# Advanced technology protects ports from underwater intruders

## Concern that ports may be vulnerable to terrorist attack has driven the development of a range of sonar systems to provide advanced warning of diver intrusion

**William Grant**, Port Technology International, London, UK

In response to the heightened concern of terrorism and the need for advanced methods of security for port and harbour infrastructure, there has been an increase in the development of sonar technology to provide early alert of a submerged threat.

Nevertheless, the design and manufacture of such sonar systems is fraught with problems posed by the difficult environmental conditions encountered in harbours, ports and shallow coastal waters. For example, depth, seabed topography and variable sound profile can lead to problems such as reverberation, multipath reflections and poor range performance. In such an environment swimmer intruders pose a major threat.

Narrow-band sonar systems struggle to deliver either the resolution or the range required to provide adequate warning to positively identify and respond to an approaching threat. But a number of new products have been developed that can resolve these problems.

Deployed as a standalone unit or in high numbers as part of an integrated perimeter defence system, the aim of each system is to alert the relevant authorities to an unwanted intruder in time to muster an appropriate response. A number of such products will be briefly described below, although many others are available.

## Cerberus

Under development by QinetiQ, Cerberus – or the 'Blue Egg' as it is more colloquially known – is part of a family of integrated harbour domain-awareness security products designed to protect a port from attack on or beneath the waterline (see Figure 2). It is designed to detect intrusion by swimmers using a snorkel, scuba or re-breather, as well as a swimmer delivery vehicle (SDV).

At its heart, Cerberus is a high-resolution 100 kHz wideband active-search sonar. Its 360° transducer array enables threat detection at ranges of up to 800m, allowing up to 25 minutes response time. By using advanced sonar-processing techniques and a database of known target signatures, the potential threat can be rapidly assessed and classified, thus minimising false alarms and providing the maximum response time.

Cerberus is a self-contained system, easy to deploy and maintain. It can be used as a single unit to provide area protection or in greater numbers to form a security perimeter. Each unit can track at least 50 targets simultaneously.

Cerberus can be deployed in a number of scenarios, including: harbour installation (from a wall or jetty); ship-deployed (to provide 360° coverage beneath a vessel); seabed-mounted (again, to provide 360° coverage of shoreside and offshore assets); and as part of a 'tripwire' perimeter defence system.
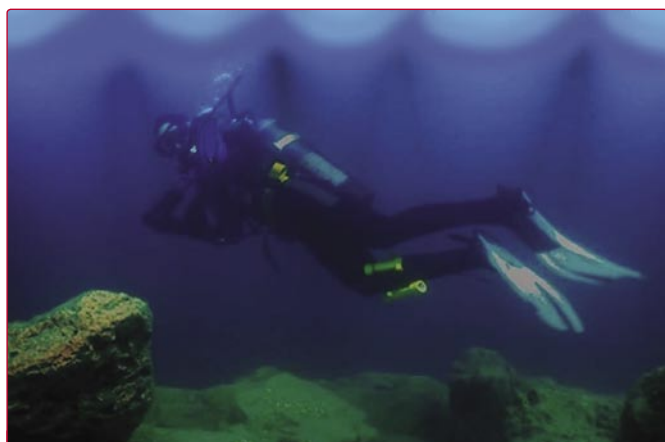


Figure 1. Those investigating the 2002 attack on French-registered tanker Limburg were told that Al-Qaeda had at one stage considered using divers and had trained personnel for this type of underwater attack. In the end a suicide boat crew was used, but the maritime community has woken up to the threat posed by divers attempting to infiltrate coastal facilities or attach limpet mines to ships in port.



Photo: QinetiQ

Figure 2. The Cerberus swimmer-detection sonar is currently being developed by QinetiQ. It is part of a family of integrated and complementary harbour domain-awareness security products designed to protect a harbour, port or other vulnerable asset from the threat of attack on or beneath the waterline.

Figure 3. Lockheed Martin Canada's Swimmer Intruder Detection Harbour System is a 360°, long-range, high-frequency sonar designed to protect harbours and high-value coastal assets from underwater swimmer intruders.



Figure 4. UK-based CodaOctopus' Echoscope sonar system was trialed in July 2005 with QinetiQ's Cerberus system as part of an integrated system for harbour protection to provide real-time, high-resolution visualisation of potential threats such as a diver entering a port zone.

