Technical Reliability of Navigation Systems in case of Collision Avoidance

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FACULTY OF ENGINEERING
Dr.-Ing. Michael Baldauf
E-Mail: michael.baldauf@hs-wismar.de
www.sf.hs-wismar.de

HOCHSCHULE WISMAR
UNIVERSITY OF TECHNOLOGY, BUSINESS AND DESIGN

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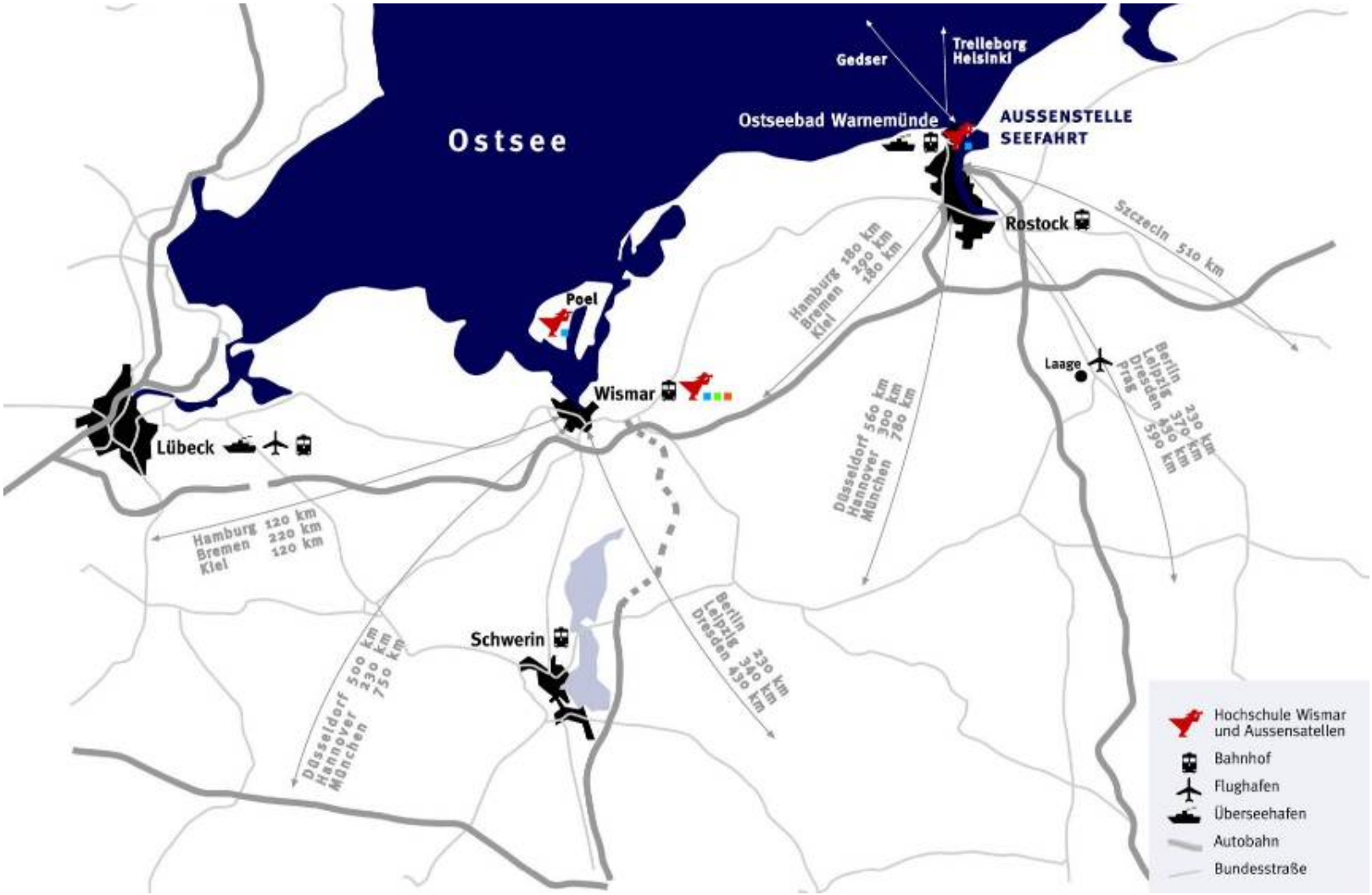
Prof. Dr.-Ing. Knud Benedict
Dr.-Ing. Michael Baldauf
Dipl.-Ing. Frank Hartmann
Dipl.-Ing. Sandro Fischer

