RCloud Tasking Form – Part B: Statement of Requirement (SoR)

Title of Requirement	**Very Small Robotics Systems: current status and future directions**
Requisition No.	**1000168215**
SoR Version	**3.0**

1.	**Statement of Requirements**
1.1	**Summary and Background Information**
	Summary The work will comprise of 3 tasks: Task 1 to develop a thorough understanding of the most significant developments in the state of the art of very small robotics systems. This may be through literature review or other approaches. (Note: very small robotics systems are defined here are systems of a few centimetres across and smaller and their subsystems. The terminology 'miniature', 'micro-' and 'nano-' robotics is often used – but it is not particularly helpful as there is confusion as to exactly what these terms mean). Task 2 to identify realistic potential concepts/ scenarios of future operation of very small robotics systems and identify the science and technology gaps/ barriers that need to be overcome to enable such scenarios and systems to become a reality. Task 3 to undertake an appraisal of the possible future directions of development of very small robotics science and technology, highlighting those areas that could be of interest from a Defence and Security perspective. The outputs of the work will be: Task 1: a report describing the work undertaken and highlighting the most novel, games changing and exciting technologies identified and describing these in a manner which is accessible to stakeholders; a summary report; graphically appealing slides including video clips of functioning robotic systems. Tasks 2/3: a futures report including outputs from Tasks 2 and 3; a summary report; graphically appealing slides to visually demonstrate future scenarios, technology gaps, and potential attributes of future systems. **Background** Embodied robotic systems science and technology is developing rapidly both within the academic and commercial sectors. The UK Ministry of Defence would like to keep abreast of current developments and have an understanding of possible future directions of this science and technology (S&T). To achieve this, a number of S&T assessments and futures appraisals are being tasked on specific topics associated with embodied robotic systems. The current task evaluating very small robotics system S&T is part of this overall aim. Very small robotics systems, sometimes referred to as miniature, micro- or nano- robotics systems, have no agreed definition. For the purposes of this study we define them as any robotic system where two dimensions of the physical operational part of the system are less than approximately 3cm. This is to enable the study to include surgical medical robotics systems, where the operational part may be attached to the end of a flexible arm and the processing may be remote from this, as well developments in mobile robotics systems down to the molecular scale.

1.2	Requirement
	(1) to develop an understanding of the current state-of-the-art of very small robotics systems and sub-systems, including trends in development, highlighting the developments that are most game-changing, novel and exciting and which may be important to the MOD in the future. (2) to identify stretching scenarios/ concepts of future operation of very small robotics systems and identify the S&T gaps that need to be overcome to enable such operations to take place – highlighting what technology developments are needed to bridge these gaps and thus enable the wider capability. (3) to undertake an appraisal (using an appropriate futures analysis approach) of the potential future directions of the science and technology of very small robotics systems, including the potential capabilities of future generations of such systems. This is highlight those areas that could be of interest from a Defence and Security perspective. Two reports (one for Task 1 and one for Tasks 2 and 3), two summary reports, and two sets of visually appealing power point slides shall be produced for the project. **<u>Technical Approach</u>** **Task 1:** Undertake a review of the current state-of-the-art in S&T relating to very small robotics systems and subsystems. This should include robotics systems where the operational robotic part has two dimensions of less than approximately 3cm (although with flexibility to go slightly larger if important items would otherwise be excluded). The review should include robotics system developments at all scales to the molecular scale. The review will be undertaken by experts in the area (ideally at post-doctoral level or equivalent). It will include a broad coverage of the most exciting developments in the literature from the last 10 years. The review will include as a minimum an understanding of the relevant state of the art and trends through time in capability. The intention is that the review will highlight exciting low Technology Readiness Level developments that may have a significant impact on the future direction of the S&T and that may in the future impact on UK Defence and Security. A number of potential sub-topics are listed below. However, these should act as a guide, rather than a comprehensive topic set. Other topics of interest are likely to be known to the potential contractor or will be identified during the work, which would enable a fuller understanding. The key is that we would like to understand cutting edge developments that might impact on UK Defence in the future. Entire system concepts Remotely operated (including tethered) systems Automated and autonomous systems Materials developments Design and structures Sensors Navigation Communication Power Actuation Effectors Locomotion Cognition Bio-hybrid robotics Very small robotics systems use cases Other aspects of very small robotics systems **Task 2:** Develop a number of stretching concepts/ scenarios for how very small robotics systems could be used in the future, either in a beneficial manner or in a manner that could be a threat. Each of these should include both an outline description of the future technology concept and the potential

