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Statement of Requirement for the R-Cloud Weapons Strategic Capability

Introduction

The Defence Science and Technology Laboratory (Dstl), part of the National Armaments Director (NAD) Group within the UK's Ministry of Defence (MOD), is refreshing its commercial agreement for Science and Technology (S&T) research contracts, known as Research Cloud (R-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 R-Cloud supplier community within the Weapons Strategic Capability.

This Statement of Requirement (SoR) relates to suppliers joining R-Cloud within the Weapons 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 weapons research are invited to apply to R-Cloud if you are a supplier of Science and Technology (S&T) research in this area. R-Cloud's weapons capability area encompasses a broad range of technical domains, not limited to but including:

Complex Weapons

The provision of integrated advice, analysis, assessment and research in air defence, strike, maritime, land and hypersonic weapon systems including weapons integration. S&T covering the system and sub-system elements of complex weapons systems including airframe; aerodynamics; seekers; Guidance, Navigation and Control (GNC); thermal management; warhead design; warhead effects and lethality; propulsion technologies; and Size, Weight and Power (SWaP) considerations. These requirements cover the performance evaluation and development of current and future concepts.

Directed Energy Weapons

The provision of integrated advice, analysis, assessment and research in Directed Energy Weapon (DEW) systems including weapons integration. S&T pertaining to Laser DEW (LDEW), Radio Frequency (RF) DEW and new and innovative DEW technologies. S&T undertaken in this domain will include investment in low Technology Readiness Level (TRL) technologies that could form the basis of generation-after-next DEW systems that can ensure the UK can maintain technology advantage as other nations also deploy such systems. It will focus on increasing the range of operation, variety of effects (for example, novel RF or other



laser bands power), aimpoint selection and tracking and improving SWaP performance (for example, to support airborne options) and will also consider countermeasures to DEW.

Tactical Effects Technologies

The provision of integrated advice, analysis, assessment and research in tactical effects technologies and systems including weapons integration. S&T pertaining to the development of driving technologies associated with small arms, medium-calibre tube launched artillery, new lethal natures, small tactical effects drones and other remote systems.

Statement of Requirement

This SoR provides a top-level description of the overarching research requirements for the Weapons Strategic Capability. It encompasses all the domains detailed above.

Maritime Surface Warfare

This requirement seeks to address the underpinning evidence to support robust requirements setting and sub-system technologies appropriate for current and future Maritime Surface Warfare (MSW) weapons, with a focus on understanding the critical system design drivers. This will necessitate activities to maintain and develop the tools and experience to undertake performance analysis of MSW weapons. The scope of MSW topics includes, but is not limited to, the following:

- Operational analysis, capability investigations and technical research studies to define future capability requirements.
- Characterisation of current and future maritime target sets.
- Novel guidance laws to intercept very fast and / or manoeuvring targets.
- Weapon requirement and concept generation.
- Sub-system performance analysis and design drivers.
- Seeker technologies appropriate for the target set and environmental conditions.
 - Including the implication of each of the seeker technologies on the system.
- Radar altimeter (Radalt) technologies appropriate for the target set and environmental conditions.
 - Including the implication of each of the Radalt technologies on the system.
- Warhead technologies and the performance of both optimised anti-surface warhead concepts as well as off-the-shelf / bespoke design concepts or multiple impacts from smaller payloads.
- Investigation of optimal strategies to overcome target defensive systems.

This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to MSW systems.
- Applied research into component, sub-system and system-level aspects of MSW systems.
- Software and hardware tools that could be used in simulation and experimentation.



- Upgrades for current UK MOD platforms and systems.

Air Defence

This requirement seeks to address the underpinning evidence to support robust capability requirements setting for future air defence weapons. In particular, the need to examine coherency across the Air-Based Air Defence (ABAD), Ground-Based Air Defence (GBAD) and Maritime Force Air Defence (MFAD) domains to identify opportunities for requirements commonality and multi-application of system technologies.

