Anti-Submarine Weapons - The State of the Art

Massimo Annati

Among the different sectors of naval warfare which underwent major changes after the end of the Cold War, Anti-Submarine Warfare (ASW) is certainly the most affected one. Nearly all the potentially hostile submarines belonged to Soviet Union, and when the latter disappeared very few boats were left in the worldwide inventory to be dealt with as potential threats. Moreover are a very complex tool, and not many navies belonging to potentially hostile nations in the so-called Third World were considered capable to deploy - both technically and operationally - such a force with a significant degree of effectiveness.

Nearly twenty years after the fall of the Berlin Wall, what is the current and prospective future situation?

ASW In The 21st Century

Clearly enough, in the Atlantic Ocean and Mediterranean basins there no longer is a submarine threat. Yet Russia increasingly appears to be indulging in sort of a Cold-War nostalgia, and no longer looks very friendly and cooperative (if it really ever had ...). Another important element of the strategic equation if the possible future evolution of the political posture of some Middle East countries like Egypt and Algeria. These are considered friendly and even allies to the West, yet are struggling to maintain their route towards democracy and development against instability caused by both domestic problems and foreign interferences.

Going eastwards Iran is the first (actually or potentially, make your choice) hostile country with a submarine force, controlling the access to one of the most sensitive areas of the world.

From the Arabic Sea and beyond, the situation is totally different. Regional tensions and concerns involve countries with significant naval services, and quite a few of these are engaged in a veritable "underwater arms race." New submarine construction or procurement programmes are underway in Pakistan, India, Indonesia, Malaysia, Singapore, Korea, China, Japan and, again, Russia. Therefore any naval deployment and operation in that large slice of the planet's waters must take into account, at least potentially, a robust ASW capability.
To conclude this very quick overview, also in the Caribbean there are local tensions, with a loud-speaking Venezuela close to acquire a batch of Russian-built KILO-class submarines.

The other main change following the end of the Cold War concerned the type of hostile Submarines one could expect to face and their operational area.

It should be appreciated in this regard that submarines are an important factor of both tactical and strategic equations, whose presence cannot and should not be disregarded. While Western technological supremacy can be counted upon to swiftly deal with attack craft, strike aircraft, coastal missile batteries and so on, submarines are a completely different story and their suspected presence require rather elaborate precautions. To underline this point with just two examples, movement of surface warships during operations in the Gulf of Sidra (1986) and the Adriatic Sea (1990s) were preceded and guarded by own submarines, just to ensure that no hostile underwater boat was in the area. After, and only after, the area was considered clear and safe, the big ships were allowed to enter it.

Yet another significant development following the end of the Cold War was the evolution of the tactical and environmental scenarios. Blue-water encounters against deep- and fast-running nuclear-powered boats were soon replaced by the hide-and-seek game against slower but very quiet diesel/electric boats, operating in shallow waters and littoral areas. Stealth - the submarine's main advantage - was even increased, as diesel/electric boats can lie motionless near the bottom, waiting for their potential preys while hidden in an environment characterised by poor acoustic conditions (critical thermal gradients, environmental and man-made background noise) and shallow waters (reverberation from both the bottom and surface, difficult use of most ASW torpedoes).

While the US Navy withdrew its SUBROC submarine-launched ASW ballistic rocket system immediately after the end of the Cold War, the Russian Navy has retained the conventional payload versions of conceptually similar weapons such as the RPK-2 TSAKRA (shown) and the RPK-7 VEDER.

A further critical factor is related to the weaponry available to submarines. A heavyweight torpedo can easily sink even a major vessel, breaking its back and, most of all, there are very few effective countermeasures available and deployable. Torpedoes can be covertly launched, providing no warning until too late to react - which is in strong contrast with most warships being fitted with electronic countermeasures and hard-kill defences supposedly capable to engage and defeat an incoming anti-ship missile. In any case, many modern submarines can launch either heavyweight torpedoes or anti-ship missiles, exploiting the best of each solution, and extending their threat well beyond the detection range of shipborne acoustic sensors.

