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

Title of Requirement	**Demonstrate scalability of charge recovery Neural Network**
Requisition No.	**RQ0000012244**
SoR Version	**1.0**

1.	**Statement of Requirements**
1.1	**Summary and Background Information**
	Defence processing needs are moving towards the edge [1], where low Size, Weight and Power (SWaP) requirements are essential [2]. With industry moving towards cloud based architectures and battery life optimised for an office working day, defence requirements may not be met. The use of AI in particular Neural Network (NN) inference is likely to become an increasingly important part of defence edge computing for tasks like image processing, classification and voice processing. It has been hypothesised that utilising adiabatic computing principles could reduce power consumption via energy recovery [3]. Recently adiabatic principles have been applied to NN inference via "Capacitive Artificial Neuron with RRAM-based Threshold Detection" [4] as a proof of concept stating an energy reduction of 90%. The goal of this task is to investigate if the proof of concept described in [4] will still provide considerable power saving when scaled up to a functional NN. [1] Close to the edge, MOD, 2021 [2] M. S. Im, V. R. Dasari, L. Beshaj, and D. R. Shires, "Optimization problems with low SWAP tactical computing," *Disruptive Technologies in Information Sciences II*, vol. 11013, p. 14, May 2019, doi: 10.1117/12.2518917. [3] Design and Analysis of Energy Recovery Logic for Low Power Circuit Design Munish Mittal, Anil Khatak, 2014 [4] An Adiabatic Capacitive Artificial Neuron with RRAM-based Threshold Detection for Energy-Efficient Neuromorphic Computing. Redacted under FOIA Section 40 - Personal Information 2022
1.2	**Requirement**
	Overarching requirement: Demonstrate that "Capacitive Artificial Neuron with RRAM-based Threshold Detection" [1] can be applied at scale demonstrating Low SWaP properties whilst performing NN inference. **Requirements:** The Deliverables shall be: 1) A demonstration of NN inference using "Capacitive Artificial Neurons" (CAN) at a representative scale:

	a. The demonstrator may be a prototype or a model with a detailed model that provides a high degree of confidence in the behaviour of an engineered prototype. b. Inference shall be performed using a credible dataset to be agreed with supplier for functionality such as image analysis and speech recognition. c. Inference shall be performed at a speed appropriate the selected dataset's intended use. d. Performance metrics such as power consumption must be measurable and reported. 2) A report: a. Comparing low SWaP properties between a more conventional approach (e.g. using a combination of CPUs and GPUs, or specialist hardware like TPUs) and CAN. b. Describing lessons identified during development. c. Outlining the path towards a usable capability, including the viability of supply chains. 3) Presentations to internal and external stakeholders: a. Technical b. Overview suitable for generalist audience **Bid** The Bid should detail how the demonstration shall be achieved including: 1) Approach to creating the demonstrator. a. Criteria to proceed from design to prototype if applicable. 2) Which dataset(s) and NN topologie(s) shall be used for inference? 3) Which metrics shall be used to evidence the SWaP properties? 4) What conventional processors (e.g. using a combination of CPUs and GPUs, or specialist hardware like TPUs) shall be used for comparison? **References** [1] An Adiabatic Capacitive Artificial Neuron with RRAM-based Threshold Detection for Energy-Efficient Neuromorphic Computing. Redacted under FOIA Section 40 - Personal Information 2022
1.3	**Options or follow on work** *(if none, write 'Not applicable')*
	Not applicable.
1.4	**Contract Management Activities**
	• A kick-off meeting where the metrics, topologies and datasets will be agreed. • A monthly progress meeting where the contractor will present the progress to date, risks, issues, finances etc. • A report and presentation provided by the contractor at the end of the design phase to be used as decision point to proceed with production. This report and presentation should contain evidence that the power reduction is achievable.

