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MURLIN defeats missile seekers

Is high-fidelity best?

A cool-headed robot

Replenishment at sea

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Defence Science and Technology Organisation

The Defence Science and Technology Organisation (DSTO) is part of the Department of Defence and provides scientific advice and support to the Australian Defence Organisation. DSTO is headed by the Chief Defence Scientist, Dr Roger Lough, and employs about 2200 staff, including some 1300 researchers and engineers. It is one of the two largest research and development organisations in Australia.

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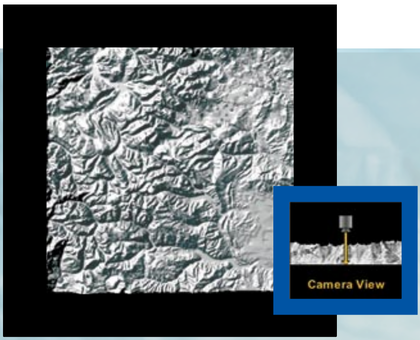
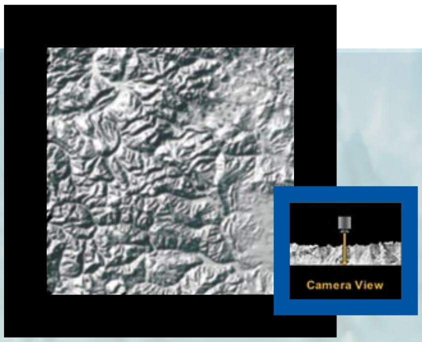
Is high-fidelity best for **depicting situation awareness?**

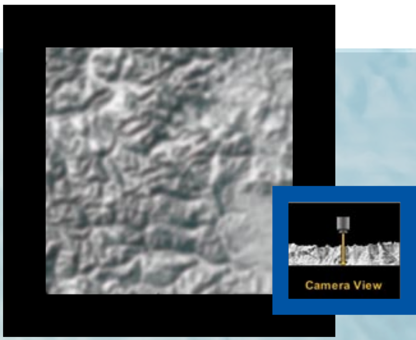
There is an apparent paradox in the preferences of decision-makers when it comes to viewing situational awareness scenes. While meticulously realistic three-dimensional (3-D) screen portrayals are readily attainable using today's powerful graphics packages, these have been shown to be less effective than sparser forms of display imagery.



3-D terrain view without modification.



3-D terrain view with low-level blurring.



3-D terrain view with high-level blurring.

DSTO's submarine operations branch in Western Australia is attempting to develop a situational awareness display that will make the work of commanders easier, using well-designed information displays and well-targeted automation-assisted information processing.

"Development of such a system requires a very detailed analysis of the information needs of submarine command in complex operations," says DSTO researcher Sam Huf. "Once having established what information to present to command, a further challenge arises in determining how to best present that information."

The common approach of those developing situational awareness displays in recent times has been to produce compellingly realistic 3-D or perspective-view situation displays.

However, these displays can cause systematic errors of human judgement, with the apparent realism drawing the observer into making predictable mistakes.

US research on realism versus utility issues

The SPAWAR Systems Centre in USA has been investigating the issues surrounding tactical military displays for several years. A group of researchers associated with SPAWAR have developed an experimental paradigm in which the relative fidelity of different 3-D terrain representations is compared.

Their findings are that the 'blurring' of certain terrain elements enables decision-makers to more readily identify important terrain constraints.

DSTO is collaborating in this research via The Technical Cooperation Program (TTCP) arrangements that facilitate collaborative design and conduct of experiments in the US and Australia.

DSTO's work on optimising display design

DSTO has assisted with the TTCP work by securing the services of PhD student Andrew Brolese at the University of Adelaide.

His task was to gather data for experiments on the efficacy of high fidelity 3-D terrain rendering versus lower fidelity rendering when used for depicting underwater scenes such as undersea terrain or bathymetric layers. This work was completed late last year.

The focus of DSTO's interest has been on optimising display technology for operations in the submarine domain, an area not directly investigated in the SPAWAR research.

Future work will include a study of issues pertaining to representations of the 3-D undersea terrain, crucial acoustic properties of the water column, uncertain information and boundaries of safety in complex operations. These studies, combined with a cognitive work analysis of submarine command, will assist with the development of enhanced command displays.

A cool-headed robot **built for hot radiological work**

Over the past year, DSTO has worked closely with the Australian Nuclear Science and Technology Organisation (ANSTO) to develop a low-cost man-portable robotic vehicle able to detect ionising radiation emissions.

The recently completed work, carried out under a National Security Task managed by the Publicly Funded Agencies Collaborative Counter Terrorism (PACCT) program, represents a potential new capability for ionising radiation incident management.

The project involved fitting an ANSTO-developed radiological sensor suite onto a custom-designed unmanned ground vehicle (UGV). This UGV, known as the Remote Advanced Sensor Platform (RASP), was developed by DSTO.

Explaining the purpose of the work, DSTO researcher Dr Brian Jarvis says, "For the first time, 'first responders' will be able to remain at safe stand-off distances and effectively investigate radiological hazards using this versatile and interactive sensor system.

"The ability to determine the nature of a threat as soon as possible will significantly assist the effective management and response to a radiological incident.

"Firstly, it will confirm the actual presence of a radioactive source, which is important information in itself. Secondly, it will identify the type of radioactive isotope present and hence, its half-life, which is invaluable for determining the type and timeliness of a response. For example, if the half-life is only a few hours or a day, then it may be much safer just to wait for the radioactive material to decay to a safer level.

"In some situations, knowledge of the type of source may also assist in a determination of its origin and whether the source is likely to be the result of an accident, or associated with some kind of malevolent activity."

