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Statement of Requirement for the R-Cloud Land 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 Land Systems Strategic Capability.

This statement of requirement relates to suppliers joining R-Cloud within Land 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 Land Systems are invited to apply to R-Cloud if you are a supplier of Science and Technology Research in this area.

Domains within the Land Systems Environment

The broad order Land capability fielded by MOD is as shown in the table below. Please note that this is a very wide ranging description of the capability in generic terms. This is to allow potential suppliers to understand the wider domain, with the aim of inviting discussion with those suppliers who have allied capabilities to offer, which may not "classically" sit in the rigid land domain.

Table 1 - Land Domain Capability Areas

The Land 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 Land system performance 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.	
Land Systems	Land Systems delivers the capabilities for the development, evaluation and demonstration of systems and concepts in the Land domain (mounted and dismounted), ensuring that proposed procurements are capable and fit for the procurement Statement of Requirement. This capability links the broader S&T and systems capabilities to the Land domain by providing the expertise to ensure the S&T is exploitable and relevant to this environment.
Systems Integration	S&T 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, but also integration into the wider force 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. The capability includes: - Platform metrics e.g. lethality, survivability, mobility - Fundamental S&T to support platform design. - Human Factors: physical/cognitive load; and Human Machine Integration. - Performance of Robotic and Autonomous systems. - Development of generic platform concepts of operations and concepts of use. - Platform integration into force structures; support 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. Includes engineering level modelling and assessment of specific system performance e.g. platform survivability, ISTAR,mobility and Lethality (noting that a dismounted soldier is also a “platform”). 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 and electromagnetic compatibility.
Specialist User Systems	Includes Technical and product support towards the manoeuvre and assault components of the land specialist user, covering land, air and maritime (above and below water) insertion, target effects and counter terrorist response (e.g. hostage release) support capabilities. Also includes rapid operational technical support (e.g. ISRP)

Statement of Requirement:

The domain description in Table 1 gives a brief overview of the effect that MOD aim to deliver. We achieve this effect by the application of skills in broad and often cross cutting capability areas, and it is in these capabilities that we invite organisations to join R-Cloud.

The principal capability areas in which we seek suppliers are outlined below. Please note, however, that this list is NOT prescriptive, and we are keen to hear from suppliers who believe that they have a product that can offer a value proposition to the Land Domain

Land Systems

1 ENABLING SYSTEMS

Enablers are those capabilities that allow the mounted and dismounted fighting capabilities to be brought to effect in a given situation

1.1 DEFENCE ARCHITECTURES

Defence architectures research develops the operational, system and technical architectures required to advance enterprise-wide interoperability. We seek suppliers who can provide:

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

1.2 INFORMATION & INTELLIGENCE SYSTEMS ENGINEERING

Information and Intelligence Systems are some of the most complex current capabilities fielded by the MOD, and are based on the application of System Engineering skills, to both initial thinking about new capabilities as well as informing upgrades to current capabilities, which are increasingly based on a mix of new and legacy systems.

Specific areas of capability of interest to MOD are presented below (as categorised in the INCOSE Handbook):

- Systems Thinking:
  - Systems Concepts;
  - Super-system Capability Issues;
  - 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;
    - System Robustness.
  - Systems Integration and Verification;
  - Validation;
  - Transition to Operations.

- Systems Engineering Management:
  - Concurrent Engineering;
  - Enterprise Integration;
  - Integration of Specialisms;

- o Lifecycle Process Definition;
- o Planning, Monitoring and Controlling.

1.3 MILITARY ENGINEERING

This capability provides systems advice to DE&S and Army HQ relating to:

- Mobility support (e.g. counter-IED and counter-mine, obstacle crossing / breaching);
- Counter-mobility (e.g. explosive and non-explosive obstacles);
- Engineer vehicles and plant;
- Base infrastructure and its protection;
- Utilities (e.g. the deployed infrastructure for water, power, fuel, waste, etc.).