Dipl.-Ing. Florian Motz
Dipl.-Ing. Sabine Höckel
(Research Institute for Communication, Information Processing and Ergonomics)

Dr.-Ing. Erland Wilske
Dr.-Ing. Peter Grundevik

Branch Rostock-Warnemünde



Department of Maritime Studies

Outline

- Introduction & aim of this paper
- Current state of the art
- Empirical field studies into AIS
  - On-board measurements
  - Investigations into alarm situation
  - Case study on reliability of AIS data transmissions
- Summary and outlook

Introduction

Introduction

Human Reliability

usually defined as the probability that a person will correctly performs some system-required activity during a given time period (if time is a limiting factor) without performing any extraneous activity that can degrade the system.

$$R = 1 - HEP = 1 - n/N$$

versus

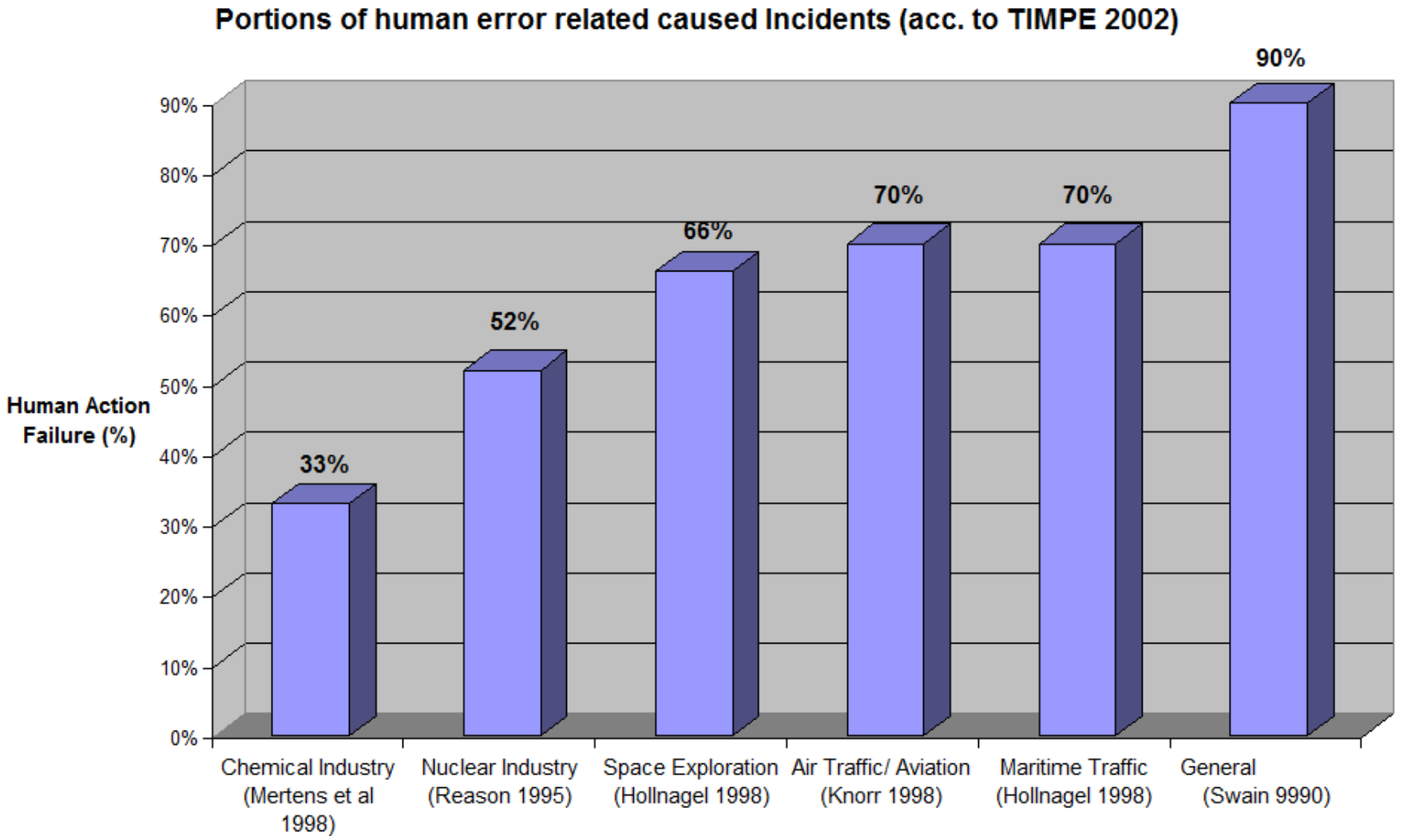
Introduction

Technical Reliability

the ability of a system or component to perform its required functions under stated conditions for a specified period of time (often expressed in terms of a probability, MTBF or Failure rate)

$$R(t) = \int_0^t f(x)\,dx$$

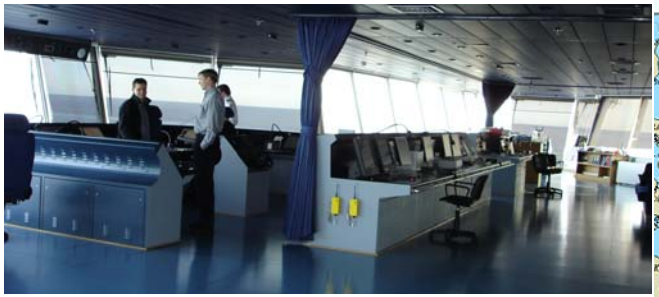
Introduction – Human Element and Technical Reliability



Field Studies – Alert Management on board (1)

Method and conduction

- a series of eight voyages of different types of vessels in different sea areas
- Voyage duration between 11 and 27 hours
- Total › 120 hours



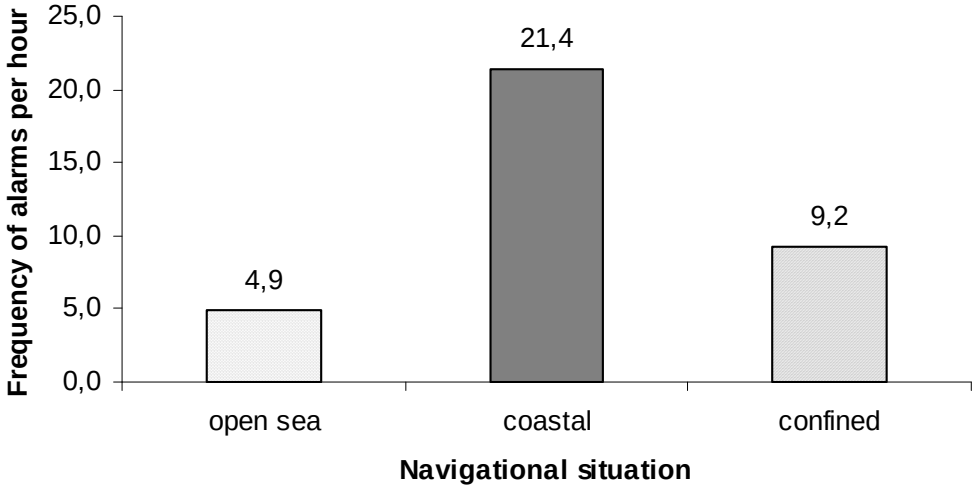
Field Studies – Alert Management on board (2)