Low-cost stand-off survey capability

The RASP vehicle was assembled by DSTO and ANSTO from commercial-off-the-shelf products in order to minimise cost. Development of the two major components of the concept demonstrator unit, undertaken separately at DSTO Edinburgh and at ANSTO's Lucas Heights facility, cost about $50,000 in total.

This page and opposite: RASP robotic radiological detection system being remotely controlled by DSTO operators.

The ANSTO payload detector was fixed to the end of a 2-degree-of-freedom manipulator arm mounted on the UGV. This small robotic arm can accurately position the sensor over a range of distances above and in front of the robot up to a height of 1.6 metres.

Guided by images obtained from a video camera mounted on the arm, an operator controls RASP's movements from a position of safety using a radio link. The vehicle is driven up to a suspect object for investigation, and then the sensor suite on the end of the arm is positioned very close to the object.

The detector sensors can identify a wide range of radiological isotopic sources with energies ranging between 30 keV and 1.5 MeV, using a fully featured gamma-ray spectrometer. It can also detect the presence of nuclear materials.

"This means in practice that most radioactive sources which might be involved in a radiological incident would be detectable by this sensor suite," says Dr Jarvis.

Processing of the ANSTO sensor signals is performed by dedicated on-board electronics controlled from the remote base station, and the results are then transmitted to the operator.

A major problem the concept demonstrator developers have had to overcome is ensuring that the sensitivities of these sensor systems are not affected by radio wave emissions associated with the RASP vehicle control and video link functions.

Small portable detection utility

The unit currently can be operated at stand-off distances as far a field as 350 metres, allowing ample safety margins for personnel.

The RASP platform, of dimensions about 40 centimetres wide by 50 centimetres long and 20 centimetres high, is readily portable by one person, and can be deployed into almost any area or location because of its small size and mass.

The current version is small enough to negotiate confined spaces such as aircraft aisles, cargo containers or for building entry.

While this model is limited to traversing flat to undulating terrain, a slightly larger platform could be given special abilities, like that of climbing stairs. DSTO already has the 'know-how' to apply this kind of mobility.

Because this platform can be ready-to-go in a matter of just minutes, and can be easily carried in virtually any vehicle, it provides a much more flexible and useful capability than larger systems. These larger kinds generally require special transportation amenities and involve lengthy setup times, and as a consequence, tend not to be used as often or as freely as field operatives would like.

Useful in many scenarios for many people

Typical scenarios where the RASP-ANSTO system would be of assistance include those where a box suspected to contain radiological materials has fallen off a truck, or a spill of radioactive materials occurs in a building, or an unknown radioactive item is detected in a shipping container.

As such, it would be of value to all Australian national security 'first responder' agencies in all states and territories, both civilian and military, including the Incident Response Regiment and deployed Special Forces. Some commercial operators may also be interested in the system to supplement their safety and emergency readiness preparations.

The developers see that the system could be readily developed to a commercial-ready status by Australian industry, should there be sufficient support from stakeholders and users.

Final trials of the capability demonstrator apparatus are scheduled for later this year at ANSTO where the system will be demonstrated to relevant stakeholder observers in realistic radiological incident scenarios using actual radioactive materials.

Easing the strain **on replenishment at sea**

When two ships travel parallel and close to each other for resupply operations, they experience significant hydrodynamic effects that impact on the motions of both ships. DSTO has been conducting research to validate the predictions provided by computer modelling tools so that replenishment operations can be performed with greater ease and safety.

In today's global military environment, Royal Australian Navy vessels are required to participate in deployments for long periods away from their home ports. As a result, the practice of replenishment at sea (RAS) is critical to maintaining operational status.

A typical RAS operation consists of two or more Navy vessels sailing in close proximity to each other to transfer cargo, water and fuel. These operations are commonly carried out at speeds of 10 to 15 knots in conditions up to and including Sea State 6.

"During these operations," explains DSTO researcher Tristan Andrewartha, "the motions of all vessels are influenced by hydrodynamic effects created by the close proximity of the vessels, with the smaller of the vessels often experiencing increased motions, particularly roll."

"Since the distance between the vessels' replenishment points can therefore change considerably, this causes the tension on hoses and cables between the vessels to vary significantly, which makes the re-supply process potentially difficult and dangerous. These undesirable motions also impact on the ability of the ships to manoeuvre," he says.

Software tool for RAS planning

To date, Navy personnel have had no option other than to rely on personal knowledge and experience to determine the suitability of conditions for undertaking replenishment.

One of the first technological aids to assist with this process was *FD-WaveLoad,* described as 'an advanced frequency-domain 3-D panel-method seakeeping prediction package that predicts vessel motion under different given conditions'. Although this tool is highly developed, its usefulness for analysing RAS operations has been limited by a lack of adequate real-world experimental data needed to validate its predictions.

To overcome this data shortfall, DSTO and the Australian Maritime College (AMC) embarked on a collaborative research program in 2005.

A series of model tests were conducted to study the influence of various parameters on the ships' motions, including transverse and longitudinal separation, and the influence of different sea states. The measurements obtained were then compared with *FD-WaveLoad* predictions for these conditions.

Tank tests in Tasmania

The model experiments were undertaken at the Australian Maritime Hydrodynamics Research Centre in Tasmania, which features a towing tank 100 metres in length and 3.6 metres wide with a water depth of up to 1.6 metres.

The facility generates waves for the experiments with a hydraulically operated wet-backed, single flap paddle, capable of creating both regular and irregular wave forms.

