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Convoys - Outdated by Technology?

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*"The sea is the greatest of all highways."
(Norman Friedman)*

1.0 Background

While the convoy lessons of World War II are important, there have been major changes to both the submarine threat and merchant shipping which do not make convoying a foregone conclusion. 1) This statement by a former SAC-LANT (Supreme Allied Commander Atlantic), Admiral Lee Baggett Jr., less than three years ago indicates that the convoy debate still is an issue in the maritime community, for example in conjunction with a revised reinforcement concept. The statement also implies that we may have a different situation today.

To find out the difference between then, now and maybe even the future, it is necessary to identify the reasons which led to convoying during World War I and II. A look at the concepts used, the impact on the opponent, and the achieved results is required to judge success. The protagonists in convoying, the merchant ship, the defender, and the attacker, have undergone major technological changes since 1945. Only by identifying those changes and evaluating their influence upon maritime transport under wartime conditions, can the question of whether or not convoying has a future be answered.

The New Encyclopaedia Britannica defines a convoy as "vessels sailing under the protection of an armed escort." Further remarks state that originally, convoys of merchant ships were formed as a protection against pirates. But the main article deals with convoying during World War I and II and emphasises the success of this tactic. 2)

Tactics, in the context of this paper is defined as "the art and science of fighting battles on land, on sea, and in the air. It is concerned with the approach to combat; the disposition of troops and other personnel; the use made of various arms, ships, or aircraft; and the execution of movements for attack or defense." 3)

2.0 Into World War I

The concept of convoying non-combatant ships as a means of safeguarding seaborne trade had shown a good record of success since the early 13th century. During the French revolutionary and Napoleonic era (1793 - 1815) for example, of the 132 recorded convoys in the first 4 years which comprised 5,827 ships, some 1.5 per cent were attacked. Of these, only some 35 ships were taken by marauders which represented 0.6 per cent of the total. 4) Notwithstanding past experience, it was quite some time before the convoy system was introduced into World War I operations.

Economic considerations were the main reason for not introducing some type of government control over shipping. Some of the arguments were that it would lead to total chaos in shipping because of the restrictions and delays inherent in the convoy system. There was anxiety that neutral countries' shipping companies could take over parts of trade because they would not be obliged to convoy as their British competitors would.

Another reason for continuing shipping under peacetime rules was the common opinion that convoys were only an "accumulation of targets", which reduce speed, increase the risk of collision, and decrease the transport capacity to an unacceptably low mark. So, in summary, it was assessed that the additional security possibly to be gained by the introduction of the system would not compensate for the economic drawbacks. None of these arguments could be proved by statistical means. Even insurance companies like Lloyds had no evidence for these assertions. 5)

In addition these arguments corresponded with the naval thinking of that time. In 1914 all navies felt that their mission was to protect 'communication lines', those 'magic' lines

drawn on a chart from one port to another, rather than the individual ship sailing along those lines. 6) The reasons - real and imagined - that kept the convoy system from being introduced much sooner in war was philosophical - the perception of the convoy as a defensive and reactive strategy, and therefore, by implication, an inferior strategy. 7)

2.1 Old recipes

In spring 1915 the Germans started their first offensive against merchant ships. The British Admiralty used the methods common then like area protection and minelaying in the choke points. It was, however, actually impossible to protect the huge sea area around Britain with those limited resources. So, the Royal Navy tried routeing for merchant shipping. But this system did not reduce the losses either. By the end of 1916 German U-boats sank about 150 ships per month.

In a desperate search for a way to reduce the loss of merchant ships the British Admiralty tried a different approach. With the increasing success of the U-Boats in 1915 and 1916 against merchant ships, the subject of self defence of merchant ships became one of paramount importance for the Admiralty. A programme was undertaken to equip British merchant ships accordingly. This took the form of 4 inch guns or larger whenever supplies permitted. The emphasis on the arming of merchant ships rather than putting them into some form of convoy was a reflection of the British Admiralty being reluctant to adopt the convoy system whilst still seeking some way to reduce shipping losses. 8)

The merchant ship crewman manning the guns were often not so well trained and had difficulties in recognizing a U-boat silhouette. On the other hand, the U-boat crews could not differentiate between an armed and an unarmed vessel. With the surface attack no longer feasible the emphasis switched to torpedo attack and the sinking of ships without warning, including neutrals; the so-called 'unrestricted' campaign. In

January 1917 about 60 per cent of merchant shipping sunk by U-boats was a result of gunfire, but after the adoption of the unrestricted U-boat campaign on 31st January 1917, the emphasis changed. By April the same year 60 per cent of all merchantmen sunk were as a result of submerged attack. 9) Even though the introduction of armed merchant vessels was not the original cause of the 'unrestricted campaign' by the German U-boats, it certainly forced the attacker to change his tactics.

2.2 Forced into convoy

At the beginning of 'the unrestricted campaign' the German Admiralty decided to deploy more submarines into the Atlantic Ocean, the North Sea and the Channel. The results were almost disastrous for the Allies. "By the end of April 1917, one and a quarter million tons had been lost, and in the next four months another one and a half million tons were sunk. British ships were being lost faster than they could be replaced, and it was estimated that by July Britain would have enough wheat to last only six or seven weeks. But then ... convoys were finally established on a regular basis in July 1917. Immediately thereafter, Britain's catastrophic shipping situation began to improve dramatically." 10) This change in the Admiralty's view of convoying was based on the report of a group of naval officers, who analysed ship movements and losses. They found out that convoys of coalships established in February 1917 between England and France suffered only minor losses. Only 5 ships were lost in a total of 2,600 movements.