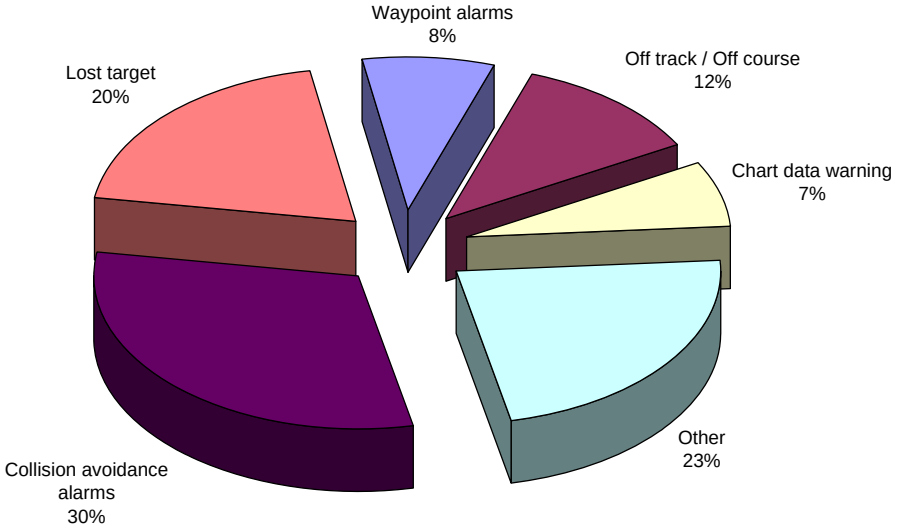
- Recording of occurrence of alerts on the bridge
- Type of alert, time of occurrence
- System / device announcing alert
- Presentation (visual / acoustical / both)
- Handling of alert, alarm limits
- Sea area (open sea / coastal / confined)
- Interviews with mariners
  - Presentation of alerts
  - Handling
  - Related operational problems
  - Centralized alert display

Field Studies – Alert Management on board (3)

Selected results regarding reliability of AIS

- High number of alerts depending on sea area and limits
- major portion AIS related alerts





Field Studies – Alert Management on board (3)

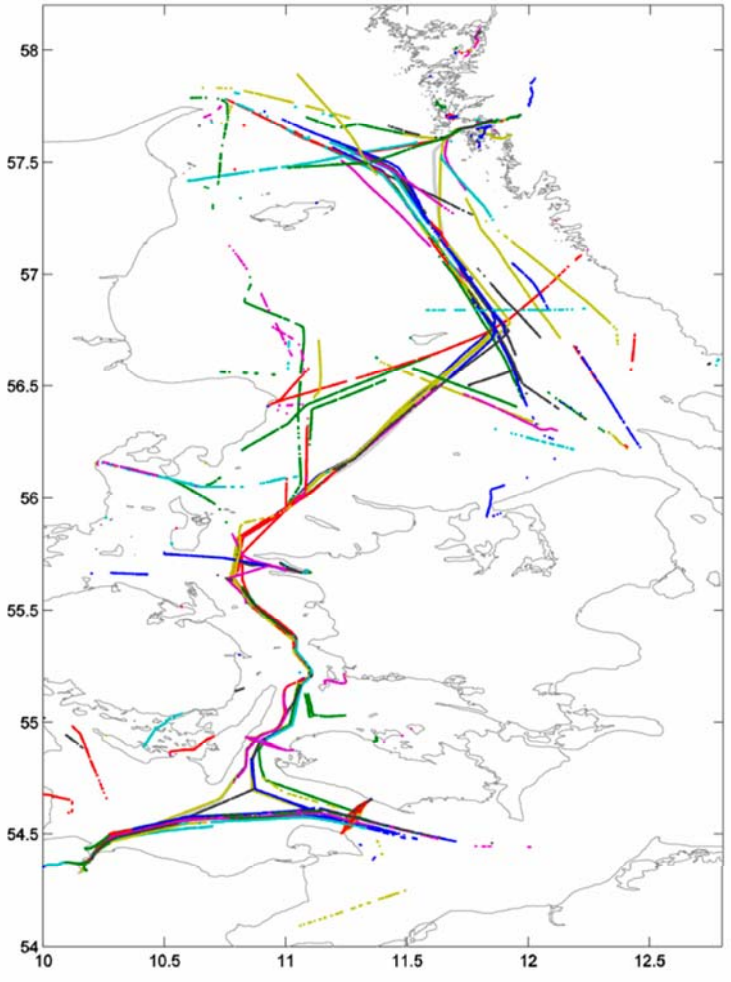
Selected results regarding reliability of AIS

