Enhanced Methodology for Impact Assessment of e-Navigation applications – the SMART case

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World Maritime University

Maritime Post-graduate University

Established by IMO in 1983

Focus on Maritime Education, Capacity-Building & Research

Principal Financial Supporters

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e-Navigation - bringing people together

MaRiSa
WORLD MARITIME UNIVERSITY

International teams of interdisciplinary, enthusiastic Researchers

Institut ISSIMS
Innovative Schiffs-Simulation und Maritime Systeme
Hochschule Wismar - Bereich Seefahrt

Outline

- Introduction
- Present Situation and State of the Art
- Assessment of Potential Impact of e-Navigation
- Training Needs and Requirements
- Preliminary Results and Discussion
- Outlook

From History to Modern …

Disasters seems to be going on

TITANIC, 1912

Andrea Doria, 1956

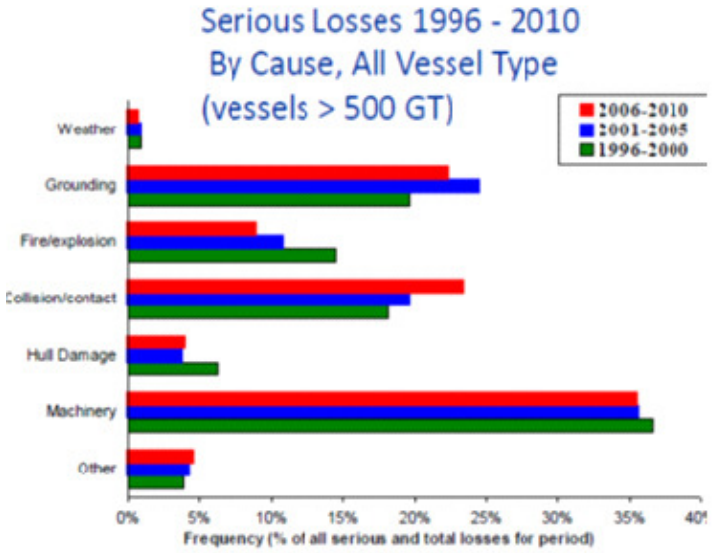
Heine - Mataram, 1988

R. Schulte, 2009

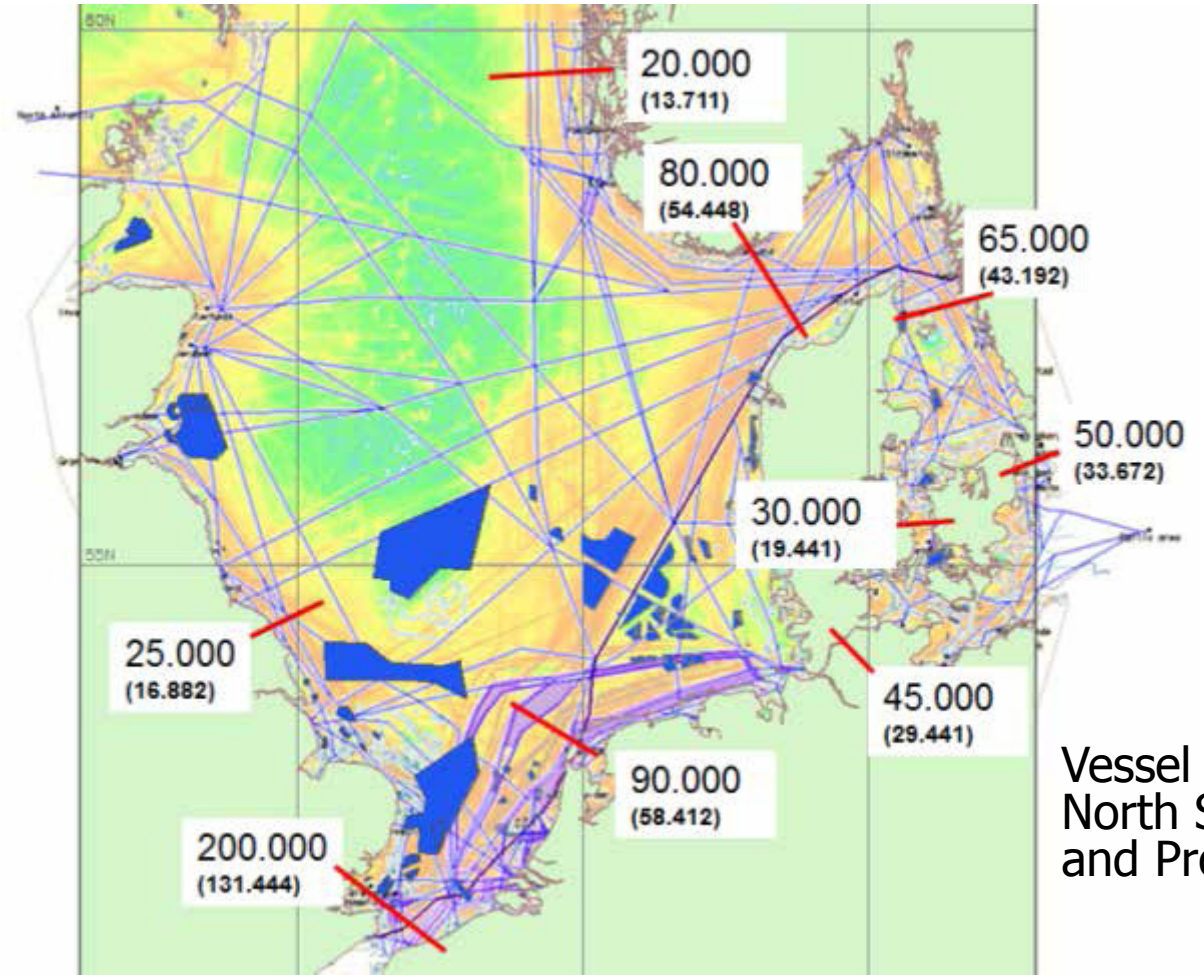
Pictures: www.titanicuniverse.com; www.shipfriends.gr