In view of these considerations, ASW was considered out of fashion for a brief period of time but is now coming back to its full importance. It is not by chance that France is building eight FREMM frigates in the ASW variant [now down to six under the new White Paper -Ed.], while four out of the first six FREMM frigates for
the Italian Navy will also be of the ASW variant. Eight of the UK Type-23 frigates are being upgraded under the Task Force Escorts programme with the addition of the Surface Ship Torpedo Defence suite and new improvements/replacements as the Type 2070 active low-frequency bow-mounted sonar, Type 2087 low-frequency active sonar towed array, and the MERLIN HM1 ASW helicopter. The German Navy is gradually upgrading its F123-class frigates and the 2009-2012 Phase 2 will include new MU-90 ASW torpedoes, MH-90 helicopters, upgrade of the DSQS-23BZ bow-mounted sonar and fitting of a new low-frequency towed active sonar.

The US Navy is equipping its most recent DDG-51 class destroyers with the SQQ-89(V)15 ASW combat system, which is also being retrofitted to most of the earlier destroyers and cruisers. This retains the SPS-53 bow sonar but replaces the old SOR-19 towed array with the new Multi-Function Towed Array (MFTA), adding a passive detection capability. The new ASW capacities will also include the MH-60R helicopters with the AQS-22 ALFS sonar and the new Mk54 lightweight ASW torpedoes. By the same token the Japanese Maritime Self Defence Force, probably the world’s most capable ASW force, is constantly adding new first-class escorts, helicopters and patrol aircraft to its inventory.

Giving the relevant changes of tactical and environmental conditions experienced over the last years, how are ASW weapons themselves being affected? The following sections attempt at providing an answer.

Heavy-Weight Torpedoes

Heavy-Weight Torpedoes (HWT) are the weapon of choice for all submarines not only for use against surface vessels, but also enemy submarines under virtually all tactical circumstances - ranging from the engagement of fast, deep-running boats to the opposite scenario of an underwater target sitting on the bottom in shallow waters. Needless to say, such a wide range of different and indeed diverging engagement conditions create conflicting technological and performance requirements. For instance, the US Mk48 Mod.6 AT - certainly one of the most advanced heavyweight torpedo in the world - faces a severe limit in terms of minimum depth at launch, as a 25m overshot is required because the significant initial negative buoyancy (due to the weight of the propellant). In contrast the WASS BLACK SHARK, designed much later for a different scenario requires only a 1.5m overshot, allowing it to be fired in very shallow waters or even from bottom-sitting boats. Additionally some HWTs, like the Mk48 Mod.6 AT or the German DM2A4, are fitted with a magnetic exploder for ASW engagements and

The Atlas Elektronik DM2A4 heavyweight torpedo equips most notably the German Navy Type 212 submarines.
are therefore unable to cope with amagnetic hulls, whereas the BLACK SHARK exploits a multi-frequency coded acoustic proximity exploder.

While all submarines can use 21-inch (533mm) torpedoes, some can also launch smaller weapons for close encounter engagements. For instance, all modern Swedish-built boats have four 533mm torpedo tubes and two 400mm tubes for Type 432 ASW torpedoes.

HWTs can also be fitted to ASW-oriented surface warships, providing an additional capability for longer-range ASW attacks. This practice, once quite common has been progressively abandoned in view of the improved performance offered by modern light-weight torpedoes, and is nowadays only in use with some Russian-designed vessels operated by the Russian, Chinese, and Indian navies. This old-fashioned approach would admittedly still offer a potential advantage in terms of single-shot lethality, but other factors such as target detection capability or countermeasures rejection also play an important role.

Heavyweight torpedoes such as this Chinese Yu-6 remain the main weapon of submarines for use against other submarines.

Light-Weight Torpedoes
LWTs represent certainly the main and most common type of ASW weapons. They are used by surface ships, helicopters and maritime patrol aircraft, and can further be carried as payload by long-range ASW missiles (see below) or even by moored ASW continental-shelf mines.

The evolution of the tactical scenarios, as described above did also have an impact on the required characteristics and performance of LWTs. However, the time, cost and technical risks related to the development of a new weapon are so high, that this process is mostly reflected in the progressive upgrade and modernisation of existing weapons rather than the introduction of completely new models. This is further compounded by powerful financial incentives for the large stocks of LWTs dating back to the Cold War era to be kept in service as long as possible, even when they are not up to contemporary operational needs.

