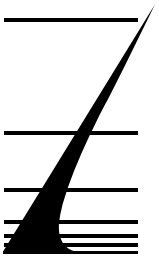
The Market for Undersea Warfare Systems

Product Code #F676

A Special Focused Market Segment Analysis by:



FORECAST INTERNATIONAL

Analysis 4
The Market for
Undersea Warfare Systems
2011-2020

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Introduction

In March 2010, the importance of undersea warfare was starkly underlined when the South Korean corvette *Cheonan* was torpedoed and sunk by a North Korean coastal submarine. The *Cheonan* broke in half as the result of a hit from a North Korean CHT-02D heavyweight torpedo and went down with the loss of 46 lives. The implications of the sinking are worrying for all nations that have to carry out maritime presence operations in littoral waters. The *Cheonan* was a small and old corvette of relatively little fighting power, but the torpedo hit that sank her would have done just as efficient on job on a much larger and more capable ship. Indeed, a DDG-51 class destroyer or LCS-1 Littoral Combat Ship would also have been sunk by a single such hit.

During the 1970s and 1980s, undersea warfare was very close to being at the top of most maritime forces' priority list. The threat of the Soviet submarine fleet focused attention on anti-submarine operations, while the hazards posed by minefields used to blockade ports and attrite naval assets received dedicated attention. During the two decades that followed the end of the Cold War, undersea warfare sank to, if not the bottom of the priority list, somewhere very close to it. Last year we remarked that this was a situation that could not last. Submarines are simply too effective as ship-killers for their abilities to go uncountered. With the sinking of the *Cheonan*, a new undersea enemy has entered the arena, and it is likely that the next decade will see the response being expressed in increased procurement and research funding.

Highway or Roadblock?

Historically, the sea served not only as a barrier against invasion, but also as a highway by which a shipborne enemy could arrive unexpectedly and wreak havoc upon a coastal community. The problem was that naval forces used for coastal defense were either essentially immobile and would, therefore, be defeated in detail, or were mobile and concentrated but unresponsive and arrived too late to defend the area under attack. These limitations were exacerbated by the inadequacies of command and control, which meant the arrival of enemy forces could not be predicted. Thus, a nation that relied upon sea power could concentrate its forces where and when it chose. In the words of Admiral A.T. Mahan, "It could take as much or as little of the war as it pleased."

The situation was expressed by two emotive phrases: The ability to use the sea as a barrier was referred to as "the sovereignty of the seas," while its use as a highway became known as "the command of the oceans." The two primary thrusts of undersea warfare evolved from this perception. Minefields were a means by which specific key areas could be protected against seaborne attack. Submarine warfare was the result of a search for an equalizer by which the available defensive forces could be assembled and concentrated without their position and intentions being revealed to an enemy.

The search for viable undersea warfare capabilities quickly mutated from the hunt for an "equalizer" to an effort to come up with a wonder-weapon that would completely nullify the current balance of sea power. Such efforts have always been futile since the balance between offense and defense has always had a shifting, transitory nature, making today's wonder weapon tomorrow's helpless target. Yet, regardless of whether the target was an equalizer or a wonder weapon, these undersea warfare efforts have always run into the same inherent contradiction. The level of technology required for the successful prosecution of an undersea warfare campaign was available only to those who also had the technical and economic resources for a large surface fleet.

This paradox is best illustrated by examining the primary weapons of undersea warfare: the mine and the torpedo. These weapons are much more closely related than their apparent natures would suggest. Mines, whether placed in a seaway or under the hull of an enemy ship, were the original submarine weapon. Equipped with motors to allow the launching platform to stand off at a safe distance, mines evolved into torpedoes. Yet, effective minefields require huge numbers of efficient mines, which require a sophisticated mass production industrial infrastructure. Large-scale mine warfare had to wait until a standardized mine was developed that could be mass-produced by industry. Torpedoes are an extreme case of the same concerns; in effect, they can be considered mini-submarines, requiring the quality engineering and fine tolerances of submarine construction combined with the mass production quantities of mine warfare.

