Title ***Efficient, Safe and Sustainable Traffic at Sea***

Acronym ***EfficienSea***

Contract No. 013

Document No. D_WP4_2a_2

Document Access: Restricted

User requirement specifications document

Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

DOCUMENT STATUS

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Document History

Revision	Date	Organisation	Initials	Revised pages	Short description of changes

Index

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Introduction

This document describes those e-Navigation services identified during the initial phase of the project. IMO has stated very firmly, that the identification of e-Navigation services must be user driven. It is our strong beleive that a solely user driven aproach is inadequate, as would be a solely engineering driven aproech. The optimal aproach involves both users, enginners and man-machine interface specialists from the beginning of the project.

Our methodology have been to identify e-Navigation services by means of different approaches.

First we have conducted simulations in order to analyse how things are done today in the maritime environment. The simulations included both ship and shore side users. Based on the simulations, areas needing improvements from future e-Navigation services was identified. The findings are reported in 'W_WP4_2a_7 Simulation report_final', which is included in the deliverable 'D_WP4_2a_1 A report describing the user requirements for e-Navigation zone(s)'.

Second we have made an interactive presentation of of proposed e-Navigation services identified through a brainstorming process. This mock-up has then been discussed in work-shops with end users. The feedback is captured in ' W_WP4_2a_3 Mock-up user feedback', which is also included in 'D_WP4_2a_1 A report describing the user requirements for e-Navigation zone(s)'.

This document describes the e-Navigation services identified throught the above outlined processes. The services are also shown in the final version of the mock-up, which is available in electronic form. In appendix A and B of this report are two screenshots from the mock-up.

It should be noted, that this report encopasses all identified possible e-Navigation services. It will not be possible to, nor has et ever been the intention to, test all these services. Some services will be selected for implementation and tests. The initial selection/prioritation is described in ' D_WP4_1_2 A proposal for solutions to be tested in the test bed', but this selection has not been finalised at this stage of the project.

Ideas for ee-INS

Information

<u>SSPA Dynamic Predictor:</u>

SSPA's Dynamic Predictor is included in ee-INS.
The Dynamic Predictor is a tool used on ferries and fast-ferries. The tool is able to calculate exact position and heading of vessel 3 to 6 minutes ahead. The input is a full model of the vessel, rudder angle, engine, depth, current, wind, etc. On ferries fitted with the Dynamic Predictor the length of vector is often set to the time corresponding to the crash stop distance.

Today the predicted position/track is kept on board own vessel for information to vessels navigator only. The idea in the project is to share this information with other vessels, VTS centers and others by sending predicted track to vessels in vicinity and thereby give them an idea of intentions and make it possible for them to see if vessel s in vicinity is maneuvering or keeping course and speed. Other vessels' predicted track is important information to the navigator in close quarter situations and when maneuvering to avoid collision.

The Dynamic predictor should have a time index like other vectors on bridge displays.

Communication:
Communication path: Ship-ship, ship-shore
Data size: 40 bytes (if AIS), likely 400 bytes if internet based.
Update frequency: Transmission every 2-200 seconds and on request. May be controlled by vessels speed and maneuvers like AIS reports.
e-Nav level: Ship-ship – all levels, ship-shore – confined waters
Possible data carriers: Internet, AIS, other ship-to-ship communication system
Data format: AIS and/or XML
Notes: Information filtering needed – by distance or other way.

<u>SSPA Dynamic Maneuver Marginal Index:</u>

SSPA's Dynamic Maneuver Marginal Index (DMM Index) is included in ee-INS.

The DMM Index is a tool being developed at SSPA. The tool calculates possible maneuvers at present speed and output is a trumpet-shaped area ahead of the vessel.
The DMM Index is shared with other vessels, VTS centers and others. The presentation of the DMM Index on other vessels and on VTS gives an indication of the vessels maneuverability and possibilities to give way.

Communication:
Communication path: Ship-ship, ship-shore
Data size: 10 bytes (if AIS), likely 100 bytes if internet based.
Update frequency: Suggested transmission every 2-200 seconds and on request. May be controlled by vessels speed and maneuvers like AIS reports.
e-Nav level: Confined waters
Possible data carriers: Internet, AIS, other ship-to-ship communication system
Data format: AIS and/or XML
Notes: Information filtering needed – by distance or other way.