The advanced features of modern/upgraded LWTs are reflected in the evolution of operational tactics. In the past such tactics foresaw e.g. the near simultaneous launch of two Mk44 torpedoes in order to increase the chances of success against a submarine, that was trying to exploit the bathy-thermal layers to hide itself. The limited sonar power and thus reduced detection range of the torpedoes made this mode of operation possible, without excessive risks of mutual interference. The higher power available to 2nd generation torpedoes (Mk46, STINGRAY, A244) forced this practice to be discontinued - but the growing availability of torpedo countermeasures available to submarines is now again changing the terms of the equation. In fact, the nearly simultaneous launch of two LWTs degrades the survival chances of a boat protected by countermeasures by a factor of three to
four. On the other hand, there is a significant risk of mutual interference between the torpedoes, especially because the reciprocal Doppler effect is relevant due to the wide array of possible relative speeds.

The solution could lay in the use of IFF-like sound codes injected within the active sonar pulses, allowing the torpedoes to reject the acquisition of friendly torpedoes and widening the operational chances, while eliminating firing restrictions (i.e., it would even be possible to locate two torpedoes at the same search depth). The A244S Mod3 is the very first LWT with embedded IFF code technique.

The traditional triple torpedo tubes mounts for lightweight ASW torpedoes onboard surface vessels (left, showing a Mk46 at launch) are increasingly being replaced by internal arrangement (right, the MU90 torpedo room onboard an "Horizon" class DDG).

**US Models**

The US Mk46 is certainly the most common and widespread LWT since the 70s. It was initially designed to operate only in deep waters, as all the versions up to the Mk46 Mod5 (included) required a minimal depth to at least 60m for shipborne launches and 90m for air launches. The self-evident need for a shallow water performance improvement led to development of the Mk46 Mod5A(SW), suitable for use with a minimum depth of 45m for ship-borne launches. Some 1000 US Navy Mk46 warshots were converted to the Mod5A(SW) standard during 1996-1998, achieving better bottom avoidance and resistance to countermeasures.

While the Mk46 Mod5A(SW) will remain in US service until 2014, there is a significant lack of shallow water capability for most allied navies, which additionally will be soon left without support for all Mk46 models. In 1996 the US Navy prematurely terminated the production of the ill-fated Mk50 torpedo after just 1065 units (versus 8000 as initially planned), due to cost reasons. The Mk50 was designed to counter the fast, deep-diving, blue-water Soviet threat, although the Mod1 variant and the Software Block Upgrade I provide improved counter-counter measures and better shallow water performances than any conceivable Mk46 evolution. The Mk50 is anyway planned to end its short service life by 2014.

The Mk54 Lightweight Hybrid Torpedo (LHT), which achieved Initial Operational Capability in 2004, finally offers a credible shallow water capability being cleared for surface launches in water as shallow as 25m and air launches in 35m. The LHT is the fusion of a number of Non-Developmental Items, like the warhead, fuel tank and afterbody of the Mk46, sonar and thermal battery of the Mk50, signal processing and speed control valve of the Mk48 Mod6, and software components from both the Mk50 and Mk48 ADCAP. However it must be underlined that the fuel used in the Mk54 poses some not insignificant operational limitations, e.g. the torpedo can be carried at high altitude only within a heated bomb-bay.
By 2014 the Mk54 Mod0 is scheduled to replace the entire inventory of Mk46s and Mk50s, with even a slight increase in warshot numbers.

In order to be ready to face the increasingly complex threats, the Mk54 is entering a spiral Pre-Planned Product Improvement (P3I) programme including new software, an improved sonar array (both leveraging from the Mk48 CBASS programme) and additional operational features, like integration with the Vertical Launched ASROC (VLA) and the High-Altitude ASW Weapon Concept (HAAWC).

