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Statement of Requirement for the R-Cloud Weapons 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 Weapons Strategic Capability.

This statement of requirement 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 Research in this area.

Weapons encompasses a broad range of technical areas, not limited to but including, Complex Weapons and Novel Weapons. An overarching view of the Weapons Strategic Capability can be found in Table 1.

Table 1: Strategic Capability Overview:

<p>Weapons</p>	<p>Weapon systems encompass a broad range of S&T capabilities that support requirements definitions, development, assessment, evaluation, testing and advice on weapons technologies and systems. It considers all aspects of the weapon engagement cycle and system integration by the assessment of operational effectiveness including effects based targeting and collateral damage. This includes expertise in support of service evaluation trials, platform/weapon integration for in-service systems and future concept development. The S&T capability elements for Weapons are complex weapons, novel weapons and effects, general munitions and non-lethal weapons.</p>
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Weapons

	Non-Lethal Weapons	S&T development of bespoke solutions that deliver proportionate "non-lethal" effects by consideration of appropriate technologies consistent with international treaties and conventions.
	General Munitions	S&T covering the system and sub-system elements of general munitions and gun systems (including munition propulsion). Notably warhead design, platform position, navigation and timing (PNT), ballistic trajectory prediction and modelling, system error budgets prediction and the aero-thermal environment. For the gun system this include; internal ballistic performance, technologies for lightweight barrels (including barrel cooling), recoil management, software and hardware components, the ability to predict and apply ballistic offsets and launch platform comms with networked assets relating to weapon and target states.
	Novel Weapons and Effects	S&T pertaining to directed energy systems that provide a kinetic effect. This covers both subsystem technologies and their integration. For laser DEW this includes; high-power, high-efficiency laser sources, power sub-systems, thermal management, beam directors and combiners, beam propagation and laser effects, and system size, weight and power (SWAP), performance and reliability. For high power RF systems this includes; power sources, micro-/millimetre wave sources, antennas, effects, system SWAP, performance and reliability. This element also covers alternative DEW technologies.
	Complex Weapons	Provision of integrated advice, analysis, assessment and research in Air Defence, Strike and Land weapon systems including weapons integration. S&T covering the system and sub-system elements of complex weapons systems namely; Air Frame, Aerodynamics, Seekers, GNC, Thermal Management, Warhead design, Warhead Effects and Lethality, Propulsion technologies, SWAP consideration. Ability to conduct performance evaluation and development of current and future concepts.

STATEMENT OF REQUIREMENT:

This Statement of Requirement provides the overarching research requirements for the Weapons Strategic Capability. It encompasses the programme areas of Maritime Surface Warfare, Strike, Air Defence, High Speed Weapons, the Land Environment and Novel Weapons.

Maritime: Scope and Activity. This requirement is in support of Maritime Surface Warfare. The requirement seeks to address the underpinning evidence to support robust requirements



setting and sub-system technologies appropriate for future Maritime Surface Warfare (MSW) weapons. With a focus on understanding the critical system design drivers associated with Initial Gate submission for the Guided Weapons. This will necessitate activity to maintain and develop the tools and experience to undertake performance analysis of MSW weapons.

1) The scope of coverage of topics related to Maritime Surface Warfare includes, but is not limited to the following:

- a) Operational Analysis, Capability investigation and Technical research studies to define future capability requirements
- b) Characterisation of current and future Maritime target sets
- c) Novel guidance laws to intercept very fast and/or manoeuvring targets
- d) Weapon requirement and concept generation
- e) Sub-system performance analysis and design drivers
- f) Seeker technologies appropriate for the target set and environmental conditions. Implication of each of the seeker technologies on the system
- g) Radalt technologies appropriate for the target set and environmental conditions. Implication of each of the Radalt technologies on the system
- h) Warhead technologies and the performance of both optimised Anti-Surface warhead concepts as well as off the shelf/Team Complex Weapons (CW) portfolio design concepts or multiple impacts from smaller payloads
- i) 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: Scope and Activity. This requirement is in support of Air Defence. The 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.