Present situation …

Maritime Accidents



Present situation …



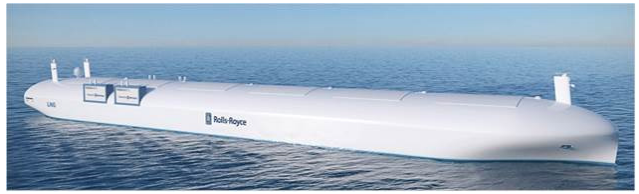
Vessel traffic in the North Sea per 2012 and Prognosis 2025

ACCSEAS

Present situation …

- Safe and environmentally-friendly shipping
- Technological Development: substantial changes in ICT (Data exchange – volume, types, almost real-time)
- VTS – FOC – Unmanned ships and autonomous Navigation

Source: www.interschalt.com



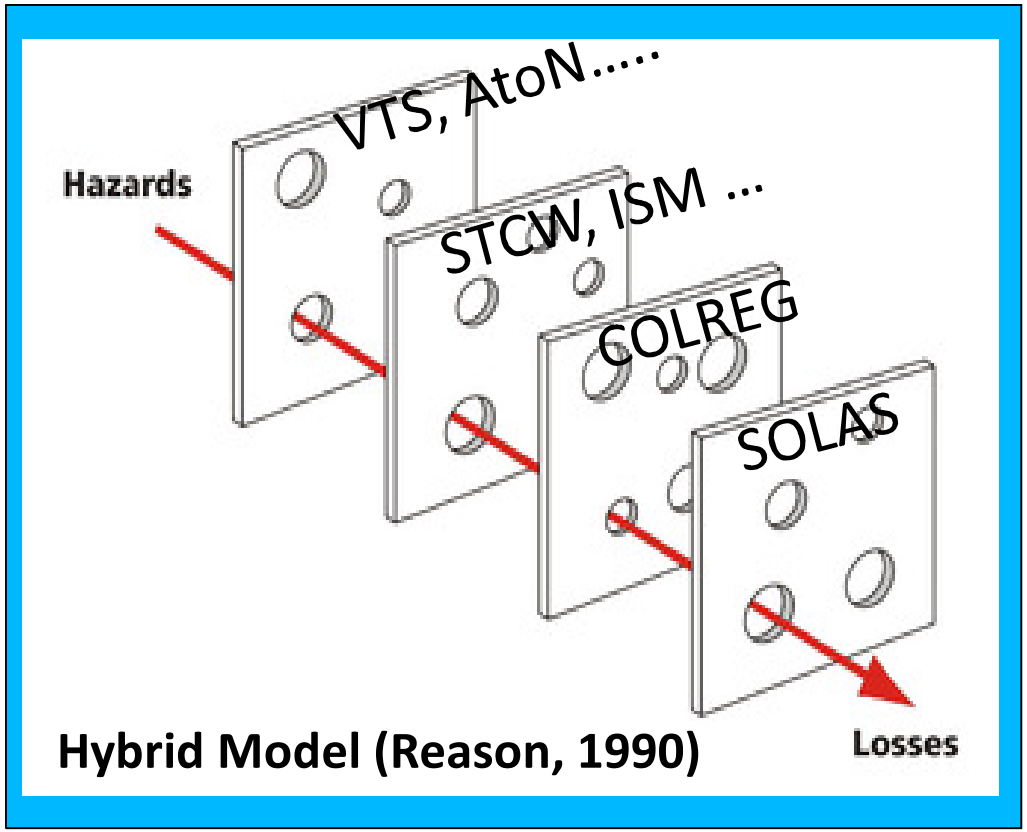
Source: www.iunmanned-ship.org

