Protecting the Soft Underbelly of Military and Civilian Port Targets

by **Steve Campbell**

The Mumbai terrorist attacks this past fall have served to highlight a potential Achilles' heel in the soft, watery underbelly of military and civilian port defences, making it clearer than ever that these areas are not well protected against incursion by terrorist or enemy special forces divers. Unfolding events continue to confirm the sub-surface weakness of ports—a soft target since at least World War II, when navy frogmen first began to use them as points of attack.

In May 2008, for example, news reports indicated that the Tamil "Sea" Tigers had successfully blown up a Sri Lankan naval ship in the heavily guarded Trincomalee harbour with a powerful pre-dawn undersea explosion. The Tigers claimed responsibility for the attack as the work of their underwater naval commandos.

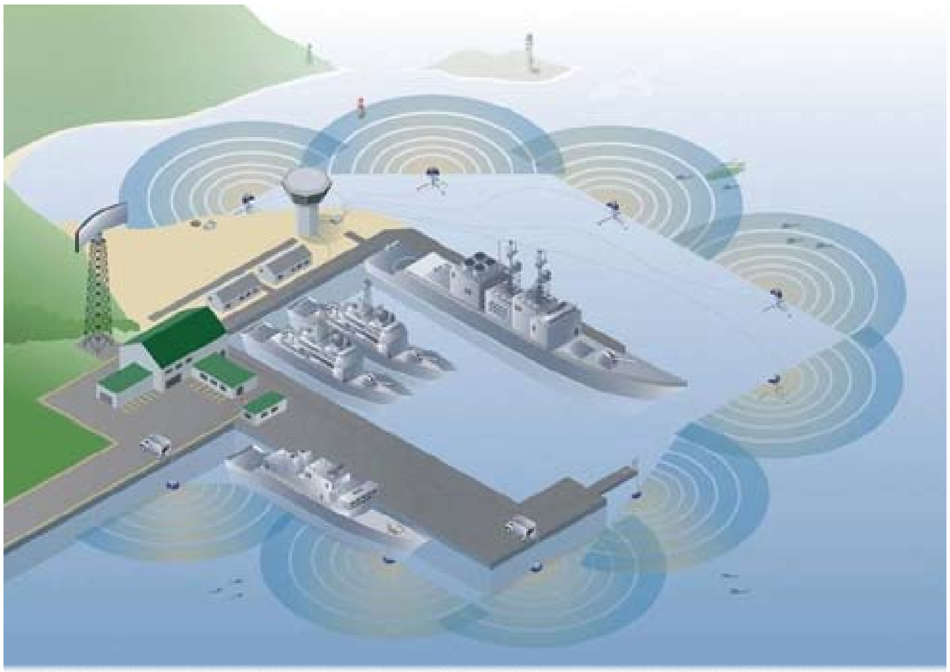
And in another attack in March, a sea mine sank a Sri Lankan naval fast attack craft off Nayaru. Again, the Tigers claimed responsibility for a sea battle—launched by their Sea Tigers suicide squad—that left three of its members and 14 Sri Lankan sailors dead.

While the exact means of this attack are unknown, experts speculate that a human suicide torpedo may have been destroyed the ship. Conversely, a group of divers may have affixed a mine to the hull of the ill-fated vessel (the suicide squad could have been dropped off hours earlier to await a strike opportunity). Whatever the strategy, the prospect of enemy divers entering ports or coastal waters undetected to attack naval and civilian ships or piers is troubling, not only for navies and military forces but also in terms of the safety and security of civilian global trade and shipping.

"The increased use of divers to attack from the water demonstrates a belief that underwater access presents an easier way to enter ports and attack ships anchored at dockside," said Phil Andrew, manager of underwater security for Kongsberg Mesotech, a leading global provider of sonar technologies that has provided sonar to the US Coast Guard through its Underwater Port Security Project. "Drug smuggling and the rise of terrorist threats over the last ten years have increased the need to monitor the underwater lanes of our ports using sonar and other technologies. Fortunately, recent sophisticated innovations are helping to address this problem."

Improving the Speed and Quality of Detection Is Critical

In the past, and still in many places today, diver confirmation has been performed by scrambling a crew of combat divers in a high-speed RIB craft. The crew enters the water and searches the area, an expensive and time-consuming task. Underwater sonar saves money and–even more important–time.



This graphic of navy vessels moored alongside demonstrates how a diver detection system can set up a security zone perimeter around these high-value assets. The underwater sonar system is mobile and can be quickly deployed from a pier, ship or truck and moved as required to provide full coverage.