## Intruder Detection Harbour System

Lockheed Martin Canada's Swimmer Intruder Detection Harbour System (SIDH) is a 360°, long-range, high-frequency, wideband omni-directional sonar (see Figure 3). Designed to protect harbours and high-value coastal assets from underwater swimmer intruders, it is capable of automatically detecting, classifying and tracking swimmers at long range in difficult operating environments.

The SIDH can be integrated with surface surveillance equipment such as radar, infrared cameras, and closed-circuit and low-light TV cameras. Sophisticated classification algorithms discriminate the human swimmer threat from marine life to reduce the false-alarm rate. The sonar can be deployed either from a surface vessel (over the side) or in a harbour as a permanent or redeployable transportable asset.

According to Lockheed Martin Canada, the SIDH will automatically detect, classify and track an intruder within a minimum 500m radius of the acoustic sensor in high-reverberation salt-water conditions. It will automatically alert the operator when an alarm is raised: minimal operator intervention is required. It can either operate as a stand-alone sensor or as part of an integrated system.

The system is designed to be effective against all types of swimmers; including bare-skinned surface/snorkel swimmers, scuba divers, closed-circuit breathing apparatus (CCBA) combat divers and self-propelled underwater delivery vehicles.

## TD Diver Detection System

Tritech International has designed a diver-detection harbour security system, featuring a specially designed high-resolution composite transducer capable of detecting divers using CCBA at ranges up to 200m and divers using conventional open-circuit diving systems at much greater ranges.

Operating at a frequency of 100kHz, the system produces vertical and horizontal beams of 15° and 7.5° respectively. The typical scan sector is 160° flyback, although this is variable to provide full 360° coverage.

According to Tritech, deployment configurations will vary according to the size and geography of the harbour or secure area, with more than one sonar head being deployed if necessary. To help counter problems with ambient noise, each head is fitted with a 'scan memory' that activates when a target is identified. The sonar effectively learns about its environment, omits known stationary objects and only concentrates on new moving threats.

## Echoscope

UK-based CodaOctopus' Echoscope sonar system (see Figure 4), designed to image fixed and moving objects at up to 200m, provides instantaneous 3-D images underwater in real time for harbour surveillance. It can be operated from the shore, from a small vessel or from a remotely operated vehicle.

Unlike 2-D sonars that generate narrow or fan-shaped beams, Echoscope covers a wide area using advanced beamforming techniques to generate a high-resolution 3-D image comprising more than 16,000 individual focused beams (128x128 beam array), with a range resolution of 10mm. By pinging at 20 times per second, Echoscope is able to distinguish static objects from moving targets, making it ideal for swimmer detection.

The operator can add actual 3-D objects to a database as a reference guide (size, shape or position) when identifying targets. For example, once the shape of a harbour wall has been programmed into the software, on sweeping the area the operator can compare the new image with the stored image and immediately pick out anomalies or foreign objects.

Trials were undertaken in July 2005 in conjunction with the NATO Underwater Research Centre in La Spezia, Italy, and QinetiQ. Deployed as part of an integrated system for harbour protection, Echoscope was used in conjunction with QinetiQ's Cerberus system to provide real-time, high-resolution visualisation of potential threats such as a diver entering a port zone.

