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U-Boat 2025

The employment of submarines is an internationally recognized core competence of the German Navy, and their construction belongs to the "core capability in the defence technology" of the German yard industry and its subcontractors. At present, the fleet disposes of four 212A Class submarines of the 1st batch and of six 206A Class submarines. The latter ones are already more than 30 years in service and will be decommissioned by 2015. With the two 212A submarines of the 2nd batch, which are already under construction, a total of just six submarines will sail under the German flag in six years. This is not enough to be able to maintain the above stated pretension. Although the current conceptual basics provide for eight submarines for the fleet, there are no additional units projected in the Bundeswehr Planning. The submarines of the 212A Class, which are presently high-tech boats, will not belong to the scrap heap in 15 years, but they will have lost their top position by then. Due to the empirically long time span of approximately 15 years from first concepts to the commissioning I refer in the following to already existing or emerging tendencies for future submarines by concomitantly paying heed to relevant aspects for the German Navy. In doing so, I wish to explicitly state that all considerations in this context are strictly personal thoughts, which do not reflect the position of the German Navy.

U212A Submarine of the German Navy. Photo: FMoD

To resolve the question of how the submarine of the year 2025 will look like, one can approach the subject in different ways. The requirement for the employment of submarines will naturally depend on the security situation prevailing in 2025 and thereafter. As there are no reliable prognoses in this respect it is alternatively possible to approach the clarification of the question from the existing types or via the tasks.

Typology

A submarine of the year 2025 will most likely be the nuclear-powered, strategic U-boat with the "Ship Submersible Ballistic Nuclear" (SSBN) missile armament. The United States, Russia, France, Great Britain, and China have such Intercontinental Ballistic Missile (IBM) – equipped systems at their disposal today already. With the ARIHANT India has launched the first of four or five planned SSBN just a few months ago. The SSBN serves the nuclear deterrence as it ensures the strategic second strike capability. Unfortunately – or gratefully enough – we have not experienced "the end of history", and even if the nuclear stalemate between NATO and Warsaw Pact or NATO and Russia, respectively, plays just a minor role today, it is absolutely possible that such a stalemate between other nations may in future gain in significance in security policy respects. The SSBN will therefore maintain its role in 2025 as well.

The nuclear-powered assault submarine (Ship Submersible Nuclear – SSN) will be another submarine of the year 2025. The special advantage of the SSN is the seagoing endurance, which is limited only by the human factor, and the high deployment speed in connection with the high payload. On the one hand its function will be the protection of the SSBN; on the other hand, it will continue to be a key element of expeditionary warfare due to its high availability and its mobility, which is not achieved by any other naval warfare means. As an illustration: in 2001, an SSN cut short its exercises off the coast of Iceland and deployed in less than four weeks to the Arabian Sea to participate in the Tomahawk Strike against Afghanistan.

The globally employable conventionally powered submarine with air-independent propulsion (AIP) components represents an alternative to the SSN and is thus the third submarine of the year 2025. The disadvantage of the "Ship Submersible Killer" (SSK) is the low deployment speed and the ensuing reduced time on station in the area of operations. Its advantage is the comparably low costs. Once arrived in the area of deployment, these boats will be capable of discharging all tasks that can be performed by an SSN. This includes the deterrence on sub-strategic level, a capability that the Israeli Navy is said to have with its submarines of the Dolphin Class today already. It can be expected that other nations, above all those that renounce the acquisition of SBBN, will choose this option. Another submarine of 2025 is the small diesel-electrically powered submarine, which can, if necessary, be supplemented by an AIP component. This submarine is optimized for an offshore employment for the protection of the own country. When the logistic support is guaranteed, the boat can also be deployed over long distances and employed far away from the home country. It is a submarine for nations whose worldwide ambitions are limited.