The provision of equipment and technological systems advice, in support of the acquisition of current and future platforms, role equipment and sub-systems. This includes the assessment of overall systems effectiveness and trade-offs to provide balanced capabilities appropriate to the requirement. This normally requires the integration and assessment of engineering / military engineering systems into existing or COTS procured platforms (vehicles, soldiers and bases) by consideration of the:

- "Fightability" of the system and consideration of the man-machine interface;
- Mobility and driveline implications:
  - o Automotive systems optimising drive and traction control for recovery, earth moving, mine ploughing, etc;
  - o Obstacle crossing, breaching, fording, snorkelling, bridging capability, tunnelling; and
  - o Mobility support, counter-IED, counter mine, explosive obstacles, crossing/breaching, counter -mobility.
- The impact of the other DLODS on system features: Reliability and Maintainability (RAM), Training System requirements, Tactics, Techniques and Procedures (TTPs) including the implications on doctrine, impact on the Defence Infrastructure, disposal solutions at the end of life.

Key skills include:

- Understanding base infrastructure and protection;
- Military engineering capability (across all DLOD and/or Tactical Functions, and including reliability, availability, maintenance and repair);
- AFV engineering and systems; system architecture; systems integration; human factors;
- Requirements definition;
- Test and evaluation;

1.4 NAVIGATION SYSTEMS

MOD has a key role in enabling fundamental research, advice, experimentation, trials, modelling and simulation to support the development of both satellite and non-satellite based navigation systems, with a focus on the following areas:

- Antenna technology inc. innovative design for challenging platform and system integration;
- Platform and system specific systems integration;
- Alternatives to satellite based navigation, for example:
  - o Visual navigation;
  - o Quantum technology;
  - o Signals of opportunity;

- o Optical flow;
- o IMUs;
- o 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;
  - o Re-use of existing platform and system sensors (for example Radar Warning Receivers) to augment primary navigation system.

1.5 LAND & JOINT LOGISTIC INFORMATION SYSTEMS

The provision of systems advice to DE&S, Joint and single-Service Commands relating to the:

- Movement of materiel by land-based means, the operation of the defence supply chain, the management of equipment relating to the movement of materiel and logistics infrastructure in both operational theatres and UK;
- Joint logistics information infrastructure, systems and capabilities, land storage and distribution and inventory management.

Key skills include:

- Understanding logistical concepts and operations;
- Logistics fleets and infrastructure management
- Logistic platform engineering and systems, systems integration, human factors;
- Requirements Definition;
- Test and Evaluation;
- Additional links to Analysis, C4ISR and Humans Systems communities.

1.6 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. MOD requirement for Suitably Qualified and Experienced Personnel (SQEP) software specialists (including practitioners) is expected to increase across the whole portfolio, and so we seek support in:

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

1.7 SYSTEMS APPROACHES

MOD applies Systems Approaches (MOD uses the term System Approaches to cover the totality of concepts including Systems Engineering, Systems Thinking and Systems Analysis) across the breadth of our S&T activity, Land Systems being no exception.

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, in the following capability strands:

- 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;
  - Semi-quantitative.
- Systems engineering foundations:
  - Systems science;
  - Complexity theory;
  - 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;
- Enterprise architecting.

1.8 UNDERPINNING S&T

This capability does not conduct specific S&T but needs to maintain awareness of S&T developments that could impact Land Environment Close Combat Systems. This is achieved through Horizon Scanning and very close working with other SCs:

- Analysis – Assessing system performance and effectiveness in the relevant context;
- Human Systems – Understanding the limits on human performance;
- Weapons – Accessing weapon system design, performance, effectiveness data for use in LE models, threat information;
- C4ISR – ISTAR and network information requirements, flows, latencies, service provision, etc;
- Cyber – Environments, threats;
- CT & Security – Threat information;
- Integrated Survivability – Optimisation and balance of survivability technologies, materials, structures, power sources.

Land Systems

2 Mounted Capabilities

Mounted capabilities appertain to the provision of mounted capabilities, i.e. vehicles. Capabilities are represented in alphabetical order; no primacy is apportioned to any one cap area. This is also reliant on the overarching capabilities outlined in the "Enablers" section

2.1 FUTURE LAND CAPABILITIES

This capability seeks support in the following deliverable areas

- Analysis of the future Land Environment in support of Future Force Development and Conceptual Force Development, considering pan-DLOD / Tactical Functions and including reliability, availability, maintenance and repair.
- Development of future capability concepts
- Consideration of doctrine appropriate to the battlegroup and below drawing from technical information and Horizon Scanning activities from a range of national and international networks.
- Understanding the Future Operating Environment to determine the system consequences of threats, likely operating areas, climate, terrain, etc.