The ship models included for study were a generic frigate indicative of those used by the RAN, and an S-175 container ship, both represented at 1:70 scale. The models were attached to a jointed towing mechanism that allowed them to move freely in heave, pitch and roll, while being constrained in surge, sway and yaw.

The motions of the vessels were measured using eight linear voltage displacement transducers. Additionally, a stationary wave probe was positioned near the wave maker to measure the water surface profile and hence determine the wave elevations and frequencies. A visual record of the experiments was also made using stills and video photography.

Since real-world replenishment operations are conducted with lateral separations of around 25 to 55 metres, two 'narrow gap' and 'wide gap' separation experiments were run to scale at 0.567 and 0.890 metre distances respectively.

Similarly, the influence of longitudinal separation on vessel motions was also studied, with the frigate model trailing the S-175 model at a scale distance between midships of 0.125 and 0.62 metres, equivalent to 8.75 and 43.4 metres full scale.

All tests were conducted in simulated head seas at a speed of 0.925 metres per second, equivalent to a real-world speed of 15 knots.

Studies were conducted using both model vessels together and also with just the frigate alone.

Rolling outcomes of tank test voyages

The two vessels, heading side by side into simulated head seas, both showed rolling motions that would not have occurred if they had travelled alone. While the larger vessel exhibited only a small amount of roll motion, the frigate was substantially affected.

As the transverse separation between the vessels was reduced, the roll of the frigate was found to increase, but very little change was seen for the S-175. Similarly, when the longitudinal separation between the vessels was reduced, the frigate showed increased roll and pitch motions but the S-175 again was only minimally affected.

The testing also allowed for a statistical examination of the expected extreme roll angle of the frigate and the relative motion between the vessels in an irregular seaway over the course of three hours – a duration representative of actual replenishment operations.

Above: tank testing for RAS research at the Australian Maritime Hydrodynamics Research Centre in Tasmania.
Main photo: Navy frigate and supply ship engaged in replenishment at sea operations.

The findings were that roll angles of up to 16 degrees may be expected for the frigate in Sea State 6 and the expected extreme relative motion in these conditions was found to be as much as 3.25 metres.

Virtual predictions versus real-world results

The work showed that *FD-WaveLoad* predictions for the motions of a vessel sailing alone agreed well with the tank test results, although some over-prediction of pitch was apparent.

For the experimentation involving two vessels, the *FD-WaveLoad* predictions varied slightly from what the tank tests showed, with higher effects predicted in some cases and lower ones in others.

With a wide transverse separation between the vessels, *FD-WaveLoad* predicted the motions of both vessels satisfactorily, except for over-predicting the S-175 heave and frigate roll. As the transverse separation was reduced, *FD-WaveLoad* predicted a slight reduction in roll motion for the frigate, whereas tests showed that the roll motion of the frigate increased.

When the motions of the vessels in irregular seas were examined in extreme terms, *FD-WaveLoad* over-predicted both the extreme roll motion of the frigate and the relative motion between the replenishment supply points on the two vessels.

According to Andrewartha, "The wealth of data obtained has allowed us to investigate the capacity of several numerical prediction codes to predict the complex responses experienced during RAS operations.

"Once we've validated these codes, we'll be able to provide Navy crews with better guidance on the selection of speeds and safe stand-off distances during RAS operations for all sea states," he says.

This work has also highlighted a deficiency in existing Classification Society rules – the regulations that are drawn up to ensure certain endurance performance levels for ship structures are met.

These rules previously required only the dynamic behaviour of the supply ship to be examined when designing replenishment systems. Results from the recent investigations indicate that the motions of both vessels must be considered simultaneously due to the significant hydrodynamic interactions.

MURLIN defeats the deadly gaze of IR missile eyes

The DSTO-designed Advanced Tactical Multi-band Research Laser INfrared (AT-MURLIN) was sent for trials in the United States in November last year, and showed itself to be highly capable of blinding the infrared guidance systems of heat-seeking missiles.

The infrared missile jamming trial, undertaken as part of The Technical Cooperation Program (TTCP) and hosted by the United States Air Force Research Laboratory (AFRL), took place at the Wright Patterson Air Force base in Dayton, Ohio over two weeks.

DSTO personnel attending the trials included Drs David Lancaster and Miro Dubovinsky, and Mr Shayne Bennetts. The AT-MURLIN system presented by DSTO for use in the trials was a new version acquired under contract from Tenix Defence in mid 2007.

"The aims of the trials," explains Dr Lancaster, "were to evaluate the AT-MURLIN's multi-band laser performance, measure its effectiveness against a range of realistic infrared missile threat simulators , and to integrate the laser with AFRL's Laser Infrared countermeasure Flyout Experiment (LIFE) Threat Adaptive Counter Measure (TACM) system."

Throughout the trial, the AT-MURLIN proved reliable and performed to specification. The AFRL team was impressed by what they saw, and acclaimed the Australian system for its high-power mid-infrared output and high beam-quality as well as its ancillary capabilities for extensive data-logging and built-in testing.

Jamming trials

The AT-MURLIN was put to the test in open-loop jamming trials. In such trials, the missile countermeasure system sends a generic infrared jamming code without collecting any infrared radiation emissions from the infrared missile threat simulator seeker systems. This setup emulates the 'state of the art' technology being used in directed infrared countermeasure (DIRCM) systems currently deployed.