1) The scope of coverage of topics related to Countering Air Threats includes, but is not limited to the following:

- a. Operational Analysis, Capability investigation and Technical research studies to defined future capability requirements



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- b. Characterisation of current and future threats
- c. Maintaining and enhancing the tools to model and assess future threats and the ability to counter them
- d. Sub-system performance analysis and design drivers
- e. IR and RF seeker design and associated processing technologies
- f. Optimisation of guidance and fuzing integration
- g. Lethal payload technologies
- h. Countermeasure technologies
- i. Propulsion and control technologies
- j. Synthetic scene generation and Countermeasure modelling
- k. Techniques and algorithms for supporting optimised Air Defence system engagement, command & control
- l. Cost-effectiveness studies
- m. Missile aerodynamics, guidance and control optimisation
- n. 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 Countering Air Threats
- Applied research into component, sub-system and system level aspects of Countering Air Threats
- Software and hardware tools that could be used in simulation and experimentation
- Optimisation of current systems.

Strike Weapons: Scope and Activity. This requirement is in support of Strike Weapons. The 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, but also includes the replacement for Attack Helicopter Weapons Capability. The activity is fundamental in developing and maintaining strike weapons SQEP, toolsets and capabilities essential to providing advice to MOD for weapons approvals and decisions.

1) **The scope of coverage of topics related to Strike Weapons Effectiveness (SWE) includes, but is not limited to the following:**

- a. Scenario and Target characterisation
- b. Mobile Target lethality modelling
- c. Development of Hard Target lethality capability in line with the future Strike Weapons requirements
- d. Requirement and concept generation
- e. 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) for key models such as PALETTE and TARVIEW.



This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to SWE.
- Applied research into component, sub-system and system level aspects of SWE.
- Software and hardware tools that could be used in experiments
- Upgrades for current UK MOD platforms and systems.

Land Weapons: Scope and Activity. This requirement is in support of the Land Environment. The requirement 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. Initial focus in this area is on the replacement for Anti-Tank weapons and Indirect Fires Systems (Javelin replacement and Direct Fire Rocket System). This also includes activity to maintain and develop the tools and experience to undertake performance analysis of land delivered ground effects and Gun Ballistic Systems.

1) The scope of coverage of topics related to Offensive Weapons Analysis includes, but is not limited to the following:

- a. Dismounted Close Combat (DCC) and Mounted Close Combat (MCC) future Complex Weapons (CW) Systems
 - i. Identification of lethal mechanism Disruptive Technologies
 - ii. Threat characterisation
 - iii. System trade studies
 - iv. Characterisation of future Armoured targets
 - v. Implications on MCC platforms of the DCC capability mix
- b. Indirect Fires (IF) Systems
 - i. Understanding the target set
 - ii. Networked Architectures and targeting chain
 - iii. Range and time sensitivity requirements
 - iv. Investigate performance of candidate technologies
- c. Gun Systems Technologies
 - i. Performance predictions and independent assessment of future Medium Calibre Ballistic Systems
 - ii. Gun heating
 - iii. Internal Ballistics
 - iv. Launcher dynamics
 - v. Ballistic flight of rounds (including course correction)

This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to Urban Weapon systems



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- Applied research into component, sub-system and system level aspects of Urban Weapon systems
- Software and hardware tools that could be used in experiments
- Upgrades for current UK MOD platforms and systems.

High Speed Weapons Disruptive Capability: Scope and Activity. This is a cross-cutting Conventional Weapons Programme requirement across a number of areas that seeks to address the significant opportunities available to advance the UK's understanding and ability to field a High Speed Complex Weapon. 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 ISR capabilities.

