Centre for Defence Enterprise

Future Sonar

Harnessing discovery and invention for future sonar advantage

Competition launch: 25 March 2014
Competition close: 29 May 2014

The Centre for Defence Enterprise (CDE) proves the value of novel, high-risk, high-potential-benefit research sourced from the broadest possible range of science and technology providers, including academia and small companies, to enable development of cost-effective capability advantage for UK Armed Forces and national security.

Proposals for funding must be submitted by **17:00 on 29 May 2014** using the Centre for Defence Enterprise Portal. Please mark all proposals for this themed competition with "**Future Sonar + challenge 1, 2 or 3"** as a prefix in the title.

- **Technical queries** should be sent to dstlmaritimeinnovation@dstl.gov.uk Please see guidance on using this facility under the 'Queries and Help' section.
- **General queries** (including how to use the Portal) should be sent directly to CDE at cde@dstl.gov.uk.

CDE: www.science.mod.uk/enterprise
Dstl: www.dstl.gov.uk

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[dstl]

Defence Science and Technology Laboratory

Ministry of Defence

Harnessing Discovery and Invention for Future Sonar Advantage

The Maritime Freedom of Manoeuvre Programme is committed to working with leading innovators across all sectors, from very small companies and world-class universities to the larger defence industry. Its purpose is to provide the Royal Navy (RN) with a step change in capability and to build the tools and knowledge from which UK industry can improve its competitiveness in maritime science and technology (S&T).

This Centre for Defence Enterprise (CDE) themed competition is about today's innovation achieving a sonar advantage in the 2030s and beyond (while addressing some of today's problems too, if possible). The RN operates world-class sonar systems from ships, submarines and aircraft that are underpinned, in many places, by innovation from the 1990s and earlier. In the future, the RN must deliver defence capability more flexibly from a mix of traditional platforms and deployable or disposable systems, while meeting the challenges of operating with a smaller Navy in the face of changing threats and a growing open-technology market. This has created the environment in which finding the technology edge is even more important.

This CDE competition is therefore about future sonar advantage that can *surprise* a UK adversary. We expect an advantage to be provided by solutions to reduce sonar cost[1], size, mass, power, environmental impact or to increase reliability, bandwidth, directionality, sensitivity, and robustness of sonar technology. However, we are seeking *all* solutions that could eventually be exploited for the RN. In particular, we are seeking proposals that can advance a recent technological discovery or breakthrough to achieve the greatest sonar advantage. This could mean conventional or unconventional ways of sensing or producing underwater sound.

This CDE competition seeks phase 1 projects spanning a period of up to 9 months. Follow-on phase 2 funding of up to three years will be available to the most promising projects to enable the proposed solutions to be matured and developed over the medium term.

This CDE competition consists of three challenges.

Challenge 1 Harnessing discovery and invention for future sonar advantage

Challenge 2 Measuring decision effectiveness

Challenge 3 Non-destructive evaluation of sonar technology

Please be aware that £600K of the total £850K available has been reserved for challenge 1 as this is the **only** planned opportunity for funding in this technology area during the next

[1] Cost can provide an advantage in itself but it is not necessary for all solutions to be "low cost" at this stage.

four years. Therefore this CDE competition is the single entry point for research in this technology area.

Scope

The desired outcome from each phase 1 project funded from of this CDE competition is an understanding of the potential impact of your solution and the pathway to impact. It is expected that under the funding available from this competition you will have advanced the exploitation readiness of your solution and therefore reduced the risks associated with the next stage of research and development and the time to when a solution could be adopted.

This competition is not limited to low technology readiness level[2] (TRL) solutions and you can offer a solution at any stage of technology development. There are opportunities for early exploitation of your technology if appropriate.

Challenge 1 – Harnessing discovery and invention for future sonar

This competition is not limited to a particular platform or capability – it seeks solutions that challenge traditional approaches and lead to a sonar advantage that can *surprise* a UK adversary.

To offer some guidance, some examples of how a sonar advantage could make a difference are presented below.

Reducing cost, size, mass, and power

Existing submarine hull arrays are physically large and very heavy, which places constraints on the physical aperture and, consequently, the detection performance of the sonar. *Your solution* here would remove some of the current limitations imposed by large and heavy arrays, such as the number of sensors that can be used or the flexibility with which sensors can be used and maintained.

It could then be possible to achieve an advantage from, for example:

- covering a greater surface area of a smaller number of submarines with sensors
- using smaller submarines and unmanned systems
- maintaining submarines and other manned platforms without costly repairs
- producing highly populated arrays from ultra-cheap sonar technology.