Small and mini boats or semi-submersible boats will probably be part of the inventory of some of the navies or also of non-governmental organizations in 2025. Alone their size restricts them in both sea going endurance and range, but a deployment with the aid of a third party does not rule out a one-off mission in distant sea areas. Even though such crafts are rather from the toolbox of pinprick tactics, their employment against surface targets and in covert mining as well in the support of Special Forces has to be taken downright seriously. Their effect should not be underestimated, however, when there is a preparedness to accept high losses on the side of the attacker and a low loss tolerance on the side of the attacked.

A vehicle can basically be designated a submarine only if its crew can stay in a pressure-tight compartment. Unmanned remote controlled or autonomous underwater systems do not meet this criterion. Nevertheless, it can be assumed that these, too, will play a significant role in submarine warfare in the future. The developments in this field are just beginning and are downright dynamic.

Tasks

In Germany the discharge of tasks of a submarine is, due to historic experience, partly still narrowed down to sinking surface vessels. The diversity of the task of a submarine has already been expressed in the presentation of the dif-

Nuclear-powered Submarine (SSBN) USS PENSYLVANIA of the U.S. Navy. Photo: U.S. Navy

ferent types of submarines of 2025 and is again completed and summarized hereinafter:

- Strategic deterrence
- Sea-to-shore weapon effect (shore bombardment effect)
- Intelligence
- Mine warfare
- Support of special forces
- Effect against surface targets (above-water warfare)
- Effect against underwater targets (underwater warfare)
- Smuggling/trafficking (operators are non-governmental, criminal organizations).

In future, the main effort of the tasks of submarines will, in addition to the strategic deterrence for the nuclear powers, be increasingly focused on reconnaissance and the support of Special Forces. This results from the trend to develop from an escort or coastal protection navy to an expeditionary navy, a tendency that is noticed worldwide in many navies. In dependence of the supplementary requirement profile of the respective navy, the employment in antisubmarine (ASW) and antisurface warfare or the enemy's ASW potential or the ASW potential of a concrete navy is determinant for the design, by taking due account of the environmental factors.

A perfect example for the employment of submarines in an expeditionary operation is the Falkland conflict. Here, submarines were employed in a way, which is to be expected to occur in similar form in future, too. After there were indications of an Argentine military operation, a British SSN was commanded into the sea area within the scope of a strategic advance deployment already weeks before the occupation of the island. This boat conducted reconnaissance missions off the coast of South Georgia and supported the operations of the task group, which arrived at a later point in time by an early contribution to the situation picture.

In the sequel the SSN HMS CONQUEROR sank the cruiser GENERAL BELGRANO. Because of its armor and heavy artillery armament the Argentine ship posed a threat to the British surface vessels and primarily to the landing force. After it was send to the bottom, the Argentine Navy withdrew from the combat area – except for its submarines. At least one British submarine was employed off the Argentine coast, which detected approaching fighter-bombers by their electromagnetic emission and reported them to the task force. This allowed the Sea Harriers to be converted to the air defence role in due time which has probably saved the Royal Navy the loss of additional ships by super-Etendard attacks with Exocet.

On the Argentine side, the SAN LUIS, a submarine of the 209 type, operated more than six weeks close to the British task force. By the way, at that time the Royal Navy was considered to be the best antisubmarine navy of the world. After the withdrawal of the surface units and when it became increasingly dangerous for the aircraft's missions, the Argentine submarine contributed considerably to the compilation of the situation picture. The sub was able to launch four torpedo attacks; all torpedoes missed the target due to a wrongly connected cabling of the torpedo tube mount. Owing to this – from a British point of view "lucky chance" – the Royal Navy was spared the loss of an aircraft carrier and thus the failure of the operation probably associated with that.

Despite the misses, this illustrates the robustness of non-nuclear-powered submarines and thus their operational justification. The multiplicity of the different tasks in connection with the capability for covert operations, the great independence from weather and supply, and the threat potential, the submarine will, also in 2025 and thereafter, act as a force multiplier or contain enemy forces to a considerable extent.