1) **The scope of coverage of topics related to High Speed Weapons includes, but is not limited to the following:**

- a. Highly Coupled Adaptive Guidance, Control, and Terminal Seeker
- b. Anti-jam Inertial Navigation Systems; plus environmentally stable, integrated multimode sensor suite.
- c. Novel and alternative non-GNSS navigation techniques and means.
- d. Data fusion and target acquisition and tracking processes.
- e. Ordnance and Precision Effects: highly energetic and environmentally tolerant explosives; tailored directional blast; Height of Burst fuzing
- f. Airframe Structures and Materials: high temperature, moderate cost, structurally integrated airframe and apertures; integral thermal management concepts
- g. Air Vehicle Systems, Avionics, and Thermal Management
- h. High Speed Tactical Propulsion
- i. Time sensitive target engagements
- j. Enhanced survivability for both sensing and missile platforms
- k. Ultra-lightweight heat management systems

This may include, but is not limited to:

- Enhancing the UK 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.
- Seekers: validate precision through real time Hardware-in-the-Loop (HWIL) simulation
- Vehicles: validate vehicle system dynamics through moderate scale low cost flight experiments
- Ordnance: validate 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.



Weapons

- Red vs. Blue modelling and simulation.
- Control design tools to understand and assess the control and stability challenges of novel integrated airframe and propulsion aspects.

Novel Propellants Disruptive Capability: Scope and Activity. This is a cross-cutting Conventional Weapons Programme requirement which seeks to address the development of game-changing rocket technology for the 50kg Family of Weapons to:

- Improve missile system performance & safety
- Reduce whole life cost
- Improve missile system ability to survive stretching environments (temperature range, vibration, etc.)
- Remove dependence on ITAR (International Traffic in Arms Regulations) and address REACH (Registration, Evaluation, Authorisation & restriction of Chemicals) requirements
- Sustain UK rocket motor design and manufacturing capability

1) **The scope of coverage of topics related to Novel Propellants includes, but is not limited to, the following:**

- Identification of cost savings measures in terms of manufacturing and qualification costs
- Assessment of Composite materials and their ability to reduce mass by 20% in rocket casing
- Development of new insulation and new polymeric binders to reduce the threat of obsolescence
- Performance and assessment of propellants in terms of surviving stretching environmental conditions (temperature range, vibration)

This may include, but is not limited to:

- Demonstrating a Smokeless Composite Propellant designed to meet the propellant demands for approx. 80% of all the UK Solid Rocket Motor applications
- Revolutionising energetics production through the use of Resonant Acoustic Mixing
- Basic research into processes, techniques and technologies that may be of use to Novel Propellants
- Applied research into component, sub-system and system level aspects of Novel Propellants
- Software and hardware tools that could be used in experiments
- Upgrades for current UK MOD platforms and systems

Novel Weapons.

Laser DEW. The requirement 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 size and performance. This will



necessitate activity to maintain and develop the tools and expertise to undertake performance, effectiveness and cost analysis of Laser Directed Energy Weapons (LDEW) as well as maintaining an awareness of the wider system issues.

1) The scope of coverage of topics related to LDEW includes, but is not limited to, the following:

- a. Laser beams: their generation, combining, fine pointing and propagation under various environmental conditions;
- b. Power generation, storage and conditioning;
- c. Sensors to enable precise locating and tracking of targets, and aim point maintenance under various environmental conditions;
- d. Target interaction including failure modes as a consequence of relevant stimuli and potential countermeasures;
- e. System integration including system level design, modelling and assessment;
- f. Command and control, including safety procedures and airspace deconfliction;
- g. 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 and the impact and dependencies on extant operational systems.

RF DEW. The requirement 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 size and performance. This will necessitate activity to maintain and develop the tools and experience to undertake performance and cost analysis of RF Directed Energy Weapons (RF DEW) as well as maintaining an awareness of the wider system issues.

1) The scope of coverage of topics related to RF DEW includes, but is not limited to, the following:

- a. Pulse forming networks;
- b. Nonlinear Transmission Lines;
- c. Antennae design;
- d. Power generation, storage and conditioning;
- e. Target interaction including failure modes as a consequence of relevant stimuli and potential countermeasures;
- f. System integration including system level design, modelling and assessment;
- g. Command and control, including safety procedures;
- h. Cost modelling;
- i. Human factors.



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This may include, but is not limited to:

- Basic research into processes, techniques and technologies that may be of use to RF DEW;
- Applied research into component, sub-system and system level aspects of RF DEW;
- 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 and the impact and dependencies on extant operational systems.