scenario of exploitation. They should be concepts/ scenarios that cannot be achieved at present, but that it is conceivable could be achieved within the next 20-30 years.
There would be a need to consider a number of different concepts/ scenarios, at a fairly high level, that would cover a range of the ways that very small robotics systems could be deployed in the future and should include, but not be exclusively, ones of military relevance. The titles of the concepts/ scenarios should be confirmed with the Dstl Technical Partner prior to progressing this task.
Once the concepts/ scenarios have been developed, the science and technology gaps that prevent such systems from currently being used in this manner should be identified. This can then act as a focus for technology watch in the future – the crossing of a technology gap potentially indicating the viability of a new concept/ capability.
It is anticipated that this task will draw heavily on the technology review in Task 1. The output of the task will be a short and graphically appealing report describing the future concepts of deployment of very small robotics systems and highlighting the future scientific developments necessary to enable them.

Task 3:
Building on the Outputs of Tasks 1 and 2, undertake an appraisal of possible future very small robotic systems S&T, describing the implications for future generations of deployable systems (over short (2-5 year), medium (5-10 year) and long (10-20 year) time frames from 2020).
Consideration should be given to potential:

- future game changing S&T developments
- system performance
- capability in complex and challenging environments (e.g. urban environments, underwater, cluttered environments, inside of other machines or even inside the human body…)
- ease of use (e.g. launch and recoverability, command and control, user interaction and level of manning, autonomy …)

The appraisal shall also identify areas of science and technology development that are likely to have the most profound or disruptive impact on future capabilities of very small robotics systems or where limiting factors such as physics will constrain the ability to develop beyond a certain point in the future.

General

- The contractor will be required to confirm with the Dstl Technical Partner (TP - the Dstl technical point of contact for the project), the relevant science and technology topics to be reviewed within Task 1 and the methodology for Tasks 2 and 3 at the start up meeting.
- Because of the range of technologies that will need to be reviewed, it is anticipated that this work will need to be conducted by a small team, each with a minimum skill set commensurate with that of a post-doctoral researcher or similar in a field of study related to very small robotics systems science or technology.

Progress Monitoring

- The tenderer must include provision for three visits to the Dstl Porton Down or Portsdown West sites (for start-up, mid-contract and presentation/ closure meetings). However, by agreement with the Dstl TP, any of these meetings could be held virtually, the mid-contract meeting could also be held at the chosen contractor's site.
- The chosen contractor will present the approach / plan for the work at a start-up meeting within 2 weeks of contract award. A presentation slide pack outlining the approach (PowerPoint) and Project Plan (MS Project) outlining the breakdown of tasks and timelines to address all requirements shall be provided to the Dstl TP at this stage. The contractor will be required to present to Dstl the relevant science and technology topics to be reviewed and the approach to be adopted to assess the capabilities of future very small robotics systems. The proposed approach shall be as described in the tender response, but may be expanded with additional information and examples. The Dstl TP will review the approach and, if content, approve it within 3 working days of the start-up meeting.