Approaching to assess impact of e-Navigation

- IMO method to assess impact of e-Nav applications
- SMART – Navigation: Korean approach to implement IMO e-Navigation : more comprehensive impact assessment

  * non-SOLAS, including fishing & coastal ships
- Development of a method for quantification
- Case study “Korea” – application and results

e-Navigation aims and ambitions
Why accidents occur?



Hybrid Model (Reason, 1990)

Main Causes

✓ Human Error : 75 ~ 96%

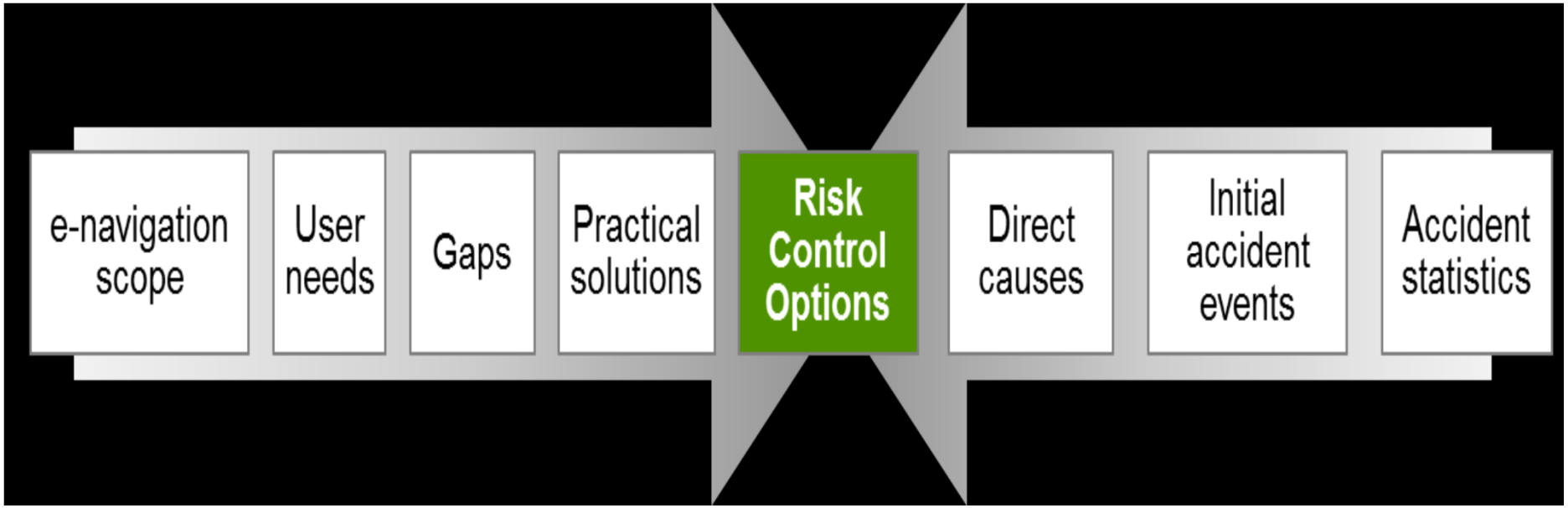
among others:
- Rothblum (2012)