In detection, time is of the essence: often these hostile divers are moving rapidly, assisted by underwater vehicles. To thwart a sabotage mission, a hostile diver's incoming signal must not only be separated out from all the extraneous underwater objects, it must also be analysed as quickly as possible. As was seen in Sri Lanka, seconds can equal life or death in these situations.

In light of the increased threat, waterside security issues are receiving much greater emphasis than in the past. It is very clear that active, high-frequency, multi-beam sonar technology is the most effective approach for protecting high-value targets from underwater threats.

Complementary sonar technologies, such as limited range "3D" sonars, can lend support to this effort. However, the number of 3D units required to secure an area make this prohibitively expensive. For restricted, high-reverberation environments where multi-beams cannot operate effectively, for example canals, single-beam scanning sonars can focus a narrow beam to either supplement diver detection systems or provide highly mobile sonar.

While diver detection ranges have been pushed out considerably over the years, they are now approaching the theoretical limits restrained by the physics of diver detection. However, where advances do continue to be made is in the reliability and consistency of that detection. Technology improvements in sonar systems over the past decade have focused on improvements in these key areas: hardware, tracking software and data fusion and systems integration.

Hardware Advances Into Portability and Increasing Range of Sonar

The most readily apparent advance in hardware over the last few years has been toward expanding the horizontal field of view–from 90 degrees to 180, and now to 360 degrees. This enables the user to monitor a wider field or search a larger area more quickly. Interestingly, some sonar technologies have the ability to adjust the vertical field of view, enabling the beam to be expanded or narrowed in the vertical dimension and even "steered" up or down to address various monitoring challenges and range conditions.

Additionally, the development of smaller, more portable sonar units is another excellent advance that allows sonar units to be moved around to different locations in the port, or to a dock to protect temporary sites (such as a visiting, high-value ship or an important event on a pier).

In addition to the use of multi-beam technology, single-beam sonar can supplement a standard multi-beam installation in two ways: first, by providing coverage in confined areas; and second, as an imaging tool for providing short-range diver confirmation. Single-beam (mechanically scanned sonar) operates much like radar sweeping an area, with a narrow, high-intensity beam that provides high-resolution images to provide detection and tracking functions.

Multi-beam sonar, on the other hand, "fires" a number of beams simultaneously to cover a broader field of view with a single "ping," operating at frequencies ranging from 70 to 200kHz. Operating at lower frequencies than scanning sonar–but with higher energy–results in a multi-beam sonar with a longer reach, increasing its effectiveness in diver detection. However, there is a trade-off in range versus resolution, with the optimal frequency appearing to be around 90kHz. US Navy studies have confirmed that the frequencies best suited for diver detection surveillance lie between 85 and 100kHz.

Advances in computer hardware–particularly the development of dual and quad processors–have meant that processor hardware cost and size have been dropping steadily. The widespread availability and reliability of network servers can now both reduce costs and improve system reliability, delivering higher-quality monitoring. In addition, "blade" servers enhance system reliability through distributed processing, with the capability to re-assign tasks to individual processor boards (blades) if there is a problem, automatically providing processing backup through redundancy.

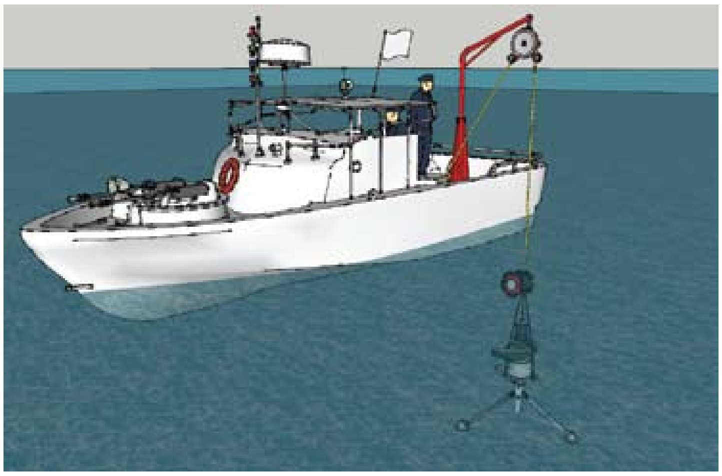
Confirmation of divers can be accomplished through the use of a small, torpedo-like ROV that launches at the push of a button to investigate a threat, navigating automatically to the target on a steady stream of data from the diver detection system–a capability that was unheard of just a few years ago. From there, the target is dealt with according to protocol and, if simply an innocent swimmer or diver, given the opportunity to leave a high-security zone. Underwater "loudhailers" are now available to speed this process along.