Collision warning of a target behind a land mass (confined waters area)

Empirical Field Studies – On board Measurements

On-board study

- Measurements and comparison of AIS and ARPA/Radar-tracked target data
- Data of 616 targets during 40 voyages (20 days) collected and examined



Empirical Field Studies – On board Measurements

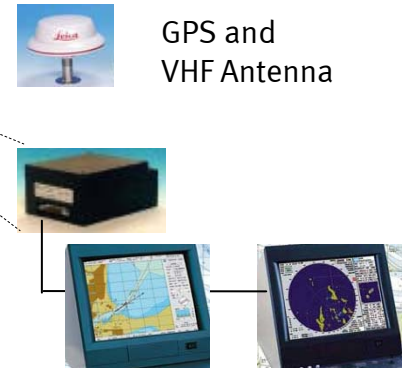
Result regarding reliability AIS

- from 18% of targets wrong heading data were received
- mean time between two consecutive AIS-messages 23 seconds
- max value 33 seconds

Scenario Study – AIS data transmissions (1)

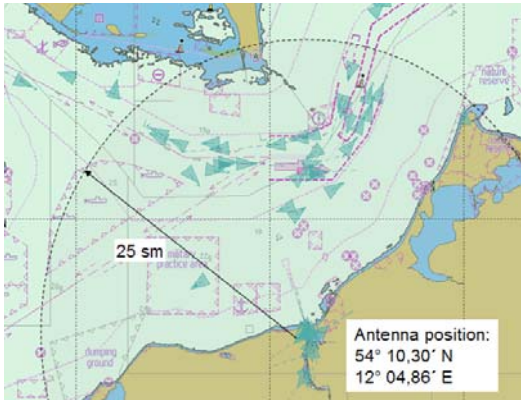
Method and conduction

- continuous, uninterrupted systematic long-term observation
- selection of a usual traffic scenario of daytime
- detailed situation analysis (11.160 sets of data from 62 involved AIS objects
- 16% wrong heading, another 16% wrong ROT