<u>Maritime Safety Information, Chart Corrections, Notices to Mariners, etc.:</u>

Maritime Safety Information and corrections relevant to the navigator is shown with international symbols. If warning/correction is far from vessels intended route it will not be shown. Same for warnings/corrections not relevant for the vessel, e.g. a new wreck with a depth of 100 meters above is not relevant for a vessel with a draught of 6 meters and a firing exercise on Tuesday is not relevant for a vessel passing the area on Monday.
If additional information is needed navigator may open textbox to see warning/correction in clear text.
The origin of the information is not important – the content of the warning/correction is.

NOTE!
IALA's e-Navigation committee Operations and Strategy workinf group has worked on identifying user requirements and system requirements for MSI. This information should be taken into account when continuing the work on MSI.

Communication (Navigational Warnings):
Communication path: Shore-ship
Data size: max. 50 Kbytes
Update frequency: When updates are received - estimate is 1 message every 8 hours, possibly less.
e-Nav level: All levels
Possible data carriers: e-Navigation internet
Data format: XML, systems today use other text formats

Notes: Existing systems for transmission of messages: NAVTEX, Voice, SafetyNET (satellite)

Communication (Chart correction and Notices to Mariners – NtM):
Communication path: Shore-ship
Data size: 20 Kbytes to 500 Kbytes (100-200 Kbytes average)
Update frequency: When updates are received – only on route.
e-Nav level: All levels
Possible data carriers: e-Navigation internet
Data format: XML or existing format
Notes:

<u>No-go Areas and Maybe-go Areas:</u>

Instead of showing depth contours and soundings on display No-go areas and Maybe-go areas adjusted for specific vessels' data is introduced.
No-go area is an area that the vessel will not navigate under no circumstances. The navigator may give input to this, for instance a minimum Under Keel Clearance (UKC) of 2 meters.
Maybe-go area is an area that the vessel will not navigate under normal conditions. The navigator may also give input for this, for instance a preferred UKC taking into account fuel consumption, vessels' vibration in shallow water, etc. Inshore traffic zones, Traffic Separation Schemes, Nature reserves, other Special Areas, regulations, etc. that restricts the vessels' navigation in an area should be shown as a Maybe-go Area.
The Maybe-go area may be navigated in an emergency, when avoiding collision, etc.

The areas are interactive and change with changes in tidal level, vessels' draught, etc.

Communication (tide):
Communication path: Shore-ship
Data size: 2.500 kbytes (100 positions, 48 hour prognosis)
Update frequency: Every 6 hours – only area around route. Continuous from waterlevel sensors – on request.
e-Nav level: Confined waters, all levels for planning
Possible data carriers: e-Navigation internet, AIS?
Data format: Possibly NetCDF
Notes:

3D view and presentation of objects:

Mental rotation theory and tests performed in Sweden by Thomas Porathe show that a 3D head-up presentation is easier to understand for both experienced navigators and people not used to perform navigation tasks.
The ee-INS presented in the Mock-up is a 3D head-up display. All objects in the screen are shown in 3D.

Communication (3D models of vessels):
Communication path: Ship-shore, Ship-ship
Data size: ?
Update frequency: Once when vessels meet
e-Nav level: All levels
Possible data carriers: ship-to-ship communication system, Internet or simple solution: AIS
Data format: ?
Notes:

Lighthouses/conspicuous landmarks:

Information from List of Lights is incorporated and additional information like pictures, status, contact details if observed unlit or unreliable, etc. is added.
If navigator needs more data than basic ECDIS information on lighthouses; marker is moved to position and additional information including picture is shown.
Pictures of conspicuous landmarks are also added.
This will help the navigator with his perception of position relative to objects around the vessel.

AtoN's – theoretical visual observation range:

Meteorological and geographical conditions' influence on visual observation of AtoN's, i.e. an algorithm taking into account reduced visibility, height of eye, etc. is giving a theoretical range of visual observation of AtoN's. The range is shown numerically and graphically on display – e.g. a round red area centered on a porthand light buoy.

