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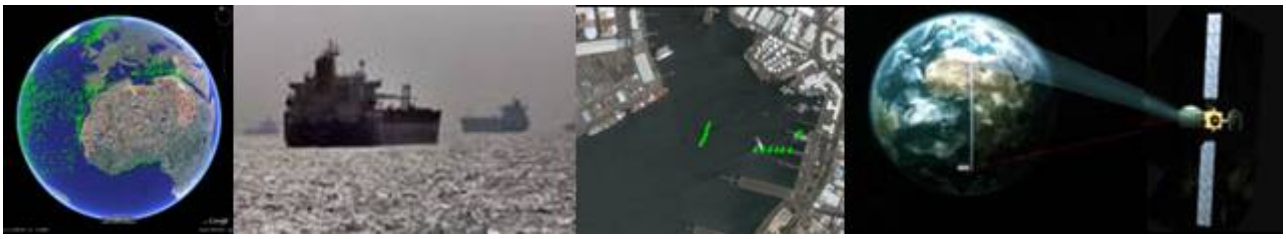

Annex 1 to Technical Note TN6-1:

Cross correlation of anonymous LRIT data and S-AIS

Issue 2

Preparatory Action for Assessment of the Capacity of Spaceborne Automatic Identification System Receivers to Support EU Maritime Policy

DG MARE Service Contract MARE/2008/06 – SI2.517298

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Applicable and Reference Documents

RD 1	Preparatory Action for Assessment of the Capacity of Spaceborne Automatic Identification System Receivers to Support EU Maritime Policy – Pasta Mare Technical Proposal Call for Tenders No MARE/2008/06
RD2	6039 PASTA MARE_LXS_TN-005_Performance Test procedure_I5

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

SCOPE

This document presents the results of the cross-correlation of anonymous LRIT data and S-AIS data. Aim of the exercise is to demonstrate the (im)-possibilities linking anonymous LRIT data and S-AIS for the purpose of deriving meaningful performance indicators for S-AIS.

1. INTRODUCTION

The challenge of assessing the performance of S-AIS data is the existence, availability and accessibility of adequate reference ship position data to which data obtained from S-AIS data can be cross referenced. LRIT seem to be one source of information, providing vessel location around the globe.

The Long Range Identification and Tracking (LRIT) of ships was established as an international system in 2006 by the IMO and applies to the following ship types engaged on international voyages:

- All passenger ships including high speed craft,
- Cargo ships, including high speed craft of 300 gross tonnage and above, and
- Mobile offshore drilling units.

These ships must automatically report their position to their Flag Administration at least 4 times a day. Flag administrations are obliged to operate and maintain LRIT data centres, facilitating also the data exchange between countries.

At glance, LRIT data seem to provide a suitable reference for assessing the performance of space based AIS data. However, there are some drawbacks, limiting the real usefulness of LRIT:

- A central database, containing all LRIT data from all flag authorities does not exist. Vessels identified by space based AIS in a specific sea area report their position just to “their national” LRIT data centres. To obtain a complete picture of the marine traffic in one region at one moment in time would require to combine all information from all LRIT data centres. Most important limitation regarding the usage of LRIT is the confidentiality of the data. They belong to Flag States, hence an authorisation form each national administration is required to access the data. This might be possible for vessel under EU flags states via EMSA which manages a EU LRIT data centre, but an almost impossible for all flag states in the word.

- Another drawback is the relatively long update interval of a vessel location report of 6 hours. To obtain a coherent picture of the vessels located in a certain area within S-AIS with an observation time window of just 15 minutes is quite difficult.

Despite this mentioned drawbacks of LRIT in the following it is tried to cross correlate LRIT data with S-AIS data. Due to the confidential status of the data only anonymous LRIT data (arbitrary MMSI) can be used. The exercise thus aims at exemplifying the (im)-possibilities linking anonymous LRIT data and S-AIS for the purpose of deriving meaningful performance indicators for S-AIS.