Reducing impact on the environment

Future sonar systems will be increasingly affected by regulatory controls; for example the use of hazardous materials and the management of discharges or expendable devices into the underwater environment, as well as new controls on the protection of marine fauna.

[2] For a description of Technology Readiness Levels (TRLs) see the Acquisition Operating Framework https://www.gov.uk/acquisition-operating-framework

Your solution here would remove some of the possible limitations in these controls about where and when sonar can be operated.

It could then be possible to achieve an advantage from, for example:

- having the freedom to gather sonar data and information in all underwater environments and at all times
- using dissolvable or degradable devices.

Increasing bandwidth, directionality, and sensitivity

Today's sonar arrays achieve an advantage from the bandwidth, directionality and sensitivity of the sonar but are unlikely to keep pace with threats and changes in the environment in the future unless these properties can continue to be improved. *Your solution* here would offer more capable sonar with which to outperform our adversaries.

It could then be possible to achieve an advantage from, for example,

- using a smaller number of platforms to achieve wide area coverage
- finding submarines and mines more easily in shallow waters
- increasing the range at which quiet targets can be detected in noisy or reverberant environments.

Increasing reliability and robustness

The current platform mix across anti-submarine warfare and mine countermeasures is likely to change in the near future and sonar performance will need to be regenerated affordably as ships are withdrawn from service. Consequently, there is an increased emphasis on robust sonar technology that can be used reliably from different platforms and with less need for monitoring or maintenance. *Your solution* here would offer known sonar performance in all operating environments.

It could then be possible to achieve an advantage from, for example,

- reducing the number of specialist manned platforms
- reducing operator workload or intervention that is needed
- increasing the influence of submarines at range
- using autonomous systems for a wider range of operations.

Increasing intelligence

Successful sonar operations depend on timely delivery of accurate and trusted information about the underwater environment. Consequently, sonar technology needs to be versatile and to be able to adapt to the threat or environment to maintain the quality of this information. *Your solution* here would enable us to get the greatest performance from the sonar technology that is available.

It could then be possible to improve on all the advantages above.

Other factors could be considered and we would encourage you to think about all the ways that a technological advance can lead to an advantage.

Challenge 2 – Measuring Decision Effectiveness

Improvements to sonar technology are important in supporting future military capability requirements. However, consideration also needs to be given to how operators make effective use of these enhancements to deliver overall military benefit.

Military combat system performance can be divided into four assessment levels (shown in Figure 1):

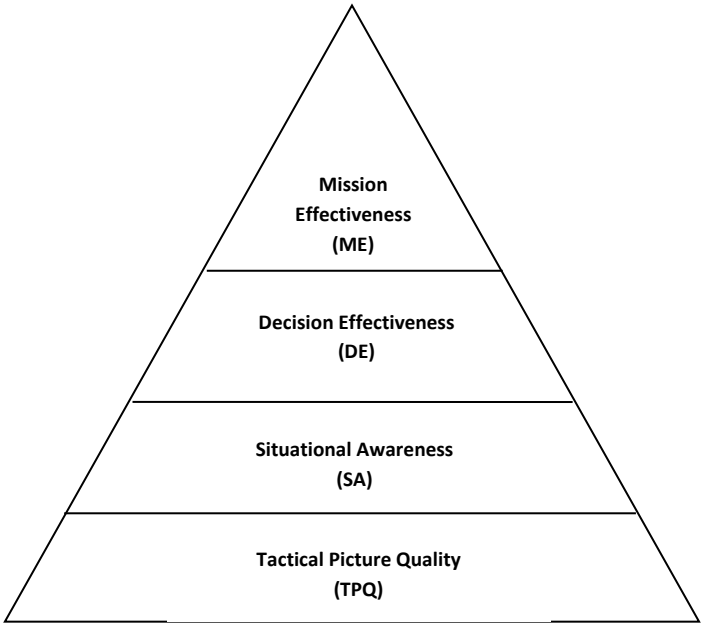

Figure 1. Hierarchy of military combat system performance levels.

The levels represent the different information processing that is carried out, and the information used by an operator or other decision maker. Within each level it is possible to measure the benefits gained by individual improvements, such as, the benefit of advanced data processing at the Tactical Picture Quality level or the benefit of improved visualisation at the Situational Awareness level.

However, without a direct measurement for Mission Effectiveness it is difficult to understand which are the most beneficial improvements. This measurement can be difficult and consequently it can become necessary to use human-in-the-loop experimentation. This can lead to conflict between performance measurements that are militarily relevant versus those that are affordable.

