MINISTRY OF DEFENCE

CENTRE FOR DEFENCE ENTERPRISE

[dstl]

# Data and Information Assimilation
## *to aid Maritime Decision Making*

Call for Research Proposals
Call Closes: 9 June 2011 (at 1200 noon)




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Proposals for funding must be submitted by 1200 (noon) 9th June 2011 using the Centre for Defence Enterprise Portal (www.science.mod.uk/enterprise). All proposals must be clearly marked “Maritime” as a prefix in the title.

- Queries relating to the *technical aspects* of the call should be addressed to DstlMaritime@dstl.gov.uk
- Queries relating to the *submission process* (including how to use the Portal) should be addressed directly to the CDE at science-enterprise@mod.uk or by phone on 01235 438445.

www.science.mod.uk
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## The Problem

Intelligence, communications, and sensory data are processed and presented to develop situational awareness, and inform command decision making. The problem is:

- High performance sensors produce a lot of data that need to be assimilated by the sensor operator(s) leading to potential *'operator overloads'* before passing that information to the command;
- The Command Management System is presented with increased information from a diverse number of sensors, which needs to be assimilated by the Command Team leading to possible *'information overload'* prior to the Command making his/her decisions;

The challenge is to optimise the flow of data and information through this sequence without rejecting valuable and useful features that could improve situational awareness.

This call for proposals is seeking innovative solutions that can realise the full potential of the information available from current and future information sources.

For clarity we define the following words used within this paper:

- **Data** are words, numbers, dates, images, sounds, measurements, etc. *without context*. In order to have meaning data items need to be part of a structure, such as a sentence, or within the context of this call, a time series.
- **Information** is a collection of words, numbers, dates, images, sounds, measurements, etc. *put into context*. To do this may require processing or filtering of the data.
- **Knowledge** is the ability of the operator(s), and command, to understand information and to then form judgements, opinions, make predictions and decisions based on that understanding. Within the context of this document information is the evidence (at varying levels of certainty) of the existence of a target.
- **Assimilation** is the overall process where the operator(s), and command, extract information, interpret its meaning, form opinions, make predictions, and ultimately make decisions.

**Key dates**

- 5th April — CDE launch seminar
- 9th June — Call closes at 1200 noon
- 14th July — Target for completion

## Setting the Scene

Maritime operations are normally complex in nature and involve military planning and decision making at a multitude of levels, see *Figure 1.*

