LFATS' Competitive Advantages for Undersea Warfare in Shallow Waters

Prasun K. Sengupta

It is the threat from diesel-electric submarines (SSK) that drives the specific requirements for active/passive low-frequency anti-submarine warfare (ASW) sonar. The quiet, modern SSK operating in shallow waters is difficult to defend against when it possesses modern torpedoes and surface-to-surface cruise missiles that have effective ranges that can exceed 70km. Because of these SSK threat capabilities, wide areas have to be searched and long standoff distances have to be cleared for the safety of high-value surface combatants. The most effective sensor to detect the SSK operating in shallow waters is the active/passive low-frequency, variable depth sonar. A warship and the naval helicopter equipped with active long-range (towed-array and dipping) sonar provide the necessary standoff safety, required mobility and technology for successful ASW operations.

Another important point to consider is that shorter-range mid-frequency, hull-mounted panoramic sonar, that is the mainstay ASW sensor for many navies, and also mid-frequency helicopter dipping sonar, has a much lower probability of detecting the SSK from simple geometric considerations. For example, for the mid-frequency dipping sonar, the SSK can outrun the area coverage of the short-range sonar between its pings. A SSK can hear the pings of the hunting panoramic sonar even before that sonar detects it, and the SSK can also figure out its likely detection range. A very good tactic for the SSK is to sprint at high speed between pings. If the panoramic sonar has a relatively short detection range the SSK has a good chance to escape. Such sprint tactics to avoid detection are far less likely to work against long-range, low-frequency active/passive dipping sonar, such as the HELRAS, and towed-array sonar like the Low-Frequency Active Towed Sonar (LFATS), both made by US-based L-3 Communications Ocean Systems. The conclusion is that short-range, mid-frequency, hull-mounted and helicopter-dipped panoramic active/passive sonar cannot reliably do the basic ASW mission. In the case of the relatively short-range, mid-frequency ASW sonar the modern SSK can remain undetected well within its weapons range envelope and hence be a lethal threat to surface combatants.

The range of an active ASW sonar system is determined by environmental conditions, by the operating characteristics of the sonar, such as power-level and beam-widths, and by the operating frequency. The general rule of thumb is, the lower the operating frequency, the longer the sonar's range. However, a lower operating frequency in the past has required a larger and heavier sonar transducer. Since especially helicopters, but also surface warships, have limitations in space and carrying capacity, traditionally a compromise would have to be made choosing as low as possible operating frequency while still maintaining the sonar to be light and compact sonar to go on the platform. This compromise has generally ended up with an operating frequency around 4.5kHz. It is extremely important to note that AT ALL TIMES, if such a size/weight/frequency compromise were not necessary, the lower the frequency the better the sonar's range performance. This is very evident considering the selected operating frequencies of almost all modern active variable depth ship-launched sonars (VDS) being designed today. For a ship the size and weight of the sonar and its winch and handling system is less critical than for the helicopter. Inevitably, the selected frequency is below 2kHz. There is a very good reason for such choice, for the lower the frequency the better the performance