The combination of capability requirements in conjunction with necessary technology studies, will aim to provide an understanding of the key operational capability and system design drivers that would subsequently inform associated weapon project concept and assessment phase activities. It will also include activity to maintain and develop the tools and experience to undertake performance analysis of air defence effects. The scope of coverage of topics related to air defence includes, but is not limited to, the following:

- Operational analysis, capability investigations and technical research studies to defined future capability requirements.
- Characterisation of current and future threats.
- Maintaining and enhancing the tools to model and assess future threats and the ability to counter them.
- Sub-system performance analysis and design drivers.
- Infrared (IR) and RF seeker design and associated processing technologies.
- Optimisation of guidance and fuzing integration.
- Lethal payload technologies.
- Countermeasure technologies.
- Propulsion and control technologies.
- Synthetic scene generation and countermeasure modelling.
- Techniques and algorithms for supporting optimised air defence system engagement including command and control.
- Cost-effectiveness studies.
- Missile aerodynamics, guidance and control optimisation.
- Maintaining the ability to provide intelligent customer status.

This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to air defence systems.
- Applied research into component, sub-system and system level aspects of air defence systems.
- Software and hardware tools that could be used in simulation and experimentation.
- Optimisation of current systems.



Strike Weapons

This activity seeks to address the future weapon requirements and sub-system technologies appropriate to provide air platform-delivered capability against future ground target sets. A key outcome of the activity is to provide strike weapons capability-based advice to key MOD stakeholders, predominantly Air Command. The activity is fundamental in developing and maintaining strike weapons Suitably Qualified and Experienced Personnel (SQEP), toolsets and capabilities essential to providing advice to MOD for weapons approvals and decisions. The scope of coverage of topics related to strike weapons includes, but is not limited to, the following:

- Scenario and target characterisation.
- Mobile target lethality modelling.
- Development of hard target lethality capability in line with the future strike weapons requirements.
- Requirement and concept generation.
- Conducting trials on fundamental blast and fragmentation effects associated with strike weapons to advance understanding in priority areas and to develop Fast Running Engineering Modules (FREMs). This may include, but is not limited to:
 - Basic research into processes, techniques and technologies that may be of use to strike weapons.
 - Applied research into component, sub-system and system level aspects of strike weapons.
 - Software and hardware tools that could be used in simulation and experimentation.
 - Upgrades for current UK MOD platforms and systems.

Land Weapons

This activity seeks to address the underpinning evidence to support robust requirements setting appropriate to provide capability against ground targets from land forces. In particular, we need to deliver robust requirements, an understanding of the critical system design drivers and early system design to deliver operational advantage. The scope of coverage of topics related to land weapons includes, but is not limited to, the following:

- Dismounted Close Combat (DCC) and Mounted Close Combat (MCC) future complex weapons systems:
 - Identification of lethal mechanism disruptive technologies.
 - Threat characterisation.
 - System trade studies.
 - Characterisation of future armoured targets.
 - Implications on MCC platforms of the DCC capability mix.
- Indirect Fires (IF) systems:
 - Understanding the target set.
 - Networked architectures and targeting chain.
 - Range and time sensitivity requirements.
 - Investigate performance of candidate technologies.
 - Gun systems technologies.



- Performance predictions and independent assessment of future medium-calibre ballistic systems:
 - Gun heating.
 - Internal ballistics.
 - Launcher dynamics.
 - Ballistic flight of rounds including course correction.
- Tactical Effects Technologies
 - This may include, but is not limited to:
 - Basic research into processes, techniques and technologies of use to conventional and novel land weapons systems.
 - Applied research into component, sub-system and system level aspects of conventional and novel land weapons systems.
 - Bespoke conventional and novel tactical weapons (ranging from small arms to tactical uncrewed platforms) system and sub-system development.
 - Broader tactical system enablers including architectures and weapon system messaging sets (e.g. Assured Intent Messaging).
 - Exploitation and development of software and hardware tools to enhance the performance of tactical effects systems.
 - Software and hardware tools that could be used in simulation and experimentation.
 - Upgrades for current UK MOD platforms and systems.

Hypersonic Weapons

This activity seeks to address the significant opportunities available to advance the UK's understanding and ability to field hypersonic weapons systems. In particular, it will facilitate the development and demonstration of technologies deemed enabling to the development of long-range, responsive, precision strike and / or survivable, penetrating highly defended targets capabilities. The scope of coverage of topics related to hypersonic weapons includes, but is not limited to the following:

- Highly coupled adaptive GNC and terminal seeker.
- Anti-jam inertial navigation systems plus environmentally stable, integrated multi-mode sensor suites.
- Novel and alternative non-Global Navigation Satellite System (GNSS) navigation techniques and means.
- Data fusion and target acquisition and tracking processes.
- Ordnance and precision effects.
 - Highly energetic and environmentally tolerant explosives.
 - Tailored directional blast.
 - Height of burst fuzing.
- Airframe structures and materials
 - High temperature, moderate cost, structurally integrated airframe and apertures.
 - Integral thermal management concepts.
- Air vehicle systems, avionics and thermal management.