2.2 LAND SYSTEMS ENGINEERING & INTEGRATION

A mixture of Systems Engineering, Systems Analysis and Operational Analysis (OA) to support decision making and the provision of technical advice and assurance across MOD and wider government. The capability draws upon cross-disciplinary teams of operational and system analysts, engineers (both physical and systems) and Military Advisers.

Assessments are made using a broad range of Modelling and Simulation (M&S) tools, underpinned by an understanding of the land threat (both current and future)and the expertise of staff in understanding how worldwide S&T developments could affect systems employed in the current and future Land Environment (LE).

The primary focus is up to Brigade (BDE) level, including those systems associated with

- Land Environment Close Combat
- Combat Support (CS)
- Combat Service Support (CSS)
- Mounted and Dismounted Close Combat
- Military Engineering
- Joint Logistics Information Infrastructure
- Land Logistics Systems
- Land Fleet Requirements (LFR).

The capability supports OA, systems design, performance and integration analysis, and capability-based advice to MOD decisions working in partnership with Industry and Allies. Furthermore, there is an adjunct requirement to provide these services to non-MoD users in the form of Other Government Departments (OGD) and related organisations.

2.3 PLATFORM EQUIPMENT SYSTEMS

The provision of equipment and technological systems advice, in support of the acquisition of current and future platforms and sub-systems engaged in the Land Environment. This includes the assessment of overall systems effectiveness and trade-offs to provide balanced capabilities appropriate to the requirement. This includes the "Fightability" of the system and consideration of the man-machine interface in the following areas:

Lethality - Knowledge of the weapon system operation including:

- Integration and mounting of direct fire weapons of all calibres
- Indirect fire weapons (mortars and large calibre)
- Guided weapons and non-lethal systems including the assessment of suppressive effects.
- Guidance systems,
- Sensors, seekers, fuzes and warheads technologies
- Internal and external ballistics
- Surveillance and Target Acquisition (STA),
- Fire control;

Platform Integrated Survivability - Consideration of the holistic ability of the platform to operate and survive in a threat environment, including:

- Cyber and EMP including countering the effects of non-lethal weapons, vehicle engine stopping capabilities
- Signature Assessment and Management - Signature Management across all relevant wavebands, EO, IR, RF, acoustic, magnetic, etc
- Physical and Electromagnetic (EM) Countermeasures;
- Active Integrated Protection Systems including the detection and effective defeat of a range of threat munitions/sub-munitions
- Physical Protection from a range of threats that could be directed at all aspects of the platform i.e. all azimuths, overhead and underbelly
- CBRN resistant coatings and hardening materials, integration of warning sensors and Collective Protection (COLPRO) systems, etc.
- Mobility – Automotive systems including transmission, powertrains, electric drive, hybrid drive, running gear, assessment of driveline performance and terrain accessibility
- Command and Battlespace Management (CBM) to provide Situational Awareness, Intelligence Preparation of the Battlefield (IPB), mission planning, coordination of network fires, etc. This requires consideration of the Integration of ISTAR assets particularly BG UAS, communication systems and networks, etc
- Robotic and Autonomous systems (RAS)– Covering remote and autonomous control of Land systems including navigation, obstacle avoidance and automatic target detection and AI based user aids.
- System integration, in particular the integration of MOD subsystems (e.g. BOWMAN, ECM etc) onto platforms and impacts on issues such as electromagnetic compatibility (EMC).

- Mission Sustainment – Reliability, Availability and Maintainability (RAM); fuels, lubricants, oils, chemical power solutions/novel power and batteries; self-sustaining technologies; filtration and water purification
- The impact of other DLODS on system features: Training System requirements, Tactics, Techniques and Procedures (TTPs) including the implications on Doctrine, impact on the Defence Infrastructure, disposal solutions at the end of service life, etc.

