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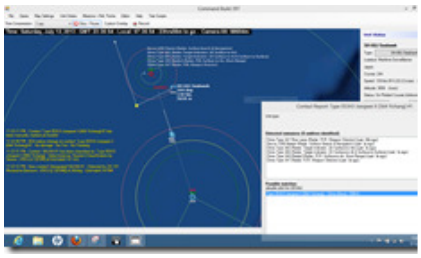

JED SPECIAL

SUBMARINE SENSORS COME TO THE SURFACE

The next generation will focus on intelligence gathering and brown-water ops

By **David L. Rockwell**

The UK's Trafalgar-class nuclear attack subs will receive new communications ESM systems, befitting their status as intelligence gatherers. (BAE Systems photo)

Many submarine forces worldwide have seen the same decline in numbers undergone by the US Navy (USN) since the end of the Cold War. Blue-water roles have lost importance and new missions, especially in the littorals, have risen to take their place. In Europe, many navies have already halved their fleets or plan to retire subs to such a level over the next decade. But despite a much greater emphasis on smaller diesel attack submarines, sensor systems are sometimes even more sophisticated than on US subs.

International Waters

The US nuclear attack submarine's role of stalking unfriendly subs and protecting carrier battle groups has lost some primacy since the implosion of the Soviet military. Nevertheless, in early 2000, the US Joint Chiefs of Staff issued a study recommending at least 68 fast- attack submarines as necessary to meet critical operational requirements in 2015. This is above the 50 subs used as a baseline since the 1997 Quadrennial Defense Review. Reports indicate the primary rationale for the upped requirement is the need for SIGINT and other special operations (see *"SIGINT Basis for Warnings Against Cutting Attack Sub Fleet",* JED April 2000). Pacific and Atlantic fleet commanders further testified in June 2000 that at least 75 subs are needed to meet future requirements for surveillance, reconnaissance, forward presence, and exercises with allies.

All existing US Navy nuclear attack submarines (SSNs) and nuclear ballistic missile submarines (SSBNs) were designed for the Cold War, even the new Seawolf (SSN-21) class. The ubiquitous Los Angeles-class (SSN-688) subs, which will continue to form the bulk of the Navy's attack submarine force for another two decades, were so tailored to Cold War deep-sea missions that their on-the-surface intelligence, surveillance, and reconnaissance (ISR) capabilities actually decreased from the earlier Sturgeon (SSN-637) class. GTE Government Systems' (Mountain Home, CA) AN/WLR-8(V) radar warning receiver was used for signals-intelligence (SIGINT) on early Los Angeles- and Ohio-class (SSBN-726) subs, but production ended in 1993. The addition of Watkins-Johnson's (Gaithersburg, MD) portable AN/WSQ-5(V) passive electronic-intelligence (ELINT) system was necessary in the late-1980s and 1990s, after the electronic-support-measures (ESM) shortfalls of the Los Angeles class became clear. The Seawolf class instead received an upgraded (V)1 version of the Sturgeon's GTE Government Systems AN/WLQ-4 Sea Nymph SIGINT system. Both the Seawolf and the Los Angeles classes mount Litton Amecom's (College Park, MD) AN/BLD-1 mast-mounted precision ESM direction-finder (only from SSN-719 on) and Sanders' (now BAE Systems) AN/BRD-7/8/9 radio direction-finders. All US subs are also receiving Litton Marine Systems' (Charlottesville, VA) AN/BPS-16(V) navigation and surface-surveillance radar.

The UK is a member of the select club that operates nuclear subs, and the country's future sensor demands echo much of US policy. At the Royal Navy (RN) Submarine Service's centennial conference in late 2000, plans were revealed for network-centric operations and increased effectiveness in the littorals. Emphasis on submarine intelligence, surveillance, targeting and reconnaissance (ISTAR) will dovetail with the RN's new operational concept, the Maritime Contribution to Joint Operations. To overcome the traditional 12-hour delay with conventional submarine-communications broadcasts, the UK's Defence Evaluation and Research Agency and Thomson Marconi Sonar Ltd. (Sydney, Australia) have developed the broadband Recoverable Tethered Optical Fibre (RTOF) communications buoy. A computer-controlled winch allows the RTOF to remain stationary on the sea

surface, without a plume or wake, while the connected sub maneuvers freely. The SSN TDL [Tactical Data Link] project will connect all UK subs by 2004, with Link 16/Satellite TDL to enter service aboard the Trafalgar class by 2006.