What we are looking for?

Challenge 2 is seeking new measures of decision effectiveness, and tools and techniques for assessing the decision effectiveness resulting from different systems or processes. It is expected that these tools and techniques will make it possible to understand which aspects of the tactical picture have the most impact and benefit to Situational Awareness and

Decision Effectiveness. Those aspects should be weighted in accordance with their importance in terms of achieving the objectives of the mission.

The desired outcome is for affordable and objective measures of decision effectiveness that can be used by government scientists, military and civilian decision makers. Solutions should be at the proof-of-concept stage and should describe the extent to which the tools and techniques have been verified and validated. Options for experimental design should be included, with consideration of ethical issues, together with alternative approaches where possible.

It is expected that solutions will draw on ideas from a broad spectrum of science and technology that have developed measures of effectiveness for non-defence purposes.

Challenge 3 – Non-Destructive Evaluation of Sonar Technology

The ability to determine the chemical and physical state of the structure of the sonar is an important part of its in-service assurance. It may become damaged during its operating life. However, the quality of the information used to determine the state of our current sonar arrays and systems can be limited by the types of materials and structures that are used.

For example, submarine hull arrays are complex structures attached to the steel hull of a submarine. Typically these comprise a decoupling layer, electronic sensors, telemetry and cabling, and an encapsulating layer (see Figure 2). The structure of the sonar is routinely subject to changes in pressure, temperature and physical impact.

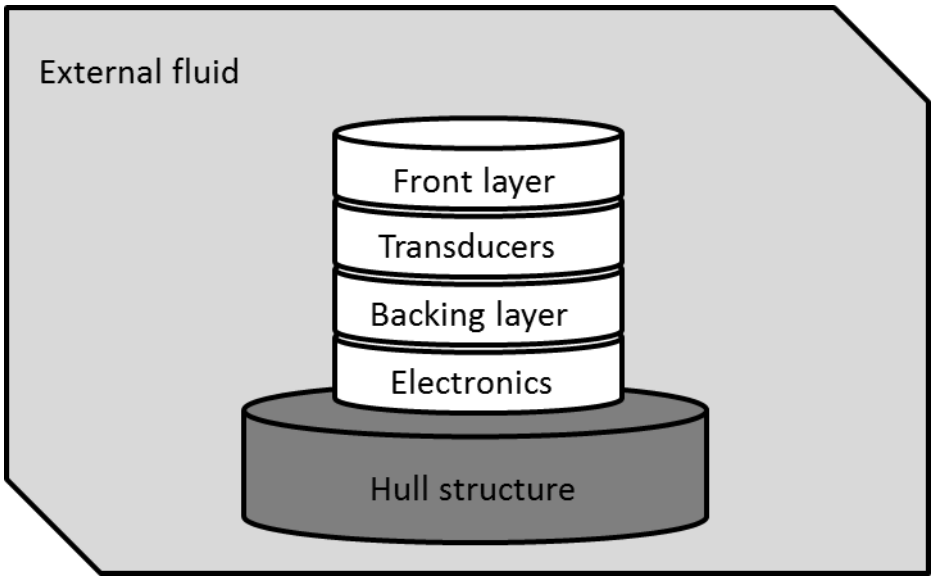

Figure 2. Illustration of the layers in a typical sonar array

Non-Destructive Evaluation techniques are commonly used to inspect the integrity of welds and other parts of the structure. They also detect faults such as cracks in metals and larger irregularities. The shorter testing time afforded by some of these techniques greatly reduces

the length of any maintenance or repair period. This ensures that the submarine is returned to service more rapidly and in a better material state. However, current Non-Destructive Evaluation techniques have limitations, making it difficult to fully assess the different properties or aspects of a sonar array.

To determine the state of current sonar technology, and improve our knowledge of the state of current arrays and systems, new techniques are needed**.** These should detect and localise water ingress along cables that are embedded in an encapsulating material, or water ingress between different layers. They should also improve the resolution of the information on the material / mechanical properties of the sonar.

What we are looking for?

Challenge 3 seeks new techniques for the Non-Destructive Evaluation of sonar technology to determine the integrity of the structure of the sonar as well as evidence of faults. These faults may be very small and may be embedded below the surface of the sonar. It is expected that new techniques will be safe to use and cost effective as well as being portable and reliable.