The latter idea, financed in June 2006 through a contract with Lockheed Martin, foresees torpedo release form an altitude of some 20,000ft while still achieving a precise water-entering point. This would allow selected MPA (P-3C or, in perspective, P-8A) to attack a submarine while remaining well outside the possible envelope of future submarine-launched anti-aircraft missiles such as the German IDAS. Additionally, this feature would reduce the stress on the aircraft airframe due to the frequent changes of altitude, and enable off-axis attacks thus widening operational capabilities. Further, sonobuoys and distributed sensors will also be fitted with GPS, providing a precise information on target position. HAAWC will enable the patrol aircraft to exploit the full sensor field, allowing high-altitude surveillance and attack.

HAAWC includes a Long-Shot wing adaptor kit with self-contained GPS guidance, enabling a long and precise glide of the aircraft-released torpedo. Once the HAAWC reaches the desired release point at the normal altitude (usually 500-600ft), Long-Shot is jettisoned and the Mk54 torpedo enters the water with a normal profile with a traditional parachute brake.

Another interesting sets of development, to be carried out during 2010-2012, include the demonstration of the integration of the Mk54 into USV, transforming the latter (a 7m RHIB) into an ASW weapon delivery system.

Turkey is the first (and for the moment, the only) foreign service to have asked to purchase the Mk54 Mod0 (under the form of conversion kits for the Mk46s on stock) and have received approval from the US Congress. However as indicated the Mk54 can only be carried by fixed-wing aircraft fitted with a heated bomb bay (which are not in Turkish service), and therefore at least two LWT models will be needed.

All the rest of the wide community of foreign Mk46 users will have to decide quite soon whether to adopt the Mk54, or to select a different LWT,... or to be left without torpedoes.
The Chinese Yu-7 LWT is understood to be a copy of the Mk46Mod.2.

**European Programmes**

Cold War requirements are also evident in electric-powered European-made LWTs. For instance, the BAE Systems STINGRAY was designed to operate down to a 900m depth in order to catch the deep-running ALPHA-class Soviet boats - which however soon disappeared from the order of battle. By the same token, features of the MU90 IMPACT such as the shaped charge warhead and precision attack software were intended to defeat the large double-hull spacing of the OSCAR-class submarines. However these features, though probably not anymore so important, would be of some use even in today’s encounters.

The STINGRAY entered service with the UK Royal Navy and Royal Air Force in 1983, and is expected to remain in use until 2030. Export users include Brazil, Thailand, Egypt, Romania and Norway. The Mod.1 upgrade, aimed to improve shallow water performances began development in 1996 and achieved operational capability in June 2006, with production expected to be concluded by 2010. Major improvements affect the guidance and homing system, the front-end array, a new SAFT Magnesium-Silver Chloride salt-water battery, new tactical and signal processing software, and a new warhead (though the two latter components are being developed under different and parallel programmes, and will be added to already delivered Mod.1 torpedoes from late 2008 onwards). Part of the Mod.1 improvements are also being made available to some export users.

The Franco-Italian MU90 IMPACT is claimed to be the best LWT on the market, having been developed from scratch with the littoral threats in mind. For instance, it can be launched in depths limited to just 20m (shipborne) or 25m (airborne), with a further improvement over the previous A244S (30m from ships). The MU90 further offers speeds variable from 29 to over 50 knots with continuous adjustment via step-less regulation according to the tactical requirements, with corresponding ranges from 25,000m to 15,000m. With its insensitive munition warhead, broadband sonar processing and tactical computer, high immunity to acoustic countermeasures, propulsion quietness and lack of wake, the MU90 provides today the performance envisaged for the future Mk54 P3I. MU90 users included France, Italy, Germany, Poland, Denmark and Australia, with two South American and South-East Asian countries likely to follow soon.

Possible future growth includes a Li-ion rechargeable battery for exercise torpedoes (further decreasing the cost of training/qualification and enhancing the performances to full warshot levels) and a large series of tactical applications.
These would include e.g. the launch from a continental shelf mine, the use as a low-lethality weapon against large surface targets in specific conditions (i.e. stopping a vessel destroying its propeller, without having to sink it), the launch from midget submarines, or even the use as a hard-kill anti-torpedo torpedo. Any standard MU90 would be capable to fulfil either ASW or ATT roles thanks to a specific resident software to be activated at the moment of the launch.