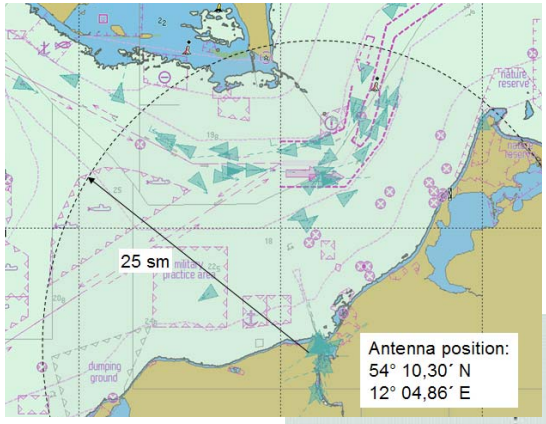


GPS and
VHF Antenna

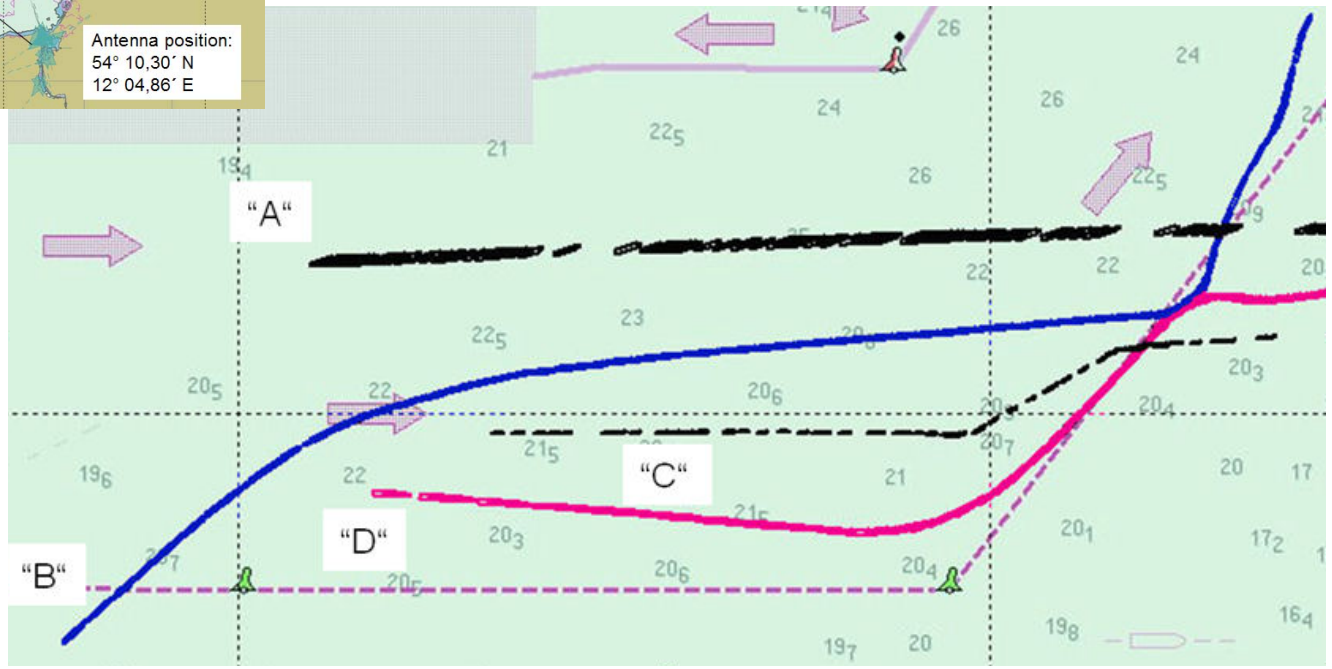
UAIS connected with
ECDIS and RADAR



Scenario Study – AIS data transmissions (2)