	• At the end of the contract, a demonstration of machine learning inference as agreed at the kick-off meeting.
	• At the end of the contract, a report evidencing:
	  ○ The power saving whilst performing inference.
	  ○ Documentation of the design approach used and, if applicable, ways to improve it.
	  ○ Next steps to progress the technology.

1.5	**Health & Safety, Environmental, Social, Ethical, Regulatory or Legislative aspects of the requirement**
	Dstl encourages all bidders to be mindful of legal and ethical considerations, particularly where experiments may impact on privacy under Investigatory Powers legislation (the Regulation of Investigatory Powers Act 2000 and Investigatory Powers Act 2016) and obligations under the Data Protection Act.

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	Kick-off meeting.	T0	Presentation (.pptx)	Redacted under FOIA Section 24 - National Security	Face to face meeting with presentation pack to include but not limited to: • Timescales. • Approach. • Metrics. • Topologies and datasets.	DEFCON 705
D – 2	Monthly progress update.	T+1 Month and each month thereafter.	Presentation (.pptx)	Redacted under FOIA Section 24 - National Security	MS Teams meeting, or face to face as agreed, with presentation pack to include but not limited to: • Update on technical progress • Progress report against project schedule. • Review of risk management plan. • Commercial aspects. • Review of deliverables. • Risks/issues. • GFA and supplier performance	DEFCON 705

D - 3	End of Design Phase	End of design phase – date TBC with contractor.	MS Word report and Presentation (.pptx)	A face to face meeting with a report and presentation provided by the contractor at the end of the design phase to be used as decision point to proceed with production. This report and presentation should contain evidence that the power reduction is achievable.	DEFCON 705
D - 4	Demonstration	Contract end (date TBC)	To be agreed with the contractor	A face to face demonstration of machine learning inference as agreed at the kick-off meeting.	DEFCON 705
D – 5	Final Report and presentation	Contract end (date TBC)	MS Word report and Presentation (.pptx)	At the end of the contract a face to face meeting, along with a report and presentation evidencing: • The power saving whilst performing inference (and reporting the benchmarks and their rationale). • Documentation of the design approach used and, if applicable, ways to improve it. • Next steps to progress the technology.	DEFCON 705

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1.7	**Deliverable Acceptance Criteria**
	As per R Cloud V4 Framework T&C's'. All work produced by the contractor must be deemed to be of acceptable standard, to time and cost by the Dstl Project Manager and Technical Authority.

2	**Evaluation Criteria**
2.1	Method Explanation
	This requirement will be competed and awarded on the basis of the Value for Money Index (VFM Index) evaluating Technical and Price using a lowest price per technical point scored. This will be ascertained by dividing each bidder's quoted price by their own final moderated technical score. 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 as follows: • Commercial: PASS / FAIL • Technical • Pricing
2.2	Technical Evaluation Criteria
	Technical evaluation will be carried out by a team of between 3 and 5 assessors who will review the technical proposals independently and then bring their scores to a moderation meeting. The moderation meeting will be chaired by the Dstl Project Manager. The weighted scores on each limb will be added together to give a final technical score. Each technical assessor will perform an individual evaluation and then a final moderated technical score will be arrived at in the moderation meeting. The moderation meeting will discuss each Tenderers response in turn and attribute a moderated technical score to each of the technical criteria and a final score calculated. Technical criteria is provided below.

Ref	Criteria	Available Score	Weighting	Total Available Score
T1	The proposal clearly demonstrates that the Contractor understands the requirement.	0-5	1	5
T2	The proposal provides details of key risks, dependencies, assumptions and any relevant ethical issues the Contractor has identified.	0-5	1	5
T3	The proposal clearly demonstrates that the Contractor has the expertise, knowledge and facilities to successfully deliver the requirement.	0-5	3	15

T4	The proposal clearly demonstrates that the personnel the Contractor has nominated to work on the requirement have the relevant experience to successfully deliver it.	0-5	2	10
T5	The proposal clearly demonstrates that the Contractors proposed approach will fully address all the key research questions / mandatory requirements stated in the RCA. Proposal should include the following: a detailed work breakdown structure, schedule, roles and responsibilities.	0-5	5	25
				60