At the same time, the losses of independent ships in the North Sea, the Channel and Western Approaches, the same area where these convoys operated, increased drastically. In trading with Norway the loss rate in spring 1917 rose to almost 25 per cent. In April the responsible officer organized convoys on that route and only a month later the losses were down to 0.24 per cent. 11) After those impressive results the British

Admiralty authorized experimental convoys. "On 10 May, 1917, the first (non-troop) convoy left Gibraltar, 11 days later, the system was adopted for all merchant shipping." 12)

2.3 The result

The results achieved were very impressive. From February 1917 until the end of World War I only 0.3 per cent of ships in convoys across the Atlantic and in the 'UK home waters' were lost compared to 5.93 per cent of those running independently. 13) The figure of 1,500 ships lost through sailing independently represented 85.5 per cent of the total number of merchant ships lost through both convoy and independent sailings. From a straight comparison of convoy versus independent losses it can be concluded that the chances of survival when sailing in convoy were almost 20 times greater than sailing independently over the same routes. 14)

Apart from the straight numbers, what can be better proof of the success of a measure than the opinion of the one who had to deal with it? The success of the convoy system was aptly summed up by Admiral Karl Dönitz after the war in his memoirs, *Ten Years and Twenty Days*, when he remarked that in the First World War the German U-boat arm achieved great successes; but the introduction of the convoy system in 1917 robbed it of its opportunity to become a decisive factor. 15)

2.4 The U-boat's problems

So why was convoying a success after being introduced so late in World War I? The convoy system was a success because it solved the principal problem that had frustrated the hunt-and-kill strategy: the lack of adequate and timely strategic and tactical intelligence of the U-boat's whereabouts. 16) Arguably indeed, finding the opponent had now become the problem for the submarine! 17)

The U-boat was not adequately suited for this task. Put simply, its structural height when surfaced kept it from being an effective scout across the possible tracks of convoys. "The method whereby the submarine could locate a potential target was essentially visual, either by sighting the funnel smoke of the ships at a distance or seeing the hulls themselves. On this basis a single ship (independent) would probably be detected within 10 miles of its track whilst for a 20 ship convoy the figure would be about 11 miles. There was not much more likelihood of 5 separate convoys of 20 ships each being detected than 5 individual ships sailing independently. In turn, the detection of 5 convoys (single ship equivalent) was a far more difficult proposition for a submarine than 100 individual ships sailing independently." 18) So by concentrating the merchant ships in groups of 20 or more the ocean 'emptied' over wide areas, leaving even more waterspace for the U-boat to search.

In addition to mathematics, which were against the U-boat, another type of 'anti-submarine escort' emerged, the aircraft. One of the first occasions that such an escort was used was with the first trans-Atlantic convoy in 1917 when a flying boat was used to patrol the route ahead of the convoy. The function of the aircraft was to locate surfaced submarines and call up AS (anti-submarine) ships using WT (wireless telegraphy). This had the additional advantage in that convoys could be diverted around the dangerous area. Once the U-boat had sighted an airship, seaplane or aircraft it had to assume that it had itself been sighted and the only reasonable response was to dive in order to avoid the attentions of surface AS vessels which it could expect to have been called up. 19) By doing so, its situation picture was normally lost for quite some time. So just by being present the aircraft fulfilled a formidable task by further reducing the submarine's effectiveness in detecting merchants ships, and therefore targets.

2.5 Summary World War I

Although the British Admiralty had excellent experience with the convoy system in previous wars, it took them almost three years after the outbreak of World War I to re-introduce it. A variety of measures was tried to reduce the losses with little success. When the sinking rate became unacceptably high in early 1917, convoying was adopted and it reduced the numbers of sunk merchant ships dramatically.

The U-boat was confronted with the problem of searching for a relatively small number of groups of ships instead of many independent going merchants. It was, however, not well suited to the detection role. In addition the defender could concentrate his limited number of escorts and thereby further complicate the submarine's problem during the attack. The use of aircraft for escort duties worked very well in favour of defence.

3.0 German considerations

The German Admiralty realised very clearly, before World War II, the importance to Britain of merchant shipping for trade. Admiral Erich Raeder states in his memoirs: "Struggle for the sea" that "Careful consideration merely confirmed our original idea that for us the only possible war against Britain would have to be concentrated against her overseas supply lines with all available forces: submarines; surface craft; and planes. Britain imported about fifty million tons of goods annually and her very existence depended on the keeping open of her overseas supply lines." 20) In accordance with this strategy the German Kriegsmarine employed warships and merchant-raiders and aircraft in the anti-trade role. The surface commerce raiders had their share of about 8.1 per cent in 1939 to a high of 11.6 per cent in 1940 of the total losses of British, Allied and neutral shipping. The German Luftwaffe started with 0.4 per cent in 1939 and reached an remarkable 23.5 per cent in 1941. The next year their contribution was down to less than 9 per cent. 21)

The most dangerous and effective adversary to maritime trade however, was again the U-boat. So, as in World War I, the question of convoying as an anti-submarine measure arose. At the outbreak of hostilities the adversaries were quite aware of each other's capabilities. One naval columnist, Sir Herbert Russell, voiced this confidence two months into the Second World War. The 'fundamental qualities' of the U-boat, he wrote, have become no more formidable than (they) were in the last war, so that the defence knows exactly what it has to meet. 22)

4.0 *The Second World War*

With the outbreak of hostilities in September 1939 the British Admiralty assumed control of the British merchant fleet. The convoy system was introduced earlier than originally planned on the main routes. The reason was probably the ATHENIA incident, which made the British Admiralty believe that the Germans intended to start an 'unrestricted campaign' as in World War I. 23) And again, the convoy system proved its value. By the end of 1939, the Royal Navy had escorted 5,756 merchant vessels in convoy, losing 12. During the same period, 102 independents were sunk. 24)

4.1 The offensive element in convoying

Between September 1939 and May 1943 alone, before the convoy system was in full bloom, 45 out of 201 U-boat sinkings were the work of offensive hunts by ship and aircraft; 150 were claimed by convoy surface and air escorts. The escorted convoy, supported by land- and sea-based air, became the best way to sink U-boats. The U-boats could not perform their mission without approaching the convoy. Usually they had to surface to maneuver to an intercept position in order to attack and preposition for follow-on attacks. 25) The argument about convoying being a defensive tactic turned out to be wrong again.

Initially the U-boats found only limited opposition due to a lack of escorts. But as the war continued the numbers and the capabilities improved and the protection could be extended further to the west until in 1943 the gap in the air cover across the Atlantic was finally closed. Thus the German U-boats were continuously threatened by surface and air escorts.