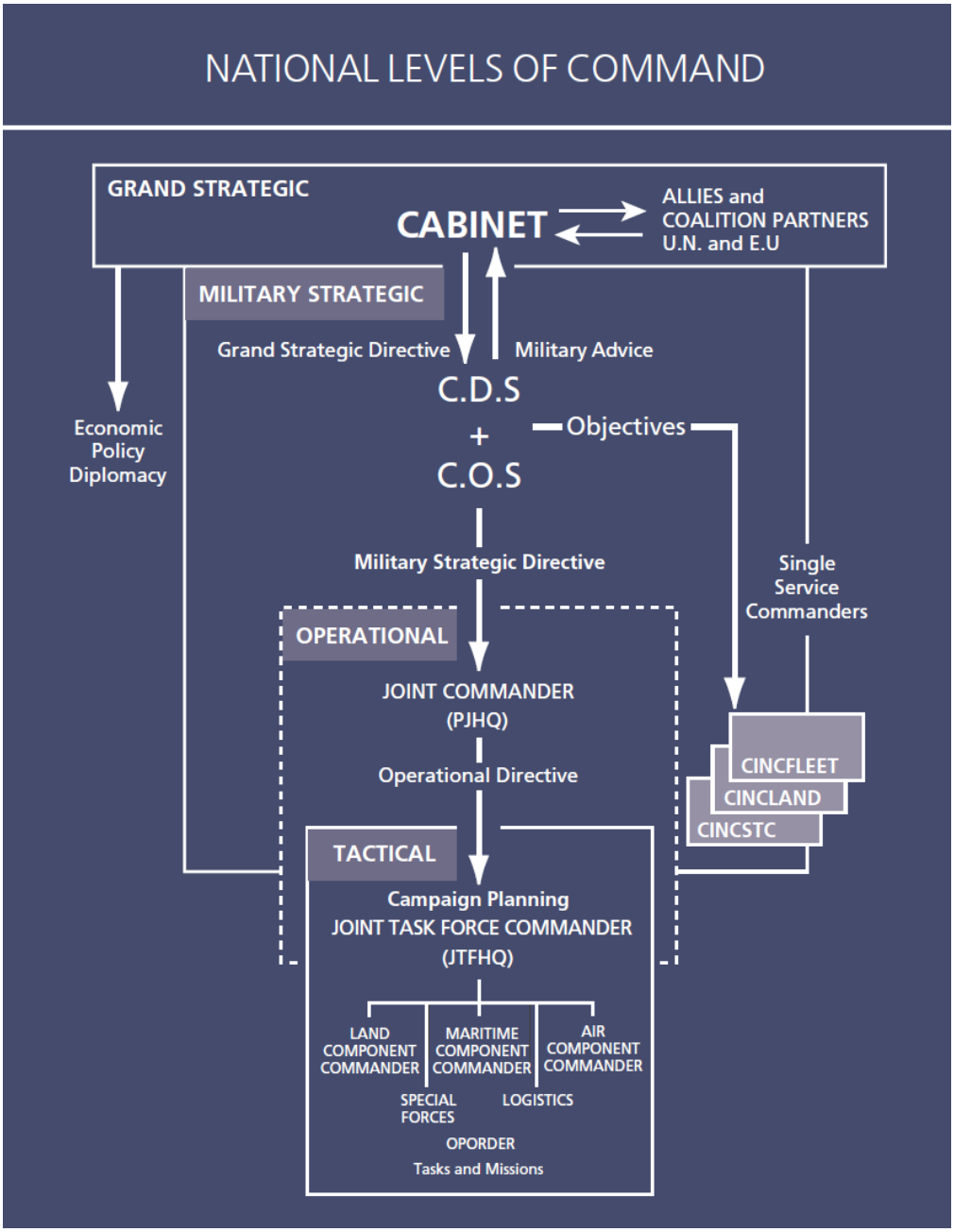


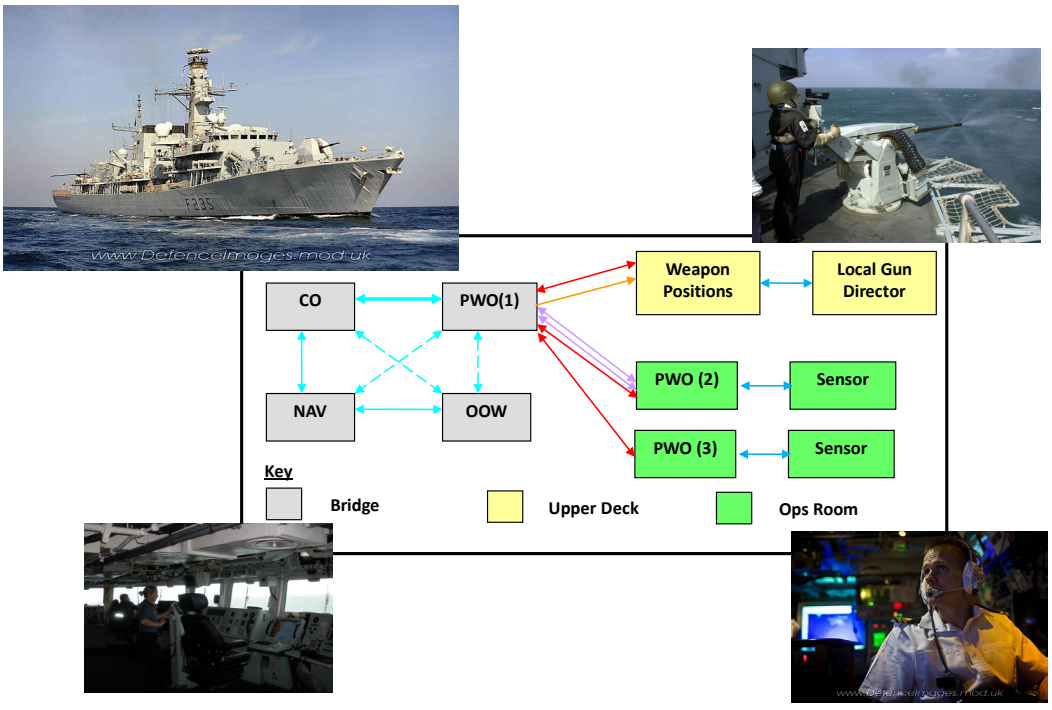

***Figure 1: Military Planning Process***

The military receive political direction, which is given to the Permanent Joint Headquarters at the strategic level. The joint commander runs the operation and he may or may not be in theatre; this is the operational level. Below is the tactical level, which is the level which concerns platforms or units, e.g. a ship. Information and decisions flow both ways throughout the command structure and

incorrect information, assessments or decisions, obviously have serious implications and which need to be mitigated.

Onboard the ship, the crew form a single large team composed of smaller teams. The decision cycle runs from the most junior operator to the most experienced and senior. Supervision helps to filter information from the sensors, which then provides as clear a picture as possible to the Commanding Officer or his representatives. Direction comes back to the operators to be used to maximise the sensor performance against a particular contact of interest or target, or in order to set up a potential weapon engagement. Without a clear "picture" or assessment of the situation, there is increased risk that command will make an incorrect decision. It should also be noted that when deployed on operations crews will be under stress, for example, through lack of sleep, rough weather and even fatigue from staring at a display for hours without sign of enemy activity. These conditions are mitigated through good leadership and other working practices but it is an important complicating factor to be considered in preparing proposals for this call.

An example, a counter-piracy operation, of the complexity of the internal workings of a ship's team is shown below in *Figure 2.* The Commanding Officer could be on the bridge or in the Operations (Ops) Room. The Principal Warfare Officer (PWO) is his senior warfare advisor onboard and is trained to and will take key decisions on his behalf. A ship will normally have two or three PWOs; PWO(1) indicates role and not seniority.




***CO*** *Commanding Officer* ***PWO(1)(2)(3)*** *Principal Warfare Officers*
***NAV*** *Navigator*

***Figure 2: Decision making at Ship Commander Level***

RN vessels always operate in three dimensions and are designed to deal with multiple threats, including those originating on land. Depending on the platform and the situation, a range of sensors

feed into building a comprehensive and real-time (as near as possible) picture, e.g. sonar, radar, infra-red, remote and autonomous sensors, etc. Other information may be drawn from databases via internal or external communications systems. A ship rarely operates in isolation and data is exchanged with other platforms to develop a situational awareness, and to manage weapon systems.

Over many years of operation, a ship is never designed from top to bottom by one company and integrating different sensors and systems represents a major challenge. Many new and modern sensors are capable of providing more data to the operator than ever before without being optimised for overall operation of the platform.

At each level, within both above water and underwater domains, the challenges faced by the command, and operators, are broadly similar but with different emphasis in the amounts of data and information, response times, and types of sensors used.

As the volume of data being processed by the human operators increases operators, need to extract important information using tools and techniques to support effective assimilation and decision making that utilises all relevant information. On board sources (such as radar, sonar and electronic support systems) are supplemented with off board sensors and networked data sources.