Technology Adaptation

Provided that the diversity of the tasks for submarines is maintained, the requirements for the type and efficiency of the individual system components are certain to increase. This is why the trends for the adaptation to the latest technology and the development of new capabilities should be looked at in detail:

Unmanned autonomous aircraft – launched from submarines – will be capable of performing reconnaissance tasks within the scope of sea surveillance, the identification of targets beyond the horizon, the support of Special Forces or even armed missions against shore targets.

Unmanned underwater craft, whether remote controlled or autonomous, whether propelled or as gliders, will be employable from submarines with many and diverse tasks. Covert reconnaissance of minefields or the employment in ASW are to be stated here just as the recovery of foreign military materiel or missions for the covert installation of stationary sensor and communication systems. And the support of Special Forces will gain in importance, too. The channeling in and out of frogmen through the torpedo tubes as it is presently handled on German submarines requires a high degree of training. Larger airlock hatches allow larger groups or less qualified personnel a quicker and safer embarking and disembarking, the carrying along of material or the launching and retrieving of unmanned vehicles.

For **shore bombardments** there are various submarine-based missile systems available today already. For the employment in expeditionary warfare, a number of navies are nowadays already equipped with missiles capable of engaging shore targets. A brief digression on Operation Desert Storm: Within the scope of strike operations, submarines employed the major part of cruise missiles. Thanks to their unidentified, permanent stay near the target area they can particularly contribute to combating time-critical targets. Apart from that, the heavy

Class 209 Submarine for Antisubmarine Warfare (ASW). Photo: ES-Archiv

torpedo as the main armament of the boat would have to be supplemented by additional effectors, which allow a selective and escalatory weapon effect.

Additional reconnaissance tasks like acoustic and electronic intelligence including communications intelligence complement the task spectrum. Today, more than 50 percent of the mission tasks of American SSN are already established in this field.

Here it will be necessary to place the attention with non-nuclear-powered submarines on their size, or better, on the maneuvering features associated with it. Compared with the SSN the great strength of the SSK lies in its excellent shallow water capability in missions in littoral environment. In order to avoid too big of an increase in the dimension of the boat, it will be necessary to design the subsystems of the submarine much more modular to effect a task-oriented equipment in that way.

Modularity might be a vogue-word, but the background is real. Here it must be differentiated between lifetime and intermission modularity. Lifetime modularity means the replacement or the supplementation of entire submarine sections like AIP propulsion or large-sized airlock hatches for divers or equipment within the scope of combat efficiency and operational improvement measures which can only be carried out within the scope of shipyard maintenance periods. Intermission modularity describes the capability to maximally prepare the submarine between two missions with little expenditure in material terms for the respective mission to be conducted. To that end it is necessary to optimize the payload. This applies to both sensors and effectors. Here it will be essential that the different subsystems can be carried along in sufficient numbers and interchanged ("fitted for the mission") with little expenditure.

It seems to be important that the different payloads can be launched into the water and air through as few locks as possible. Where the retrieval is connected with great efforts and expenditure, a resorting to one-way systems can represent a cost-effective alternative, which should not be dismissed in general.

Autonomous VOLANS aerial vehicle an upgraded derivative of the ALADIN UAV presently in service – shown here in folded state in Triple M multifunction mast. The drone can supplement the possibilities of the submarine within the scope of sea surveillance and allows the classification of targets even beyond the horizon or in littoral shore areas. Photo: Fa. Gabler

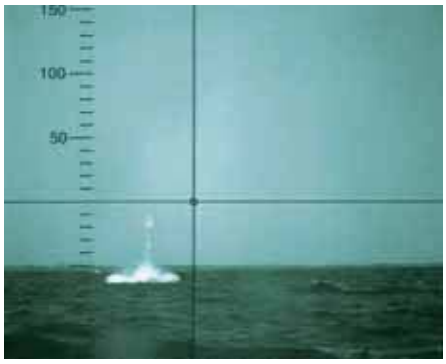
In the discussions of the past years the argument came always up that submarine missions should in future, too, be oriented to the classic strengths of the submarine, i.e. remote and clandestine operating, and that such subsystem were not to be taken seriously. This argumentation has become outdated by the reality of life. The largely covert operating remains the strength of the submarine, which will be in demand in future as well, but the integration into task groups and the increasing significance of other tasks for combating surface targets is everyday reality. This includes explicitly the tactical communications intelligence for the support of a task force commander at sea. The mentioned upgrading of the equipment will substantially enhance the efficiency and effectiveness of the submarine.