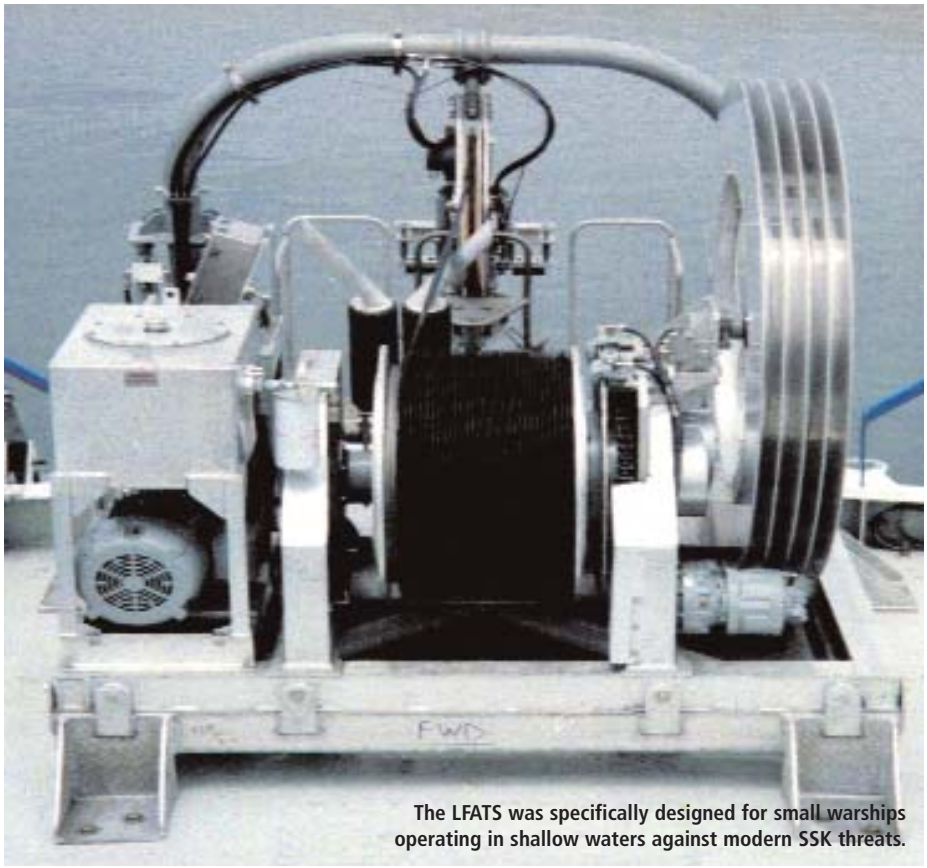
The low frequency designed into the LFATS using proprietary transducer and beam-forming technology allows multiple boundary interactions and reduced reverberation contamination of the received signals.

against the modern SSK! Lower frequency is particularly important for good range performance in shallow tropical waters. The main reason is that the lower frequency suffers much less losses as the acoustic signal interacts with the shallow-water surface and especially bottom boundaries.

L-3 Communications Ocean Systems solved the size-performance compromise problem with the invention of new transducers which are much smaller and lighter, yet still transmit very high power at low frequencies. This new technology has been applied to the design of the HELRAS helicopter-dipped sonar and the LFATS towed-array sonar. The LFATS was specifically designed by L-3 Communications Ocean Systems for small warships operating in shallow waters against modern SSK threats. Typically, LFATS is at least one quarter the size and weight of competitive sonar systems. L-3 Communications Ocean Systems' ability to achieve this level of sonar performance in such a small form factor is unique.

The system comprises a towed body that integrates separate transmit and receive arrays operating at 1.38kHz, a compact winch along with its handling system, and shipboard electronics. The LFATS can reach an operational depth of 300 metres (985 feet). It easily fits into warships like the Indian Navy's existing Project 15-class guided-missile destroyers (DDG) and the three projected Project 15A DDGs, three Project 17 guided-missile frigates and six Project 28 ASW corvettes, and gives the sonar, in shallow waters, a range that is at least two times the range of any competing mid-frequency sonar. In deeper waters the average range advantage increases to between four to eight times. Overall, this gives low-frequency sonar an advantage of between four to at least 16 times the area coverage for all operating conditions that a navy might encounter. The beneficial impact of this performance advantage is staggering! It is something that should be of one of the primary considerations for any navy that is evaluating new towed-array sonars for eventual procurement.

The LFATS' small size and weight means that its integral winch and handling systems are also much smaller and lighter than competitive systems. This gives LFATS a great advantage on small surface combatants operating in littoral waters, where a navy can embark the payload with minimal impact to the warship and its existing onboard equipment. The LFATS' tow-body is



