Call for Proposals

Call for Proposals title:	Development of near real-time, high-resolution hazard prediction models for urban environments
DMTC Program:	CBR Modelling and Simulation
Issue Date:	May 2021
Proposal Due Date:	16 July, 2021

Contents

1. EXECUTIVE SUMMARY

DMTC Limited (formerly the Defence Materials Technology Centre) is a not-for-profit collaborative venture that brings together Defence, industry, universities and research organisations to develop technologies and solutions that enhance Australia's Defence and National Security capability.

Defence Science and Technology Group (DSTG), through DMTC, are seeking innovative research proposals to develop near real-time, high-resolution hazard prediction models for chemical, biological or radiological (CBR) transport and dispersion in urban environments. Australian universities, research organisations, and industry are invited to submit research proposals that aim to improve the resolution and performance of state-of-the-art hazard prediction models. Up to $1.5 million over 3 years will be available to fund research projects. Outcomes from this program will enhance Defence and National Security capability, and contribute to the wider hazard modelling community.

2. INTRODUCTION

2.1. STRATEGIC CONTEXT

The emerging threat and interest in CBR weapons by state and non-state actors presents a growing risk to Australia and its interests. In response to this growing threat, the Australian Department of Defence is investing in capability to support operations in CBR contaminated environments. The scope of future Defence Force operations is likely to include populated and urban environments. Preparedness and response to these threats requires an ability to rapidly and accurately predict the effects of a CBR release in urban environments.

2.2. ABOUT DSTG

DSTG is a key enabler to support the Australian Defence Force's (ADF) CBR capability. DSTG use hazard prediction models to estimate the effects of a CBR release and provide time-critical information to support Defence Force operations; Defence capability and acquisition programs; inform threat and risk assessments; and inform National Security policies.

Near real-time, high-resolution hazard prediction models are required to enhance Defence Force capability and accurately characterise the contaminated hazard area in an urban environment. Accurate and rapid characterisation of the contaminated hazard area will:

- Enable near real-time situational awareness of the CBR threat;
- Inform optimal development and employment of CBR capability;
- Support the conduct of large-scale sensitivity analysis for researchers and analysts; and
- Guide operations and activities in contaminated environments such as sampling, decontamination, sensor placement, and manoeuvres.

2.3. BACKGROUND

Accurate prediction of the transport and dispersion of CBR material in an urban environment is dependent on the resolution of wind flow in the urban complex. Wind flow around buildings and street canyons is inherently complex and exhibits a wide range of physical phenomena. This includes unsteady flow regimes, adverse pressure gradients, multiple vortex systems, impingement, separation, and large variations in wind speeds. Wind-field models are used in hazard prediction models to calculate the flow-field patterns and turbulence parameters for transport and dispersion of CBR material. Wind-field models for urban environments are typically categorised into either: 1) fast-running, low-fidelity diagnostic methods; or 2) high-fidelity prognostic methods.

Diagnostic methods estimate the flow-field patterns and turbulence parameters from observed data using empirical fitting schemes or mass consistent flow-techniques. They typically do not contain flow-field physics (besides mass conservation), and are, in general, quick to execute. This makes them suitable for real-time operational and emergency response planning. MicroSWIFT/SPRAY[1] and QUIC[2] are representative of this type of hazard prediction model and use a diagnostic method developed by Rockle[3].

Unlike diagnostic methods, prognostic methods are physically-based. Prognostic methods model and simulate the governing equations of fluids to resolve the flow-field patterns. Computational fluid dynamics (CFD) codes, such as direct numerical simulations (DNS), large eddy simulations (LES), detached eddy simulations (DES), Reynolds-averaged Navier-Stokes (RANS) equations, and the primitive equations are examples of prognostic methods used in urban flow-field modelling. These methods use minimal atmospheric data to accurately resolve the microscale urban environment. In principle, prognostic methods provide forecasting capabilities at finer resolutions than state-of-the-art diagnostic methods.

The complexity and computational demands of prognostic methods have limited application in operational and emergency response planning hazard prediction models. Prognostic methods require improvements in numerical algorithms, physics sub-models and hardware processing speed to become practical in real-time operational and emergency response planning.