The desired outcome is for advanced techniques that can overcome the limitations of traditional Non-Destuctive Evaluation techniques. Solutions should be at either the proof-of-concept or early demonstration stage. They should describe the extent to which the techniques have already been verified and validated. They should also describe the body of evidence that will be generated to provide confidence in the technique for this application.

It is anticipated that Non-Destructive Evaluation techniques and other methods have been developed for non-military applications. Consequently successful solutions are likely to be drawn from a broad spectrum of science and technology.

Invitation for Proposals

We are seeking applications from experts and innovators who are leading the thinking and creating the knowledge around a recent technology discovery or breakthrough, or leading the understanding of improving the readiness for exploitation of emerging technology.

You do not need to be part of a collaboration to enter this CDE competition but you will be encouraged to make new connections during phase 1 that can increase the impact of any phase 2 follow-on funding.

This CDE competition will fund phase 1 proposals spanning **up to 9 months**. Our aim is for contracts to be awarded before the end of July 2014 and completed before the end of April 2015.

This CDE competition has a total budget of up to £850k, with £600k of this reserved for challenge 1.

There is no cap on the value of proposals but it is more likely that at phase 1 a larger number of lower-value proposals (eg £40k—£80k) will be funded than a small number of higher-value proposals.

Proposals must include as a minimum:

- a clear description of the programme of work that would be carried out
- a clear description of the proposed solution and the exploitation readiness at the start and end of this programme of work
- a clear description of the deliverables and how they will be proven or demonstrated
- a clear description of the benefit of the solution

Please note that proposals should include attending an interview and preparing a costed plan for follow-on work in the list of deliverables for phase 1.

Proposals will be assessed by subject matter experts from MOD and Dstl using the MOD Performance Assessment Framework (PAF) (available from the CDE website).

If you are not successful in this CDE competition you will still be welcome to participate in the Maritime Collaborative Enterprise (MarCE)[3] that is acting on behalf of Dstl to deliver the majority of the "sensing and decision making" elements of the Maritime Freedom of Manoeuvre Programme.

Follow-on Research and Development Programme in Acoustic Sensing

Up to **three years** of phase 2 follow-on research funding will be available to the most promising projects. Please note that any additional funding will be awarded and contracted separately using a different contracting mechanism (ie not via CDE).

Proposals for follow-on funding should be submitted as a deliverable from the first phase of work **by 19 March 2015**. They should include a summary of the outcomes from phase 1, a full description of the proposed follow-on project, a price breakdown structure and proposed start date and outputs. Full details of this requirement will be provided within the contracts awarded from the phase 1 CDE themed competition. The provision of a phase 2 funding proposal should be a costed deliverable within the phase 1 proposal submission.

[3] For more information about the Maritime Collaborative Enterprise (MarCE) Sense to Decide contact MarCES2D@baesystems.com

Successful phase 1 organisations will be required to attend an interview at Dstl Portsdown West **on 15-17 April 2015** to provide a presentation and answer questions about the achievements and outcomes from their projects and about their bids for follow-on work. The interview will be looking for confirmation that the organisation understands the potential impact of their solution and that the bid for follow-on phase 2 funding would mature the solution and lead to future sonar advantage that could eventually be exploited by the RN. This will be combined with a formal assessment of the bids from which the most promising will be awarded follow-on contracts. The attendance at the interview should be a costed deliverable within the phase 1 proposal submission.

Interview assessors will use questions similar to the examples below to guide their consideration of your bid for follow-on phase 2 funding:

> **Purpose.** To what extent would the follow-on work be expected to increase the potential for exploitation of the technology under investigation? What makes the follow-on work ambitious, risky and transformative? Would the technological discovery or breakthrough being investigated surprise a UK adversary if it was adopted by the RN?
>
> **Skills and experience.** What evidence is provided that your organisation is leading the thinking and creating knowledge around the technology under investigation? What recent or relevant experience does your organisation have in developing and exploiting innovation? Would the follow-on work develop tools and knowledge to offer long-term benefits to the S&T research community?
>
> **Delivery.** To what extent would your organisation develop an understanding of the potential impact of your solution and the pathway to impact? What partnerships would be used or developed as part of follow-on work? Would the follow-on work develop an understanding of the likely costs and infrastructure needed to mature the technology under investigation?
>
> **Benefits and novelty.** What evidence is provided that the proposed solution would improve the status quo? Would the proposed work offer value for money and outcomes that could be exploited?

Organisations should consider these example questions in preparing a response to the challenges presented in this document.