Software Improves Image Resolutions and Reduces False Alarms

One of the biggest goals in diver detection has been reducing the number of false alarms triggered by marine life. There are two discrete types of software programmes employed in the diver detection process. The Sonar Processing software operates the sonar head and processes the returned data.

The other, referred to as Automated Detection and Tracking software (ADT), utilises this data to detect, track and classify potential threats. The built-in algorithms incorporate elements of artificial intelligence to logically select only those targets with the characteristics of underwater or surface swimmers. Other detection parameters may be incorporated to broaden the variety of targets considered threatening. Advances in this area include better reliability, fewer false alarms, and the ability to specifically identify the target as a SCUBA, vehicle-assisted or CCBA diver.

It is possible to use multi-beam or single-beam sonar without automatic target detection and tracking software, but this requires a trained operator to constantly view the sonar image–an unrealistic and costly expectation.



The portability and versatility of advanced underwater sonar technologies enable fast mobile deployments from boats in harbours or other waterways.

One of the major challenges navies face today is a shortage of qualified personnel to operate the detection systems. Increasingly, they are looking for sophisticated yet easy-to-use technology, both to fill the gap and to aid in training. One plus of some of today's technologies is the ability to play back diver tracks in simulation for training purposes.

The recent development of significantly more sophisticated auto-detection algorithms and advanced computing power means that the reliability of these systems is improving rapidly, and commercially available, off-the-shelf or COTS technology has now reached a level considered acceptable for long-term naval use.

The US Navy developed one of the earliest and most effective anti-frogman systems: the AN/WQX-2. In this system, the sonar head is combined with a sonar processor and auto-detection and tracking software to distinguish divers clearly. Kongsberg Mesotech has recently combined the latest generation of sonar head, the DDS 9000, with its Defender II automated detection and tracking software. Output of targets and target track data can be fed into the Defender X software, which has the ability to combine the data from up to ten systems.

On an even larger scale, data from diver detection sonar, radar and Automatic Identification Systems (AIS) can be amalgamated to provide a much larger picture of Maritime Domain Awareness.

In addition to the auto-detection and tracking of targets, today's advanced software is capable of displaying the output in a standard military format to enable a surveillance system display, or to be output to other command and control (C^2) systems. The benefit here is that all tracking data on targets can be merged on a single C^2 display screen for fast action. Once the target is detected, the operator should receive an alarm, along with additional information regarding the target's tracking path.

After detection, the ADT system will make a series of signal measurements to determine whether the target meets the criteria of the tracking algorithms. If it does, it is up to the command structure to decide how to react to the approaching threat. Given the potential negative outcomes, the purpose of today's technology is to offer as much early warning as possible toward prevention of an attack.

In today's expanded military environment, where terrorists are taking the attacks to more vulnerable port cities, shorelines and ships at dockside, a few seconds can literally mean the difference between a propaganda victory of sinking a ship and the successful elimination of a diver threat.

Data Fusion and Systems Integration

The dual challenge of detecting a target as small as a human diver at extended ranges and maintaining constant contact are being addressed through the combination of data from multiple sensor types. Using active and passive sonar in conjunction with radar or other sensors can increase the probability of detection by integrating complementary functions.

One example is the combination of surface radar, sonar and AIS data in systems to provide exactly this type of Maritime Domain Awareness (MDA), identifying friendly surface craft, unknown surface craft and underwater threats.

This concept can be extended further by providing a complete system of overall MDA to port authorities and law enforcement. These systems typically involve multiple sonar, radar, EO/IR (electro-optics infrared), AIS (automatic identification systems), and satellite data inputs. These features operate on a real-time basis, working together in a multi-faceted, fully integrated system for dealing with surface and subsurface attacks.

Encouragingly, integrated advances in hardware and software technologies have made diver detection systems much more effective in addressing port underwater security issues. As other terrorist groups observe the exploits of organisations like the Tamil Sea Tigers and continue to refine and enhance their own techniques and tactics, the possibility exists for a large expansion in port attacks and terrorism. Thankfully, advances in diver detection systems are keeping pace in the race to protect the soft underside of our global ports. ■

Steve Campbell is a technology writer who writes about advanced technologies and advanced technology companies.