✓ Multiple reasons combined

Among others:
- Hollnagel, Schröder-Hinrichs & Baldauf (2012)
- Wagenaar & Groeneweg (1987)

e-Navigation aims: main tool kit applications

- ✓ 5 Prioritized Solutions
- ✓ 7 Risk Control Options (RCOs)
- ✓ 16 Maritime Service Portfolios (MSPs)

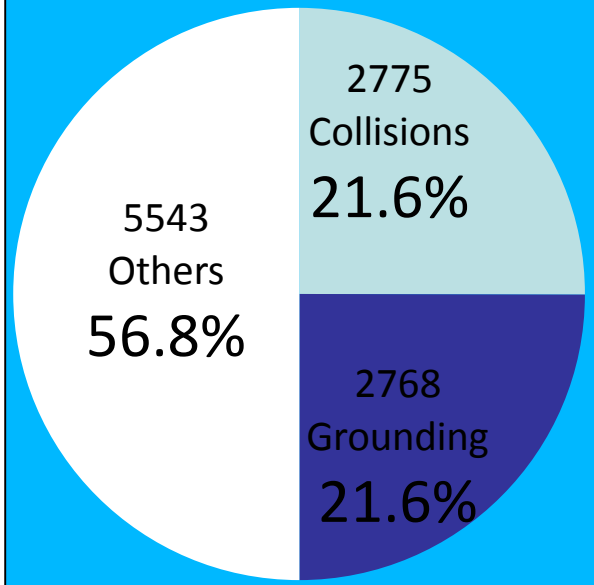


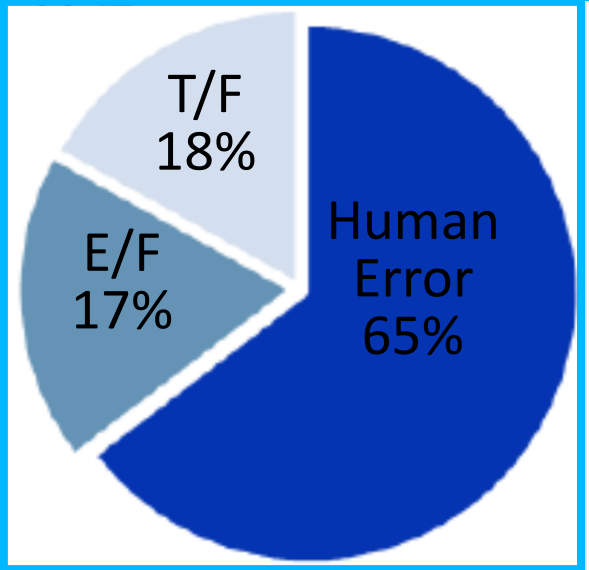
* Source: Annex 1 of NAV 59/6, p 20

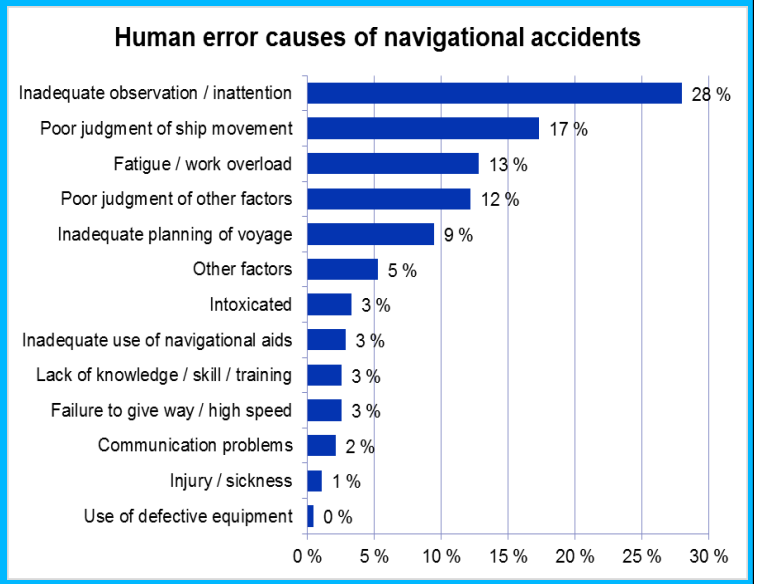
✓ IMO e-Navigation (MSC95, 2014)
- Expected Reduction of accidents for SOLAS ships: 22,8%