This is accompanied by the requirement to integrate the submarine into the **Network Enabled Operations (NEO)**. It requires special technical solutions because of the design and mission-related conditions. Due to the present-

ly restricted communication capacities and since the submarine is more or less out of reach in deeply submerged states, it is necessary to limit the exchange of information with the submarine to the essential. This is actually an already introduced procedure, as the transmission options of the very-low frequency (VLF) transmitter of the submarine are simply very limited because of the low transmission speed. The approach and proposal according to which the crews should again learn to be brief in telex messages has become outdated by the development. On the one hand, the information demand of the superior command has grown considerably; on the other hand, leading and commanding via telex in missions is no longer relevant with many other navies. From the experience gained in maneuvers it can be stated that without IP-based communications one is cut off from the information flow. Particular problems in the integration of the submarine into NEO exist in the fact of achieving it securely and quickly under water, too, and realizing maximally covert communications. This also includes the enabling of the submarine to send own information over broad bandwidths and with high transmission rates. Based on numerous research and development projects on this subject it can be assumed that there will be respective communication options in 2025 for transmitting messages also from and in the depth of the sea. The networking on command level will then also be prerequisite for advancing the networking on effector – and above all – on the sensor level. In the ASW of the future, both active and passive low-frequency sonar systems will be of significance as they will unfold their full effectiveness when they are combined to multistatic systems and merged with the sensor information of other systems. Here, the submarine in its function as sensor and weapon carrier is, aside from the maritime patrol aircraft (MPA) and the ASW frigate with shipboard helicopter, an indispensable element of the ASW pool.

External Factors

Today, the mission profile of the navies and thus that of their submarines is essentially determined by the requirements set by the EU and NATO. A regional restriction as it existed with the concept of the submarine classes of the German Navy was abolished. The long approach and return routes as well as the necessity for long endurance periods at sea have changed the mission profile of submarines in a way that present concepts do no longer take full account of the requirements. A distinctly extended range allows more flexibility in the selection of a logistic base and increases thus the operational independence. Prolonged sea endurance can clearly improve the ratio of time on station in the deployment area to the approach and return sailing and the port periods. As a consequence, a larger quantity of fuel has to be carried along and the load and energy storage capacity needs to be increased. Everything results in a larger boat design, which nevertheless has to be suited for shallow water employment.



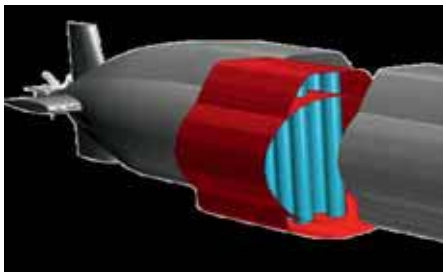
IDAS – shown here when first launched from a submarine in 2008 – is a fiber-optic-guided missile, which can be employed from the dived submarine and is to serve mainly for defence against ASW helicopters. It has also got the potential to engage other targets and is escalatory employable as a weapon for precision fire. Photo: HDW

The **curse of low numbers** has an increasing impact. Globally, the procurement of submarines is effected in extremely uneconomical numbers only. Respective experiences are well known already, as various NATO partners have

been confronted with the consequential problems for years already. On the one hand, the low numbers result in a considerable expenditure for logistics and training; on the other hand, the impacts on the regeneration of the personnel and the availability of units are clearly noticeable.

The **recruiting problem** will continue to aggravate due to the demographic change in primarily the Western-oriented industrial countries so that the competition for the best minds can be managed with attractive parametric conditions only. This will be possible only by offering attractive pay and up-to-date work schedules by which the compatibility of official and private plannings can be improved. In the long run this will be achievable only by multi-crew concepts. When considering the additional costs generated by this, the crew strength will rather decrease than increase. But such problems do not crop up with nations, which show a high quota of young people with increasing population numbers.