4.2 Optimizing the number of escorts

In Britain operations research specialists of the Admiralty found out by analytic studies of the convoy operations of 1941/42 that the number of sunken ships in a convoy was independent of the size of the convoy. On the contrary the number of sunken ships depended on the number of attacking submarines. When there was no air cover available the number depended additionally from the number of escorts. Therefore the average size of a convoy was increased from 32 to 54 ships and the number of escorts from 6 to 9. One found out, that the losses from convoys could be reduced by 56 per cent by increasing the convoy and by 25 per cent with increasing the number of escorts. 26) The effect of this analysis was twofold; on the one hand, the number of convoys could be reduced by increasing the size of each convoy, and on the other hand, the protection for the individual convoy could be increased without the need for adding to the total number of available escorts.

4.3 A look at technology

Technology certainly played a very important role in maritime warfare during World War II. There was, however, no fundamental breakthrough which could have made the convoy system obsolete. At the outbreak of war British and American escorts had the ASDIC (Allied Submarine Devices Investigation Committee) and SONAR (Sound Navigation And Ranging) operational. They were both very reliable underwater detection devices. Competent operators could detect a submerged U-boat up to 1,500 m, giving bearing and range on a display. The effectiveness of those systems was, however, more or less neutralized by the German submariner's tactic of conducting night attacks on the surface. Another case was the development of the 'Zaunkönig' torpedo for the German U-boats. This acoustic torpedo homed on to the noise, made in the water by a ship. It was quickly countered by the Allies

with the FOXER, a noisemaker towed at a safe distance behind an escort to draw the torpedo off the ships.

The introduction of an improved radar on the escort ships and aircraft, and the improvement of the automatic HF/DF (high frequency direction finding) capabilities on board the escorts as well as ashore shifted the balance of the fight in favour of the defender in the second half of 1942. The German introduction of the snorkel, a radar warning receiver and new torpedoes came too late to be a decisive factor.

4.4 An attempt to counter the convoy

German U-boats successfully applied the so-called "wolf pack" tactic for the first time in June and July 1940. The tactic was an attempt to counter the concentration of the convoy with a concentration of U-boats. In this way the basic problem of the hunting U-boat, already known from World War I, of finding a merchant and therefore a target, ought to be solved. As only a limited number of U-boats was available for ocean operations in 1940, the coverage against convoys was still unsatisfactory and reconnaissance aircraft were not available at that time to help out the U-boats.

From convoy battles in January and February 1943 the German Admiralty learnt that at least 15 to 20 U-boats were necessary to be successful against an Atlantic convoy. So in March 1943 fifty U-boats were on patrol in the North Atlantic, deployed in three groups. The result: 85 ships sunk during the first 20 days of March, 67 of those out of convoys. The danger arose that the whole convoy system would have to be dropped. 27) The reason for this was that the anti-convoy forces could bring so many weapons into the battle that they almost matched the number of vessels in convoy. Due to the professionalism of the escorts, however, the losses on the attacker side were heavy, and two months later Admiral Dönitz ordered the U-boats to leave the North Atlantic to wait for the introduction of the snorkel-equipped submarine.

4.5 Summary World War II

The German Admiralty concentrated their efforts against the overseas supply lines of Britain from the outbreak of war, and later against those of her allies as well. The U-boat became again the main adversary to merchant shipping. The question whether convoy operation was defensive or offensive was again clearly answered by the success of the escorts in sinking U-boats.

The major breakthrough was achieved by British operations research scientists. Based on their analysis the convoy system was optimized and proved even more successful.

Technology played a very important part in the convoy battle. Developments such as radar and sonar gave vital support to the defender's task. But no technology emerged that would make the convoy obsolete.

The 'wolf pack' tactic was an attempt to overcome the U-boat's problem of finding the target. Apart from a few months in early 1943, there were never large enough numbers of U-boats to make this tactic successful.

The balance after World War II was as follows: German submarines sank a total of 2,753 ships, a combined tonnage totalling 14,557,000 tons. The highest one-month loss was 700,000 tons, in June 1942, despite the Allies having accumulated almost three years of experience in the conduct of anti-submarine warfare. To defeat the U-boats the Allies eventually deployed 950 escort vessels and 2,200 aircraft. 28) The Germans had 1,170 U-Boats, of which they lost 630 in the operation areas and 81 in home waters.

It may sound cynical to talk of success when looking at the total tons lost, but only 28 per cent of those were from convoys.

5.0 The convoy lessons from two World Wars

In both wars the allies employed a variety of methods to counter the U-boats. Patrolled areas, armed merchant ships, minefields, decoy or Q-ships 29), and the formation of a dedicated ASW (Anti Submarine Warfare) 'hunter-killer' groups were all used with varying degrees of success. 30) But looking at the statistics, it becomes obvious that the protection of shipping by convoying was most successful. "Tactically speaking, the concepts of sailing merchant vessels independently instead of convoying and using allegedly offensive hunter-killer operations to neutralize submarines were overwhelmingly discredited, with minor or temporary exceptions, in both World Wars I and II." 31)

Norman Friedman describes the major rules that are inherent in convoying and which made it a success in both World Wars: "Convoy made it more difficult for the anti-shipping forces to find targets. The concentration of the targets leaves most of the ocean empty. In World War I, the Germans had no means of locating merchant ships in the open ocean; they spread their U-boats in hopes of coming upon ships out along the major trade routes. Sightings, and therefore attacks, declined very sharply when most of the ocean was emptied. Moreover, even if it came upon a convoy, a U-boat could attack only a few targets at a time." 32) After the U-boat had detected a convoy, she first had to pass a screen before she was able to launch an attack. Confronted with many targets, she then had to select those assessed to be the ones with the highest value. Depending on the type of target, the U-boat used at that time a varying number of torpedoes according to the valid firing doctrine. The number of targets did therefore outnumber the number of weapons.

While encountering one target the remaining units of the convoy continued, possibly with evasive maneuvers which upset the U-boat's attack calculations. In addition the U-boat revealed itself by attacking a target and left itself open to counterattack by escorts. Most of the ships in any substantial convoy would therefore escape. "The idea of convoy was to concentrate the targets together with the anti-submarine ships, so that any submarine attempting to deal with the targets automatically made herself vulnerable." 33)

Three conclusions can be drawn from this, summarizing the preference of convoying to independent shipping during the two wars:

1. Convoying made it more difficult for the anti-shipping forces to find targets.
2. When a U-boat encountered a convoy, it could attack only a few targets at a time. It was therefore favourable to sail large convoys.
3. Convoy escorts were more effective in sinking submarines than in other types of ASW actions. This was due to the concentration of escorts in an area where the enemy was most likely to attack.