Nav. Acc.(43. 2%) x total Direct Causes (52.7%) = 22.8%

HE(65%) x detailed DCs (94%) x c (65%) = 39.7%
TF (18%) x detailed DCs (82%) x c (65%) = 9.6%
EF (17%) x detailed DCs (30%) x c (65%) = 3.3%







SMART-Navigation – Application and coverage

Scalability

Non- SOLAS : SMART-phone like services

LTE Service

5 Solutions
6 RCOs
16 MSPs

1. Provide NAS service to fishing boats and non-SOLAS ships for Collision prevention
2. Tug-Barges dumping dredged-sediments
3. Sightseeing, Coastal Passenger boats
4. Coastal Ship; Dangerous Cargo Carriers

65% for SOLAS Ships, 55% for non-SOLAS Ships

SMART-Navigation: SMART-phone like services
Non-SOLAS ships: S-mode. LTE-M + VDEs

Items	Analog	Digital		
	VHF	3G	LTE	WiFi
Data Sp'd	9.6 kbps	2.4-14.4 M	40-50 M	60-70 M
Compare	1	250-1500	4200-5200	6250-7300

SMART-Navigation
Identification of RCOs relevant for non-SOLAS

RCO 1 : Integration of navigation information & equipment including improved software quality assurance
RCO 2 : Bridge alert management
RCO 3 : Standardized mode(s) for navigation equipment
RCO 4 : Automated and standardized ship-shore reporting
RCO 5 : Improved reliability and resilience of onboard PNT
RCO 6 : Improved shore-based services
RCO 7 : Bridge and workstation layout standardization

Impact Assessment: enhanced and comprehensive quantification

$$AVSA = \sum(RSAD \times ARDC_{HF/TF/EF})$$

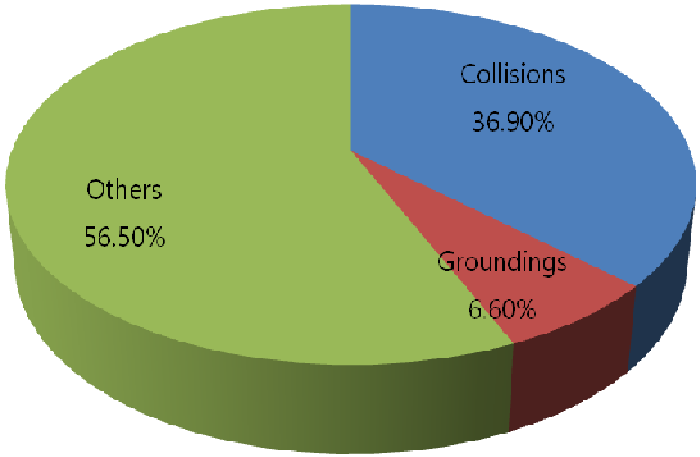
$$= \sum(RSAD \times c \times \sum RDDC_{HF/TF/EF})$$

$$= c \times \sum(RSAD \times \sum RDDC_{HF/TF/EF})$$

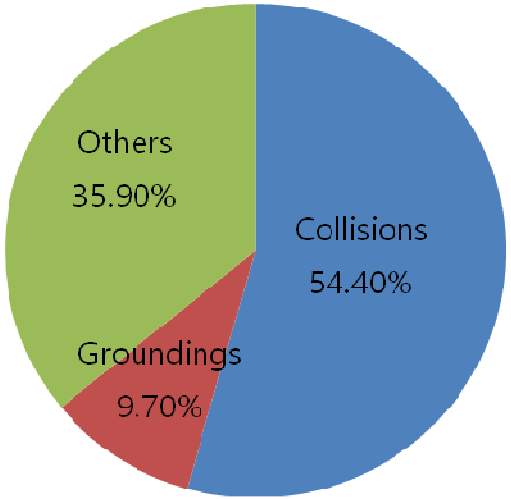
where is :

c	= Coefficient (65% for SOLAS ships, 55% for non-SOLAS ships)
AVSA	= Actual Volume of selected accident to be reduced by e-navigation
RSAD	= Rate of selected accident distribution
ARDC	= Actual Rate of risk reduction of each direct cause to be reduced by e-navigation
$RDDC_{HE}$	= Rate of risk reduction of detailed direct cause of Human Error to be reduced by e-navigation
$RDDC_{TF}$	= Rate of risk reduction of each detailed direct cause of Technical Failure to be reduced by e-navigation
$RDDC_{EF}$	= Rate of risk reduction of each detailed direct cause of External Factor to be reduced by e-navigation