If the number of units cannot realize a conceptually specified availability, the logic conclusion will be to realize it through **multi-crew concepts**. Here, the technical availability must a priori be provided for by the conceptual potential for an **intensive use**. The strength of the ship is to be guaranteed by extended **technical redundancy**. These requirements will have foreseeable influences on the conception of new submarine constructions, which will increase the trend towards larger designs even more as it is already the case with the aspect of the prolonged sea endurance.



Lifetime Modularity. The possibility to retrofit entire segments – here with integrated vertical launcher; in the long term it grants the possibility to maintain the combat power and to adapt the capabilities of the submarine to the changed requirements. Grafic: HDW

Cost Reduction

The low numbers of units do not allow a realization of the advantages to be gained by batch production in the manufacture, which leads to relatively high costs per unit. In order to realize cost advantages in the procurement, it would be necessary to acquire large series, if possible.

This, however, is unrealistic when each navy is looked at separately. Whether it is possible to succeed in reconciling the demands and requirements of all potential interested parties (navies, industry, political groups) is, according to the experiences made with the failed Scandinavian Viking project, rather doubtful. Another example is the incapacity to realize within the scope of the existing German-Italian cooperation in the U212A project an identical 2nd batch for both navies. This would certainly require an elucidation of the background, which would go beyond the scope of this article, however. In early 2010 the Norwegian Navy will make a decision on whether there will be a follow-on program of the ULA Class (U210). There are indeed signs for the intention to once again cooperate with Germany as it was already done with the 1st batch of U212A. But in view of a German submarine program not projected in the planning horizon, it is hardly likely that this chance will be taken advantage of. The success of collaborations will certainly also depend on the extent to which the budget restrictions can force the user to accept a compromise in the design or to make cuts in the requirement profile, i.e. to accept 80-percent solutions. Another consequence of the low number of submarine per navy is the extremely high expenditure for logistics. To be particularly mentioned here as a keyword is the stockage of spare and repair parts as well as the provision and manufacturing of long-lead components for a shortening and cost reduction of intermediate and depot maintenance. By a reduction of these costs it would be possible to compensate at least in part for the additional costs needed for other developments. This would necessitate, however, that the procurement programs of several nations be synchronized and that common logistics be build up. In this respect the German-Italian cooperation proves to be an exemplary success model.

CALLISTO signal buoy has low, non-acoustic signatures. When additionally equipped with organic sensors, this system allows broadband communications from the depth with concomitant surveillance of the close-in area. Photo: Fa. Gabler

The SSK 2025 – Summary

When disregarding nuclear-powered and mini submarines, the motto reads: deeper, quicker, and farther. The intended worldwide employment results in requirements for high deployment speeds and long periods on station. In detail this means: higher propulsion power, higher deadweight tonnage, higher energy storage capacity, higher fuel supply, increased crew comfort, additional expenditure for supply and waste disposal. With a low number of units, an acceptable availability can be reached only through intensive use and multi-crew concepts.

The operational benefit of the boat is enhanced by modular equipment options; the equipping with sensors and effectors will be constantly developed and advanced to keep up with the state of technology. In context with the many and diverse mission options the modular equipping with sensors, effectors, and subsystems is necessary to optimize the efficiency of the weapon system "submarine". Concomitant with that is the networking of subsystems, which are employed by the submarine, but above all the networking within the task forces.

Class 210 is a class of submarines built in Germany for the Norwegian Navy. In Norway these boats are known as ULA Class. Photo: ES-Archiv

Depending on the requirement profile of the future user the above stated developments will probably result in boat designs, which are larger than the types in service today. In the implementation of the requirement to conduct worldwide missions it will become necessary to make a compromise between a pronounced shallow water feature and boat size. To achieve a cost reduction the solution must be to procure within the scope of international cooperation larger numbers of a series. ■

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