	• At the start-up meeting a schedule of fortnightly telephone/ virtual progress meetings will be agreed. • A short monthly progress report will be provided by email. The report shall document and summarise the results of work done during the period covered and shall be in sufficient detail to highlight: the results achieved; current substantive performance and any problems encountered along with proposed corrective action. The report shall also explain any difference between planned and actual progress, why the differences have occurred and (if behind planned progress) what corrective steps are proposed. • Access to the Dstl TP will be available to provide clarification, liaison and support as required. The main liaison shall be between the Dstl TP and the Contractor Technical Lead, or alternative arrangements to be made within the Contractor technical team as required, with a target response time between parties of 3 working days. The Dstl TP will chair all meetings held. • A meeting will be held at Dstl Porton Down or Dstl Portsdown West during the last month of the contract. At this the contractor will present the outputs of the work to a small audience of interested Dstl and MOD personnel. The Dstl TP may request this meeting to be held virtually. **Reporting Requirements** Two reports (one for Task 1 and one for Task 2 / Task 3), two summary reports (to summarise in an easily digestible form for the non-specialist the two detailed reports) and two sets of visually appealing PowerPoint slides shall be produced for the project. The detailed reports shall include technical discussion of the issues, leading to relevant conclusions. The task 1 report shall highlight the most novel, games changing and exciting technologies identified and describe these in a manner which is accessible to stakeholders. The reports shall: • comply with the Defence Research Reports Specification (DRRS), which defines the requirements for the presentation, format and production of scientific and technical reports prepared for MOD • be authoritative and accessible; • not be disproportionately focused on a specific topic or the contractor's particular speciality; • be comprehensive yet concisely written. Technical details (e.g. relating to mathematics, or physics concepts) shall be kept to a sufficient minimum in the main text, but may be expanded upon in annexes; • be free from spelling or grammatical errors; • be fully referenced in accordance with an appropriate referencing standard (using hyperlinks where appropriate); • contain a full glossary; • use frequent graphics and tables at relevant points in the report to aid accessibility; • focus on key messages and novel/ game-changing/ exciting technologies; • be delivered in Microsoft Word or pdf format. Note: The contractor's own template may be used. The summary reports shall highlight the key issues in a short accessible and graphically appealing format. It shall be accessible to senior decision-makers and non-technical personnel. It shall be delivered in Microsoft Word or pdf format, free from spelling or grammatical errors and include appropriate graphics and tables. The presentation slides shall contain high quality images that may be used by Dstl and wider MOD personnel, to describe the outcomes of the work. The presentations will be aimed at a technical but non-specialist audience. The slides shall not contain excessive written text. The slides shall contain presenters' notes. They shall be delivered in Microsoft PowerPoint or compatible format and be free from spelling or grammatical errors.
1.3	**Options or follow on work** *(if none, write 'Not applicable')*

	N/A
1.4	**Contract Management Activities**
1.5	**Health & Safety, Environmental, Social, Ethical, Regulatory or Legislative aspects of the requirement**

1.6	Deliverables & Intellectual Property Rights (IPR)					
Ref.	**Title**	**Due by**	**Format**	**Expected classification (subject to change)**	**What information is required in the deliverable**	**IPR Condition**
D – 1	Progress Reports	*T0+1 month, and monthly thereafter*	Full Technical Report (MS Word & PDF)	Redacted under FOIA Section 26 – Defence	The Progress reports shall highlight the key issues in a short accessible and graphically appealing format. It shall be accessible to senior decision-makers and non-technical personnel. It shall be delivered in Microsoft Word or pdf format, free from spelling or grammatical errors and include appropriate graphics and tables.	*Default RCloud Agreement Terms and Conditions shall apply* All reports are to be fully distributable to MOD, Government, Industry, Academia, International allies. Dstl require the additional ability to publish at its discretion in the public domain.
D – 2	Detailed Task 1 Report	*T0+4 Months*	Full Technical Report (MS Word & PDF)	Redacted under FOIA Section 26 – Defence	*The detailed reports shall include technical discussion of the issues, leading to relevant conclusions. The task 1 report shall highlight the most novel, games changing and exciting technologies identified and describe these in a manner which is accessible to stakeholders.*	

D – 3	Summary Task 1 Report	*T0+4 Months*	Summary Report (MS Word & PDF)	Redacted under FOIA Section 26 – Defence	The summary reports shall highlight the key issues in a short accessible and graphically appealing format. It shall be accessible to senior decision-makers and non-technical personnel. It shall be delivered in Microsoft Word or pdf format, free from spelling or grammatical errors and include appropriate graphics and tables.	The work being undertaken is a literature review of public domain information. It is not expected that the supplier will include any background or 3rd party IP. No IP should be generated.
D – 4	Detailed Task 2/ 3 Report	*T0+6 Months*	Full Technical Report (MS Word & PDF)	Redacted under FOIA Section 26 – Defence	*The detailed reports shall include technical discussion of the issues, leading to relevant conclusions.*	
D – 5	Summary Task 2/3 Report	*T0+6 Months*	Summary Report (MS Word & PDF)	Redacted under FOIA Section 26 – Defence	The summary reports shall highlight the key issues in a short accessible and graphically appealing format. It shall be accessible to senior decision-makers and non-technical personnel. It shall be delivered in Microsoft Word or pdf format, free from spelling or grammatical errors and include appropriate graphics and tables.	