Other RN developments also parallel those of the USN. Captain Steve Ramm, Deputy Director Equipment Capability (Under Water Battlespace) with the Ministry of Defence (MOD) spoke at the RN Submarine Service's centennial conference of a remotely deployed, distributed sensor network using COTS technology. A 50-km, 10-node system, currently in the technical-demonstration phase, Ramm said, "can be provided for a unit cost of not more than the best Mercedes on the market today." BAE Systems (Farnborough, UK) and DERA's Marlin UUV, acceptance trials of which will be completed next year, could move sensors into place or could carry its own sensors. The Trafalgar- and the new Astute-class nuclear attack subs will also receive a new communications ESM suite designed by DML (UK) and manufactured by Argon Engineering Associates (Fairfax, VA). Eight systems are to be delivered from 2002-2010 under a $38-million contract awarded in mid-2000. These will coordinate with Thales Ltd.'s Outfit UAP(V) Radar ESM systems aboard all UK subs. Finally, Pilkington Optronics will provide a non-hull-penetrating optronic mast for the first three Astute-class boats, the first of which will launch in 2004. The mast will mount high-resolution color and low-light-level cameras, along with a thermal imager. Current UK subs, as well as the Australian Collins class, all mount masts by Thomson Marconi Sonar.

The French are developing Europe's other major new nuclear submarine, under the $3.5-billion Project Barracuda. Six Barracuda-class attack subs will replace the Amethyste class from 2012. The Amethyste-, L'Inflexible M4-, and Le Triomphant-class nuclear ballistic-missile "dissuasion" subs - still in production - all mount the Thales DR 3000 ESM system.

Germany's HDW Group continues to produce the increasingly ubiquitous Type 209, Type 212, and Type 214 diesel subs. The first of four U212s is due to enter service with the German Navy in 2004, with Italy to get two from 2005 (built by Fincantieri). All these will have the EADS/Thales FL 1800U ESM system, derived from the highly successful FL 1800 S-II for surface ships. They will also mount the Zeiss-Eltro Optronic (ZEO) SERO 14 search periscope with an optical rangefinder, thermal imager, and GPS. Greece ordered three next-generation Type 214 subs in March 2000, with the first to be delivered in 2006, and in November 2000 the Republic of (South) Korea (ROK) also selected three Type 214s, to be commisioned from 2007-2009. Earlier Type 209 subs are still being built for Turkey, South Africa, Brazil, and the ROK. Denmark, Norway, and Sweden have combined to study a next-generation "Viking" diesel submarine, which would probably mount a non-penetrating mast and networked ESM systems. Production could begin as soon as 2005. The three Swedish Gotland-class subs, which entered service in September 1999, mount Thomson Racal's Manta ESM system.

Outside Europe, Israel received its last of three Dolphin-class submarine from HDW in October 2000. Customized for Israeli needs, the Dolphins will replace five Gal-class subs in service since 1977. It has been reported that the Dolphins will mount the Elbit (Haifa, Israel) Timnex series ESM system. Egypt also plans to replace its older Chinese Romeo-class submarines, with the Dutch-designed Moray class, perhaps to be built in the US. The Romeos carry Condor Systems' (San Jose, CA) AR-700-S5 ESM/DF system. Australia's troubled Collins-class submarines were to receive all-new combat-control systems, but this program has recently been frozen by the Australian government.

Finally, in the Americas, Canada's four new Victoria-class (ex-RN Upholder-class) diesel attack subs will receive Lockheed Martin Librascope's Submarine Fire Control System, cannibalized from recently retired Oberon-class-boats. Reports indicate that the Victoria-class subs will also mount the Guardian Star Mk 4(V) ESM/DF system from Litton Marine Systems. In South America, Chile ordered two Franco-Spanish DCN Scorpene diesel subs in mid-2000, to enter service in 2005 and 2007.

Uncharted Waters

The US Virginia (SSN-774) class has been designed from its beginnings in the 1990s as a new type. According to Admiral Frank Bowman, director of USN naval nuclear propulsion, there will be an emphasis on sensor and communications connectivity, rather than the extreme solo sub operations of the past: "Our attack submarines must incorporate new technologies to monitor, report, and respond in real time to the tactical situation, both in shallow water and on the beach." Beyond this, the great success of submarine-launched Tomahawk missiles in Kosovo has proven the submarine as "an ideal platform for the land attack mission," according to Admiral (ret.) William D. Smith. The US Naval War College has also conducted numerous studies which show surface combatants becoming increasingly vulnerable as more nations have access to satellite imagery and GPS-guided weapons. New sensor systems will give the Virginia class a comprehensive ESM and electro-optical (EO) capability equal or superior to that found on dedicated spy subs in the past.