## CSDS-85 Omni Active Surveillance Sonar

Canada's C-Tech Ltd has been involved in the production of harbour security sonar for over 20 years. Its latest, the fourth-generation CSDS-85 Omni Active Surveillance Sonar, is designed to detect underwater intruders such as divers with open and closed breathing apparatus, SDVs and mini-submarines.
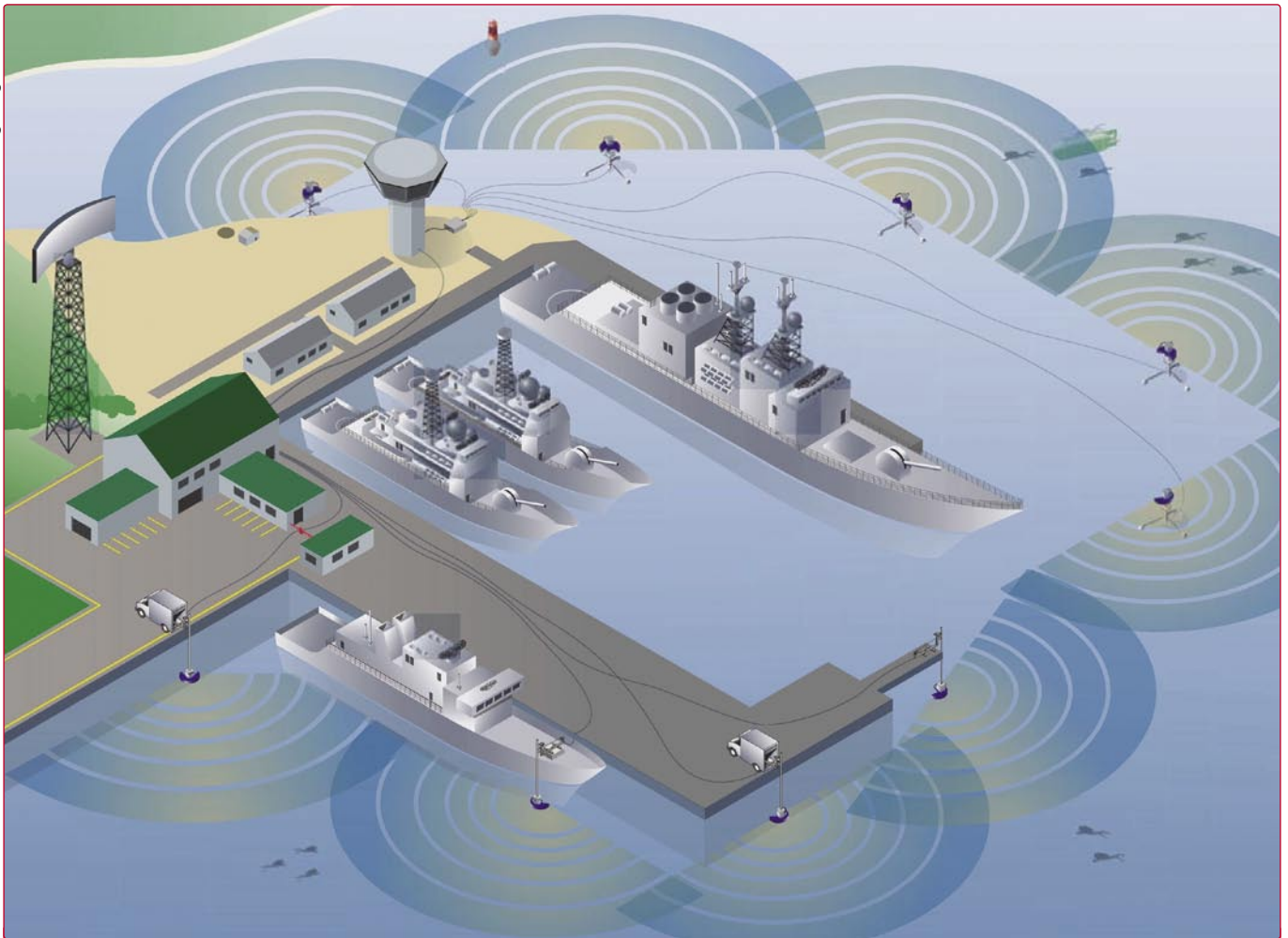
Photo: Kongsberg Mesotech



Figure 5. Many diver detection sonar on the market can be used as a single unit to provide area protection or in greater numbers to form a security perimeter, with each unit acting as a node in a wider network.

It can be deployed from the seabed, dockside or from a ship, and can be operated with a series of sonar systems to cover a wider area. It has a detection range of up to 2,000 m (with range scales at 250 m, 500 m, 1,000 m, 1,500 m and 2,000 m) and can be deployed and operated down to 70 m.

CSDS-85 functionality includes a high–resolution real-time display, automatic target detection, automatic or manual target tracking and a 360° horizontal field of view. Coverage is provided by an array of 256 rapidly scanned, preformed receiver beams.

Each narrow vertical beam has a horizontal width of 3°, an adjustable vertical width of 6°, 12° or 24°, and is continuously tiltable under operator control from +24° to -24°.

An automatic detection facility with audible alarm is available, with the option to set specific exclusion areas. There is also a zoom feature for target classification. Operators can select a static suppressed image mode whereby echoes or images from stable background targets (such as sea walls) are suppressed, leaving the display to provide video of only new or moving targets.

### ABOUT THE AUTHOR

**William Grant** is a freelance maritime defence journalist with over 10 years experience in the industry. Publications he has written for include Jane's Navy International, EEZ International, International Ship Operator and Port Technology International, among others.

### ENQUIRIES

Angus Dawson

Editorial Manager

Port Technology International

E-mail: adawson@porttechnology.org

Website: www.porttechnology.org