Technical Scoring Guide - Definition of Terms:

Word or phase	Meaning
Comprehensive	Including or dealing with all or nearly all elements or aspects
Close to comprehensive	Including or dealing with slightly less elements or aspects than comprehensive
Satisfactory	Acceptable
Limited	Missing some minor / important elements
Inadequate	Missing some major / important elements

T1. The proposal clearly demonstrates that the Contractor understands the requirement.	
Score	**Key Indicators**
5 = Exceeds	• Demonstrates a comprehensive understanding of the Authority's requirements and objectives, – illustrating knowledge that goes significantly beyond that presented in this Statement of Requirement; • Provides excellent insights into how the context and associated requirements may evolve - going well beyond the material presented in the statement of requirement.
4 = Fully meets	• Demonstrate**s a** close to comprehensive understanding of the Authority's requirements – illustrating knowledge that goes beyond that presented in this Statement of Requirement; • Provide good insights into how the context and associated requirements may evolve - going beyond the material presented in the statement of requirement.
3 = Adequately meets	• Demonstrate**s** an understanding of the Authority's requirements; • Provide some insights into how the context and associated requirements may evolve - going beyond the material presented in this statement of requirement.
2 = Fails to meet in a minor respect	• Has shortfalls in demonstrating an understanding of the question area / requirement – for example, simply mirroring the information presented in this Statement of Requirement; • Offers little insight into how the context and associated requirements may evolve.
1 = Fails to meet in a major respect	• Fails to demonstrate understanding of the question area / requirement; • Offers no insights into how the context and associated requirements may evolve.
T2. The proposal provides details of key risks, dependencies, assumptions and any relevant ethical issues.	
Score	**Key Indicators**

5 = Exceeds	• Provides a comprehensive overview of key risks, dependencies, assumptions.
4 = Fully meets	• Provides a close to comprehensive overview of key risks, dependencies, assumptions.
3 = Adequately meets	• Provides a satisfactory overview of key risks, dependencies, assumptions.
2 = Fails to meet in a minor respect	• Provides a limited overview of key risks, dependencies, assumptions.
1 = Fails to meet in a major respect	• Provides an inadequate overview of key risks, dependencies, assumptions.
T3. The proposal clearly demonstrates that the Contractor has the expertise, knowledge and facilities to successfully deliver the requirement.	
Score	**Key Indicators**
5 = Exceeds	• Demonstrates comprehensive expertise and facilities of relevance to the requirement.
4 = Fully meets	• Demonstrates close to comprehensive expertise and facilities of relevance to the requirement.
3 = Adequately meets	• Demonstrates satisfactory expertise and facilities of relevance to the requirement.
2 = Fails to meet in a minor respect	• Demonstrates limited expertise and facilities of relevance to the requirement.
1 = Fails to meet in a major respect	• Demonstrates inadequate expertise and facilities of relevance to the requirement.
T4. The proposal clearly demonstrates that the personnel the Contractor has nominated to work on the requirement have the relevant experience to successfully deliver it.	
Score	**Key Indicators**
5 = Exceeds	• Demonstrates that the project team has comprehensive expertise and relevant experience to successfully deliver this requirement.
4 = Fully meets	• Demonstrates that the project team has close to comprehensive expertise and relevant experience to successfully deliver this requirement.
3 = Adequately meets	• Demonstrates that the project team has satisfactory expertise and relevant experience to successfully deliver this requirement.
2 = Fails to meet in a minor respect	• Demonstrates that the project team has limited expertise and relevant experience to successfully deliver this requirement.
1 = Fails to meet in a major respect	• Demonstrates that the project team has inadequate expertise and relevant experience to successfully deliver this requirement.
T5. The proposal clearly demonstrates that the Contractors proposed approach will fully address the key research questions / mandatory requirements stated in the RCA. Extra points will be awarded for more complex inference tasks such as real time spatial-spectral-temporal processing (e.g objects and activities in real time video). Proposal should include the following: a detailed work breakdown structure, schedule, roles and responsibilities.	
Score	**Key Indicators**
5 = Exceeds	• Provides a comprehensively detailed technical approach, illustrating how it may evolve during the life of the contract; • Comprehensively addresses all of the key research questions / mandatory requirements; • Provides significant additional relevant information and clear insights; • Provides strong examples and reasoning to back up any arguments presented, including reference sources; • Demonstrates excellent awareness of key challenges and provides significant detail on how they may be addressed.
4 = Fully meets	• Provides a comprehensively detailed technical approach; • Comprehensively addresses all of the key research questions / mandatory requirements; • Provides some additional relevant information or insights;