"While convoys were always successful in protecting shipping today neither the provision of escorts nor the planning for the assembly and sailing of merchant convoys are subjects that attract much interest."! 34) Quoting this statement from the convoy debate leads to the question of the importance of the central figure in convoy operations, the question of the role of merchant shipping in today's economy.

6.0 Today's role of merchant shipping in trade

On the first April 1989 the world merchant fleet consisted of 33,106 ships with a capacity of 377,662 million tons. The volume of goods transported across the sea in 1988 totalled 3,666 milliard tons. All major ports in Western Europe transferred about 971 million tons (1987 figure). 35) Even these few figures indicate the major role that trade across the oceans still plays today. But they also clearly indicate the dependency of many nations on seagoing trade. It is often mentioned that the United States of America is not as dependent on Sea Lines of Communications (SLOCs) as, for example, Western Europe. But, in 1984 General Alexander Haig, former Supreme Allied Commander Europe, expressed the importance of those lines for the US: "The United States is inordinately and increasingly dependent on foreign sources of supply for many of the raw materials critical to our defense and our economy. In 1950, only four of the thirteen basic industrial raw materials were imported in quantities of 50 percent or more. Today (1984) we have reached that level of import for nine of the same thirteen materials." 36)

6.1 Western sea lines of communication

From a naval point of view it is of importance to see where these SLOCS mentioned above are located in the western hemisphere. "The military cargos are likely to transit along the same routes used in the two world wars, from the United States and Canada to Western Europe and from Britain to the mainland. For the economic cargos, however, the routeing will be quite different. While large quantities of items like grain, coal, iron ore and general cargo will continue to be transported from North America to Europe, the bulk of the economic cargos will come from the Persian Gulf, South America and

Australia. Furthermore, a significant portion of this shipping will be going to North America as well as Europe." 37)

6.2 Military requirements for shipping

The establishing of NATO in 1949 changed the political and military situation. This maritime alliance tied Europe and the North American continent together and intensified the relations between the old and the New World, not only militarily but also economically. Before the CFE (agreement on Conventional Forces in Europe) it was assumed that in case of a crisis or even war approximately up to 100 ships must reach Europe daily merely to ensure civilian supplies. The military requirements are estimated to be in the order of 1,800 shiploads over a period of up to 90 days, just for the reinforcement phase.

While the figures for the civilian supplies probably still apply, the CFE places quite significant limitations on the peacetime reinforcement actions. Future reinforcements to Europe will be limited to the margin between CFE ceilings and the national actual holdings in peacetime.

Admiral Baggett, former SACLANT, recently stated that the primary purpose of the so-called 'Atlantic Campaign' within the framework of NATO's maritime strategy is to ensure the safe and timely passage of reinforcements and resupply cargoes to European ports. Over 90 per cent of those will be seaborne. And he emphasised further: "It should be noted that reinforcement and supply ships which are able to transit before the beginning of hostilities have all of the advantages of independent routing without the disadvantages or possibilities of loss. For this reason, a decision to reinforce made well before hostilities will permit a far faster and more certain reinforcement." 38) With the CFE it has become even more critical to secure a timely political decision in a period of crisis prior to the outbreak of hostilities, as long as a potential aggressor has not breached the treaty.

From the above, it is obvious that there may be increased shipping activity at least for civilian supplies already at the beginning of a crisis. The intensity would probably build up within a few days. A certain amount of 'control' or 'guidance' would be of great help. It will therefore be useful to take a brief look at today's situation concerning the direction of shipping, which did not work so well in World War I but was quickly initiated in the early days of World War II.

6.3 Control of shipping

According to Allied Tactical Publication No. 2 (ATP-2), Volume II, NATO has an organisation at hand to handle all the questions concerning control of shipping. In periods of tension there will be only 'voluntary naval control'. The movements of shipping in certain areas of interest will be controlled. The use of the ship remains under the control of the owner. 39)

"In war, full naval control of merchant shipping will be instituted by governments to operate under the Allied Naval Control of Shipping Organisation." 40)

The concept differentiates between the control of employment, to be executed by the Civil Direction of Shipping Organisation (CDSORG), and the control of the movements of the merchants by the Naval Control of Shipping Organisation (NCSORG). 41) Both authorities are responsible for all NATO ocean-going merchant ships. Coastal shipping will remain under national control. Also excluded is traffic by the Military Sealift Command.

The responsibility for the protection of allied merchant ships rests with the naval commander in a described area. His duty as Operational Control Authority (OCA) includes protection in port and at sea. This requires him for example to sail ships in convoy or as independents according to certain policies in force at that time. These policies for or against convoy will

probably be formulated at the highest political and military level in NATO.

What this policy would most likely be can be assessed from the currently ongoing convoy debate. "The escorting of merchant ships in convoy would probably only be adopted by NATO as something of a last resort 'when shipping losses reach a level that is politically unacceptable', to quote a senior British Naval Control of Shipping officer. - That the bitter lessons of two World Wars are thus set at nought is explained on the grounds of the enormous enhancement of weapons and sensor systems since 1945, making the concept of convoy obsolete if not actually dangerous. The technological revolution of 100 years ago was also used then as an argument for the abandonment of convoy and led directly to the failure to reintroduce convoys until early 1917 by which time Britain was within a couple of weeks of starvation and defeat." 42)

To find out if the argument about technological evolution making convoy an obsolete tactic is superficial or well-founded, some of the major technological contributions to maritime warfare will be identified and evaluated with respect to their possible influence on future convoy operations.

7.0 Main technological changes

Since 1945 naval warfare has indeed undergone enormous technical changes; nuclear powered submarines (SSN), anti-ship missile systems and improvements in ocean surveillance techniques through the use of satellites have made the offensive threat even more formidable. 43) Offensive in this context is not necessarily meant against the convoy. As will be seen later, those technical changes can also be used in favour of the convoy forces. Most commentators on maritime technology agree that these three developments caused the second revolution in maritime warfare of this century; the first was caused by the development of the internal combustion engine between the World Wars.