The Industrial Component of Strategy

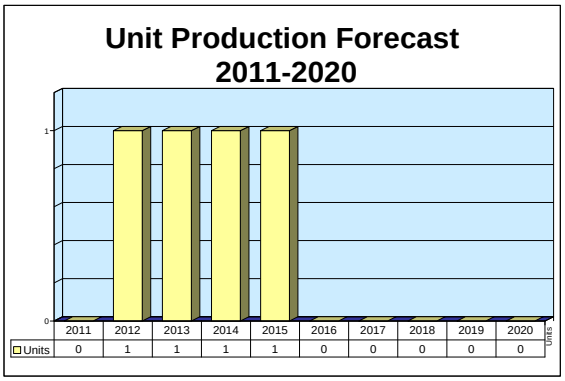
The weapons of undersea warfare require the same industrial and scientific infrastructure needed to produce a surface fleet. In order for submarines to be practical, several technologies had to come together: the diesel engine, efficient batteries, and optically effective periscopes, followed later by sonars, missiles, and nuclear powerplants. Moreover, it took (and very much still takes) high-quality engineering to produce the

Continued…

Type 2076

Outlook

- British defense review endorses Astute class production
- Advanced Type 2076 may be adopted for SSBN(R)
- Delay of SSBN(R) opens gap for production of two additional Astute class SSNs
- Next 12 months may clarify situation enough to allow an expanded forecast



Orientation

Description. The Type 2076 sonar is a fully integrated passive/active search and attack sonar suite. It is scheduled to be installed on the Astute class and as part of the midlife update of the Trafalgar class submarines.

Sponsor

Ministry of Defence Procurement Executive
Contracts Branch CB/UW
Egdon Hall
Lynch Ln
Weymouth
Dorset
United Kingdom
Tel: + 44 1305 774301

Status. In service.

Total Produced. A total of four Type 2076 sonar systems are being produced for Trafalgar class submarines, and three have been ordered for the first batch of Astute class submarines.

Application. The Type 2076 is a fully integrated active/passive submarine sonar suite providing search-and-attack capability for Trafalgar and Astute class nuclear-powered fast attack submarines.

Price Range. The estimated unit cost of a Type 2076 system is $75 million.

Contractors

Prime

Thales Underwater Systems Ltd	http://www.thalesgroup.com/naval, Ocean House - Troop Rd, Somerset, BA11 2TA Templcombe, United Kingdom, Tel: + 44 1963 370551, Fax: + 44 1963 372200, Prime
Enertec SA	185, Av du General de Gaulle, Clamart Cedex, F-92143 France, Tel: + 33 3301 4128 8787, Fax: + 33 3301 4128 8700, Email: sales@enertec.avicore.com, Consortium Member

Type 2076

MASS Systems	4601 Littlejohn St, Baldwin Park, CA 91706 United States, Tel: + 1 (626) 337-4640, Fax: + 1 (626) 337-1641, Email: cmay@ameronglobal.com, Consortium Member
Ultra Electronics Maritime Systems	http://www.ultra-ussg.com, 40 Atlantic St, Dartmouth, B2Y4N2 Nova Scotia, Canada, Tel: + 1 (902) 466-7491, Fax: + 1 (902) 463-6098, Email: mktg@ultra-uems.ca, Consortium Member

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. The Type 2076 is the main sensor outfit of the upgraded Trafalgar class and the new Astute class submarines. Supplied by Thales Underwater Systems, it is an integrated suite, with bow, intercept, flank, and towed arrays. The fully integrated Type 2076 bow, flank, and towed arrays contain some 13,000 sensitive hydrophones, many times the number fitted to earlier submarines. The processing power within Type 2076 is about the equivalent of that of 60,000 PCs.

The original solution to the Type 2076 architecture made extensive use of parallel processing using INMOS T-9000 transputers. A contract option allowed for the use of Thales PVdF technology for the flank arrays if studies showed this to confer significant advantages.

MASS designed an onboard centralized data recording system, called DIORS, which forms part of the Type 2076. Its role is to log all mission and system data on what is referred to as the Tactical Weapon System Highway.