2.4. THE PROBLEM

Operations in contaminated environments require detailed resolution of the effects of a CBR release in urban complexes. Current hazard prediction models based on diagnostic methods lack the resolution to estimate the effects of a CBR release in the building or sub-canyon length-scale (1 – 10 m). DSTG is interested in improving the resolution of state-of-the-art diagnostic methods, or developing prognostic methods capable of supporting real-time operations and emergencies.

2.5. CALL FOR PROPOSALS

DSTG, through DMTC, is seeking innovative research proposals from Australian universities, research organisations and industries to partner with Defence to develop near real-time, high-resolution hazard prediction models. Priority areas include the development of new prognostic wind-field models, improvements to physics sub-models, and efficient numerical schemes. Research proposals should provide a statement of work that aims to improve the resolution and performance of the state-of-the-art in urban wind-field models or urban contaminant dispersion models. Details of submission requirements are outlined in section 4.

---

[1] Borrego C, Tinarelli G, Brusasca G, Oldrini O, Anfossi D, Castelli S and Moussafir J (2006), *Micro-Swift-Spray (MSS): A New Modelling System for the Simulation of Dispersion at Microscale – General Description and Validation*, Air Pollution Modeling and Its Application XVII, pp. 449-458.

[2] Brown M, Gowardhan A, Nelson M, Williams M and Pardyjak E (2009), *Evaluation of the QUIC wind and dispersion models using the Joint Urban 2003 field experiment dataset*, 8th AMS Urban Environment Symposium, Phoenix USA.

[3] Rockle R (1990), *Bestimmung der Stromungsverhaltnisse im Bereich komplexer Bebauungsstrukturen*, Ph.D thesis, Vom Fachbereich Mechanik, der Technischen Hochschule Darmstadt, Germany.

3. PROJECT SCOPE

3.1. AREAS OF FOCUS

The program seeks innovative methods to rapidly and accurately estimate the effects of a CBR release in an urban environment. Research proposals should aim to address one or more of the key areas of focus outlined below:

- Microscale, obstacle-aware diagnostic or prognostic wind-field models;
- Obstacle and building-aware dispersion models;
- Development of turbulent sub-models in urban environments; and
- Numerical methods to improve the resolution or performance of existing diagnostic or prognostic wind-field models.

Priority will be given to prognostic methods that can resolve wind-fields and hazardous effects in the sub-street canyon length-scale (1 – 10 m) in near real-time.

3.2. OUT-OF-SCOPE

The following areas are out of scope and unlikely to receive endorsement:

- Methods based on optimising existing CFD codes for parallel computations, high-performance computing (HPCs) environments, or graphical processing units (GPUs);
- Commercialisation of existing codes;
- Software and data integration between software suites, databases and sensors;
- Application of commercial or open-source CFD codes to generate large datasets for scenarios;
- Verification trials and/or studies supporting model validation. This includes large-scale field-trials and laboratory experiments[4].

3.3. FUNDING OPPORTUNITY

Up to $1.5 million over 3 years will be awarded by DSTG. Where multiple proposals of merit are received, funding may be divided to support multiple research projects or invited to form a strategic partnership. This should be taken into consideration when scoping and costing the submission.

4. APPLICATION PROCEDURE

4.1. PROGRAM GOVERNANCE

A stakeholder community representing the interests of Defence and National Security will be appointed by DMTC. On behalf of this stakeholder community, the CBR Modelling and Simulation (M&S) Technical Advisory Group (TAG), will be responsible for approving, endorsing and guiding the projects during the three-year life of the program. DSTG, as the project sponsor, will provide oversight and technical guidance to the project. Day-to-day administrative, management, reporting and support activities will be overseen by DMTC. Reporting delivered to DMTC will consist of quarterly and as-agreed technical milestone reports, and include a formal project review every six months throughout the duration of the project.

[4] It is expected that the verification and validation of developed software and underlying models will form the basis of subsequent programs of work. Proposals which describe how models could be validated in future work programs will be viewed favourably.

