements for maritime geospatial information, associated information flows and non-military sources of information;
- Sensors, techniques and systems for maritime geospatial information acquisition;
- Acoustic underwater environment modelling;
- Modelling of maritime geospatial information; and
- Ocean Bathymetry.


## MARITIME COMBAT SYSTEMS, SITUATION AWARENESS AND DECISION AIDS

- Command decision support / effectiveness aids, (Submarines and Ships);
- New displays for submarine Situational Awareness (SA);
- Future combat system architectures to support new ways of working;
- Visualisation, simulation and emulation of command space concepts, information flows, etc;
- System demonstration of open architecture based combat system demonstrator, in accordance with MOSA principles;
- Development of metrics for AW SA;
- Development and modelling of techniques to facilitate TEWA (Target Evaluation and Weapon Allocation); and
- Development of command decision aids software integrated within OACS (Open Architectures Combat System).

## DIVING TECHNOLOGY

- Research, development and demonstration of novel diving technology and systems.

## IN-WATER WEAPONS

- Future weapon technology studies;
- Weapon / submarine platform Integration, stowage and launch;
- Ultra-lightweight torpedo concepts, feasibility and technology options; and
- In-water weapon concept performance and effectiveness modelling.

## MARITIME UNMANNED VEHICLE SYSTEMS

- Command and Control System concepts and demonstration for UxVs;
- Development and demonstration of UAV systems, (incl. sensors and algorithms, to support automated operation);
- Novel autonomous vehicle concept development, (e.g. Long Endurance Maritime USV (LEMUSV));
- Rotory Wing UAS Concept Capability Demonstration, (safety/Airworthiness, Capability Development and demonstration);
- USV launch and recovery concepts; and
- USV launch and recovery demonstration.

## MARINE ENGINEERING AND SEA-BASED PLATFORMS

- Development of outline designs for ships to be considered in fleet mix analysis;
- Design of innovative solutions for Landing Craft replacement and cost effective enhancements to LCU Mk10;
- Design concepts for next generation lightweight propulsors for submarines;
- Advanced propulsion motor technologies;
- Demonstration of energy storage technology (20MJ);
- Electric ship architecture modelling;
- Development of advanced hull materials;
- Design and evaluation of hydrodynamic metamaterials;


- Evaluation of acoustic metamaterials; and
- Corrosion control of Naval Shipping.