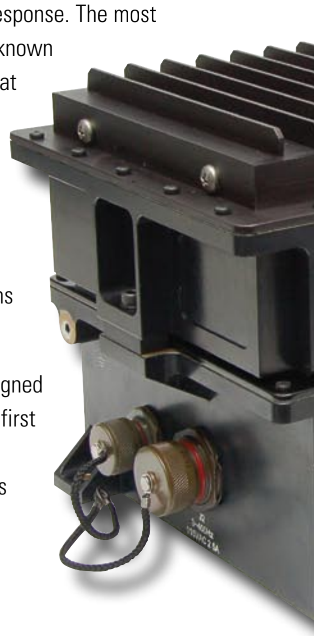
During the open-loop trials, conducted on a 2.3 kilometre laser range, the AT-MURLIN was shown to be successful against a range of threat simulators representative of a wide range of man-portable air defence systems (MANPADS) and air-to-air systems.

The AT-MURLIN was also tested in closed-loop trials after being integrated into the TACM developed by AFRL. This system features a capability, developed by AFRL, to determine the type of infrared target seeker being used in an attacking missile.

In closed-loop operations, the TACM threat adaptive process allows the system to uniquely identify the seeker type. Once this is established, the system synthesises seeker information and provides signals to the laser to transmit an optimised infrared jamming code for the particular seeker simulator under test.

With the closed-loop trials, the researchers were able to estimate the effectiveness of different jamming techniques by measuring the quality and strength of the signal from the target missile simulator during jamming.

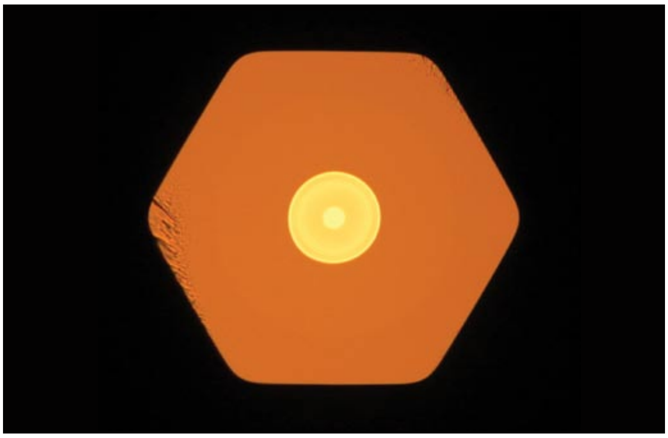
The seeker signal is strongest when the IR guidance has 'locked-on' to the target being tracked. The more effective jam techniques are therefore the ones that cause the most abrupt response. The most disruptive of these techniques causes an effect known as 'break-lock', which, once attained, ensures that the seeker will never hit its target.

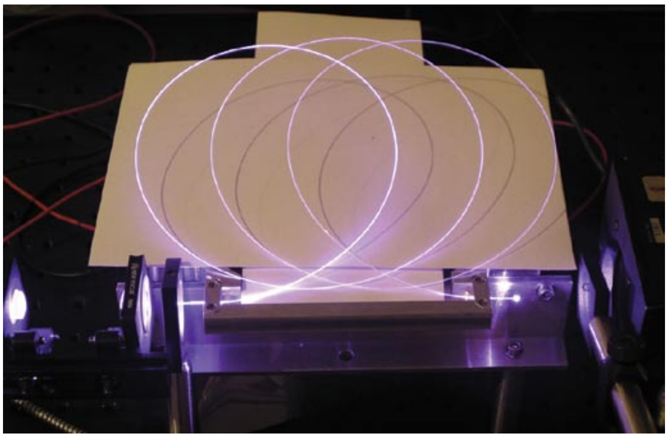


Successful integration with positive jamming outcomes

An unanticipated success of the trials was the discovery that the TACM and AT-MURLIN systems could readily work together.

"Even though the AT-MURLIN laser was not designed to operate in the AFRL system, we achieved the first TACM jamming of a number of representative threat simulators using an Australian laser," says Dr Lancaster.





Far Left: red dot of AT-MURLIN countermeasures laser as seen 2.3 kilometres down range from US AFRL tower in Dayton, Ohio.
Left and below: Fibre optic components of the AT-MURLIN system.

One of the findings of the trials was that a minor modification to the AT-MURLIN laser would enable its optimal use in the TACM system.

The data collected throughout the trials, including simulated missile signatures and missile jam characteristics, will be used in DSTO's hardware-in-the-loop system for further research as well as to support DIRCM deployment on aircraft such as the Airborne Early Warning & Control, the Multi Role Tanker Transport and C17.

Far-reaching ramifications

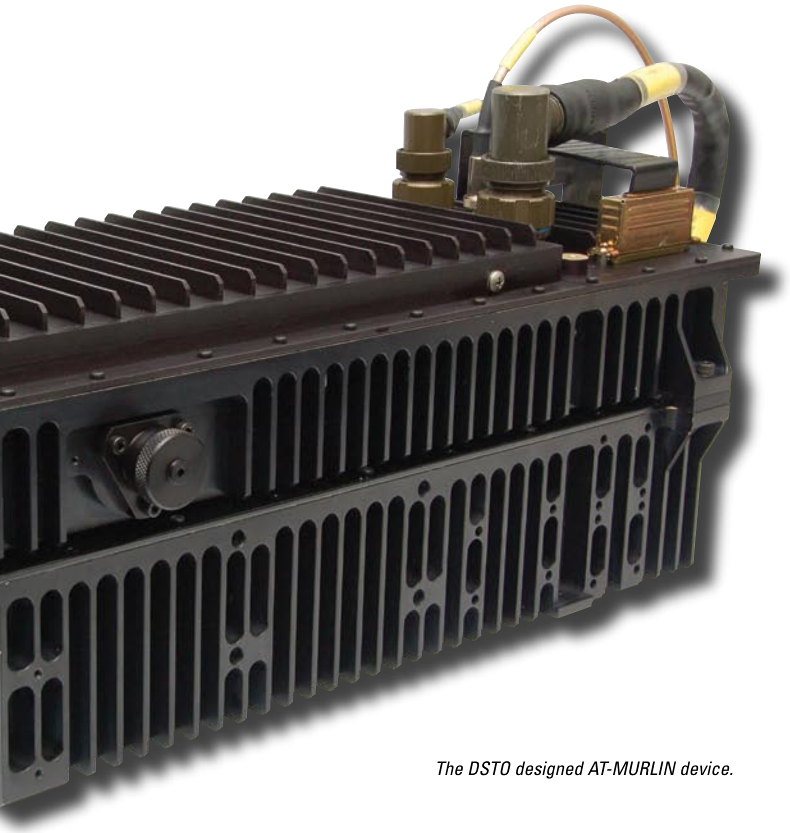
This collaborative trial is seen to have significantly advanced the work of Australian DIRCM researchers, who have had only limited resources for DIRCM testing and experimental DIRCM technique development in the past.