7.1 The nuclear powered submarine

Whereas World War II submarines were considered fast if they had an underwater speed of 16 knots, the attack submarine of the future, the SSN, is now credited with a submerged speed of anything between 28 and 42 knots, depending on the class and the nationality. 44) In addition, nuclear power gives the submarine independence from the surface. Another important characteristic is very limited volume. As a result, weapon capacity is very limited. The problem is aggravated by the fact that a submarine generally cannot have her weapons replaced at sea. 45) The German U-boat Type VII C, the one most commonly employed against convoys, had a maximum load of 14 torpedoes, 12 being the norm. According to Jane's Fighting Ships the Soviet SIERRA class SSN for example can carry a mixed load of up to 22 torpedoes, the most common type VICTOR III class up to 18 torpedoes. 46) Even if the numbers are not impressively higher than those for the U-boat, it is reasonable to assume that the technology of submarine launched homing torpedoes has undergone substantial improvements since 1945. The distances from which

the submarines would have to fire their torpedoes are realistically about 10 nm, which would still leave them open for counterattack by escorts.

Given the relatively limited number of weapons, the second conclusion would still be valid, that the SSN at least can only attack a limited number of targets within a convoy. In a large convoy a certain proportion of merchant ships would therefore survive to deliver their cargo.

7.2 The anti-ship missile

Anti-ship missiles can be launched from an aircraft, a surface ship or even a submarine. Whatever firing platform is used, the missile will materialize as an immediate air threat to the target. There is, however, a significant difference concerning the exposure of the attack platform which may possibly give extra warning time to the defender. The worst case from the convoy's point of view is the nuclear powered cruise missile carrying submarine (SSGN) because most of them can launch their missiles while remaining submerged. "They are currently credited with underwater speeds of 25 - 35 knots and with carrying between 8 and 24 missiles. Providing that the submerged submarine is able to locate its convoy targets with adequate precision, the fact that it would be able to stand off at some distance from the convoy (and thus be less likely of being detected) could well make it a more serious threat than the torpedo firing SSN." 47) The present SSGNs in the Soviet inventory for example are mostly ECHO II-class submarines with either eight SSN-3A missiles, range 250 nm, or eight SSN-12, range 300 nm. In order to fire and to guide the missile the submarine must surface. This may take several minutes, during which it is highly vulnerable to counterdetection and attack. With the introduction of the SSN-7 aboard the CHARLIE-class submarines, the submerged launch was introduced, probably based on own sensor information out to a firing range of up to 35 nm. The latest OSCAR I and II class submarines has trippled its missile load to 24 of the SSN

19 type with a maximum range of 340 nm. 48) In order to use these long ranges effectively against a seaborne target, almost realtime target information from an external source, such as a reconnaissance aircraft, surface ship or satellite, is required. This puts constraints on the operations of the SSGN while collecting the information, which could even make it vulnerable.

Compared to the performance of the torpedo, the anti-ship missile, especially one fired from a submarine, gives the main advantage of greater stand-off distance. However, due to the limited payload of the missile and improvements in ship-building, one missile will not necessarily always sink a ship, as experience showed with the US Frigate STARK in May 1987 in the Persian Gulf.

Furthermore, many missiles are susceptible to deception measures, provided sufficient warning time is available to take electronic defensive measures. These could be flares or chaff, depending on the type of dispenser and the expected missile threat.

The introduction of the anti-ship missile has not really changed the situation in relation to the second conclusion. Depending on the type of submarine, the number of weapons may have been increased. Most types have a mixture of torpedoes and missiles, making the total numbers only slightly higher, as already previously stated. However, the OSCAR I and II class submarines represent a formidable increase in fire-power, even though they require an external sensor.

7.3 The satellite

In the past the detection of a convoy was achieved either by visual means or on extended ranges by radar, preferably airborne. An aircraft's radar has, at 10,000 ft, a range of approximately 120 nm. "The surveillance satellite which was launched so as to orbit over the oceans would introduce a new

approach to the localisation process. Depending on its altitude it could have a visual range of 300 - 600 nm whilst travelling over the ground at over 17,000 knots. Orbital periods of about 90 minutes would not be uncommon." 49)

Surveillance satellites operate at altitudes between 250 and 600 km to make optimum use of the limited resolution capability of their sensors. Limiting factors such as the weather dependency of, especially, photo and infrared satellites will be reduced by a combination of different sensors such as radar or electronic surveillance equipment.

It may be imagined that the problem of localisation in the case of surface ships has already been solved because they are detectable by radar aboard aircraft or satellites. However, to detect a ship in, say, the North Atlantic is not to identify it as the target. At any one time, several thousand ships are at sea. At present the Soviets for example approach the problem by relying initially on signals the targets themselves make, such as unique radar emissions. As a result, it is reportedly possible for entire battle groups to "disappear" from the Soviet fleet plot for days or even weeks at a time. 50)

In general terms the threat for the convoy is twofold:

1. an air threat from the missile fired by a submarine, a surface ship or an aircraft and
2. a subsurface threat from the torpedo-firing conventional or nuclear submarine.

Whatever platform is used for the attack, it relies on target information. This may be in the early stages of detection, so the attacker can intercept the convoy, or in the last stage just before attack, to collect final target data. In many cases the satellite will be the primary source of information, as described above. It was mentioned that there are few problems involved in detecting a target; however, identifying one would be somewhat more difficult. A convoy moreover is a different kind of target. The fact that it is an accumulation of ships in

loose formation moving in one direction eases the problem of identification. This would probably be even easier if intense convoying concentrated shipping and thus emptied the seas.

With the introduction of the satellite, the first conclusion that convoying makes it more difficult for the anti-convoy forces to find targets seems to be out of date. This is certainly true if the opponent chooses to attack tonnage without differentiating between high and low value targets. If, however, identification is required, satellites have deficiencies today and in the foreseeable future which will be difficult to solve.

To summarize the influence of the three major technological changes on convoying; combining the SSN with the anti-ship missile (SSGN) and providing up to date target information seems to be the most dangerous.

A look at the technological levels of the protagonists today and in the foreseeable future may bring out deficiencies or strengths which will influence convoy tactics.