Communication:
Communication path: Shore-ship
Data size: 150 bytes per AtoN
Update frequency: On request
e-Nav level: All levels
Possible data carriers: Internet, AIS, other shore-to-ship communication system
Data format: XML - AtoN ID + visibility
Notes: Format? Expiry date/time?

Exchange of routes:

Routes are transmitted to other vessels and to shore based users.
Other vessels' routes are shown on display if navigator wants the information or if system deems it necessary for the safe navigation of the vessel.

Vessels may receive route suggestions or suggestions to change speed from VTS Centers.
As an addition to route suggestion vessels participating in Search and Rescue operations may have the possibility to receive search areas and search patterns from Search and rescue Coordinators.

Communication:
Communication path: Ship-ship, Ship-shore, Shore-ship
Data size: 4-500 bytes
Update frequency: Once when vessels meet or when entering area, e.g. VTS area, when shore suggest change of route, suggested SAR search area/pattern
e-Nav level: All levels
Possible data carriers: Internet, AIS, other ship-to-ship communication system
Data format: XML or other suitable format
Notes:

Display of Radar information:

The radar picture is not visible under normal conditions. Unidentified radar targets (no AIS information) are presented on ee-INS display as a box with size of object in question and a vector showing course and speed. Radar settings are automatic or are controlled on ee-INS display.

Radar overlay may be an option. VTS operators may want this option as they use the raw radar image to assess the precision of data from other sources.

Radar image or targets from shore based radar sites are transmitted to vessels. May be used in places where land or an object create radar shadow, e.g. at Elsinore.

Communication (exchange of radar targets):
Communication path: Shore-ship
Data size: 100 bytes per target (max. 100 targets – 10 KBytes)
Update frequency: Continuous – every 4-5 seconds
e-Nav level: Confined waters

Possible data carriers: Internet
Data format: XML
Notes: Format? Further information needed

Display of AIS information:

AIS information is shown in display. Information is compared and checked against radar input.

Virtual AtoN's

The use of virtual AtoN's is tested in test beds.
DaMSA has tested virtual AtoN's in other projects. Experience gained in these projects is used and new tests are developed.

Communication:
Communication path: Shore-ship
Data size: 30 bytes per virtual AtoN (if AIS), 300 bytes per virtual AtoN (if XML)
Update frequency: Every 3 minutes
e-Nav level: All levels
Possible data carriers: Internet, AIS
Data format: XML – other suitable solution
Notes:

Information on ee-INS display:

It is important that information to the navigator is filtered in an intelligent way to avoid information overload.
Only relevant information is shown on display, e.g.:

- Light characters are not shown in daytime unless lighthouse/buoy is lit 24H.
- Depth information is not shown unless relevant – No-go areas and Maybe-go areas are used instead.
- Maritime Safety Information and Chart corrections are only shown if relevant for the vessel and close to the planned route.

Important information is augmented to make it clear to the navigator.

Oceanographic information - Current:

Current at positions of buoys and light houses is shown.

DaMSA is planning to fit a number of buoys with current meters. Present speed and direction of current is transmitted to vessels (and shore based users) via AIS/other means and is shown on ee-INS.
It is possible to calculate precise current in other positions than where the current meters are placed – the grid is today 1nm by 1nm – working on 600m by 600m grid and in some areas 200m by 200m grid. The calculations are carried out every hour – according to oceanographers this is often enough to give valid current information to navigators.
Salinity, sea temperature and other data is also made available.

Communication:
Communication path: Shore-ship (Ship-shore for collection of data)
Data size: Navigational mode only – planning mode will need more data.
8,8 bytes per data point. Data available for 48 hours with 1 hour resolution.
Typical size: 100 geographical points ~ 50KBytes
Update frequency: Every 6 hours – only area around route. Continuous from current meters – on request.
e-Nav level: All levels
Possible data carriers: e-Navigation internet, AIS
Data format: Possibly NetCFD
Notes:

Meteorological information - Weather:

Information on wind, waves, swell, visibility, temperature, etc.
All information – analysis, forecasts and warnings – are made available to vessels.
Weather information is linked to geographical positions and presented graphically on display.
Weather information is also used in efficiency module where optimum route is calculated based on among other things weather.