4.2. SUBMISSION REQUIREMENTS

Applicants should provide a research proposal that addresses the problem of improving the resolution and/or performance of state-of-the-art hazard prediction models. Research proposals should address one or more areas of focus, and include:

- A brief statement of the research problem;
- A brief statement of how this research problem complements the applicant's research interests and strategic priorities;
- Key research questions and objectives;
- The methods used by the applicant to address the research problem;
- Background and supporting information to substantiate the method;
- Expected contribution to the state-of-the-art in hazard prediction models, and any anticipated improvements to the resolution and/or performance;
- Key deliverables and outcomes;
- The Technology Readiness Level (TRL) at the commencement of the project and the anticipated TRL at the end of the project (see Appendix 2 for TRL definitions); and
- Funding and resourcing requirements.

Joint submissions between multiple universities, research organisations and companies are also encouraged.

4.3. SELECTION CRITERIA

Research proposals will be assessed by the CBR M&S TAG and DSTG according to the following criteria:

- Anticipated improvements to the state-of-the-art hazard prediction models;
- Feasibility of the research proposal and likelihood of success;
- Innovation of methods;
- Demonstrated knowledge and experience in related fields;
- Alignment with applicant's own research and development (R&D) interest and strategic priorities;
- Alignment to Defence requirements;
- Commitment to develop a genuine and enduring research partnership with the Defence hazard modelling community.

Where multiple proposals of merit are received, the CBR M&S TAG and DSTG reserves the right to invite those organisations to submit a collaborative research proposal.

While there is no requirement for cash or in-kind contributions to the project, it will demonstrate a genuine interest in developing a collaborative partnership. Please outline any cash or in-kind contributions to support this research program in your proposal. Please also ensure that any cash or in-kind contributions included in the proposal have been endorsed by your organisation with the necessary delegated authority.

4.4. ELIGIBILITY

To be eligible you must:

- have an Australian business number (ABN);
- be registered for the Goods and Services Tax (GST).

and be one of the following entities:

- an entity incorporated in Australia;
- an incorporated association; and
- an incorporated not for profit organisation.

4.5. INTELLECTUAL PROPERTY

DMTC's intellectual property (IP) policy[5] closely aligns with other national defence innovation programs[6]. The key aim is to ensure that industry has the ability to commercialise project outcomes whilst guaranteeing ongoing access to government and research stakeholders for non-commercial purposes. DMTC will own the foreground IP. DMTC arrangements facilitate innovation and allow joint industry, researcher, and government engagement in projects without probity risks for future national procurements.

DMTC's IP approach streamlines adoption and utilisation of technology developed under DMTC program activities. Partner rights for utilisation of the IP created in projects are articulated in the engagement agreements, removing the need for negotiation of usage licenses after the IP has been developed.

DMTC partners always retain ownership of the intellectual property they bring to a project. Most DMTC projects involve multiple industry partners, with DMTC assuming the coordination role, and providing licences to partners to apply foreground IP in their fields.

4.6. CONFIDENTIALITY

DMTC will treat all applications confidentially. DMTC will share submitted proposals for this Call for Proposal with Australian Government stakeholders including DSTG and the members of the Technical Advisory Group.

4.7. DISCLAIMER

Applicants with an area of expertise, research or technology relevant to the aims of this project may be requested to provide further information. Review of additional information does NOT guarantee funding will be granted.

4.8. CONTACT PERSON

All questions related to this Call for Proposal and lodgement of application should be directed to:

Name:	Dr Matthew Byrnes
Title:	Program Leader – CBR Modelling and Simulation
Address:	DMTC Ltd Level 2 24 Wakefield Street Hawthorn Vic 3122
Telephone:	03 9214 4447
Email:	matthew.byrnes@dmtc.com.au

[5] DMTC IP policy: https://dmtc.com.au/wp-content/uploads/2018/03/DMTC_IP-Factsheet.pdf
[6] Defence Innovation Hub IP policy: https://www.dst.defence.gov.au/sites/default/files/basic_pages/documents/Innovation_Hub_IP_Strategy.pdf

4.9. LODGEMENT INSTRUCTIONS

Please use the attached DMTC CBR M&S Proposal Template for your submission.

Completed proposals should be returned by no later than Friday July 16, 2021. Earlier applications are welcome.

Please submit applications to: matthew.byrnes@dmtc.com.au

All submissions should be in **Word format**.

When responding to the Call for Proposal by email, please ensure the following line appears in the subject line:

- "***Call for Proposals: Development of near real-time, high resolution hazard prediction models for urban environments***".