[Redacted] Under FOI

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

Title of Requirement	mm-wave Metamaterial arrays PhD
Requisition No.	**RQ0000008273 Contract reference [Redacted] Un0000004628**
SoR Version	**0.1**

1.	**Statement of Requirements**
1.1	**Summary and Background Information**
	This Statement of Requirement is to initiate a four year PhD with the [Redacted] Under FOI Exemption (single source) for the study of graded metamaterials arrays for mm-wave applications. It is directly linked to a proposal received from the [Redacted] Under FOI Exemption [redacted] MOD and [Redacted] need to be pushing at the forefront of innovation and technology trends; in cellular applications, this frontier is associated with developments in the portion of the electromagnetic spectrum known as the mm-wave region. The transition to the mm-wave region has many associated technical challenges to overcome; this PhD is framed to help address one aspect of future system requirements – the antenna and RF front end. As mobile communications have advanced, the "crowding" of the electromagnetic (EM) spectrum has forced the technology into ever-higher frequency bands. These higher frequencies have some advantages, but are problematic for some traditional antenna designs. This project will address these problems through the design of new electromagnetic materials. To understand how antenna design has changed, consider that early mobile networks used frequencies of around 1GHz, where the wavelength is 30cm and there is very little atmospheric absorption or scattering. Meanwhile current 5G networks make use of frequencies up to around 50GHz, where the wavelength is 6mm. Although 6G technology is yet to be defined, the expectation is that it will use the largely empty portion of the EM spectrum at even higher frequencies; from 100GHz to 3THz, where the wavelength ranges from 0.1-3mm. These shorter wavelengths come with advantages, but also new challenges. Firstly there is attenuation. These higher frequencies approach the rotational and vibrational resonances of atmospheric molecules, and the mm scale approaches the size of larger airborne particles where Mie scattering also becomes significant. Therefore, a mm wavelength beam will typically be attenuated much more strongly than microwave communication at frequencies of tens of GHz or below. To overcome the limitations of attenuation, mm wave antennas produce a highly directive beam, concentrating more radiated energy at the receiver. This PhD will explore the art of the possible providing theoretical and practical details back on how best to achieve future system requirements, driven from the exploitation of a metamaterials approach.
1.2	**Requirement**

	The requirement of the PhD is to study and understand the extension of graded metamaterial forms and their suitability and applicability to mm-wave requirements. Once established, the scope of the study will be to design and manufacture metamaterial forms that will allow for the practical evaluation of the radiated performance. Finally, it is desired that array forms of the metamaterials which have been proven prior, be designed and packaged in arrays to show how radiated waves and fields may be achieved. **Payment Plan** Progress payment 1: end of PhD Year 1 (end of August 2023) Progress payment 2: end of PhD Year 2 (end of August 2024) Progress payment 2: end of PhD Year 3 (end of August 2025) Milestone 1: PhD Thesis – on completion of PhD Year 4 (end of August 2026) **NOTE: Payment will be annually in arrears, and upon satisfactory completion of all deliverables at the end of each PhD Year.** **Additional Definitions** "PHD Year" A consecutive twelve (12) Month period during the Term, commencing on the date that the Authority formally confirms approval of the student in writing **Research Workers** Supervisor – [Redacted] Under FOI Exemption Co-Supervisor – [Redacted] Under FOI Exemption Student – [Redacted] Under FOI Exemption
1.3	**Options or follow on work** *(if none, write 'Not applicable')*
	Not Applicable
1.4	**Contract Management Activities**
	• Annual progress reports • Final PhD Thesis on completion of PhD
1.5	**Health & Safety, Environmental, Social, Ethical, Regulatory or Legislative aspects of the requirement**
	Not Applicable

[Redacted] Under

1.6	Deliverables & Intellectual Property Rights (IPR)				
Ref.	**Title**	**Due by**	**Format**	**Expected classification** (subject to change)	**What information is r deliverab**
D - 1	Annual progress reports that should coincide with the academic reporting requirements and / or end of academic year requirements	Every 12 months from PhD commencement (i.e. by September each year of PhD)	Report	[Redacted] Under	• Update on technical • Technical results • Technical designs • Application informati
D - 2	Final PhD thesis	End of PhD year 4	Thesis	[Redacted] Under	PhD Thesis

1.7	**Deliverable Acceptance Criteria**
	All Reports included as Deliverables under the Contract e.g. Progress and/or Final Reports etc. must 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. Interim or Progress Reports: The report should detail, document, and summarise the results of work done during the period covered and shall be in sufficient detail to comprehensively explain the results achieved; a description of current substantive performance and any problems encountered and/or which may exist along with proposed corrective action. An explanation of any difference between planned progress and actual progress, why the differences have occurred, and if behind planned progress what corrective steps are planned. Final Reports: shall describe the entire work performed under the Contract in sufficient detail to explain comprehensively the work undertaken and results achieved including all relevant technical details of any hardware, software, process or system developed there under. The technical detail shall be sufficient to permit independent reproduction of any such process or system. All Reports shall be free from spelling and grammatical errors and shall be set out in accordance with the Statement Of Requirement (1) above. The Report shall summarise the results of work performed during the period covered in sufficient detail to comprehensively explain the results achieved, provide a description of current substantive performance and details of any problems encountered and/or which may exist along with proposed corrective action. The Report must contain sufficient detail to explain the work undertaken in that period, this could include supporting information such as raw data in an Excel or GraphPad Prism format, relevant scientific graphs and diagrams. If upon review of the progress reports and/or the final PhD thesis, the Authority [redacted] does not accept the deliverables, the Contractor shall provide acceptable replacements at no additional cost to the Authority.

2	**Evaluation Criteria**
2.1	Method Explanation
	Evaluating this based on technical compliance and affordability.
2.2	Technical Evaluation Criteria

	Confirmation that the proposal fully meets the Authority's Statement of Requirement. Pass/Fail
2.3	Commercial Evaluation Criteria
	Tenderer has submitted a commercially compliant bid. Firm priced version submitted within budget of [redacted] Pass/Fail Labour rates and price as per single source rates uploaded to R Cloud Pass/Fail Completion of Research Workers Form's Pass/Fail Completion of Statement Relating to Good Standing Pass/Fail Completion of SAQ Pass/Fail Confirm acceptance of R Cloud Version 4 Terms and Conditions Pass/Fail Completion of DEFFORM 711 Pass/Fail

Government Furnished Assets (GFA)					
GFA to be Issued - Yes					
GFA No.	**Unique Identifier/ Serial No**	**Description:**	**Available Date**	**Issued by**	**Return Date or Disposal Date (T0+)**
GFA-1	[redacted]	May be a requirement to use a [redacted] piece of test equipment for the evaluation of the materials performance. This will need to be conducted at a [redacted]	When required	[redacted]	[redacted]