According to Dr Lancaster, "Collaborative activities such as this are critical because they allow Australia to realise the large investment Defence has made in the MURLIN programs. The trial has given us access to very valuable data on infrared threat missile simulators and countermeasure techniques.

"Such trials are also critical in that they ensure the countermeasure lasers we're developing are optimised towards advanced DIRCM techniques, which will be essential for protecting platforms against increasingly sophisticated infrared seeker guided missiles."

Another important outcome of the trials is the development of relationships between Australian and US Government Defence research organisations to further this work.

Connections being explored included the formation of a working partnership between DSTO and AFRL for research on advanced DIRCM technologies, possibly leading to a bilateral research agreement, and the creation of Australian-US Defence industry collaborations for development of advanced DIRCM systems.



The DSTO designed AT-MURLIN device.

DSTO's AT-MURLIN research tool

The Advanced Tactical-MUlti-band Research Laser, Infrared (AT-MURLIN) is a multi-band DIRCM solid-state laser.

DSTO last year received delivery of the second of two AT-MURLIN systems from Tenix Defence, representing the completion of yet another significant milestone in five years of collaborative development between DSTO and Tenix under the PA10 program.

The AT-MURLIN laser is an outstanding achievement of Australian military capability development, in which a complex laboratory-based laser system produced for DIRCM research has then been semi-ruggedised, robustly packaged and designed and optimised for flight trials.

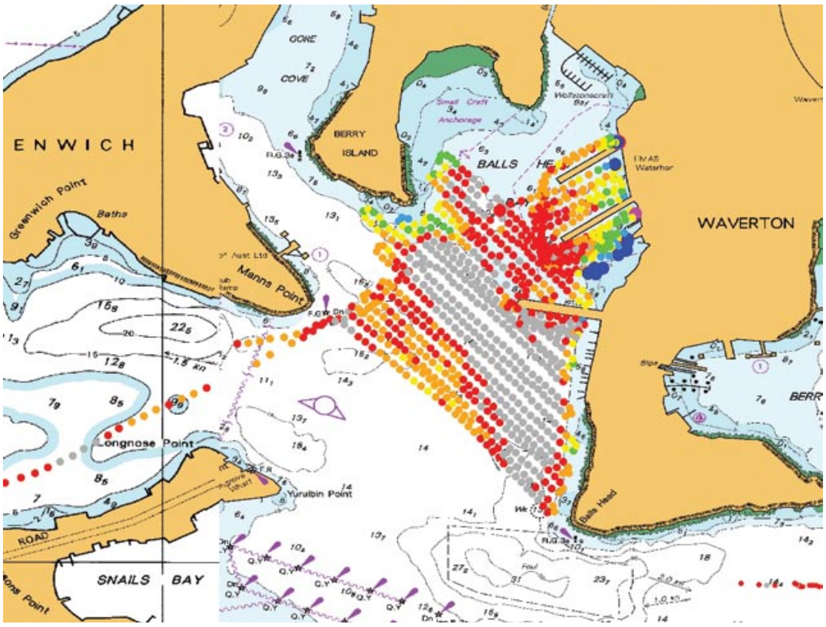
Scanning the seafloor for maritime operations

DSTO is developing a more efficient way of mapping seabed conditions to improve accurate use of sonar, and thereby assist with Defence maritime operations such as anti-mine and anti-submarine warfare.

To use sonar systems most effectively, it is important to know what type of seabed material the sonar signals are being reflected from, since this strongly affects the intensity of the reflected signal.

Describing the range of information carried by sonar signals, DSTO researcher Les Hamilton says, "The seabed echo not only gives a measure of depth, but is also indicative of particular seabed types, such as mud, sand, gravel, or rock, as well as larger form structures like sand ridges and sand waves.

"While the time taken for an echo to return indicates depth, the echo length indicates seabed roughness and the capacity of a seabed to scatter sound. Echo energy, meanwhile, is related to seabed hardness – strictly speaking, this is acoustic hardness or reflectivity, not physical hardness, but the two are often closely related."



Above: graphic of readings obtained during ECHON trial in Sydney Harbour.
Opposite: DSTO researchers with ECHON system components.

A knowledge of seabed conditions is critical for anti-mine and anti-submarine activities in order to undertake these tasks with confidence. If mines are laid in an area of very rough seabed where echo backscatter is very high, or buried in soft sediment that is highly absorbent of sound, they can remain undetected. When faced with such conditions, Navy commanders will know that mine clearance operations are not likely to be effective or safe, and can make their choices accordingly.