Novel approaches are needed to support the assimilation of this information and its use in decision making, including techniques to handle and visualise large and complex datasets. Opportunities to automate some functions and reduce workload need to have justified benefits.

## The Issues

**Align perception with reality**
Improve alignment between perception (the world according to the command/operator(s)) and reality (the real or sensory world).

**Manning**
Across defence the drive is towards reduced levels of staffing. Possible substitution, multi tasking, and gapping of functions compound manning issues.

**Operator Alertness**
Missions may have long periods of low activity interspersed with periods of high activity. We need to improve the ability of the command/operator(s) ability to respond to significant events.

**Overcome Stress**
A symptom of excessive stress is reduced 'operator alertness' however this is probably a separate issue.

**Data Overload**
Sensor operators are continually overloaded by very large amounts of data. The command may experience highly variable loading.

**Time criticality**
**I**n the above water situation things tend to happen extremely quickly hence both the command and operators(s) need to react almost instantly. In the underwater world things tend to happen at a more measured pace, clearly situations may arise when a submarine may need to respond quickly to an attack, however decisions are usually taken in a more considered timely measured manner. It might be argued that above water decisions tend towards being reactive, whilst in under water is more proactive.

**Holistic appreciation**
Both up and down the command chain decision makers need to have a holistic appreciation of the developing situation.

**Right information, right time**
Decision makers need to have access to the right information, at the right time, of the right reliability/accuracy … not swamped with superfluous information that may cloud judgment.

**Maintaining Continuity**
The platform needs to maintain continuity of situational awareness between watches.

# The Challenges

**What we want**
We need to quantify, and understand, the boundaries of what is achievable.
We are seeking radically innovative solutions to the problem that is explained below.

**What we don't want**
We are not looking for minor changes, or tuning, of solutions that have been tried and have previously failed; a proposal submitted to this call should move well beyond modifications to current sensor displays. Successful proposals should seek to eliminate the information bottlenecks and look forward to future generations of sensor systems.

The challenge is split into two groupings at the command level (integration of complex scenes), and at the operator level (overcoming operator overload).

What follows represents a number of ideas, however, they are by no means exhaustive and this call is open to innovative ideas from areas not traditionally associated with defence.

## Challenge 1 – Command Assimilation of *Information in* complex scenarios

To improve the capability to make command decisions by command level through better assimilation information provided as communications, intelligence, and information from sensor operators.

Possible areas for improvements could be achieved using virtual reality, three dimensional displays, use of sound, touch, etc., and perhaps semi, or complete, automation for the control of weapon systems and defence aid suites.

This call does not include data fusion, or command systems, which is covered elsewhere in the research programme.

## Challenge 2 – Operator(s) Assimilation of Data and Information

### *Challenge 2.1 - Improving the Operators' Ability to Assimilate Data/Information*

Historically, sensor operators are *'instructed'* how to use specific pieces of equipment, and how to interpret the features on their displays. They develop and use fixed strategies for searching through the data to extract information with tried and tested methods that they know work.

Successive generations of recruits have increasingly been brought up and educated on new and more sophisticated electronic and computer interfaces from across the internet, social networking gaming and many other areas. This provides both an opportunity and a challenge to consider new types of interface that will assist the assimilation of data.

For example, neuroscientists have conducted experiments to augment human sensory capabilities; of note is *'Magnetoception'* which gives the brain the ability to detect a magnetic field to perceive direction, altitude or location.

- Is it possible to use neuro-plasticity (where the brain functions are not fixed, but can change according to experience) to allow us to overcome bottlenecks?
- Could the problem be partitioned to make it scalable over one, or more sensor operators?
- Is it possible to use additional sensory channels not normally used by operators in their role to overcome bottlenecks on the others?

***Challenge 2.2 - Reduce the amount of Data/Information to be Assimilated***

Much of the sensor data presented to the operator is of no interest i.e. clutter, or data from known or benign sources. Only a very small proportion of the data is from a source that is a cause of concern. In addition there is the challenge of de-conflicting benign data from data of interest when they are coincident in range and bearing.

