End of the tether: Active dipping sonar technology

Active dipping sonar technology is advancing to address challenging threat environments and open up new regional markets for smaller ASW helicopters, reports Richard Scott

Anti-submarine warfare (ASW) helicopters gain powerful and organic long-range acoustic detection with active dipping sonar systems, which deploy submersible bodies containing transmit and receive elements while the host platforms hover. The systems transmit pulses of sound through the water column and listen for return 'echoes', which are processed on board to indicate a target's range, bearing, and opening or closing rate relative to the helicopter's position.

Several trends are under way in technology and operations. Manufacturers have developed systems that operate at lower frequencies (below 5 kHz), which provide significantly greater area coverage and improved performance against submarines clad in anechoic coatings. Meanwhile, to enable installation in smaller helicopter types and extend on-station time, an ongoing effort aims to reduce the size and weight of hardware such as submersible units, reeling machines, and processing/display units.

[Continued in full version...]

Head to head

Western navies and/or rotary-wing prime contractors searching for an active dipping sonar can choose from two suppliers that are going head-to-head in the marketplace and can each point to an impressive sales pedigree. In one corner of the ring is L-3 Ocean Systems, which markets its top-end HELRAS DS-100 system and a clutch of lighter-weight AN/AQS-18 variants. In the other is Thales, which is offering standard and compact variants of its Folding Light Acoustic System for Helicopters (FLASH) dipping sonar system.

L-3 traces its dipping sonar heritage back to Bendix, then AlliedSignal. The company began developing HELRAS in the 1970s, based on low-frequency flex disc transducer technology, and has secured orders from at least nine navies.

Operating at a centre frequency of 1.38 kHz, lower than the rival FLASH system, the HELRAS 'wet end' comprises a receiver array of eight hydraulically driven arms (expanding to a diameter of 2.6 m when deployed) and a transmitter array of seven projector elements (plus an underwater telephone transducer) suspended below the submersible unit to form a 5.2 m vertical projector array. Maximum operating depth is 500 m.

The vertical line projectors transmit narrow beams that reduce boundary interaction and couple efficiently with complex signal modes to permit long-range propagation. The receive array has good directionality to discriminate ambient and biological noise, reducing acoustic interference and providing maximum sensitivity for extended detection ranges.
Low frequency

L-3 claims that HELRAS's low transmit frequency delivers significant performance advantages in both oceanic and littoral waters over rival mid-frequency systems. Operating modes include active (continuous wave [CW], frequency modulated [FM], and combination), passive, and underwater telephone (STANAG-1074). CW pulse transmissions are used for long-range detection in the sonar convergence zone. FM and short CW pulses are employed for target re-acquisition, location, and attack. Long-shaped CW pulses and wide-bandwidth FM pulses (up to five seconds) are available to detect near-zero Doppler low-echo-strength targets. HELRAS frequencies allow an FM bandwidth of around 300 Hz.

HELARAS was nominated by the Italian Navy in 1985 as the preferred dipping sonar for its fleet of EH101 (now AW101) anti-submarine helicopters. The system has subsequently chalked up sales worldwide on a range of platforms, including the S-70B export variant of the Seahawk, the AS532C Cougar, and the NFH variant of the NH90 helicopter.

![Italian NH90 NFH helicopters are equipped with L-3 Ocean Systems' HELRAS dipping sonar (integrated with the OTS-90 sonics suite). (AgustaWestland)](image)

The first HELRAS contract, to supply an initial 10 systems to the Italian Navy for fitting aboard EH101 helicopters, was approved in December 1998, with the order received by L-3 in 1999. Italy and the Netherlands have also selected HELRAS to equip their NH90 fleets, employing an application in which the dipping sonar is integrated with a common acoustic processor as part of the Selex ES OTS-90 sonics suite.

Brazil, Greece, Singapore, Thailand, and Turkey have all selected HELRAS for their S-70B variants, while Canada is receiving the system as part of the mission fit for its 28 new CH-148 Cyclone maritime helicopters. Chile is another customer, having selected HELRAS for the upgrade of its five AS532SC ASW helicopters.
L-3’s HELRAS sonar has been sold to Chile as part of the upgrade of its five AS532SC ASW helicopters. (L-3)

It was announced in November 2014 that 11 AS565 MBe Panther helicopters are to be supplied to the Indonesian Navy by PT Dirgantara Indonesia (PTDI) in partnership with Airbus Helicopters. In March 2015 Rotorcraft Services Group announced it had teamed with PTDI to develop and integrate an ASW suite for these aircraft including HELRAS and a lightweight torpedo launch system (allowing for either the Mk 46 or A244/S weapon).

However, given that HELRAS weighs a hefty 325 kg, including 153 kg for the wet end, L-3 Ocean Systems is now also pursuing the development of Firefly: the latest lightweight evolution of its AQS-18A mid-frequency active dipping sonar. Earlier AQS-18 variants have already been sold to countries including Egypt, Germany, Portugal, South Korea, and Taiwan.
Portuguese Navy Super Lynx Mk 95 helicopters are equipped with L-3 Ocean Systems’ AN/AQS-18A mid-frequency dipping sonar. (AgustaWestland)

FLASH messages

Established in the marketplace for over two decades, with more than 310 systems delivered or on order, the Thales FLASH active dipping sonar has its origins in the late 1980s, when what was then Thomson Sintra Activités Sous Marines began developing a new-generation active dipping sonar designated TSM 8260.
Thomson Sintra had previously sold its DUAV-4 lightweight dipping sonar to the French and Dutch navies for their respective Lynx Mk.2 (FN) and SH-14D Lynx helicopters, and had also enjoyed substantial export sales success with its HS 12 and HS 312 dipping sonars.