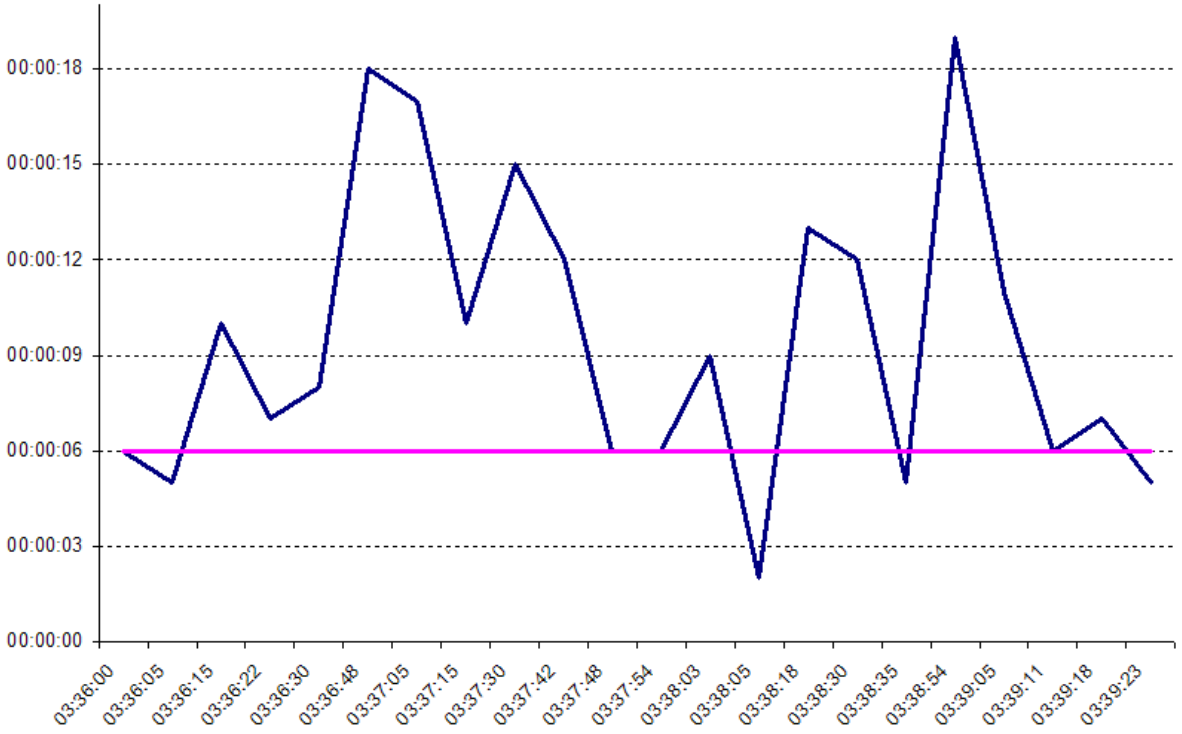


Selected course of a collision situation (20 minutes length) within the overall scenario



Scenario Study – AIS data transmission (3)

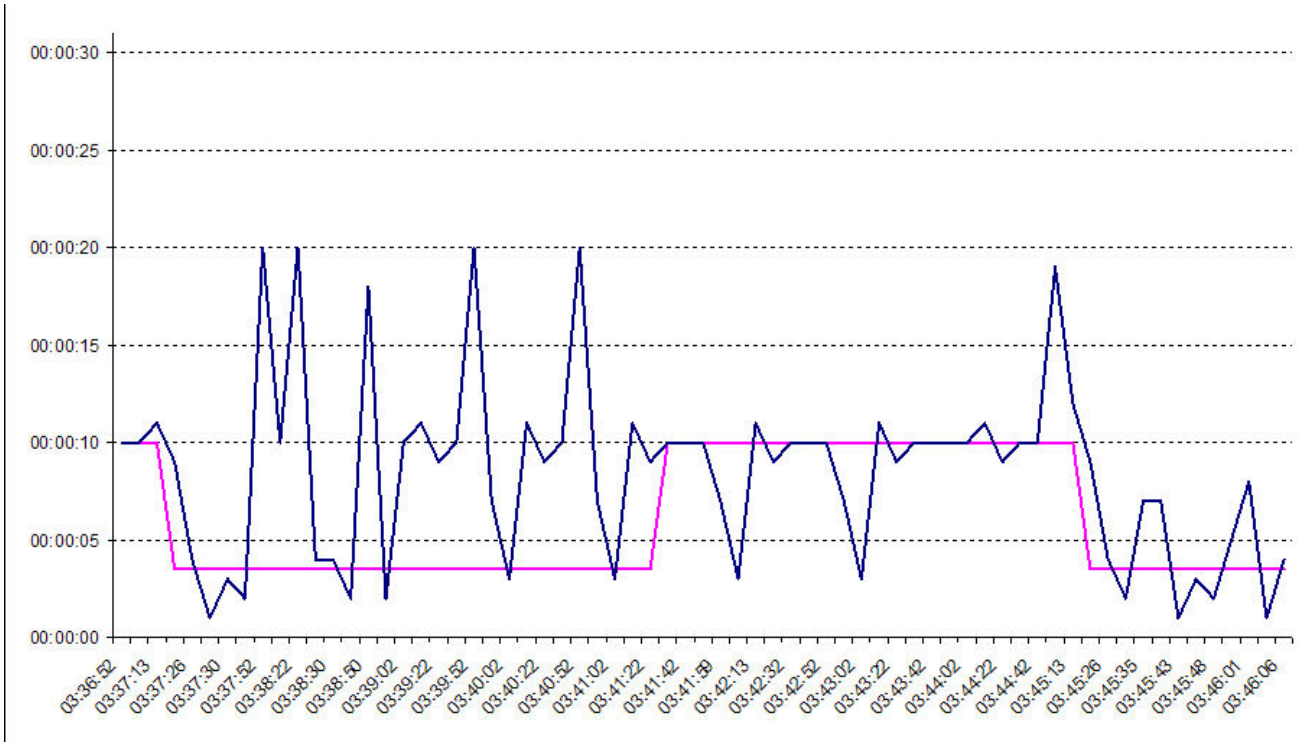
Example for preliminary results regarding reliability of AIS data transmission



Received AIS position reports from a target with speed › 14 kn on constant course

Scenario Study – AIS data transmission (4)