8.0 The escorts

Technological evolution in the area of sensors, especially ASW sensors, has taken place, though probably not as dramatic as the introduction of the cruise missile or the satellite. An escort for today's convoy might not be a ship, it could be the shipborne helicopter, a maritime patrol aircraft (MPA) or a hunter killer submarine as described above. In addition, sonar and the associated signal processing equipment have undergone major improvements.

When it comes to examining the performance of the convoy escort, the maximum operating speed of hull mounted active ASW sonars has been credited with having reached a plateau in the region of 20 knots, with little hope of significant development beyond this. This being the case the surface escort would also appear to have little prospects of regaining the position of speed superiority that it had in relation to the submarine in the last war. 51) Outside the search phase, however, many ASW ships can move much more quietly than before at high speed. At the same time they provide platforms from which helicopters can operate; "and they can carry air defence weapons which are now important in the ASW battle. It is also worth recalling that they can carry the most powerful active sonars and a wide variety of weapons, particularly important perhaps in counterattack modes." 52)

In the foreseeable future the surface ship will not be replaced by the aircraft or the submarine for certain tasks. As long as the protection of SLOCs is of interest to nations, only the ship seems to be capable of managing a simultaneous defence against air and subsurface threats. 53)

What then of those two most potent anti-submarine vehicles, the attack submarine and the LRMP (Long Range Maritime Patrol) aircraft? They both prefer to operate in a quiet acoustic

environment away from the hurly-burly of merchant shipping, and they are increasingly good at cooperating with each other. 54) This is especially true in searching for and prosecuting nuclear submarines. This is because of the considerable improvement in detection ranges against submarines made possible by towed array sonars. Therefore the employment of the two platforms will be best in a distant support role. At the same time this provides defense in depth against the SSGN.

The conventional submarine would be hunted by the LRMP with its primary search radar when the submarine uses its snorkel to recharge its batteries, or its periscope to search for the convoy. The improvements in radar technology for MPA and shipborne helicopters have made it almost standard that a submarine's snorkel can be detected 30 nm away. "The technology required to positively identify ships on radars is only beginning to appear in the west: inverse synthetic aperture radar (ISAR), which uses the motion of the radar target itself to generate what amounts to a high-definition radar." 55)

In summary, today's escort has many faces, and often is optimized for its task. Related to the third conclusion, which gave the escort a greater effectiveness in convoy operations than in other types of ASW actions, the outcome of the battle against the anti-convoy forces is difficult to assess. Cooperation between different types of escorts will probably be the key to success.

8.1 SSN versus escort

It is often argued that today's nuclear submarines have a significant speed advantage over the convoy and its escorts. Derived from that fact, it is assumed that the pursuit of the SSN after its attack on the convoy would put the defender in a more or less hopeless position, being unable to match the submarine's speed. These commentators ignore, however, the capabilities of today's ASW forces. The SSN faces not only

the escort ship, but probably a helicopter embarked as well with a very effective dipping sonar. The flexibility and unpredictability of the helicopter's movements compensate for the speed disadvantage of the escort. In a direct support situation the convoy would probably also enjoy the assistance of an escort ship equipped with a towed array, assisted by Maritime Patrol Aircraft (MPA). Both platforms are optimized for the detection of nuclear submarines. When evading pursuit at high speed after an attack, the SSN makes more noise, thus increasing its chances of being detected. Last but not least a convoy of some higher priority could probably also enjoy the protection of a hunter killer submarine, which would be even worse for the attacker.

8.2 Nuclear weapons against convoys

Another situation that could be envisaged would involve the anti-convoy forces perceiving the concentration of shipping as such an attractive target as to invite the use of nuclear weapons without going through an initial conventional attack phase. 56) And it is further assessed that the large convoy would be especially endangered by nuclear weapon employment. This would make the second conclusion obsolete, which favoured the large convoy. It should however be noted that tactical nuclear weapons in stock today mostly have a relatively small warhead due to their increased precision. The latter is most important because it is highly desirable to reduce any side effects. It should therefore be no serious problem for the convoy to counter a nuclear threat by spreading its formation, according to ATP-2, to distances of one to six nautical miles between units.

8.3 The merchant ship

Merchant ships have perhaps altered least in the last 35 years. Service speeds of 15 knots are more the general rule than the 30-plus knots of certain container ships, important though the

latter may be not only in their own right but perhaps in their adaptability to combatant support roles.

The tonnage of merchant ships has of course much increased, with probable draught, manoeuvrability, cargo vulnerability and noise problems in their wake." 57) At the same time, due to the increased tonnage, the chance of survival increased for the merchant too.

According to Contingency Plans, the primary figure of concern is 'escorts'. Because the available escorts are planned for many tasks and they are unable to protect all ships, clear planning and decisions are required about which transport, depending on the priority of the goods, is to be protected. Without expanding too much on the subject, a brief look at the possibilities for arming a merchant in order to supplement convoy operations underlines the technological improvements also in this field. To ease the problem of modifying merchant ships for a military task, containerized functional units for e.g. air defence could be installed. In ports of destination the container could be transferred to an outgoing vessel for optimum use. Container ships could be modified to operate VSTOL (Very Short Take Off and Landing) aircraft on board and so on. 58)

We have talked about Arapaho 59) for almost 10 years now, and do not seem to have achieved very much. But in less than 10 days, under the pressure of events in the Falkland Islands, a number of merchant ships were converted into operational platforms. We must remind ourselves that war at sea is not just concerned with major fleet actions - it is about the protection of merchant ships in war. And merchant trade even in war is not confined within the NATO area. We must also look at other ways, such as self defence, for protecting merchant ships. 60)

8.4 External sources

There are two basic possibilities of carrying out ASW in the protection of SLOCs: area control and local defence (e.g. the convoy). The control of an area, e.g. the Atlantic Ocean, can be achieved by denying the opponent freedom to enter undetected. One way of doing this, provided geography permits, is to establish submarine barriers. These geographic barriers can include monitoring submarines and hunter submarines, plus sonobuoys, which can be monitored by MPA or stationary hydrophones monitored from ashore. Moreover, minefields can be laid at great depth, using Captor type mines especially designed to deal with submarines.