2. MATERIAL AND APROACH

2.1 ANONYMOUS LRIT DATA FROM 26.03.2009

Through POLESTAR, an Application Service Provider in change of managing LRIT data centres for various flag countries, made available some LRIT data. Due to confidentiality reasons, data had to be anonymous, meaning that MMSI had to be replaced by a random code.
The LRIT data set provided by POLESTAR covers a 24 hour period (26.03.2009), and contains 41.886 messages from 11.988 ships operating globaly. Table 1 shows the number of messages transmitted via LRIT during the 24 hour period. Considering a message frequency of 6 hours, in theory vessels should transmit between 4 and 5 messages. This is the case for only around 40% of the vessels!

Messages sent during 24 hour period	N° LRIT vessels	%
1	5292	44.1%
2	1305	10.9%
3	722	6.0%
4	3406	28.4%
5	353	2.9%
6	208	1.7%
7	63	0.5%
8	100	0.8%
9	47	0.4%
>10	492	4.1%
	11988	100%

Table 1: Number of LRIT messages per vessel

2.2 ORBCOMM S-AIS DATA

In 2009 all 6 Orbcomm satellites were still operational. For the 26th March 2009 more 227.057 position reports could be gathered, an ideal source of data to conduct the comparative analysis.

3. RESULTS

3.1 APPROACH

In order to assess the performance of S-AIS a simple indicator can be derived, which is the ratio between the AIS messages received out of the LRIT messages submitted.
It is assumed that all vessels transmit both, LRIT and S-AIS message reports.

Since there is common identifier enabling the link between the anonymous LRIT data and S-AIS data, any automatic database query using the MMSI as the common key in both datasets cannot be performed.
Instead, the link between the anonymous LRIT and S-AIS position reports can only be done "manually" via the vessel track as reported by both systems. This means that the data needs to be displayed on the screen and each displayed vessel position has to be checked trying to align the LRIT and S-AIS tracks for each individual vessel. For checking the plausibility of the alignments the time stamps of each position report and each ship, the travel distance and directions need carefully to be validated.

3.2 EXAMPLES OF VESSEL TRACKS REPORTED BY LRIT AND S-AIS

The following examples highlight the challenges:
The alignment can be quite straightforward very if the time gap between LRIT and S-AIS is small and the ship follows a straight course (see example 1 and 2).

Figure 1: Simple Assignment of LRIT (red) and S-AIS data (blue)

In other cases it can be difficult or almost impossible, notably in higher density areas with many overlapping ship tracks. The vessel track in example 3 seems to be from one single ship, but in fact, these are three ships following each other on an identical course. Based on the time stamp and an estimation of the travel distance, it needs to be checked which LRIT report could belong to which the single S-AIS message. Only if for the S-AIS report and the anonymous LRIT report fit together in a plausible way, it can be assumed that both reports belong to a single ship.

Figure 2: Unclear assignment of LRIT (red) and S-AIS data (blue)

Obviously, the alignment carries some uncertainties or ambiguities, since this synchronisation of the position reports might be false although plausible.
Example 4 demonstrates that if the ship changes course, the ambiguity of a correct alignment increases substantially.

The example blow shows a subset from the South African Coast, close to Port Elizabeth with main coastal shipping lane. The identification of vessel tracks as reported by anonymous LRIT and S-AIS is very difficult and often almost impossible.

Figure 3: Overlay of LRIT and S-AIS position reports along the South African Coast

Another drawback of the approach is the fact that it may happen that a vessel transmits LRIT position reports, but the vessel's AIS seems to be switched of. The following example shows the LRIT ship track over a 24 hour period, composed of 4 position reports. Although the vessel was passes at least 5 times by one of the Orbcomm AIS satellites, not even one single AIS message could be received. One could argue that the satellite was unable to decode the message, but this case seems to be rare.