Roketsan of Turkey, in cooperation with Aselsan, is developing an indigenous Anti Submarine Warfare (ASW) rocket under a R&D contract for the Turkish Navy. The depth of the underwater explosion of the rocket's HE warhead will be able to be adjusted digitally before launch, using a fire control system. Under the project a two-axis, 6-8 cell stabilised rocket launcher (ASRLS) will also be designed and manufactured by Aselsan. The new ASW system is expected to be installed on the MILGEM Patrol/ASW corvettes as well as other existing and future platforms of the Turkish Navy.

(Photo: Ibrahim Sünetçi)

The Otto-fuel engine of torpedoes such as the Mk46 does pose a significant risk for leakages.

Asian Developments
While the LWT world market is nearly completely covered by the US Mk46, the UK STINGRAY and the Franco-Italian MU90, some models were developed in Asia, tough only for domestic use (at least for the moment).

The Korean BLUE SHARK is considered from many points of view a tentative cloning of the MU90, especially as regards the brushless motor and propellers. Even the technology of the AI-AgO battery was probably derived from the MU90, though its development appears not yet completed.

Japan developed a domestic version of the Mk50 (GRX-4), with a number of national components. As usual for most Japanese weapon system, no information is available on performances, quantity procured, etc. A further LWT model is now under development.

The Indian NSTL was inspired by the A244S torpedo when developing the NST58 TAL, a rather similar LWT with a modified acoustic head and guidance system, exploiting a copy of the SAFT Mg-AgCI sea water battery.
Finally, the Chinese operate reverse engineering copies of both the Mk46 Mod2 (Yu-7) and more recently the A244S (ET52).

Long-Range Torpedo Carriers
The use of ballistic rockets and guided missiles to carry ASW torpedoes arises from the need to deliver the payload at ranges longer than the ship launch would allow. Their use is mostly alternative to ASW helicopters and offers some clear advantages. First of all no aircrew or expensive aircraft are required or put at risk for delivering the ASW ordnance on top of the target submarine. While this risk is admittedly relatively minor under the current operational conditions, things may well take a distinct shift for worse should submarine-launched anti-aircraft weapons become available. Second, once the boat is positively detected and classified, the time of reaction is definitely shorter than the flight of a helicopter to the launching point, and, third, the operation is not affected by adverse environmental conditions.

On the other hand, a missile is just a weapon delivery system and doesn't offer the same operational flexibility of a helicopter. Also, the ASW helicopter with its dipping sonar would often be anyway indispensable to reconfirm the target as first discovered by the ship's sonar, and thus it makes much practical sense to have the helicopter also acting as the platform for immediate LWT delivery.

The most common ASW rocket is the US ASROC. The venerable Mk112 eight-cell "pepperbox" ASROC launcher is now fitted to just some second-hand ex-US Navy frigates serving into allied navies - with one important exception, though, because all JMSDF destroyers are fitted with either the Mk112 or a Vertical Launched ASROC (VLA) capability for their Mk41 VLS. The VLA features a maximum range of 10km and carries a Mk46 Mod-5A(SW), while the Mk54-carrying version should achieve IOC later this year and progressively replace the previous model over the next ten years although in sharply reduced numbers (nearly half the current inventory).
Lockheed Martin is currently developing the VLA-ER extended range version, which will maintain 90% commonality with the existing weapons but will be capable of four-five times the ranges through the addition of a wing glide kit (a further increase to up to some 100km could be reached through spiral developments). The VLA-ER is a potential weapon of choice for net-centric warfare operations, in that it can exchange data during its flight and receive target position updates. A VLA-ER variant without booster, called Common Launch Anti-submarine Weapon (CLAW) is also being proposed for arming the P-8A patrol aircraft, as a possible alternative to the HAAWC concept.

Copies of the VLA, or at least very similar weapons, are also being locally built in Japan (N-ASROC) and South Korea (K-ASROC, a.k.a. RED SHARK).

The only Western counterpart to ASROC is the Italian MILAS, i.e. an OTOMAT/TESEO anti-ship missile airframe modified to carry an LWT (either the Mk46 Mod-5, the A244S, or the MU90). The system, with a range of 55km, can be controlled in flight from the very same consoles used for the OTOMAT. MILAS was jointly developed by Italy and France, but is has been procured only by the Italian Navy in very small numbers (out twelve warshots).