A complete list of the sonar components of the Type 2076 system is hard to obtain. Some reports suggest that the full system may contain as many as 17 sonar-related subsystems. Known components include:

- An active-passive bow sonar, probably designated Type 2079
- An active fire control bow element, possibly designated Type 2078
- Type 2077 Parian obstacle avoidance sonar
- Type 2081 environmental monitor
- Type 2094 oceanographic sonar
- Flank array (designation unknown)
- Towed array, possibly Type 2065

Non-sonar parts of the Type 2076 system include an upgraded submarine command system (SMCS) with new command consoles, a new Tactical Weapon System Highway, and upgraded radio communications (RICE 10). The upgrades also include a new propulsor and new Flexi couplings for seawater services in order to reduce self-noise, as well as upgraded signature reduction capabilities.

Operational Characteristics. The Type 2076 sonar development contract was the largest single sonar order ever placed by the U.K. government. The system includes inboard data handling, data processing, and display processing subsystems, together with the outboard sensors and arrays.

Ultra has designed the Type 2076 operator console to meet Thales Underwater Systems' specific requirements for layout, which cover screen angles and heights and desk height. The console consists of two ruggedized liquid crystal display (LCD) monitors, a peripheral component interconnect (PCI) processor fitted with a commercial off-the-shelf (COTS) processor, network and graphics cards, and a bespoke audio interface designed and built to TUS requirements. The console operates as an X-terminal and utilizes the LINUX operating system. This console design has successfully passed proving trials that included shock, vibration, and electromagnetic capability (EMC) performance testing relevant to the U.K. submarine compartment environment. The console is designed to be capable of backfitting onto the Trafalgar class platform if required.

Variants/Upgrades

Type 2076 Upgrade. In September 2006, Thales was awarded a GBP30 million contract for a major upgrade of the Type 2076 sonar. This will replace the existing inboard processing equipment with an open architecture COTS-based processing system. The initial contract covers the upgrade of three systems, two for shore-based training establishments and one for a Trafalgar class SSN.

Sonar 2076. In recent years, there has been a change in practice by which the word "type" in British designations is being replaced by "sonar" or "radar" as applicable. Under this convention, Type 2076 is referred to as Sonar 2076. This represents no more than a change in nomenclature style.

At present, there are no variants to this system in service other than the changes necessary to optimize the equipment for the Trafalgar and Astute class submarines.

Thin-Line Upgrade. The U.K. is exploring "thin-line" towed array sonar solutions for the Type 2076 integrated sonar suite. Use of lightweight thin-line technology offers improved handling and a more compact winch installation, and enables the deployment of a longer acoustic aperture. One option being closely examined is the U.S. Navy's latest thin-line towed array (TLTA), the TB-29A. Serious interest has also been shown in a production version of the Crustacean TLTA developed and trialed by QinetiQ (comprising the bulk of the former Defence Evaluation and Research Agency) under funding supplied by the Ministry of Defence. Since the requirement for the Astute class SSN was drawn up, the operational scenarios in which RN submarines are expected to operate have changed significantly. Operations in the littoral are becoming far more commonplace, and commensurately there is less emphasis on deepwater anti-submarine warfare. Reelable lightweight TLTAs are seen as ideally suited to operations in restricted shallow waters.

Program Review

Background. The Type 2076 sonar system emerged when the final two submarines to receive the Type 2074 upgrade re-entered service toward the end of 1994. In February 1995, GEC-Marconi Naval Systems (now Thales Underwater Systems) received a $17 million contract for application of the Type 2074LRE upgrade to the six in-service systems.

The S&T Upgrade

This development opened the way for the Swiftsure & Trafalgar (S&T) class update, a two-phase incremental program to counter sonar obsolescence and to deliver enhanced military capability to the in-service attack submarines. The Initial Phase (Stages 1 and 2) Type 2074LRE successfully achieved its in-service date of June 1996. This phase resolved sonar obsolescence, introduced enhanced capability to the Type 2074 and 2082 sonars, integrated the new submarine command system (SMCS), and delivered an incremental improvement in weapon system effectiveness to the Swiftsure class and older Trafalgar class submarines.

As conceived at that time, the final phases (Stages 3 and 4) would enhance the operational effectiveness of the four newest Trafalgar class submarines, principally through the introduction of a new integrated sonar suite (Sonar 2076), an upgraded tactical weapon system, and a number of signature reduction measures.