The standard method used for getting data on seabed conditions, used for producing what are known as bottom texture sheets, has been to lower a grab or corer device to the seabed from a stationary vessel at a series of points across an area. However, this can be a difficult, time-consuming and potentially hazardous process.

A better approach to charting bottom texture

A more efficient way of getting this information is to chart the seabed using sonar into areas of similar type according to the wave shape and energy of the echo.

Hamilton explains, "Although it isn't yet possible to determine with high confidence what kind of seabed lies below based on the different properties of sonar echoes, they can clearly indicate differences between types of sea floor, and so, it is only necessary to take one actual sample in these different areas to establish what a particular area consists of."

"Information about the seabed can be gathered continuously by sonars of many different types while vessels are in routine transit. This provides far more information than point sampling and in far less time, since samples from the seabed only need to be taken when the type of seafloor condition is shown by sonar to have changed," he says.

DSTO has developed a low-cost system called ECHON for routine acquisition of data on seabed characteristics in the littoral zone.

The ECHON system

The ECHON equipment consists of a laptop PC, a hand held GPS, a 'fishfinder' echo sounder and electronics equipment inside a splash-proof case, and a transducer mounted on a pole-bracket arrangement.

The fishfinder device features a beamwidth of 55 degrees, which has the necessary width for gathering backscatter measurements at angles away from vertical incidence.

The system can be operated using battery power, and is able to be handled by one person, making it suitable for use on small vessels such as light utility boats.

The software that runs the system includes Seafarer chart displays, and geo-referenced backscatter data can be exported in Environmental Systems Research Institute (ESRI) shape file format, enabling direct uptake as a data layer by Geographic Information System (GIS) software already in use by the Royal Australian Navy (RAN).

ECHON is currently being used only to provide estimates for an acoustic seabed backscatter index. These are fed into mine hunting algorithms to assess the chances of a particular sonar successfully detecting mines. Low values of backscatter of 0 to 1 usually indicate soft mud, while high values of 3 to 4 usually indicate gravel and rock, but these inferences cannot be assumed.

In addition to the seabed backscatter index, the system also provides acoustic seabed parameters that enable classification of the seabed into areas of similar type, an operation presently performed using post-processing software. The possibility of real-time seabed classification is currently under investigation.

Sydney Harbour ECHON trials

DSTO and the RAN Reserve team ANRDT5 carried out trials with the ECHON system in Sydney Harbour during July last year in the course of Reserve route survey activities. The initial Reserve surveys were conducted without DSTO personnel present in order to assess ease of use.

The surveys resulted in the collection of excellent quality backscatter data and proved the operational soundness of the basic system despite a few minor equipment problems. Feedback provided to DSTO by the Reserve included suggestions for enhancing the displays, and aspects of system performance that could be improved.

The system also underwent trials in Jervis Bay later in the year.

Development of the ECHON system overall has been a team effort, involving the application of electronic circuit design, GIS programming, instrument control, signal processing, and acoustics.

The ECHON system can be used as an adjunct to other sonar systems to provide additional forms of information of military interest without interfering with the primary purpose of these sonars, being generally that of depth sounding.

Future work may be undertaken to integrate the type of point information obtained by ECHON with other types of sonars such as sidescan and multibeam which provide swathe information.

Better ways to link people securely by satellite

DSTO has developed a communications system that will more readily allow users to communicate with others at a distance whenever they see a need to, and to the full extent that they need to, with military grade security.

Satellite links form a crucial part of today's communications networks, helping to provide high-quality communications services in remote settings that people in all walks of life have now come to rely upon to do their work effectively.

The Secure Satellite Internet Protocol Network (SSATIN) is a communications system devised by DSTO to demonstrate access-on-demand and bandwidth-on-demand capabilities to the Australian military.

According to DSTO researcher Phil Stimson, "SSATIN has been envisaged as a means of supporting networked operations in a deployed theatre, with communications connected back to Australia by a separate, but network-connected, rear link.

"The advantages SSATIN offers over traditional satellite link systems are that the available bandwidth can be used more efficiently and more flexibly.

"SSATIN essentially constitutes a sky-borne Ethernet system that can be easily integrated with terrestrial Internet Protocol (IP) networks and network management systems."

Space communications terminal

The system has been trialled using the Ka-band regional and steerable spot beams of the Optus C1 satellite, but could be used on any satellite with transponders having sufficient bandwidth.

The Optus C1 satellite has a steerable spot beam capability that enables the system managers to change the area of terrestrial coverage provided by the satellite transponder in the near-Australia region, if necessary, when supporting deployed military operations.

The system makes use of a form of media access technology called Time Division Multiple Access (TDMA), commonly applied in mobile phone networks. TDMA allows several users to share the signal bandwidth of a particular frequency channel by dividing the signal into different timeslots.

Each of several users on a given frequency has an individual set of timeslots, with blocks of digital information (constituting a voice call or computer file transfer operation) being transmitted in rapid succession.

Right: Graphic of SSATIN system showing two deployed users accessing the service with connectivity back to home base via rear link.

During SSATIN transmission operations, IP packets of digital data flow from a Local Area Network into a SSATIN terminal, and are divided into transmit data blocks. These blocks are transmitted to the satellite and subsequently received by all the modems in the SSATIN system. The appropriate terminal then transfers the data to the destination host.

A transmission burst size of 160 user data bytes has been chosen for SSATIN as an optimal compromise between small bursts, which are more efficient at Voice Over Internet Protocol (VOIP) transmissions, and large bursts, which offer greater efficiency for data file transfers.

SSATIN communications traffic control

The SSATIN system consists of a number of interlinked communications terminals, so that any terminal can interact with any other in the SSATIN system if authorised to do so.