Key Dates

- 25 March 2014 — Competition launch and network event
- **29 May 2014** — **Competition closes at 17:00**
- 01 July 2014 — Competition decision conference*
- End of July 2014 — Target for phase 1 contracts awarded
- **19 March 2015** — **Closing date for proposals for phase 2 funding**
- **15, 16, 17 April 2015** — **Interview panels**
- End of April 2015 — Phase 1 contracts completed
- End of June 2015 — Target for follow-on phase 2 contracts awarded

Only dates in bold are fixed; other dates are indicative and should be used for guidance only.

*We aim for all proposers to be informed of the funding decision for your proposal within 2 weeks of the decision conference. Please do not contact CDE during this time as we will not be able to provide you with the outcome any sooner.

Process

Proposals must be submitted by **17:00 on 29 May 2014**, via the Centre for Defence Enterprise Portal **www.science.mod.uk/engagement/the_portal.aspx** . The Portal runs using an account system; if you do not yet have an account please ensure that open one as soon as practical.

All proposals must be clearly marked with "**Future Sonar + challenge 1, 2 or 3'** as a prefix in the title.

Please plan the timeline for submitting your proposal carefully. If you have not used the CDE Portal before you will need to become familiar with the guidance, including how to open an account starting with the Quick Start Guide (available on the CDE website).

Other information and guides are available on the CDE website:

- general CDE advice: www.science.mod.uk/engagement/cde/working_with_cde.aspx
- contract & IPR guidance: www.science.mod.uk/engagement/cde/funding_contracts.aspx

- on using the Portal: www.science.mod.uk/engagement/the_portal.aspx. The Portal is optimised for proposals based on physical sciences and engineering and we are aware that proposers sometimes struggle to adapt to using it with social science based proposals. The key points (rather than the detailed questions) that are sought under the main headings still apply and further advice can be obtained from CDE.
- presentation material giving advice on creating effective CDE proposals: http://www.slideshare.net/MOD_CDE/cde-creating-effective-proposals-part-1-of-2-final-na-u http://www.slideshare.net/MOD_CDE/cde-creating-effective-proposals-part-2-of-2-final-na-u

Common errors in preparing and submitting a proposal include:

- **character limit** – there is a limit of 1000 characters in each individual descriptive paragraph within the proposal; when completed they must be added to the document; additional paragraphs can be added if 1000 characters is insufficient.
- **it is a web-based tool** – please save your work regularly to avoid 'time-outs' that lose work.
- **attachments fail** – they must be Word 97-2003 format, portrait format, should have generous margins with no material overhanging the margin and a max size of 1 MB. Please note that attachments should only be used for supplementary information, the main points of your proposal should be written into the online form. Care should also be taken to make sure that attachments are placed in the relevant section (e.g. technical information should not be attached to the commercial section).
- **failing to properly submit** - **publish is not the same as submit**. You have **not** completed the submission process if your proposal is at the FINAL / PUBLISHED stage (in the status and published status columns respectively); CDE have no sight of the proposal at this stage. To complete submission you need to press 'submit' under the 'Tasks' column. This changes the status of your proposal to 'SUBMITTED'; it will then change (normally after a few days, often sooner) to 'RECEIVED' indicating that the proposal has been accepted by CDE for assessment.

For a proposal to be accepted for assessment:

- the standard terms and conditions of the CDE must be unequivocally accepted
- there must be at least one deliverable against which payment can be made
- the commercial section of the proposal must be completed.

Please do not leave submission of your proposal until just before the deadline. Past experience has shown that the Portal becomes heavily loaded near the competition close resulting in slow operation (up to 1 hour to publish rather than a few minutes) and that with the pressure of the deadline, mistakes are made that mean proposals are not submitted or accepted.

All proposals and content placed on the Portal must be UNCLASSIFIED.

Queries and Help

As part of the proposal preparation process, queries and clarifications are welcomed:

- **Technical queries** should be sent to dstlmaritimeinnovation@dstl.gov.uk.
  Capacity to answer these queries is limited in terms of volume and scope. Queries should be limited to a few simple questions or if provided with a short (few paragraphs) description of your proposal, the technical team will provide, without commitment or prejudice, broad yes/no answers. This query facility is not to be used for extensive technical discussions, detailed review of proposals or supporting the iterative development of ideas. Whilst all reasonable efforts will be made to answer queries, CDE and Dstl reserve the right to impose management controls when higher than average volumes of queries or resource demands restrict fair access to all potential proposal submitters.

- **General queries** (including how to use the Portal) should be sent directly to CDE at cde@dstl.gov.uk or by phone on 01235 438445.