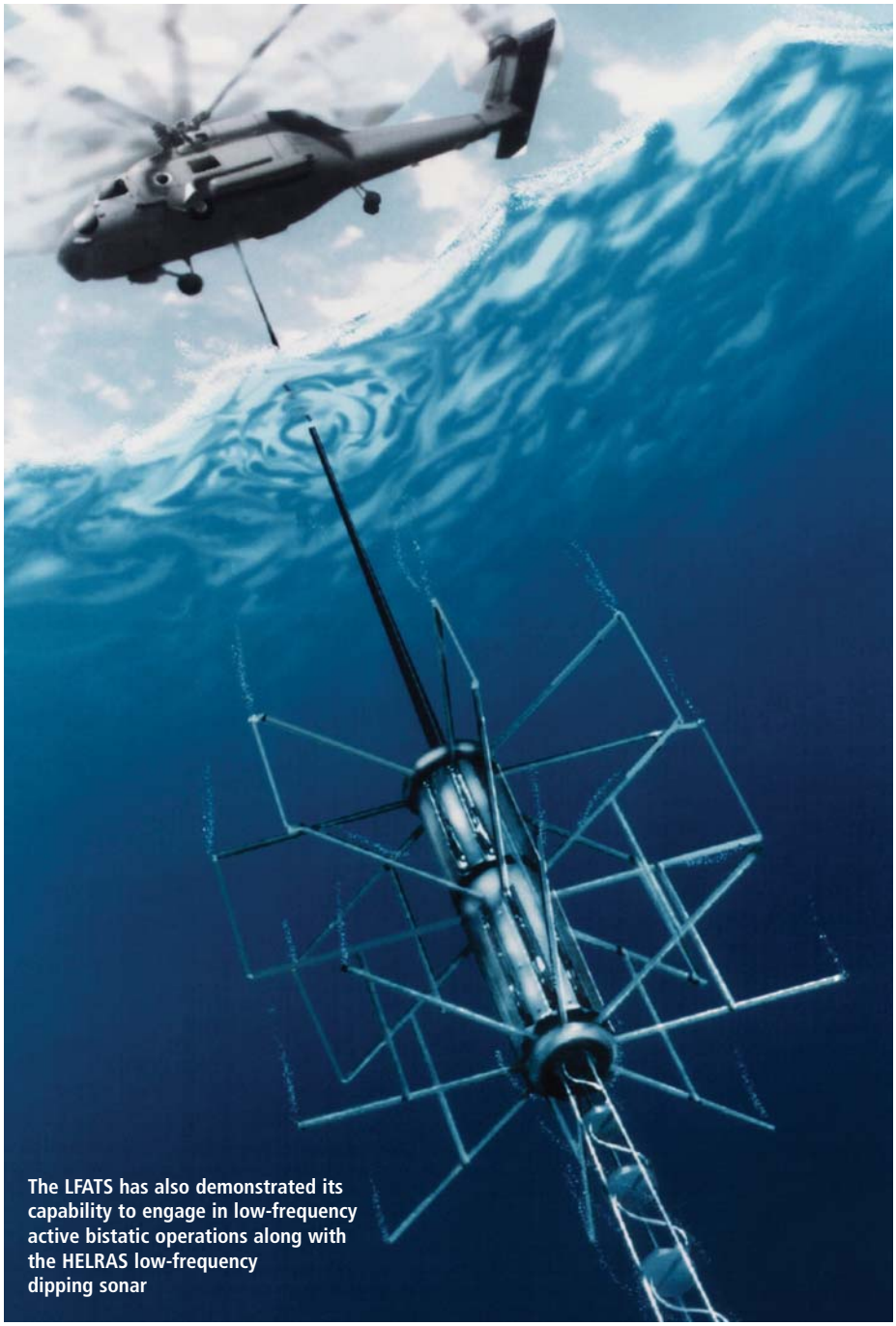
The LFATS was specifically designed for small warships operating in shallow waters against modern SSK threats.

uniquely configured for shallow-water operations, which creates major competitive advantages over the traditional VDS. Traditional VDS configurations have placed the tow-body a significant distance back from the warship to prevent acoustic interference from the warship's own noise on the sonar. The LFATS' very advanced adaptive noise cancellation, however, removes such own-ship interference and allows the short-scope tow of the system required for shallow water operations. The effectiveness of this noise cancellation was recently tested in warm shallow waters from a very noisy tow ship. The results were outstanding. The LFATS typically operates in waters as shallow as 10 metres.