The process of regulating the system is undertaken by a device called the Network Controller, which issues transmission instructions in updated form every 0.4 seconds in what is known as the Burst Plan.

One aspect of this plan involves determining how bandwidth, or the number of slots per frame, is allocated between the terminals.

Another aspect of the plan involves determining which specific time slots each terminal has permission to transmit on.

During operations, the SSATIN terminals continually monitor their IP traffic loads and traffic priorities. Requests based on this information are sent to the Network Controller, which, giving consideration to each terminal's current bandwidth allocation, is able to grant more bandwidth for needy service users while reducing allocated bandwidth for idling users, thereby optimising network operations.

The Network Controller additionally regulates a range of other transmission activities, including which terminals are authorised to connect to the network, request acknowledgements and internal management and status information.

Flexible autonomous and secure operations

The SSATIN terminals also continually monitor their own transmissions to adjust their timing in order to compensate for gradual changes in satellite position, thus ensuring correct synchronisation for transmission throughout operations.

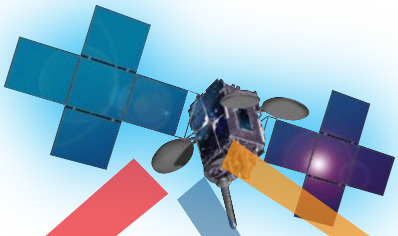
To protect against eavesdropping, various aspects of system operations, including user data, network management information and user requests for access and bandwidth, are all encrypted, and packet length information is also protected.

In addition to data security, SSATIN incorporates features to enhance security against interference. Protective measures include control signals that are time-hopped in a random manner, and all user terminal slot allocations are likewise randomly varied.

To guard against system failure, identical software is loaded on all SSATIN terminals so that any terminal may become a Network Controller if the original controller becomes defective.

SSATIN allows for the simultaneous use of full duplex (two way), asymmetric and broadcast (one way) services simultaneously. Voice communications are carried via VOIP technology, and multicast IP traffic for audio-visual communications is also supported.

The SSATIN system overall is seen to offer the advantages of flexibility, access for greater numbers of users, increased efficiency with higher total traffic volumes serviced, and a synergy with other network-based information technology systems. It also makes possible reductions in manning and personnel costs, and provides better communications support for operatives on the move.



An improved tool for **countering mine attack at sea**

DSTO has developed a more user-friendly ranging system to measure the signals passively emitted by ships that sea mines home in on.

"When considering ways to counter mine attack on a naval platform," says DSTO's Andrew Munyard, "the ability to measure these various kinds of passive signals is crucial to the development of survivability capabilities and strategies."

Mines can be actuated using a variety of triggers, including contact, acoustic, magnetic, and pressure influences. Newer mines can also sense phenomena such as the ship's electric field. Being equipped with sophisticated computing power, the decision of whether or not to detonate may involve complex logic based on the detection of several different kinds of influence, plus the levels of each influence, to ensure the desired type of ship is targeted.

"To measure the influences a ship emits for countermeasure purposes, the vessel is 'ranged' with an array of seabed sensors controlled by shore-based facilities," explains Munyard.. "The data acquired is known as the signature of the ship."

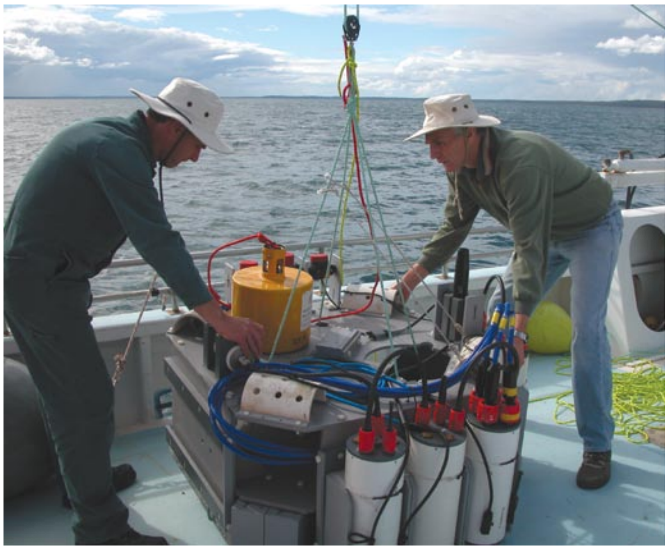
Using this signature information, systems onboard the vessel, such as degaussing coils for magnetic signature reduction, can be adjusted to ensure the vessel's signatures overall are optimal for reducing the threat from mines. A threat prediction that quantifies the risk level of mine strike for the platform can then be determined.

The benefits of an easily deployable range

The Royal Australian Navy has three relocatable ranges that can be deployed around Australia as well as fixed ranges situated in Sydney and Perth, offering considerable amenity for ships operating in Australian waters.

The logistics of redeploying the relocatable ranges, however, are formidable, limiting their flexibility of use. A dive team and a vessel with a lifting capability of half a tonne are required, plus transportation facilities for two tonnes of underwater sensors, quarter of a tonne of associated cable and an ISO shipping container for control. The set-up phase takes approximately a day, as does packing up..

Meanwhile, a significant issue for Navy ships operating in northern hemisphere waters is that the modelling of magnetic effects used for making signature settings has not been verified for such large changes in latitude.



DSTO personnel with the prototype Multi-Influence Range system.

Furthermore, hull stresses encountered during the transit from Australia can change the ship's magnetic signature, and therefore render signature settings made in Australia inaccurate.