BAE Systems Electronics Ltd, formerly BAE Systems Astute Class Ltd (BACL), as prime contractor for both the Astute class and the S&T-class update Final Phase, selected derivatives of the main Final Phase subsystems for the Astute class. Approval for full development and initial production of the Final Phase subsystems was granted in January 1994.

Final Phase system procurement was initially being undertaken under eight separate contracts with various equipment suppliers, including the Sonar 2076 contract with Thales Underwater Systems Ltd (TUSL). These contracts were novated in 1997-98 to the prime contract with BAE Systems Electronics Ltd (GEC-Marconi Astute Class Ltd at that time) as part of a risk reduction strategy embracing both the S&T class update and the new Astute class. Alternative procurement options were considered in mid-2000 in light of the difficulties experienced with the Sonar 2076 program. These were discounted due to their unacceptable impact on the timescales and costs of both the S&T class update and the Astute program.

As part of the Sonar 2076 recovery program, approved in November 2002, a common product approach to the Type 2076 was taken across the S&T update and the introduction of the Astute class submarines. This approach significantly reduced the risks to the Astute class combat system program. However, about this time, the Swiftsure class was dropped from the upgrade

program and the Type 2076 restricted to the Trafalgar and Astute classes.

Entering Service

In January 2003, the Royal Navy's nuclear-powered HMS *Torbay* rejoined the active fleet following a $380 million update and reactor refueling. The upgrade, which was managed by the DPA Attack Submarines integrated project team, led by Muir Macdonald, involved installation of the integrated Sonar 2076, including bow, flank, and towed array; a new command system; and stealth measures. HMS *Torbay* was the first of four Trafalgar class submarines to re-enter service under this $960 million program, which is equipping these boats with effectively the same advanced combat capabilities intended for the much larger Astute class, now in build. The next submarine to rejoin the fleet was the HMS *Trenchant.* Originally scheduled to be ready for operations in late 2003, the *Trenchant* entered service behind schedule. These four boats are providing a core of highly advanced military capability until the Astute class enters service.

In 2004, the U.K. Ministry of Defence released a defense white paper that included news that the Royal Navy SSN fleet would be reduced to a total of eight hulls. This fleet would be an interim of three Astute class and five modernized Trafalgar class SSNs. Ultimately, plans called for the five Trafalgars to be replaced, although it was unclear what form that replacement would take. This could have meant a second batch of Astute class SSNs or a new design entirely.

Second-Generation Type 2076

In September 2006, Thales was awarded a $54 million contract for a major upgrade of the Type 2076 sonar. Under this upgrade, the existing inboard processing equipment was to be replaced with an open architecture COTS-based processing system. The initial contract covered the upgrade of three systems, two for shore-based training establishments and one for the Trafalgar-class SSN HMS *Trenchant.* The *Trenchant* entered service with the upgraded system in 2009.

Development of the upgraded version of Type 2076 was seen as a key requirement for the placement of additional orders for Astute class submarines. Shortly after work was started on the upgraded sonar system, the long-awaited order for the fourth Astute class boat, HMS *Audacious*, was placed. By this time it was accepted that the eight-boat standard for the SSN fleet was doomed and that it was unlikely any additional Astute class boats would be ordered. This, it was feared, would mean the RN would be reduced to a fleet of four Astute class SSNs.

The British Strategic Defence Review of October 2010 allayed these fears to some extent. Although no numbers were explicitly quoted, the review made clear that the Astute program would continue, with additional submarines being ordered. The implication is that the fleet will reach at least seven boats (with either the first six ordered or long-lead item procurement started), with a strong possibility the eighth boat will be added. These plans will extend the Type 2076 production run accordingly.