Example for preliminary results regarding reliability of AIS data transmission



Received AIS position reports from a target with speed < 14 kn and manoeuvring

Scenario Study – AIS data transmission (5)

Preliminary results regarding reliability of AIS data transmission

Tar-get	Position Reports (Msg.-Id. 1 and/or 3)			faulty reception intervals	Update rate (Reception intervals)	
	Total number	Total without repetitions	expected number		Mean value	Maxima
"A"	115	101	200	42	9,34 s	82 s
"B"	286	178	280	47	4,27 s	22 s
"C"	90	62	165	43	13,42 s	56 s
"D"	153	101	215	41	7,78 s	30 s

Summary and Conclusions

- Data exchange using AIS was investigated by several field studies
- AIS provides data that support and enhances CA
- However, there are significant deviations from defined standards (Heading and ROT, destination are hardly coded according to IMO recommendation)
- Update rates are often not according to the transmission scheme specified for AIS
- Increase of data integrity is needed for enhanced AIS based applications for collision avoidance
- E-Navigation is maybe addressed to contribute to solve these existing problems

Project Concept - Outlook

GALILEO supported innovative Collision Avoidance – Displays

Sensors/Data:

GALILEO
- Pos, COG, SOG

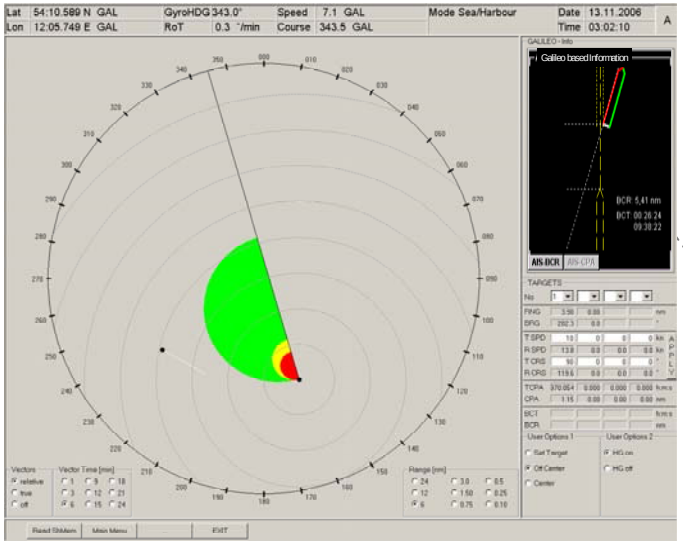
AIS
- Target-, OS-Data

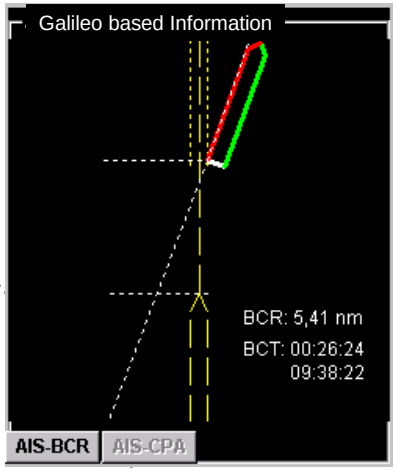
Radar/ARPA
- Target-Data

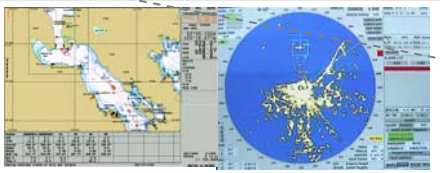
VDR and Dynamic Predictor

- Manoeuvring Data Related to actual manoeuvring capabilities of the Own Ship – **Precisely measured by GALILEO**

Collision-Avoidance-Display:
with new approach for Risk based coloured areas







Navigation Console with
ECDIS, Radar/ARPA, ...

\+ Mobile Trial System

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Thank you for your attention!
Awaiting your questions!

Hochschule Wismar
FACULTY OF ENGINEERING
Department of Maritime Studies in Warnemünde

Dr.-Ing. Michael Baldauf
E-Mail: michael.baldauf@hs-wismar.de
www.sf.hs-wismar.de