FLASH built on this pedigree but broke new ground with reduced weight and volume, a short dip cycle (due to optimised hydrodynamics and a high-speed hydraulic reeling machine), a greater operating depth, and a lower operating frequency (3-5 kHz).

The result was a dipping sonar with a much improved search coverage. Thanks to its deep dip capability (up to 750 m), FLASH offered the ability to insonify the full water column, exploiting the deep sound channel and avoiding 'shadow' zones. Furthermore, its lower frequency and large-bandwidth active transmission provided a detection/classification capability commensurate with a new generation of lightweight torpedoes.

FLASH has a smaller receive transducer array diameter than HELRAS (700 mm versus 2.6 m) because its operating frequency is higher and its unitary transmit array configuration does not require a second electric deployment motor (with a negative impact on mean time between failures). Its 1.5 m-long transmit antenna embodies eight conventional ceramic ring transducers operable down to 750 m.

While the positive-gradient FLASH exploits at 700 m water depths may imply a shorter absolute range than the negative gradient used by HELRAS at 500 m, Thales contends that this affords FLASH a continuous detection capability without gaps or shadow zones. The company also highlights FLASH's large bandwidth (1,000 Hz FM), arguing that this offers the superior definition needed for analysing low-Doppler echoes and overcoming reverberation effects.

Rather than using an existing unit, FLASH has an optimised reeling and control system that gives the wet end maximum descent and ascent rates of 4.5 m/sec and 9 m/sec respectively. This translates into a dip cycle time at 700 m that is no greater than that of HELRAS down to 450 m. Theoretical assessments show that, against a worst-case target (for example a submarine escaping radially at 30 kt), the FLASH-equipped helicopter could have as many as three dipping opportunities while the target remains within torpedo-detection range.

In December 1991 FLASH was selected as the active dipping sonar to equip the UK Royal Navy's 44 Merlin HM.1 helicopters. Designated Sonar 2089, the chosen system combined the FLASH array with the AQS-950 sonics processor. The upgraded HM.2 variant of Merlin retains the Sonar 2089 fit, but the processing is now hosted in a common acoustic processor. Under the Merlin Capability Sustainment Programme 30 HM.2 upgrades are currently planned.

Variants of FLASH integrated with the Thales TMS2000 sonobuoy processing system have been selected for the navies of France (14 systems for the NH90-NFH Caiman Marine) and Norway (five systems for its NFH variant). Both have specified a palletised system designed to enable rapid airframe re-roling. The United Arab Emirates is another customer, having procured a standalone FLASH fit for retrofit to five AS532 Cougar helicopters under Project Alcyon.
Compact variant

While FLASH was engineered with size and weight reduction in mind, its all-up mass of 332 kg prevented the system from making inroads in the maritime intermediate helicopter market. This spurred Thales to develop a slimmed-down version of FLASH to meet the needs of those regional navies - notably in the Asia-Pacific region - requiring an intermediate maritime helicopter able to support an autonomous ASW search-and-attack capability.

This activity has spawned Compact FLASH: a lighter-weight (267 kg) active dipping sonar installation that enables intermediate maritime helicopters - such as the 5-tonne-class Super Lynx 300 or the 6-tonne AW159 - to maintain FLASH performance and have a meaningful time on station.
An AgustaWestland Super Lynx 300 helicopter seen deploying Thales’ latest Compact FLASH dipping sonar. (AgustaWestland)

Weight has been lost through a series of engineering changes. First, while the existing reeling machine is retained, about 65 kg has been trimmed from overall system weight by supplanting FLASH’s hydraulic motor with a lightweight electric drive (in any case a necessity for the AW159, given its lack of hydraulic capacity).
Second, cable length is reduced from 750 m to 340 m and a lighter drum has been introduced. The shorter cable and lighter drum are tailored to a maximum dip depth of 300 m, considered sufficient as Compact FLASH’s target market is oriented towards ASW operations in shallower littoral waters.

Further weight has been saved by taking advantage of advances in lightweight COTS electronics for the processing unit. Elsewhere, existing hardware is maintained, including the 78 kg wet end, as is the functionality offered by the full FLASH system: a choice of three transmission frequencies between 3 and 5 kHz; FM, CW, and combined FM/CW pulse modes; mono- and multi-static active modes; and a range of operator aids (active and passive raw displays, panoramic/geographic display, auto-alert management, automatic multiple target tracking, performance prediction, and optimum depth tools).

Thales announced a first contract for Compact FLASH in February 2013, with AgustaWestland selected to supply three systems to equip Super Lynx 300 helicopters for an export customer. Deliveries began in late 2014. While the end customer for these systems has not been disclosed, IHS Jane’s understands that Compact FLASH is equipping three out of six Super Lynx 300 aircraft ordered for the Algerian Navy for operations from two new MEKO A-200 frigates.

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