The core of these requirements will be met by the billion-dollar AN/BLQ-10 Sea Sentry system (formerly ASTECS). Lockheed Martin's Naval Electronics & Surveillance Systems-Syracuse (Syracuse, NY) - teamed with Condor Systems (San Jose, CA), ST Research (Newington, VA), Raytheon Co. (Lexington, MA), and others - has been developing the BLQ-10 since July-1995 under an engineering and manufacturing development (EMD) contract. It will provide automatic detection, acquisition, identification (including specific-emitter identification), analysis, and direction finding (DF) for radar and navigation signals emanating from commercial and military ships, aircraft, submarines, and shore-based emitters. The production AN/BLQ-10 systems are being built in two configurations: a forward-fit Virginia-class configuration (AN/BLQ-10[V]1), which includes full system capability in both the communications and radar bands, and the back-fit Los Angeles-class configuration (AN/BLQ-10[V]2), which covers the radar band only. The BLQ-10 does not have a communications DF capability and will, thus, not replace the AN/BRD-7/8/9, but will otherwise provide a comprehensive ESM fitment. SIGINT capabilities can also be improved for some missions with additional "plug-in" equipment, including special

processors, algorithms, or hardware. The BLQ-10's open architecture makes this easy, according to Rick Suciu, Lockheed Martin's BLQ-10 program manager. On the Virginia class, the BLQ-10 will directly interface with the Command, Control, Communication and Intelligence System.

BLQ-10 operational evaluation (OPEVAL) was completed in mid-2000 (see *"Sub ESM System Successfully Completes OPEVAL"*, JED, September 2000), being declared operationally effective and operationally suitable. Following a $32.6-million limited-production contract in late 1999, the first six systems are to be delivered for two Virginia- and four Los Angeles-class subs. Milestone III was reached in December 2000, when the US Navy exercised options for an additional three systems, one for Virginia and two for Los Angeles classes. With production now underway in Syracuse, the next task is to reconfigure the BLQ-10 for the Seawolf class, according to Suciu. This would provide newer technology, including expanded frequency coverage and greater automation. Lockheed Martin is also working on a slightly smaller BLQ-10 for the Ohio class, but the Navy has no plans for these upgrades yet. But even without Ohio production, total BLQ-10 procurement funding will probably exceed $800 million, according to Teal Group Corp. (Fairfax, VA), a market intelligence firm.

In order to remain stealthily out of sight, most submarine surface sensors have been mounted on masts, traditionally hull-penetrating systems such as the Kollmorgen (Northhampton, MA) Type 8 periscope. All of the US Navy's current submarines mount a version of the Type 8, according to Kollmorgen, and in November 2000 the US Navy awarded a $5.9-million contract modification to fund development and production of an infrared (IR) capability for the Type 8B Mod 3 periscope aboard the Los Angeles class. Many international navies already have an IR capability on their submarines, and it is probable that all US subs will eventually get versions of the current development system. The current contract funds a two-year development program, after which a pre-production IR system will begin at-sea testing and evaluation. The easily detachable add-on IR module will include a forward-looking IR (FLIR) camera, optical mechanisms for precise FLIR orientation, and a thermal- management system. The program also includes a new IR-imaging display.

The Virginia class will mount a new mast system: the Universal Modular Mast (UMM). The UMM is an integrated system for housing, erecting, and supporting eight non-hull penetrating mast-mounted sensors. Important sensor systems will include two photonics masts and two high-data-rate (HDR) satellite-communications antennas. Kollmorgen is serving as UMM prime, after an EMD contract awarded in 1996, and after acquiring mast-producer Calzoni SpA (Bologna, Italy) as a subsidiary. Since there will be no hull- penetrating optical periscope, all data will be transmitted via fiber-optic cable.
Kollmorgen is also prime contractor for the AN/BVS-1 photonics mast, which underwent at-sea risk-reduction testing aboard the USS *Annapolis* (SSN-760) last year. A $17.5-million production contract for the second Virginia-class sub, USS *Texas* (SSN-775), was awarded in December 1999. BVS-1 sensors include a Sony #XC-003 (3-chip/RGB) color TV and #XCH-1125 monochrome high-definition TV, a Raytheon 3- to 5-micron, 640x480-pixel staring-array FLIR, and an eyesafe laser rangefinder. Also mounted are ESM antennas for the BLQ-10, and a communications and GPS receiver. Retrofitting photonics masts on Seawolf and Los Angeles classes has been discussed, but with the recent Type 8 IR contract, this is probably unlikely for the near future. An export version with more limited sensors, Kollmorgen's Model 86 Optronic Mast, was contracted in early 2000 for four Egyptian submarines.