Other conceptually Western similar systems such as the French MALAFON or the British-Australian IKARA have since been withdrawn in light of the increasing availability of helicopters and the comparably short detection ranges offered by shipborne acoustic sensors against modern submarines in coastal waters.

The Russian Navy however still operates a number of similar weapons. The submarine-launched RPK-7 VEDER (SS-N-16B STALLION) has a 650mm calibre and carries a Type 40 torpedo to a range of up to 100km, while the 533mm RPK-2 TSAKRA (SS-N-15 STARFISH) has a range of 45km and can be launched either by submarines or surface ships. Other Russian surface-launch systems include the obsolescent RASTRUB (SS-N14 SILEX) with a E53-72 torpedo and a range of 55km, and the new RPK-9 MEDVEDKA (SS-N-29) with a Type 40 torpedo and a range of 25km.

The most recent addition is represented by the 91 RE1 12 members of the KLUB (SS-N-27) family. These are ballistic anti-submarine missiles whose payload is an underwater rocket-propelled homing torpedo. The 91RE1 is designed for surface
ship launch tubes, while the 91RE2 is designed for submarine torpedo tubes. The maximum range is 50 and 40km, respectively. Is not clear whether the system is already installed on operational submarines, and if it has been exported to China or/and India together with the other anti-ship and land-attack variants of the KLUB family. In any case, the expected detection ranges would not allow a full exploitation of the range of the torpedo-carrying missiles, especially in case of littoral encounters.

An air-launched STINGRAY lightweight torpedo about to enter water being slowed down by its parachute. This is the procedure for virtually all air-launched LWTs.

The RBU6000 is one in a range of Russian "brute force" ASW weapons, that are still being used for contemporary naval designs.

Small & Smart
Another way to extend the delivery range of an LWT is to use an UAV. Back in the sixties the US Navy established the Q-50C DASH as a long-range ASW weapon carrier. As many as 750 drones were built for the US Navy and the Japanese MSDF, but the revolutionary approach was soon abandoned after a great number of drones were lost due to both technical problems and human mistakes.

Now, over forty years later the same concept has been resurrected, as the MQ-8B FIRE SCOUT VTUAV will also be fitted with the Compact Rapid Attack Weapon (CRAW). In turn, this is a derivative of the developmental 6.75" (171.5mm) Common Very Lightweight Torpedo (CVLWT), suitable for use as hard-kill anti-torpedo torpedo onboard both surface ships and submarines. The demonstration of CRAW will begin in 2009 and should extend to 2013, with air-drop homing and engagement demonstrations planned for 2010 and 2011, respectively. CRAW will be the main ASW armament of the MQ-8B VTUAVs operating from the Littoral Combat Ships. It will offer a reduction factor in weapon size and weight of two-three times compared to the present lightweight weapons, while still offering a very high lethality versus most existing submarines.

The three most significant technology challenges for such a revolutionary change are represented by the development of a single-crystal, high-power broadband transducer capable to be fitted into the "needle nosed" torpedo; the production of
a very compact battery with high rate power, suitable for weapon applications; and, finally, a compact and effective warhead.

A new specific sonobuoy-like communication device will be used to ensure guidance of the CRAW towards the target, before stepping into the small torpedo autonomous terminal homing.

The RPK-9 MEDVEDKA (picture shows the launch tubes) is the latest development in Russian series of long-range carriers for lightweight torpedoes. It carries a Type 40 torpedo to a max. range of 25km.

Some Russian-designed or Russian-inspired surface combatants still carry torpedo tubes for heavyweight ASW weapons. Picture shows a mid-ship detail of the Indian Navy destroyer INS MYSORE.

"Dumb" Weapons With Massive Punch
At the opposite extreme, the last category of ASW weapons to be summarised is represented by multiple rocket launchers.