Communication (Wind average, wind gusts, waves, swell, visibility, temperature):
Communication path: Shore-ship
Data size: 4,4 bytes per variable (6 all together). Number of data point 20 plus 48 in time (48 hours).
Size: 30 KBytes.
Update frequency: Updated every 6 hours – only area around route. Continuous from sensors
e-Nav level: All levels
Possible data carriers: e-Navigation internet
Data format: NetCDF, XML or other existing format
Notes: In Denmark, wind gust and swell is available from DMI (Danish Meteorological Institute)

<u>Zones and lines:</u>

Relevant zones and lines are presented on surface.
Reporting lines, VTS area, Traffic Separation Schemes (TSS), Nature Reserves, Anchorages, Port areas, Danger/restricted Zones, Shooting ranges, air draught reporting to Copenhagen Airport etc.

When vessel is passing reporting line report is send to relevant authority automatically.

Communication (active shooting ranges):
Communication path: Shore-ship
Data size: 200 bytes
Update frequency: When updates are available (every 4-6 hours) – only area around route. Continuous from waterlevel sensors – on request.
e-Nav level: All levels
Possible data carriers: e-Navigation internet
Data format: XML
Notes:

Communication (reports at reporting lines):
Communication path: Shore-ship
Data size: ?
Update frequency: When updates are available (every 4-6 hours) – only area around route. Continuous from waterlevel sensors – on request.
e-Nav level: All levels
Possible data carriers: e-Navigation internet
Data format: XML – maybe existing format?
Notes: Size and format? Further information needed

Functionalities

CPA/TCPA and collision avoidance tools (Trial maneuver):

Closest Point of Approach (CPA) and Time to Closets Point of Approach (TCPA) is shown on other vessels course lines/route lines. CPA/TCPA is calculated from both radar and AIS input.
If navigator is using trial maneuver function (maybe through activation of autopilot) the present CPA/TCPA is made transparent and trial CPA/TCPA appears and moves on course line following the course and/or speed change.
It is necessary to figure out if CPA point is linked to present course/speed of own and other vessel or to the vessels routes or both.

Trial maneuver function:

- Automatic by clicking riskmeter.
- Automatic by changing CPA/TCPA on screen
- Manual by changing course on autopilot (before accepting course change)

Automatic trial maneuver takes into account all relevant data, i.e. COLREG, depth, buoyage, other traffic, etc.

In aviation automatic collision avoidance systems are used. In case two planes are on collision course automatic systems on board the aircrafts “agree” on best maneuver to avoid collision and execute for both. It is possible for the pilot to override the automatic system.

Communication (back-up information for vessels systems):
Communication path: Shore-ship
Data size: 200 bytes
Update frequency: When needed.
e-Nav level: Confined waters
Possible data carriers: e-Navigation internet
Data format: XML
Notes:

<u>Risk assessment tool:</u>

International investigation shows that a large number of collisions and groundings happen due to human errors (up to 80%). In close to 50% of these accidents the navigator is not aware of the dangerous situation before time of collision/grounding or before vessel is so close to the accident that action is useless.
The risk assessment tool should check input from all electronic equipment like radar, AIS, echo sounder, ECDIS, etc. and alert the navigator if there is a risk of collision or grounding.
Present risk or alert level is presented on display and it should be possible to see which vessels and what areas with shallow water are causing an increase in risk.
A trial or automatic remedy tool should be included.

Communication:
Communication path: Shore-ship
Data size: 200 bytes
Update frequency: Continous update – every 4-5 seconds. If risklevel exceeds certain threshold.
e-Nav level: Confined waters (areas with VTS)
Possible data carriers: e-Navigation internet
Data format: XML
Notes:

<u>Efficiency Module:</u>

Data from agents, port authorities, customs, immigration, ISPS authorities, etc. are available on board.
Arrival notices from vessels are generated and send automatically.
Agents can update arrival time to make it possible for the vessel to reduce speed in time – will reduce fuel consumption, reduce time at anchor, reduce the risk of collision as vessels are berthing in one long sequence instead of several vessels waiting in the same area, etc.

