Anti-submarine warfare - Measures of Performance

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Abstract — To ensure full benefit from anti-submarine warfare (ASW) training and exercises, and efficient use of sensors and weapon systems, data collected during such exercises are subject to immediate analysis to evaluate the level of performance, so called ASW - Measures of Performance.

In 2006, the Royal Norwegian Navy (RNoN) took delivery of the first of five Fridtjof Nansen (FN) Class frigates. Over the years, a substantial number of ASW exercises have been analysed, which have given us good insight into our systems capabilities and limitations. However, these analyses are focused on various details and areas of interest, and thus not suitable for evaluating the level of performance over time. In addition, these analyses are often time consuming, resulting in a considerable time delay between when an exercise, or test, is conducted and the ASW crew gets the analysis feedback. We realized that RNoN was in need of a more functional and standardised feedback after an exercise in order to measure their own performance related to systems, operators, and teamwork. These analyses also need to be ready for presentation shortly after the completion of the exercise.

To measure the performance in the ASW area in a standardised and systematic way, we have developed algorithms and procedures. The Royal Norwegian Navy (RNoN) has proposed seven parameters for evaluation after an exercise, which form a basis for our analysis. These parameters make it possible to get statistics of the performance over time, as well as measures of performance for each exercise. The analysis is mainly automatic, ensuring rapid results that can be subject to immediate analysis.

In the analysis, recorded data from participating vessels, along with environmental data, are processed, target tracks classified, distances measured, settings compared, and so on. We have also used FFI developed tools such as Lybin, Simson and Sonar Guidelines to complete the work. The results are finally presented in standardised figures and tables.

The results are employed as a tool for both the operating crew and command to supervise the performance level in ASW. The measures of performance are predetermined and thoroughly explained, which give the operators goals to strive for, even in exercises with minor contact time. The analysis is well defined and efficient, and the format allows for accumulating statistics over time. In addition, such analysis may be used to evaluate differences between crews or vessels.

1 Introduction

In 2006, the Royal Norwegian Navy (RNoN) took delivery of the first of five Fridtjof Nansen (FN) Class frigates. In the years that followed, testing and evaluation of the frigate as a platform and combat system have been conducted and a substantial number of ASW exercises have been analysed. This has given us good insight into our systems capabilities and limitations. However, these analyses are focused on various details and areas of interest, and thus not suitable for evaluating the level of performance over time.

The Norwegian Navy has compiled a list of seven measurement parameters. The purpose of these parameters is to measure the performance of underwater warfare, after major exercises, in a uniform and systematic way. The parameters will provide a basis for evaluating how the level of underwater warfare develops over time, and can also be used as a tool to identify problem areas. RNoN can then initiate measures based on deviations from the average level.

2 Data

In order to demonstrate the usefulness of the measurement parameters a sonar data set has been synthesized following the steps of [1]. The acoustic model Lybin **Error! Reference source not found.** is run using range-dependent topography, a measured sound speed profile and specified sonar parameters in order to estimate the geographic distribution of false detections. In addition, actual submarine detections are synthesized using signal excess estimated by Lybin. The target strength model, TAP [2], is also employed to ensure realism in how the target strength changes as the submarine moves relative to the frigate.

Figure 1 shows an example of synthetic echoes and tracks along with the movements of both the frigate and submarine.
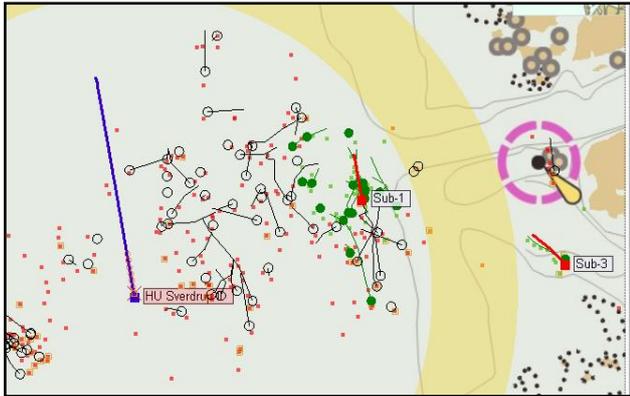
Figure 1   Movements of frigate (blue) and submarines (red) along with tracks (green and black) and echoes (red dots).

3   Method

Echo and track level sonar data, sonar settings and navigational information from the sonar vessel and targets are organised according to timestamps of sonar transmissions, better known as a ping structure. This ping structure is then the basis for an automated track matching and pre-classification to separate tracks on the target and false tracks [4]. The automated pre-classification of target tracks is checked with the use of a sonar data visualisation tool, Simson **Error! Reference source not found.** in order to assure all and only tracks on target are classified a target tracks.

In addition to the ping-structure data we need a relevant sound speed profile from the exercise. Using Lybin and Sonar Guidelines [6] we can establish a theoretical optimal sonar performance.

Once sonar tracks have been correctly classified, the data can be used to investigate the different measures of performance:

Sonar system performance

Time difference between when sonars have tracks on target and sonar operator successfully classifies the target.

Optimal sonar performance

Time difference between when the sonars have verified tracks on target and target is within theoretical sonar range.

Chain of information – Sonar

Log time usage and information flow as a track on target is managed, from the appearance to it being reported to the entire fleet.

Sonar downtime

Measure the total time spent with one or more sonar systems out of action due to technical difficulties.

Tactical use of weapons

Log the amount of torpedo attacks conducted, the rate of attacks conducted according to guidelines, and the rate of successful attacks based on simulations.

Combined ASW picture

Measure to what extent the ASW units are able to maintain a joint subsurface picture.

Submarine picture

Measure at what rate the submarine is able to maintain the correct position and ID on surface vessels during and exercise.

4   Results and discussion

The results are presented in standardised figures and tables.

5   Operative benefits

The measurement parameters provide a tool for the RNoN to monitor and evaluate the ASW performance level over time. The measurement parameters feedback is standardised and can be presented shortly after an exercise.

6   Summary

The measures of performance are predetermined and well described, which motivates the operators and provide working goals during the exercises. The method also prepare for an efficient and precise post-analysis, and provide data for accumulating statistics over time.

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