One prerequisite for a maritime peacetime strategy is the need for the surveillance of the potential opponent. Based on technological developments in acoustic underwater detection equipment the United States began trials in 1950 and started to operate SOSUS (Sonar Surveillance Underwater System) in the early sixties. This system is also considered to be one of the major advances in acoustic warfare since 1945. "They (SOSUS) can hear submarines at very long (oceanic) ranges, but at such distances location cannot be very precise. Typically a maritime patrol aircraft (such as a P-3 or a Nimrod) is sent out to search the area, probably several thousand square miles in size, defined by the long-range contact - to classify and to localize the possible target." 61)

Considering the actual situation, it is clear that the geostrategic situation does not favour the Soviet submarines from the Northern Fleet which need some days to transit the Norwegian Sea and afterwards would have to fight for the entrance into the Atlantic.

9.0 About maritime strategy

In the framework of this paper a short discussion of NATO's current maritime strategy will help to judge convoy operations in the overall picture.

Even though East-West confrontation is beginning to disappear slowly, it is assessed that the maritime strategy could basically remain unchanged in the near future - simply because the Soviet Navy remains a powerful force and the main naval opponent to NATO. In the years to come, however, the reduction of naval assets due to cuts in national defence budgets may force NATO to revise its maritime strategy.

In 1986 NATO published a new maritime strategy, "The Concept of Maritime Operations (CONMAROPS)." NATO's main objectives in war were described in five different scenarios, the so-called 'campaigns'. The two of concern for the convoy discussion are

- the Norwegian Sea Campaign and
- the Battle of the Atlantic Campaign.

The objectives of the 'Norwegian Sea campaign' are, broadly described, the containment of the Soviet Northern Fleet and the defence of the RE/RE operations (Reinforcement/Resupply) necessary for this campaign. Closely related is the 'Battle of the Atlantic Campaign' with its purpose of ensuring the safe and timely arrival of RE/RE and economic supply shipping across the Atlantic Ocean. This will primarily be executed by barrier operations in the GIUK-gap.

Remembering the above mentioned SLOCs between North America and Western Europe, the interrelationship becomes obvious. As long as the two campaigns are successful, there

will be hardly any threat to shipping in the Atlantic Ocean and therefore probably no need for convoying.

10.0 Summary

"It is clearly true that if no assault is being made upon shipping, then sailing ships upon the shortest courses, at best speed, immediately loading is completed, is going to produce delivery at the earliest moment. There is also a level of attack below which losses are so low that the same is true." 62) To define that level means at the same time to define a boundary beyond which convoying was the answer in the past. The use of convoy tactics did not prevent losses, but they could be kept on a bearable level.

Based on the lessons of the two world wars, it was concluded that firstly a convoy made it more difficult for the anti-shiping forces to find targets; secondly that it was favourable to sail large convoys due to the limited weapon load of the attacker, and thirdly that the effectiveness of convoy escorts sinking submarines was much greater than in other ASW actions.

The introduction of the satellite into ocean surveillance makes the first conclusion basically obsolete. The convoy, being an assembly of ships in some type of loose formation, can easily be detected by the satellite. Considering this capability, it may be actually dangerous to adopt convoy tactics. It is, however, not the presence or the capacity of the satellite, but the ability of the opponent to use it for an attack, that may endanger the convoy.

The anti-ship missile did not change the situation for the large convoy drastically. In the case of a strict anti-tonnage war the impact of a SSGN with the qualities of the OSCAR class is difficult to assess. The same is true considering the third conclusion in the light of the technological evolution. The SSGN is capable of operating at longer distance from the convoy if external target information is provided. The effect-

iveness of today's ASW equipment on the escort side has not been tested in a full scale war. But the basic principle remains true, that the submarine must be close the convoy to fight it.

The trend to faster, quieter and deeper diving submarines with long range missiles causes a number of detection and fighting problems. Protecting ASW around a convoy will no longer be possible in close defence. A deep layered defence is required. The goal is to detect and "kill" the submarine outside its weapon range.

A new dimension was introduced with SOSUS. Even if it will not detect every submarine passing the barrier, it is certainly an important factor to be considered by the opponent, thus giving extra protection to the SLOCs.

11.0 Conclusions

The introduction of the nuclear powered submarine, the anti-ship missile and even the surveillance satellite did not change the balance between convoy and anti-convoy forces drastically. The main reason probably is that those technologies are available to both sides. The main consideration for or against convoying seems therefore to be of tactical, or even strategical, origin. There were however other elements in the decision process, at least into World War I, which are difficult to understand considering the initial losses.

"With the estimates of probable losses of merchant ships reduced dramatically, did convoying reenter as the preferred strategy? Not exactly, because there were too many other considerations - political, budgetary, and strategic, affecting the decision. The present attitude towards the desirability of convoying is, in some circumstances yes, in others no. Here the interrelationship with strategy enters the picture. If the Maritime Strategy ... is executable, then that will have a powerful and positive effect in reducing the need for convoying. If we are surprised as the Allies were in World War I and II, then the strategist has some assurance that the tactics are in hand to convoy the most vital shipping - if we must."
63)

Notes

- 1) Baggett, Lee Jn. "The Security of Sea Lines of Communications" *NATO's Sixteen Nations* January 1988, p. 20
- 2) *The New Encyclopedia Britannica*, 15th Edition Chicago 1986, convoys, p. 592 ff
- 3) *Ibid*, tactics, p. 490
- 4) Wignall, M.B. " The Convoy System: Retrospect and Prospect Part 1" *Royal Naval Scientific Service* January 1983 p. 80
- 5) Potter, E.B.; Nimitz, Ch.W.; Rohwer, *Seemacht*. München: Bernhard & Graefe 1974, p. 432 (free translation from German language, also for the remaining notes)
- 6) Mahan, Alfred Thayer , American admiral and theorist on the war at sea, (1840 - 1914). At that time, Mahan's thoughts and books had influenced largely the strategic thinking of the Admiralty not only of the Royal Navy. Mahan had the problem of finding a new terminology for his thoughts and therefore he 'loaned' the terminology from land warfare like 'Lines of communication', 'Searoads' or 'Supply route'. Very soon they became the "strategical language" in the Navies: from Potter, p. 432
- 7) Breemer, J.S. "Defeating the submarine: choosing ASW Strategies - Part I: The First World War" *Naval Forces* IV 1988, p. 40
- 8) Wignall, p. 81
- 9) *Ibid*, p. 82
- 10) Mayer, Charles, W. Jn. "Looking Backwards into the Future of the Maritime Strategy, Are We Uncovering Our Center of Gravity in the Attempt to Strike at Our Opponents?" *Naval War College Review* Winter 1989, p. 35
- 11) Potter, p. 436 ff
- 12) Breemer, p. 40