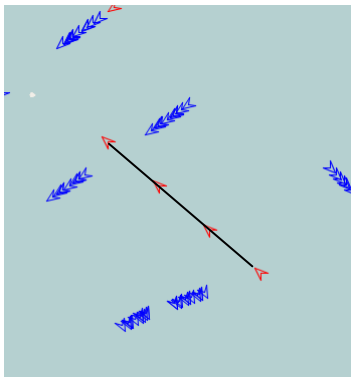

Figure 4: LRIT 12 hour vessel track (red) without corresponding AIS massages

3.3 TESTS PERFORMNED

Despite the before mentioned limitations and ambiguities related to the alignment of anonymous LRIT and S-AIS data and hence the uncertainties of assessing the performance (probability of detection) of space based AIS, two test cases have been selected to further demonstrate the drawbacks.

3.3.1 LOW DENSITY AREA OVER THE PACIFIC

Figure 5 shows the vessel positions as reported by S-AIS and LRIT over the Pacific (UTC 7:15). This area can be considered as a low density vessel area with a number of ships, following each its specific route at a certain distance to each other. There are only 10 vessels reporting their position via LRIT. Out of the 10 vessels, for 6 ships a corresponding S-AIS message can be retrieved, resulting in a PoD of 60%. Apart form the very small LRIT sample of just 10 ships, it seems to be a feasible approach

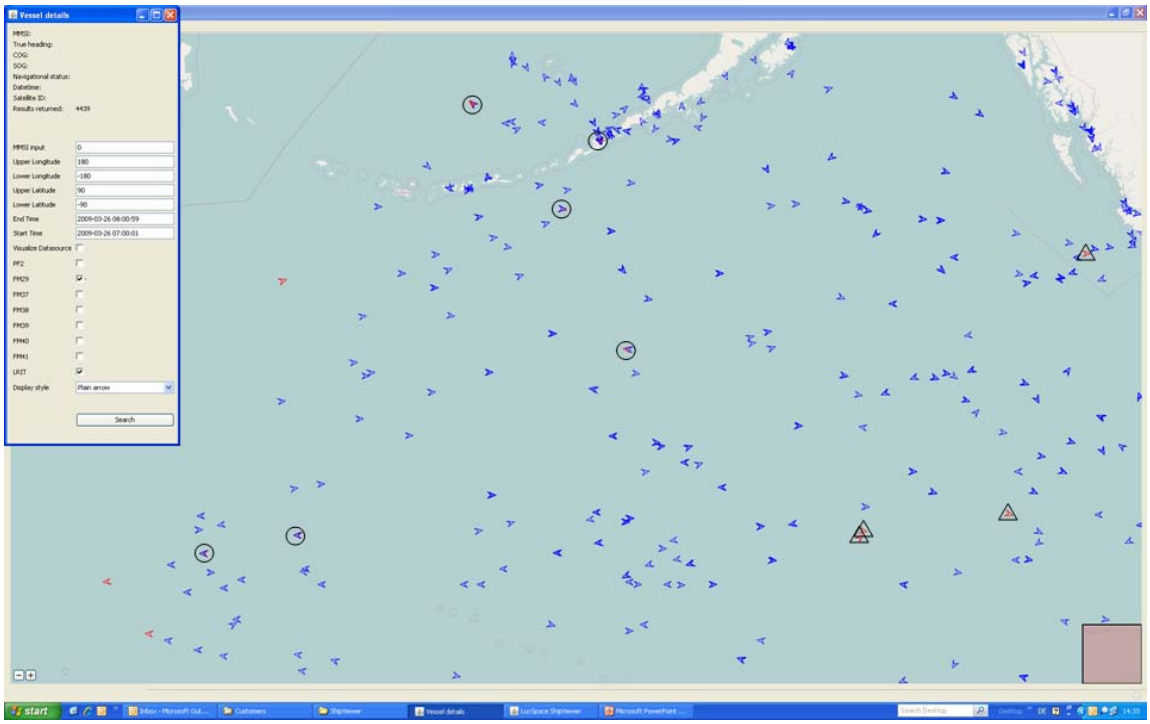

Figure 5: Vessel positions captured 26.03.2010 over the Pacific by Orbcomm FM 29 and LRIT

3.3.2 MEDIUM DENSE VESSEL DENSITY AREA ALONG THE SOUTH AFRICAN COAST:

The second example shows the vessel track along the South African Coast. It's a medium dense vessel traffic area and it becomes obvious that the "manual" alignment of S-AIS and LRIT is impossible.