D – 6	PowerPoint Presentation	*T0+7 Months*	PowerPoint Presentation	Redacted under FOIA Section 26 – Defence	The presentation slides shall contain high quality images that may be used by Dstl and wider MOD personnel, to describe the outcomes of the work. The presentations will be aimed at a technical but non-specialist audience. The slides shall not contain excessive written text. The slides shall contain presenters' notes. They shall be delivered in Microsoft PowerPoint or compatible format and be free from spelling or grammatical errors.	
D – 7	Customer Presentation/ closure meeting	*T0+7 Months*	Meeting	Redacted under FOIA Section 26 – Defence		

1.7	**Deliverable Acceptance Criteria**
	All Reports, including Progress Reports and Final Deliverables must comply with the reporting requirements set out above. Failure to comply with the above may result in the Authority rejecting the deliverables and requesting re-work before final acceptance. Draft versions of Final Deliverables will be provided to Dstl by the supplier 20 working days prior to the final deliverable date, for review and acceptance / rejection. Review and acceptance / rejection of final versions will take place at Dstl. This process will be completed within 15 working days of receipt of the deliverables to enable the supplier to make corrections and achieve the final deliverable date.

2	**Evaluation Criteria**
2.1	Method Explanation
	See below
2.2	Technical Evaluation Criteria
	See below
2.3	Commercial Evaluation Criteria
	See below

Commercial Evaluation. The Commercial Criteria shall be reviewed on a strict PASS / FAIL basis. Failure in any of the Commercial Criteria shall result in a non-compliant bid.

Response No	Description	Pass/Fail
1	Dstl requires a fully transparent bid with a detailed cost breakdown provided.	
2	Provide full details of the points of contacts for commercial, project management and technical, for the proposed contract duration.	
3	Compliance with the required quotation validity period of 60 days from tender due date.	

4	The commercial response must contain unqualified acceptance of Dstl Terms and Conditions and Special Conditions as per the tasking form.	

Tender Evaluation

All bids received by the closing date will be assessed against the tender evaluation process detailed below.

The Authority will use an evaluation model consisting of three criteria, weighted as follows:

- Commercial: PASS / FAIL
- Technical: 70%
- Pricing: 30%

The highest-scoring technically compliant bid will receive a score of 70 and the technical scores for the remaining bids will be calculated using a percentage (%) difference method as follows:

$$Technical\ Score\ =\ Total\ Available\ Marks\ \times \left(\frac{Tender\ Technical\ Mark}{Highest\ Technical\ Mark}\right)$$

A simplified worked example is shown below:

Tenderer	Score (Note: figures quoted are for example purposes only)	Calculation	Score Awarded
1	106	-	70
2	93	70 x 93/106	61.5
3	90	70 x 90/106	59.5

The lowest-priced compliant bid will receive a price score of 30 and the price scores for the remaining bids will be calculated using the a percentage (%) difference method as follows:

$$Pricing\ Score\ =\ Total\ Available\ Marks\ \times \left(\frac{Lowest\ Priced\ Technically\ and\ Commercially\ Compliant\ Tender}{Tender\ Price}\right)$$

A simplified worked example is shown below:

Tenderer	Tender Price (Note: figures quoted are for example purposes only)	Calculation	Score Awarded

1	£63,000	30 x 55000/63000	26
2	£55,000	-	30
3	£79,000	30 x 55000/79000	21

The scores for the Technical and Price elements will be added together and the overall highest score shall be awarded a contract. Therefore, using the examples shown above, Tenderer 1 would be awarded the contract with an overall score of 96.

In the event that two or more tenders score the same overall, the Tenderer achieving the highest score in the Technical section shall be awarded a contract.

Commercial Evaluation

The Commercial Criteria shall be reviewed on a strict PASS / FAIL basis. Failure in any of the Commercial Criteria shall result in a non-compliant bid.