These weapons trace their origin back to an US WW2 concept ("Hedgehog"), and can still be found on nearly all Russian, Indian, and Chinese surface warships. Different models are available: RBU 1000 (1 km range, 6 tubes, 55kg warhead), RBU 6000 (6 km range, 12 tubes, 31kg warhead), RBU 12000 (12km range, 10 tubes, 80kg warhead). China also built a local variant, though is more and more relying on LWTs as its primary ASW weaponry. In all of these weapons, the rockets are unguided and their depth charges are comparably dumb - yet for this very reason they can't be jammed or deceived and deliver a brute slamming force against the submarine. The RBUs are also being used as torpedo defence, both as hard-kill effectors and as launchers for acoustic decoys, and can easily be employed also against combat divers and underwater intruders.
The planned engagement sequence of the extended-range version of the Vertical Launch ASROC (VLA-ER).

It is worth to note that most of their western Counterparts (the Bofors 375mm rocket launchers, the British LIMBO ASW mortar, the Norwegian TERNE and so on) were progressively withdrawn from service as soon as LWT became available and reliable. By contrast, the Russian attitude indicates a continued confidence in the effects of delivering a real shower of explosive around a given area to saturate the likely target position, rather than achieving a precise kill as an LWT would be expected to do. As a result, the Russian Navy doesn't operate real lightweight torpedoes beyond the 400mm weapons intended only as payload for missiles or as helicopter armament, and the RBU rockets represent a sort of anti-submarine CIWS. China operates alternatively either RBUs or LWTs, yet not together on the same platform.

The MILAS long-range ASW missile was developed in Franco-Italian cooperation based on the OTOMAT/TESEO anti-ship/land-attack missile, but it has entered limited procurement only with the Italian Navy.

The only recent western counterpart is the small ASW grenade launchers fitted to some Swedish and Finnish vessels, like the Saab ALECTO and ASW-601 (1200m range). Also in this case the launchers are being used also for different payloads.
(chaffs, decoys) and the relevant vessels aren't fitted with LWTs (or, in a case, limited to 400mm torpedoes) as the ASW rocket-propelled grenades are considered especially useful in the extreme littoral waters of the archipelago, as well as during intrusion incidents when the ASW action would be intended to force the intruding submarine to surface with minor damages rather than sinking it. Thus, yet another adaptation of traditional ASW weaponry to specific operational needs.

**New Heavyweight Torpedoes for the French Navy**

The French Defence Procurement Agency (DGA) has selected DCNS as prime contractor to deliver, integrate and maintain a new-generation heavyweight torpedo to replace the F17Mod2 model currently carried by the French Navy SSNs and SSBNs.

In detail, the €420 million contract covers the manufacture of about 100 torpedoes, an initial six-year period of post-delivery through-life support for the proposed weapons and crew training, integration studies with French nuclear-powered submarines as well as the validation and integration of the new weapon with the submarine that will carry the first batch. Deliveries will start in 2015. Options include additional batches of production torpedoes that will be ordered for successive submarines as each comes due for scheduled refit.

The French Navy's new torpedo will be derived from the BLACK SHARK torpedo developed and marketed jointly by Finmeccanica subsidiary WASS (Whitehead Alenia Sistemi Subacquei) of Italy in cooperation with DCNS, which will act as prime contractor, design authority and lead integrator for the proposed weapon system.

DCNS and WASS will supply complete torpedo subassemblies in line with their respective areas of expertise, while DCNS will subcontract the manufacture of the acoustic head to Thales Underwater Systems (TUS). The programme will be led and managed by the Saint-Tropez plant with contributions by other DCNS centres. The contract will represent some 50% of the Saint-Tropez plant's workload.

With a range of over 50km and a top speed in excess of 50 knots, the new heavyweight torpedo is designed to knock out enemy surface combatants and submarines. Both the torpedo and its warhead, which is sized to destroy all types of ships, comply with the demanding safety requirements laid down for French nuclear-powered submarines. The 6m-long torpedo features electric propulsion and wire guidance combined with final-phase autonomous homing and counter-countermeasure capabilities. Like the BLACK SHARK, the new torpedo will offer far higher performance than heavyweight types currently in service.

The new torpedo, which will be fully compatible with the latest combat systems carried by French submarines, opens up new development prospects for DCNS, including international orders for heavyweight torpedoes for new-build submarines or for the modernisation of complete submarine combat systems or their weapon systems.