- 13) Wignall uses those figures in Table 3 of his article; they are based on Marder's publication: *From the Dreadnought to Scapa Flow*; UK home waters are defined as UK coastal, Dutch, Scandinavian and the French coal trade convoys.
- 14) Wignall, p. 84
- 15) *Ibid*, p. 85
- 16) "For seven days, two perhaps three U-boats sank more than 30 merchantmen in an area off the south coast of England that was being watched over by 49 destroyers, 48 torpedoboats, and 168 armed auxiliaries. During this time, the submarines were actively hunted by 13 destroyers and seven O-ships, but suffered no losses." Bremer, p. 40
- 17) Bremer, p. 40
- 18) Wignall, p. 86
- 19) *Ibid*, p. 88
- 20) Raeder, Erich, *Struggle for the sea*. London: Kimber 1975, p. 127
- 21) The figures are taken from Roskill, S.W. *The war at sea 1939-1945*, appendix R, Table 1 of Vol. I and Appendix O, Table 1 of Vol. II
- 22) Bremer, "Defeating the submarine: Choosing ASW strategies - Part II: The Second World War" *Naval Forces* VI 1988, p. 73
- 23) The day Britain entered the war, the passenger ship ATHENIA was sunk by the German submarine U 30. This obviously happened accidentally because the submarine commander acted against given orders and mistook the ATHENIA for a commerce raider. From Potter, p. 487
- 24) Williams, E. Cameron "The four 'Iron Laws' of naval protection of merchant shipping" *Naval War College Review* May-June 1986, p. 39
- 25) Bremer, Part II, p. 83
- 26) Potter, p. 541
- 27) *Ibid*, p. 542

- 28) Mayer, p. 36
- 29) The so called Q-Ship was a U-boat trap; a merchant ship equipped with camouflaged guns, operated by well trained personell. When stopped by an U-boat the guns were suddenly uncovered and fired.
- 30) Mayer, p. 37
- 31) Bowling, R.A. "Keeping open the sea-lanes" *United States Naval Institute Proceedings* December 1985, p. 97
- 32) Friedman, Norman. *The US Maritime Strategy*. London: Jane's 1988, p. 128
- 33) *Ibid*, p. 61
- 34) Mayer, p. 44
- 35) All figures from *Fischer Weltalmanach 1990*, Frankfurt a. M., Fischer 1989, p. 915
- 36) MacDonald, Wesley L. "The critical role of seapower on the defense of Europe" *NATO's Sixteen Nations*, No. 1 (Special) 1984, p. 14
- 37) Baggett, Lee Jn. "The Security of Sea Lines of Communications" *NATO's Sixteen Nations*, January 1988, p. 20
- 38) *Ibid*, p. 22
- 39) NATO: Allied Tactical Publication ATP 2 VOL II - Allied Naval Control of Shipping - Guide to Masters, NATO - Unclassified Change 3: February 1989, chapt. 1
- 40) *Ibid*, chapt. 1, 0101 c.
- 41) The term 'employment' covers acc. to ATP-2 cargo, loading, discharging, maintenance, repair, manning, storing etc.; 'movement' includes selection of routes,organisation of convoys, tactical diversions, movement reporting etc..
- 42) Desmond Wettern, Insert "Naval Control of Shipping" in *Navy International* October 1988, p. 489
- 43) Grove, Eric J., "The convoy debate" *Naval Forces* March 1985, p. 42
- 44) Wignall, "The Convoy System: Retrospect and Prospect Part 3" *Royal Naval Scientific Service* January 1983, p. 216
- 45) Friedman, p. 95

- 46) All figures from: *Jane's Fighting Ships 1989-90*, Coulsdon: Jane's 1989
- 47) Wignall, part 3, p. 219
- 48) All figures from Jane's
- 49) Wignall, Part 3 , p. 215
- 50) Friedman, pp. 219-220
- 51) Wignall, part 3, p. 219
- 52) Hill, J.R. "Submarine attacks on shipping" *Naval Forces* March 1982, p. 13
- 53) Jopp, Heinz Dieter. *Marine 2000*. Baden-Baden: Nomos 1989, p. 27
- 54) Hill, p. 15
- 55) Friedman, p. 148, note 23.
- 56) Wignall, part 3, p. 222
- 57) Hill, p. 13
- 58) Joop, p. 218
- 59) "The U.S. Navy developed a concept for a modular system called ARAPAHO, to provide convoy protection using a commercial containership as an anti-submarine warfare (ASW) helicopter platform. The British Royal Navy leased this system and operated it successfully in the Falklands and in Lebanon". From Rodrick, Eugene; Maurer, David M.; Grochowski, Raymond B. "A Modular Shipboard Helicopter Support System" *Naval Engineers Journal* March 1988, p. 293
- 60) Eberle, James Sir "The Atlantic Link" *Naval Forces* January 1983, p. 38
- 61) Friedman, p. 125
- 62) Grove, Eric, J. "The convoy debate" *Naval Forces* March 1985, p. 42
- 63) Hughes, Wayne P., Jr. "Naval Tactics and their influence on Strategy" *Naval War College Review* January-February 1986 p. 4

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Convoys - Outdated by Technology?

Based on the good record of the two World Wars the impact of conveying on the operations of the main opponent to shipping, the U-boat, is discussed and leads to three conclusions in favour of convoys from the lessons of the two World Wars: 1. the U-boats had more difficulties in finding targets due to the concentration of shipping; 2. the limited weapon load of the U-boat favoured larger convoys; and 3. the effectiveness of convoy escorts sinking submarines was much greater than in other types of ASW actions.

Furthermore, the author focusses on major significant technological developments of the post-war era, and their influence on the conduct of future convoy operations is assessed.

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