"In light of all these considerations, we came to see that a small portable range would greatly assist Navy by enabling all vessels to readily re-evaluate their levels of threat prediction, and modify their operational procedures before entering a new area of operations," says Munyard.

DSTO's ranging system

The prototype Multi-Influence Range (MIR) system developed by DSTO combines the sensors of ranging systems for measuring acoustic, magnetic, underwater electric and pressure signatures into a single package that is truly portable, easy to deploy and recover, and uses a minimum of resources.

The package is deployed in 'sleep mode' and 'woken' by signals sent from the surface via underwater acoustic modems. The MIR battery storage capacity allows for about eight hours of continuous operation, which can be spread over many days if the system is returned to 'sleep mode' in between ranging operations.

The system deployment process is relatively quick and effortless without need of diver assistance, and it self-recovers after use by sending a recovery rope to the surface on command via the underwater acoustics.

Further work is planned for the MIR to miniaturise it into a two-man portable system.

ADF frontline personnel to benefit from sports technology

A workshop series called the 'Frontiers of Human Performance' was recently inaugurated by the Australian Government to examine ways of better preparing athletes and soldiers for the physical challenges they take on.

The first workshop, held at the Australian Institute of Sport (AIS) in ACT, was attended by representatives from many of Australia's top human performance research organisations, including DSTO, CSIRO, AIS, National Information Communication Technology Australia, industry and academia.

The aim of the work is to find ways of applying new ideas and technologies that give soldiers and athletes an advantage in their respective arenas. The range of areas to be studied includes nutrition, injury prevention, remote monitoring and performance in extreme environments.

Army Sgt Dan Cross with Minister for Defence Science and Personnel, the Hon Warren Snowdon MP, Minister for Sport, the Hon Kate Ellis MP and Chief Defence Scientist Roger Lough at the workshop series launch.

Personal radar warning receiver units tested

DSTO staff attended a recent trial carried out by the Australian Test and Evaluation Organisation (ATEO), formerly known as DTRIALS, to test the performance of Personal Radar Warning Receiver (PRWR) units produced by Tenix Defence under the Capability & Technology Demonstrator (CTD) program.

The aim of this CTD project was to demonstrate the detection of emanations from Ground Surveillance Radar (GSR) in a man-portable device.

The concept for a small cigarette packet-sized device was conceived and first developed by DSTO, with Tenix Defence then successfully presenting a proposal to refine the concept for manufacture.

During the CTD trial, the measures of effectiveness under scrutiny included detection and identification range, direction finding accuracy and the ability to identify emissions from multiple units of one type of GSR.

The PRWR unit performed successfully in each of the test scenarios. DSTO is considering further miniaturisation of the device and giving it increased functionality through the use of RF Integrated Circuits.

Keeping hot weather soldiers properly fed

DSTO has been asked by Army to develop a new ration pack that maintains soldier nutritional levels more effectively in hot environments than the existing ration pack range.

Army has found that in hot conditions, soldiers often discard ration pack foods because hot meals have little appeal, or their appetite overall is suppressed by the heat.

As a result, troops may fail to eat enough to meet their energy needs.

Additionally, since eating stimulates thirst, an inadequate food intake may also lead to dehydration, which can further limit a soldier's operational effectiveness.

Given the large numbers of Australian Defence Force personnel currently serving in hot climates, the ration pack work being undertaken by DSTO is seen to be critical for mission success in many arenas.

DSTO research has shown that sports drinks, fruit, trail mixes and savoury biscuits are some of the most popular items soldiers would like included in hot weather rations.

A prototype hot weather ration pack has been trialled in the field at Tully in Far North Queensland. The results of the trial will be used to further refine the contents.

Chief Defence Scientist retires

Chief Defence Scientist Dr Roger Lough has retired from DSTO after nearly 45 years of service. He joined the Weapons Research Establishment in 1963 and went on to lead a number of research divisions in DSTO.
Dr Lough was appointed Chief Defence Scientist in 2003. Dr Ian Sare is currently acting as the Chief Defence Scientist till a replacement is appointed after an executive search.

CALENDAR

23 - 25 Jun 2008	Power and Energy Systems Corfu, Greece **http://iasted.com/conferences/home-608.html**
18 - 20 Aug 2008	Signal and Image Processing Kailua-Kona, Hawaii, USA **http://iasted.com/conferences/home-623.html**
18 - 20 Aug 2008	Internet and Multimedia Systems and Applications Kailua-Kona, Hawaii, USA **http://iasted.com/conferences/home-623.html**
1 - 3 Sep 2008	Artificial Intelligence and Soft Computing Palma de Mallorca, Spain **http://iasted.com/conferences/home-628.html**
1 - 3 Sep 2008	Visualisation, Imaging and Image Processing Palma de Mallorca, Spain **http://iasted.com/conferences/home-628.html**
29 Sep - 1 Oct 2008	Nanotechnology and Applications Crete, Greece **http://www.iasted.org/CONFERENCES/home-615.html**
27 - 31 Oct 2008	Land Warfare Conference 2008 Brisbane Convention and Exhibition Centre Brisbane **http://www.dsto.defence.gov.au/events/lwc2008/**
16 - 18 Nov 2008	Parallel and Distributed Computing and Systems Orlando, Florida, USA **http://www.iasted.org/CONFERENCES/home-631.html**
23 - 26 Mar 2009	Health and Usage Monitoring Systems 2009 DSTO Fishermans Bend, Grand Hyatt Melbourne, Avalon Airport Victoria **http://www.dsto.defence.gov.au/HUMS2009/**

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Cover image: *RASP robotic radiological detection system being remotely controlled by DSTO operators.*