Additional systems considerations which are also enablers for platforms include:
- System reliability and maintainability;
- System health monitoring;
- Safety & Security systems;
- Asset management and usage monitoring;
- Energy and power sources and management.

Key models that support decisions and trade-off analysis are:
- NATO Reference Mobility Model (NRMM) for terrain access;
- Drive C, driveline performance;
- Weapon Target Interaction (WTI) Vulnerability and Lethality modelling
- AVROT;
- ATLAS, Combat Simulation.

Key skills include:
- Armoured Fighting Vehicle (AFV) systems engineering and sub-systems;
- System architecture and systems integration;
- RAS design, integration and safety
- Consideration of human factors;
- Requirements Definition (RD);
- Test and Evaluation (T&E);
- Additional links to Analysis, Cyber, C4ISR, CB, CT & Security, Weapons, Human Systems and Integrated Survivability communities.

2.4 VEHICLE ELECTRONICS (VETRONICS)

This capability encompasses an appreciation of the research requirements for vetronics systems engineering and their corresponding generic architectures that span the entire spectrum of platforms and infrastructure across the Land Environment. The key skills required to support this capability are vetronics, a broad understanding of system engineering and a keen appreciation of “system of systems” thinking as applied to military systems and specifically how open, modular and scalable standards should be specified and assessed.

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3 Dismounted Capabilities

Dismounted research is as pertaining to the delivery of an effective infantry capability. This is also reliant on the overarching capabilities outlined in the "Enablers" section

3.1 SOLDIER EQUIPMENT SYSTEMS

The provision of equipment and technological systems advice, in support of the acquisition of Dismounted Close Combat (DCC) equipment and associated sub-systems. A key part of this capability is an understanding of impact on design of the human in terms of ergonomics, physical and cognitive loading limitations, weapons effects on the soldier, effectiveness of small and large team collectives, performance and battlefield measures of effectiveness e.g. the psychology of suppression. System "Fightability" and consideration of the man-machine interface has to be considered across all the NATO soldier domains:

- Lethality - Weapon system lethality performance and assessment for the integration onto the dismounted soldier and infantry section of direct fire, indirect fire and non-lethal systems. This includes the integration of sensors for ranging, auto-correction of shot, assessing weapon effects and suppressive effects on targets, and how the design of ammunition and explosive stores, weapon release or discharge could affect the human and the wider system;
- Survivability – An integrated approach encompassing:
  - Signature Management – Selection of clothing materials and camouflage patterns; specialist paints; coatings; photochemistry, etc;
  - Shot detection from hostile systems;
  - Integration of Electronic Counter Measure (ECM) systems and particularly how they affect mission duration and TTPs;
  - Physical protection from a range of threats including the effects of blast;
  - CBRN - hand held detectors (e.g. Chemical Agent Monitor, CAM), CBRN warning capabilities and area detection capabilities (e.g. PBDS).
- Mobility – Consideration of mobility aids for terrain and obstacle crossing including the integration of organic platforms such as quad bikes into the infantry section;
- CBM – Integrating C4I systems to provide effective situational awareness and mission planning;
- ISTAR - Integrating organic technologies in the ISTAR network to provide enhanced ground awareness, Intelligence Preparation of the Battlefield (IPB);
- Sustainment - A key part of the capability is the assessment of soldier performance and reduction of soldier burden through Human Factors' considerations for the soldier to bear equipment, increase stamina, strength, wakefulness, observation skills, heat/core temperature management, associated training implications;
- The impact of the other DLODS on system features: RAM, training system requirements, Tactics, Techniques and Procedures (TTPs) including the implications on doctrine, impact on the Defence Infrastructure, disposal solutions at the end of life.

Key skills include:

- Soldier systems engineering and sub-systems;
- System architecture and systems integration;
- Consideration of human factors;
- Requirements Definition (RD);
- Test and Evaluation (T&E);
- Additional links to Analysis, Cyber, C4ISR, CB, CT & Security, Weapons, Human Systems and Integrated Survivability communities.

Key models that support decisions and trade-off analysis are:

- IWARS, soldier combat model;
- S2A.