Traditional single-receive arrays on competitive systems are many hundreds of yards long. The LFATS' tow-body has two short towed-arrays for active receive, which are less than 100 feet long. These dual short arrays facilitate shallow-water operations without restricting the warship's manoeuvres and also allow it to reliably and quickly resolve port and starboard bearing ambiguity, without the traditional need to wait while the array straightens out again after a course change. This also allows the warship to manoeuvre at will in shallow waters, without worrying about the towed-body and arrays grounding in turns and at slow speeds. The active projectors on the LFATS' tow-body are a variable geometry. The projectors automatically retract at speeds greater than 23 Knots, allowing the warship to transit at sprint speeds up to 30 Knots without the need to recover the tow-body. When the warship slows down again to operating speed the system automatically resumes active operations without delay.

The LFATS' low frequency also minimizes the effects of boundary (surface and bottom) losses to maximize detection range in warm shallow waters of the type prevailing throughout South and Southeast Asia. Low-frequency operations have significantly lower volume absorption losses than high-/mid-frequency systems, thus enabling long-range detections. The LFATS' broadband FM transmissions and processing also provide significant reverberation reduction, thereby allowing the detection of slow-moving targets in shallow waters.

High levels of reverberation often limits the performance of high power active ASW sonar in shallow waters. The LFATS is designed to minimize the limiting effects of



The LFATS has also demonstrated its capability to engage in low-frequency active bistatic operations along with the HELRAS low-frequency dipping sonar

shallow water reverberation. It uses a variable geometry projector array that is small and compact for stowing and handling, and expands to a large vertical aperture during operations. This allows the formation of narrow transmit beams that significantly reduce reverberation. Also the LFATS uses multiple towed receive arrays. This allows advanced and effective reverberation processing that is physically not possible with single array systems. In summary, the LFATS has the following competitive operational advantages:

- It is extremely small and lightweight, allowing it to fit on the small vessels with ease. Thus far LFATS has been used successfully on vessels as small as 70 tons.
- The same features allow minimal ship impact, in terms of installation, ship manoeuvres and operations. In addition, the LFATS has virtually no impact on ship speed, trim, fuel consumption, etc.
- Its small size and weight make it easy and safe to launch and recover the tow-body with a small crew.
- It puts 15 times the sound intensity into the water as the competing systems, in spite of its small size.
- It broadcasts in both omni and quadrant modes, allowing the tactical use in shallow waters by only putting power where the operator believes the target to be (away from the shore for example).
- Its high-gain, towed-array receiver allows target bearing ambiguity to be resolved instantly because of its twin receive arrays, without the need for time-consuming ship manoeuvres.
- By using variable projector array geometry for narrow vertical transmit beams and physically separated twin receive arrays, the limiting effects of shallow water reverberations is largely eliminated.
- It is safer to operate in shallow waters because of its short receive arrays, rather than a long towed-array, and/or long lay-back of the tow-body, which is vulnerable in turns and at slow speeds.
- Its short arrays stabilize quickly after manoeuvres—a significant advantage for operations in shallow or congested waters. It also uses short-tow scope which is a significant benefit in shallow water operations.
- It is equipped with a depth sensor allowing for the automatic adjustment of its cable scope and consequently depth control of the tow-body.
- The highest level of sonar performance, often approaching that for a free sonar in the open sea, is achieved using an effective, proven adaptive noise cancellation processing to remove own ship's noise interference.
- It is designed for ASW work, allowing the warship to go to full speed without the need and time to recover the tow-body.
- Its low frequency maximizes the detection range in warm, shallow waters of the type prevailing in South and Southeast Asia.
- It is fully bistatically/multistatically compatible with L-3 Communications Ocean Systems' HELRAS low-frequency dipping sonar.
- It is frequency bistatically/multistatically compatible with most modern sonobuoys and some towed-arrays.
- It is designed with sophisticated multi-purpose waveforms (CW and FM) and processing for the maximum figure of merit against fast and slow, or stationary, targets.
- It augments existing hull-mounted panoramic sonar with its ability to operate below the layer in both shallow and deep waters. ●