- High speed tactical propulsion.
- Time sensitive target engagements.
- Enhanced survivability for both sensing and missile platforms.
- Ultra-lightweight heat management systems.

This may include, but is not limited to:

- Enhancing the UK's understanding of the specific sub-system challenges associated with a high-speed weapon.
- Identifying, maturing and demonstrating hardware and algorithms up to TRL3 to mitigate the challenges identified.
- Risks associated with key technology options.
- System performance modelling and simulation.
- Trajectory and parameter optimisation.
- Validation of seeker precision through real time Hardware-in-the-Loop (HWIL) simulation.
- Validation of vehicle system dynamics through moderate scale low-cost flight experiments.
- Validation of lethality through arena and live sled tests.
- Basic research into processes, techniques and technologies that may be of use to high-speed weapon systems.
- Applied research into component, sub-system and system level aspects of high-speed weapon systems.
- Software and hardware tools that could be used for the purposes of simulations and experimentation.
- Weapon survivability modelling and simulation.
- Control design tools to understand and assess the control and stability challenges of novel integrated airframe and propulsion aspects.

Laser DEW

This activity is to establish the utility of high-power, laser-based weapon systems, mature relevant technologies and establish the limitations of the approach. The aim is to inform procurement decision points in the maritime, land and air environments with regards to their utility in comparison with more conventional means; to highlight additional benefits and limitations of their use. The main emphasis is on defeat, destruction and degradation and less so on denial, i.e. dazzle. There is, therefore, a broad range of applications and hence potential solutions, specifically with regards to SWaP and performance. This will necessitate activities to maintain and develop the tools and expertise to undertake performance, effectiveness and cost analysis of LDEW as well as maintaining an awareness of the wider system issues. The scope of coverage of topics related to LDEW includes, but is not limited to, the following:

- Laser beams including their generation, combining, fine pointing and propagation under various environmental conditions.
- Power generation, storage and conditioning.
- Sensors to enable precise locating and tracking of targets and aim point maintenance under various environmental conditions.



- Target interaction including failure modes as a consequence of relevant stimuli and potential countermeasures.
- System integration including system level design, modelling and assessment.
- Command and control, including safety procedures and airspace deconfliction.
- Cost modelling.

This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to LDEW.
- Applied research into component, sub-system and system level aspects of LDEW.
- Software, and experimentation techniques and equipment that could be used to assess performance, at either a sub-system or system level.
- Operational concepts including Concepts of Employment (CONEMP) and the impact and dependencies on extant operational systems.

RF DEW

This activity is to establish the utility of high-power, RF-based weapon systems, mature relevant technologies and establish the limitations of the capability. The aim is to inform procurement decision points in the maritime, land and air environments with regards to their utility in comparison with more conventional means, to highlight additional benefits and limitations of their use. The effects required range from deter and disrupt to defeat, but with the emphasis on reducing long-term effects. There is therefore a broad range of applications and hence potential solutions, specifically with regards to SWaP and performance. This will necessitate activities to maintain and develop the tools and experience to undertake performance and cost analysis of RFDEW as well as maintaining an awareness of the wider system issues. The scope of coverage of topics related to RFDEW includes, but is not limited to, the following:

- Pulse forming networks.
- Nonlinear transmission lines.
- Antennae design.
- Power generation, storage and conditioning.
- Target interaction including failure modes as a consequence of relevant stimuli and potential countermeasures.
- System integration including system level design, modelling and assessment.
- Command and control, including safety procedures.
- Cost modelling.
- Human factors.

This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to RFDEW.
- Applied research into component, sub-system and system level aspects of RFDEW.
- Software, and experimentation techniques and equipment that could be used to assess performance, at either a sub-system or system level.
- Operational concepts including CONEMP and the impact and dependencies on extant operational systems.



DEW Futures

The requirement is to investigate new and innovative technologies that could broaden the scope and applicability of DEW. This may include, but is not limited to:

- Ultra-high intensity and extremely short pulse lasers.
- Particle beam and plasma science.
- Other emerging technologies that could offer different effects to the traditional continuous wave lasers and pulsed RF systems.