In total 125 LRIT position reports are captured, compared to 148 S-AIS position reports. Only 9 vessels and their corresponding LRIT and S-AIS messages can be synchronized. Due to the high number of vessel, following a very narrow shipping trajectory it is almost impossible to synchronies the tow data sources just based on the vessel tracks the

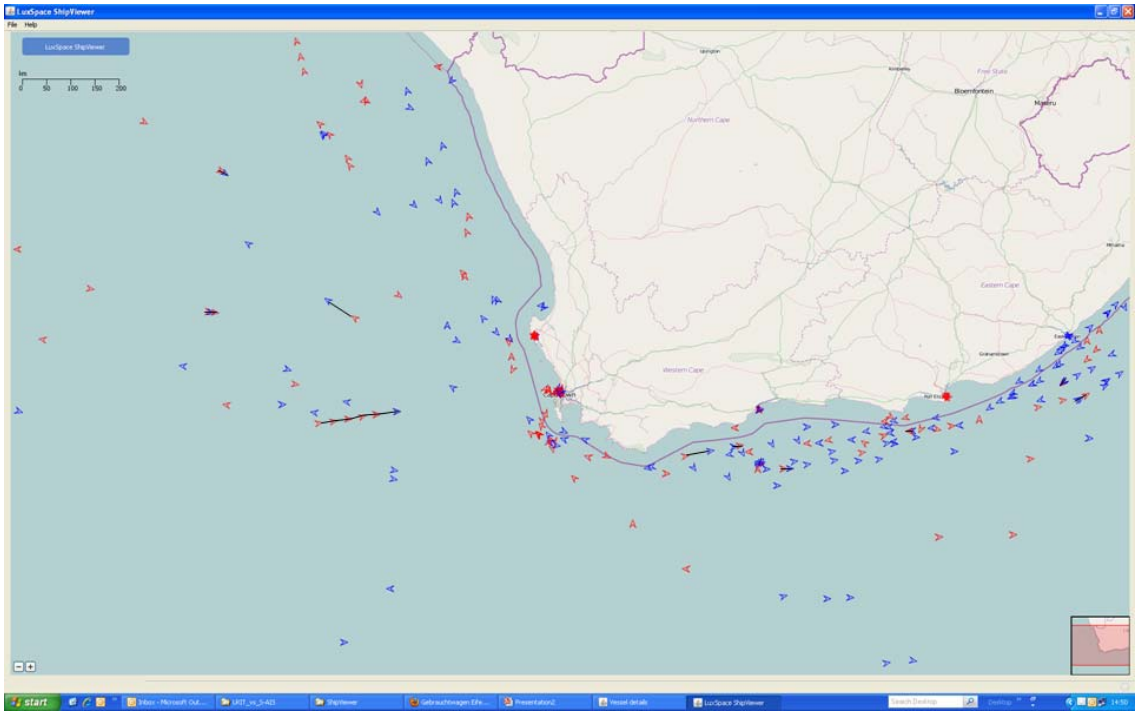

Figure 6: Vessel positions captured 26.03.2010 along the South African Coast by Orbcomm FM 29 (blue) and LRIT (red)

4. CONCLUSION:

The examples provided show that the alignment of space based AIS and anonymous LRIT is almost impossible for a thorough performance assessment due to several reasons:

- the small LRIT sample which limits the statistical significance of the assessments
- the impossibility of synchronisation of vessel positions obtained by LRIT and S-AIS, notably in medium and high density area
- the need to do the assessments manually
- the ambiguity of the results, since MMSI cannot be used for a definitive link between the position reports from a single vessel

However, for future performance assessments the non-anonymous LRIT could become a powerful reference data source, provided that a large number of LRIT data becomes available and it is ensured that all the vessel in the LRIT sample have properly switched on their AIS transponder.