Related News

Three New Astute Class Submarines to be Ordered – Three additional submarines of the Astute class were to be ordered on October 25, 2010, according to the British government. They will be named HMS *Agamemnon*, HMS *Anson* and HMS *Ajax*. The first honors a pre-dreadnought battleship that was scrapped in 1927. HMS *Anson* honors a King George V class battleship that served in World War II and was scrapped in 1957. HMS *Ajax* honors the Leander-class light cruiser that fought in the Battle of the River Plate, driving the German battleship *Graf Spee* to seek shelter in a neutral port and eventually scuttle herself. HMS *Ajax* was scrapped in 1949. (*SeaWaves*, 7/10)

Funding

The Major Projects Report for 2001 estimated Type 2076 program costs to total $1.1 billion (on a resource basis at outturn prices) for both the Initial and Final Phases (Stages 1 to 4). Of this total, some $985 million was attributable to the Final Phase. The current expected cost of the Final Phase is $1.16 billion, which is in line with the latest project approval in November 2002. The increased costs reflect the impact of program delays brought about by software development problems and slippage in the submarine refit program, together with launch of the new Sonar 2076 Stage 5 program and the allotment of funds for the S&T Final Phase sea trials. Recognition of the remaining technical risk also contributes to this increase.

The current assumption is that the in-service support responsibilities for the equipment will be transferred from the Attack Submarine Integrated Project Team (IPT) to the appropriate IPT within the Warship Support Agency. However, other options are being considered, particularly for common equipment such as the Sonar 2076, where there may be an opportunity to provide support more cost-effectively by exploiting the contractor logistic support arrangements being established for the Astute class submarines.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Ferranti-Thomson Sonar Systems	192	Feb 1994 – Type 2076 development contract.
Thales Underwater Systems	180	May 2002 – Procurement of four Type 2076 sonar systems for Astute class submarines.
Thales Underwater Systems	54	Sep 2006 – Phase 5 of Type 2076 development, including production of three modernized systems.
Thales Underwater Systems	234.7	Sep 2008 – Second phase support and development of Type 2076 and other British sonars.
Thales Underwater Systems	29.5	Oct 2008 – Supply of Sonar 2076 system for Astute Boat 4, *Audacious*, comprising both inboard and outboard of bow, fin, intercept and flank arrays and the associated inboard processing.

Timetable

Month	Year	Major Development
Feb	1994	Type 2076 development contract awarded
May	2002	Type 2076 selected for Astute class
Jan	2003	HMS *Torbay* runs trials with Type 2076
	2004	Full Operational Capability
Jul	2007	Stage 5 passes Critical Design Review

Worldwide Distribution/Inventories

U.K. Three systems for Trafalgar class, and additional installations on four Astute class submarines.

Forecast Rationale

The endorsement of the Astute class submarine program contained within the October 2010 British defense review is very good news for the Type 2076 sonar. Combined with the order for the next three Astute class submarines, what once appeared to be a very shaky future for the program now looks a lot more assured. The question that remains is whether the British government will order a final pair of Astute class submarines to provide a homogenous fleet of eight SSNs.

The news that the SSBN(R) program is being delayed so that the first ships of the class will enter service in 2027 is, ironically enough, a strong pointer toward this being so. The delay of SSBN(R) opens a gap in the nuclear submarine production schedule that would accommodate the final pair of Astute class submarines. The SSBN(R) is a possible contender for a version of the Type 2076 sonar system. Initial Gate for SSBN(R) is due to be agreed upon in 2010, with Main gate for final development to be passed in 2016. This schedule makes 2076 a strong contender for SSBN(R).

Type 2076

The British government has specifically stated that there are no plans to release this technology for export. The forecast is based upon production of systems for the Trafalgar and Astute classes. By next year, the position on the two final Astute class submarines and the equipment fit for the SSBN(R) programs may well have been clarified. In a way, this outlook illustrates a common problem with designing advanced systems: it doesn't matter how good the system is (and the Type 2076 is reputed to be very good indeed) if the platforms are not built to carry it. The outlook for Type 2076 is much more hopeful than it was this time last year, and the next 12 months will determine whether that hope can be translated into an increased production forecast.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		**High Confidence**				**Good Confidence**			**Speculative**			
	Thru 2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Thales Underwater Systems Ltd												
Type 2076 <> United Kingdom <> Navy												
	7	0	1	1	1	1	0	0	0	0	0	4
Total	7	0	1	1	1	1	0	0	0	0	0	4

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