Technical Evaluation

Technical evaluation will be carried out by a minimum of 3 assessors, who will review the proposals independently and then bring their scores to a moderation meeting which will be chaired by the Dstl Project Manager. The final score attributed to each of the four questions detailed below for each Tenderer shall be an output of this moderation meeting. Once all questions have been moderated, suppliers will be ordered according to their total score for their technical response and scores out of 70 calculated as based on the evaluation methodology detailed above.

	Context	Question	Available Mark	Score Definition
TE1	The tenderer must demonstrate a proven track record of a range of the science and technology of relevance to very small robotics systems.	Please provide an overview of your individual / team experience in science and technology of relevance to this field (maximum 1000 words, excluding references) CVs should be included (not included in word count).	30 (Score x 3)	10 = demonstration of a record of published original research in multiple science and/or technology topics of relevance. 6 = demonstration of relevant expertise in a limited number of science and technology topics of relevance. 3 = little relevant expertise or deep expertise in only one narrow area. 0 = Tenderer did not respond to the question or tenderer's response indicated that their capabilities wholly failed to meet Dstl's requirements.

TE2	The review of the current state-of-the-art in science and technology relating to very small robotics systems (Task 1) needs to be detailed and balanced, covering relevant topics to an appropriate level of depth and highlighting the most novel, game-changing and exciting science and technology.	Please describe how you would go about undertaking the literature review to achieve this, whilst not missing items of importance. Please provide a table containing of: •a short description of the topics you consider to be the most important in relation to this study, and which you will include in the work; •the minimum number of references for each topic you would plan to review; •the name of the individual who would be reviewing each topic area (linked to CVs provided above). (maximum 1000 words – not including references or table).	30 (score x 3)	10 = very comprehensive description of approach and list of topic areas for review. Proposed numbers of references are suitable. Personnel identified to review topic areas are recognised as experts in those areas. 7 = comprehensive description of approach and list of topic areas. Reference numbers adequate, but some limitations in the extent of the literature review could result. Personnel are recognised as experts in most topic areas being reviewed. 4 = limited description of approach and list of topic areas to be reviewed. Reference numbers low but may be adequate to understand general trends in literature (if correctly chosen). Personnel are knowledgeable in some areas. 2 = Limited consideration of the approach to undertaking the review. Some aspects are described. 0 = Tenderer did not respond to the question or tenderer's response indicated that they do not understand the requirement.
TE3	An appropriate approach needs to be employed to evaluate the technology improvements required to develop future advanced deployable very small robotics systems and to evaluate possible future systems capabilities (Tasks 2 and 3).	Please provide a description of how you would go about undertaking Tasks 2 and 3 this this work to generate outputs that can guide futures understanding in relation to very small robotics systems. (1000 words maximum)	30 (score x 3)	10 = a very well developed concept of how to undertake future very small robotics system scenario and capability assessment. Excellent details of approaches and methods to organise output. Detailed consideration and understanding of all the issues are demonstrated. 7 = some good consideration is given to how to undertake the work. The approach and outputs are described well, but with some limitations. 4 = consideration is given on how to undertake most aspects of the work. But the descriptions are limited or demonstrate uncertainty. 2 = Limited consideration of the plan, approach or outputs. 0 = Tenderer did not respond to the question or tenderer's response indicated that they do not understand the requirement.

TE5	The deliverables must be concise and accessible	Please describe how you would structure the outputs to make them accessible to a wide range of interested parties. You may include up to two examples of previous outputs which you would highlight as being similar to that which you would provide form this work. Please confirm that you will comply with the technical reporting requirements as described in the ITT. (300 words maximum, excluding example outputs).	10	10 = excellent description of approach. Outputs likely to be clear, concise and very accessible to a non-expert. 6 = acceptable description of approach. Outputs likely to be acceptable to non-exeprts. 1 = not clearly written or accessible to a non-expert. 0 = Tenderer did not respond to the question or tenderer's response indicated that their capabilities wholly failed to meet Dstl's requirements.

Note: Dstl reserves the right to fund more than one compliant bid.

Note: Bids receiving less than 50% of the available technical score will be considered to be non-compliant.