Case study: Quantify potential effect of SMART-Navigation



Non-Fishing



KMST Statistics (2009-2013)

- Total : 4,871
- Navigational Accidents
  - 43.5% among total
  - 64.1% among non-Fishing
  - 37.1% among SOLAS Ships
  - Human Error : 90.7%

cf. NMA : 43.2% (SOLAS), Human Error : 65%

Case study: Quantify potential effect of SMART-Navigation

Items	IMO e-Navigation	SMART-Navigation
Reduction	22.8% + non-NA	56.6%
Navigational Accidents	22.8% (52.7%)	33.9% (65%) • Fishing: 19.1 %, non-F: 14.8% • SOLAS: 9.2%, non-S: 24.7%
Other Accidents	Not provided	22.7% • Fishing : 16.5% • non-Fishing : 6.2%
SOLAS non-SOLAS	SOLAS only (22.8%)	• SOLAS ship : 13% • non-SOLAS Ships : 43.6%

Challenges for improvement

Complexity:

e-Navigation will provide a mixture of applications, require interaction between a great variety of users

- Maritime Cloud
- Multi-Source Positioning & R-Mode MF DGNSS ; AIS Services
- Maritime Safety Information/Notices to Mariners Service
- Tactical Route Suggestion Service (shore/ship)
- Tactical Exchange of Intended Route (ship-ship and ship-shore)
- Dynamic Predictions
- SMART-Applications, …

Questions:

What is the exact contribution to more safety?
How to ensure smooth introduction to achieve all potential benefits?
How can we avoid “e-Nav-assisted” accidents?
…

Simulation-based case studies to identify risk reduction factors and dependencies

Tactical route

- Shore-ship route suggestion
- Electronically transfer a route segment
- Display of intended route

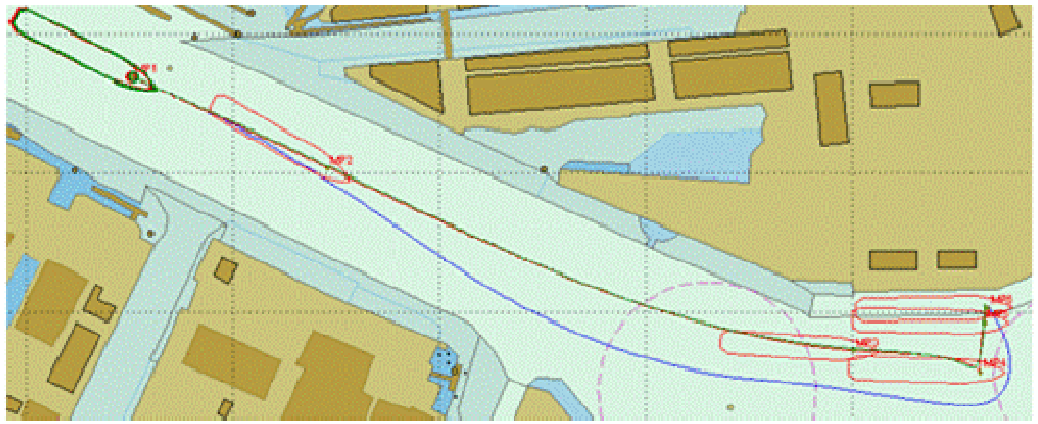
Strategic route

- Long term planning

Simulation-based case studies (2)

Use of dynamic predictions

- Planning of safe, sustainable; time-and energy-efficient manoeuvre sequences
- Monitoring and correcting/adapting the manoeuvring process



Simulation-based case studies – synergy effects

Selected Outcome and Results for MET

Training should include:

- Type specific training (urgent user demand/need)
- Training on operational use, limits & possibilities
- Limitations of sensors and information given in the system
- Overall simple and easy to use

Summary, Conclusions and Outlook

- Assessment of potential impact of e-Navigation applications shall include not only SOLAS nut also Non-SOLAS vessels
- IMO Member states shall investigate maritime safety situation in their countries in detail to identify best solutions and priorities
- Application of SMART-Navigation tool kits can have significant impact on Safety of Navigation
- Learning from the past: Adequate training measures needs to be identified and implemented to ensure smooth introduction and avoid e-Navigation-assisted accidents
- Identification and quantification of risk reduction factors

Thank you for your attention!
Awaiting your questions!

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