The complexities of the threat mean that the use of simple databases, to filter that information, is fraught with danger generating false alarms and missing genuine threats.

- Is it possible to associate information with data that is contained within databases, such as known sequences of events?
- Do methods of associating information to spatial and/or temporal location reduce that loading, or focus the operators' attention to regions that are of tactical importance?
- Do alternatives include the rejection of non-target like information, or the use of completely different methods of signal processing?

***Challenge 2.3 - Focus Operators attention to relevant Data/Information***

A considerable amount of effort has been devoted to automatic detection and alert processes for broadband, narrowband, and transients. Most of these methods depend upon analysing the statistical properties of signals. For various reasons the high false contact rates that are associated with such techniques distract the operators away from their perceived function (traditional role) and have gained little acceptance.

***Challenge 2.4 – Remove the man from the loop***

Is it possible to remove the operator completely from the sensor system?
This may at first seem to be a step too far, however, we are open to such suggestions.

# The Process

**Getting involved**

Proposals for *'Data and Information Assimilation to aid Maritime Decision Making'* are invited from industry, and academia, particularly those working within neuro sciences and other related areas of research. As part of the proposal preparation process, queries and clarifications on the types of data being analysed are welcomed by the technical team

Proposals in response to this call must be submitted via the CDE process (www.science.mod.uk/enterprise).

Proposals should focus on a short (approx. 100 working days) 'proof-of-concept' programme; proposals can include a descriptive scoping for a longer programme of any duration but the proposal should be clearly partitioned with a costed proof-of-concept stage which is the focus of this call. Dstl will be available to provide advice and/or guidance throughout the project and provide the interface with the MOD stakeholder community. There is no cap on the value of proposals but it is most likely that at this initial stage a larger number of lower value proposals will be funded than a small number of higher value proposals.

Proposals for work beyond the proof of concept stage will only be considered after the proof of concept stage has delivered, using the understanding gained to make an informed decision. Whilst Dstl does not commit to fund any follow on work as a result of any contracts placed via this CDE call, the most promising areas of work may be further developed in FY2012/13

Assessment of the proposals will be conducted using the MOD PAF (Performance Assessment Framework) that is available as a download from the CDE website. Proposals must include a clear description of what is novel in the proposed solution and the value of the solution to operational capability. Proposals should clearly state the programme of work that would be carried out and the outputs (deliverable) from the work.

## Proposal submission process

**Proposals for funding should be submitted by 1200 hrs (noon) on 9th June 2011 using the CDE Portal (www.science.mod.uk/enterprise). Proposals should be clearly marked with "Maritime" 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 open an account and become familiar with the guidance, starting with the Quick Start Guide this and other guides are available on the website www.science.mod.uk/engagement/the_portal.aspx.

Common errors include:

- Character limit – there is a limit of 1000 characters in the descriptive paragraphs of the proposal which when completed must be added to the document; additional paragraphs can be added if 1000 characters is insufficient.

- 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.
- Failing to properly submit - publish is not the same as submit, *you must submit as an additional action after you have 'published as final'*.

Please do not leave submission of your proposal until the last minute, past experience has shown that the Portal becomes heavily loaded near the call close date and that this can result in slow operation and that in the pressure to meet the deadline, mistakes can be made that mean proposals are not submitted or accepted.

Proposals that are received after the deadline will not be included in the call but will be submitted into the CDE monthly open call process.

- Queries relating to the *technical aspects* of the call should be addressed to the 'Maritime Technical Lead' (Dstl Naval Systems) at DstlMaritime@dstl.gov.uk.

- Queries relating to the submissions process (including how to use the portal) should be addressed directly to the CDE at science-enterprise@mod.uk or by phone on 01235 438445.

**Key dates**

- 5th April 2011 CDE launch seminar
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