Raytheon Co. (Marlborough, MA) has developed the HDR multiband dish antenna, which allows direct communication with a number of satellite systems, including Milstar and the Global Broadcast Service. While not a sensor itself, the HDR is crucial to propagating the Virginia's voluminous digital data. Intelligence data, including digital visual images, will be transmitted in real time, instead of waiting for physical delivery or sending only simple text messages - as has been standard procedure with submarine intelligence information.

Those days are gone. The Los Angeles-class attack submarine USS *Scranton* surfaces near its charge, USS *George Washington.* Increasingly, US submarines are being called upon for intelligence gathering and brown-water operations, rather than for fleet protection. (US Navy photo)

Beyond Virginia

In July 1999, DARPA awarded 18-month research contracts to two design teams - the Team 2020 Consortium (Lockheed Martin, Northrop Grumman, General Dynamics, and others) and the Forward PASS Consortium (Raytheon, Boeing, General Dynamics, the BBN division of GTE, and others) - to investigate the design of future attack submarines. The project focused on sensors, payloads, and subsystems, including improvements in payload capacity, modularity, and deployment. Concepts studied included covert local sensor networks, rapid response close-coupled precision strike, harbor & riverine penetration, covert deployment and operation of air and ballistic missile defenses, deployment of unmanned aerial vehicles (UAVs) and unmanned underwater vehicles (UUVs), and submarine hosting of force-level command and control functions. Developments will undoubtedly be incorporated into later Virginia- class subs.

The US Navy finalized its *Submarine Joint Strategic Concept for the 21st Century* in October 2000. This built on the Defense Science Board's *Submarine of the Future* (July 1998) report, the JCS fast-attack-sub study (Spring 2000), and the Navy Department's *Naval Maritime Concept* (April 2000). A primary conclusion was the need to "extend the tactical horizon" using distributed sensors and covert off-board vehicles. Although still at the concept-formation stage, distributed surface and subsurface sensor networks, linked by fiber optics, will be a major focus of research and funding over the next 20 years. Plans also exist to field UAVs and UUVs aboard the Virginia class under the Defense Advanced Research Projects Agency/US Navy Payloads and Sensors program (see *"Photonics Upgrade, Unmanned Vehicles Enhance SSN-774 Capabilities"* JED, November 2000). The Long-term Mine Reconnaissance System (LMRS) UUV will reach initial operational capability in 2003. An out-growth of the LMRS,

the Multi-Mission UUV program is scheduled to begin in FY04. This will build on the LMRS design by providing "plug and play" sensor packages for potential missions such as intelligence, surveillance, and reconnaissance (ISR). The Navy has proposed sensors for electro-magnetic and electro-optical ISR, and indications, and warning. UAVs launched from subs may be further down the road, but Lockheed Martin Aeronautical Systems has reportedly already designed a submarine UAV recovery system.

If submarines are to retain their crucial importance in the world's navies, they too must rise with new abilities. The US Navy's new Virginia class is doing just this, designed from the outset as a multipurpose, modular, upgradable platform whose inherent stealth abilities will make it a crucial addition to the littoral battlespace. When the USS *Virginia* goes on patrol with the US Navy - probably in the brown water off a far-flung coast - it will bring a host of new sensor capabilities.

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Jimmy Carter

Some found it odd when the third Seawolf-class submarine was named *Jimmy Carter* (SSN-23), breaking US Navy traditions of fish, city, and state names. But now even the former president may find it odd, as his namesake is being converted to a spying and special operations sub. The Multi-Mission Project will create the most capable and expensive submarine in Navy history, by lengthening SSN-23 with a mid-ship "ocean interface" section behind the sail. A wasp-waisted inner pressure hull and full-width outer hull will create a large steamlined space for special weapons, SEAL (Sea/Air/Land special forces) delivery vehicles, larger mines, UUVs and other equipment. An advanced communications mast will aid the *Jimmy Carter* 's other role, as an intelligence-gathering reconnaissance platform for secret missions. Specifics regarding sensor payloads are classified, but sources claim the new sub will replace the veteran USS *Parche*, a converted Sturgeon class spy sub due to retire in 2002. SSN-23 delivery has been delayed from 2002 to 2004.

President and Navy submariner Jimmy Carter (left) hoists a replica of the USS *Jimmy Carter* (SSN 23) at a naming ceremony in the Pentagon on April 28, 1998. The USS *Jimmy Carter* will see duty as an intelligence-gathering reconnaissance platform for secret missions. (DOD photo)