	• Provides some examples and reasoning to back up any arguments presented, including reference sources; • Demonstrates good awareness of key challenges and how they may be addressed.
3 = Adequately meets	• Provides a satisfactorily detailed technical approach; • Satisfactorily addresses all of the key research questions / mandatory requirements; • Provides little additional relevant information or insights; • Provides few examples and reasoning to back up any arguments presented, including reference sources; • Demonstrates awareness of some of the key challenges and how they may be addressed.
2 = Fails to meet in a minor respect	• Provides limited detail in the technical approach; • Limited consideration of the key research questions / mandatory requirements; • Provides no additional relevant information or insights; • Provides insufficient examples, and/ or little reasoning, to back up any arguments presented; • Demonstrates only limited awareness of key challenges and how these may be addressed.
1 = Fails to meet in a major respect	• Provides an inadequately detailed technical approach; • Inadequate consideration of the key research questions / mandatory requirements; • Provides no additional relevant information or insights; • Provides no examples or reasoning, to back up any arguments presented; • Demonstrate no awareness of key challenges and how these may be addressed.

2.3 Commercial Evaluation Criteria

Evaluation of Commercial bids will be undertaken against responses to the sub-criteria detailed below and scored in accordance with the 'Commercial Scoring Definitions' underneath.

The Authority reserves the right to reject any Tender if a supplier scores a 'Fail' in any of the criteria below.

Ref	Sub-Criteria Description	Scoring Range	Sub-Criteria Weighting	Maximum Weighted Score
C1	Please submit your full firm price breakdown for all costs to be incurred, including: • What rates are being used for what Grade • Quantity of manpower hours per Grade • Travel & Subsistence costs • Journal publication fees	Pass/Fail	n/a	Pass/Fail

	• Any Materials costs • Any Facility costs • Any sub-contractor costs • Any other costs			
C2	Compliance with the Task specific terms and conditions as stated within the Statement of Requirement and Tasking Form.	Pass/Fail	n/a	Pass/Fail
	Subtotal Available Weighted Mark			**Pass/Fail**

The score (Pass/Fail) awarded to each of the Commercial Sub-criteria will be in accordance with the following definitions:

Score	**Definition**
Pass	Fully meets the Authority's requirement. Provision and acceptance of the sub-criteria information in the format requested, which is clear, unambiguous and transparent.
Fail	Unacceptable/Nil Return. Tenderer did not respond to the question or the response wholly failed to demonstrate an ability to meet the sub-criteria requirement.

Pricing

The price of each proposal will subsequently be divided by the final moderated technical score to arrive at the lowest price per technical point scored. The bidder with the lowest price per technical point scored will be adjudged as the winner.
Example:
Supplier A submits a proposal costing £150,000. Their proposal receives a final moderated score of 50.
£150,000/50 = £3000 per technical point scored.

Supplier B submits a proposal costing £125,000. Their proposal receives a final moderated score of 40.
£125,000/40 = £3125 per technical point scored.
In this scenario, Supplier A would be the winner as their price is lower per technical point scored.