Possibility of Automatic Route planning taking into consideration weather, current, regulation, vessels draft, tide, desired arrival/departure time, time for pilot boarding/berthing, etc.
Gives the navigator more time to navigate, makes it possible to use internationally accepted routes, easier ways of controlling traffic,

Communication:
Communication path: Shore-ship
Data size: ?
Update frequency: When updates are available (every 4-6 hours) – only area around route.
e-Nav level: All levels

Possible data carriers: e-Navigation internet
Data format: XML or other format
Notes: Size and format? Need further information!

Automatic and/or simplified exchange of administrative information:

Information for customs, port authorities, immigration, agents, etc. is send automatically before vessel arrival.
Vessel will fill in information in the system once. The necessary reports are generated from this.
The different shore based authorities share information to maximum extent.

Communication:
Communication path: Shore-ship, ship-shore
Data size: around 500 kbytes (may vary significantly)
Update frequency: When needed – not time critical.
e-Nav level: All levels
Possible data carriers: e-Navigation internet
Data format: XML - mails, forms and/or scanned documents
Notes:

VHF communication and identification:

By clicking on vessel or shore station on display communication link is established automatically.
When transmit button is activated onboard a vessel the vessel will be identified on ee-INS's on vessels in vicinity.
This could be obtained by sending MMSI when transmit button on VHF handset is activated.

When a vessel cross a reporting line or enters an area an automatic communication system could send a synthetic voice message on VHF to the navigator – e.g. when entering VTS area a welcome message including a description of services in the area could be send.

Communication:
Communication path: Ship-ship, Ship-shore, Shore-ship
Data size: 200 bytes
Update frequency: When handset used or information requested from other vessel.
e-Nav level: All levels

Possible data carriers: VHF, VHF-DSC
Data format: ?
Notes:

<u>Other interactive functions:</u>

<u>Pilot:</u>
It should be possible to book a Pilot by click on ee-INS display.
Information on arrival time is automatically transmitted to Pilot station. If there is changes in boarding time this is transmitted to vessel.
Pilot may change or accept boarding time and add information on pilot boarding position, wanted height and position of pilot ladder, boarding speed and other relevant information.
This will reduce the need for irrelevant vessel to pilot radio communication in a stressed arrival situation.
Information from pilot is read by navigator when needed.

Vessel is marked on display when pilot is on board – pilot flag on the 3D AIS model of the vessel.

Communication (booking and exchange of boarding information):
Communication path: Ship-shore, shore-ship
Data size: 2 kbytes
Update frequency: When needed
e-Nav level: All levels
Possible data carriers: e-Navigation internet,
Data format: XML
Notes:

<u>Report of problems with buoyage:</u>
The system has functionality to report problems with buoyage to responsible authority, e.g. unlit, off station, damaged, etc.
This function may not be necessary as buoyage may be monitored by automatic systems.

Communication:
Communication path: Ship-shore
Data size: 2 kbytes
Update frequency: When needed.
e-Nav level: All levels

Possible data carriers: e-Navigation internet
Data format: XML
Notes:

Harbour:

Vessels' arrival information is send automatically, e.g. booking of berth, mooring men, ISPS guards, etc.

Communication (Vessels' arrival information, booking of berth, mooring men, ISPS guards, etc.)
Communication path: Shore-ship, ship-shore
Data size around 500 kbytes (may vary significantly)
Update frequency: When needed
e-Nav level: Available in all levels – not time critical
Possible data carriers: e-Navigation internet
Data format: XML - mails, forms and/or scanned documents
Notes:

Other e-Navigation issues

S-Mode:

S-mode, as suggested in several IMO documents, is introduced.
The concept of S-mode and the level of complexity are to be investigated and defined.
It is important that standards for S-mode are not too basic and too far from what the industry is able to do.
If the S-mode display is very different from the display normally used the S-mode function will be useless.

Navigators and pilots may have a personal dongle where preferred setting of displays and instruments are stored. Dongle is loaded when taking over the watch and displays go to preferred mode and setup.

Position Fixing:

More than one position fixing system is to be used and a high level of redundancy is needed as own vessels position is the most important information to the navigator.
Existing electronic systems may be supplemented by a system doing automatic radar range/bearing to preconfigured radar conspicuous objects.

ee-INS display issues - Menus:

Placement of menus has to be considered. Should menus stay in right side or in bottom of display as on ECDIS displays today or could some information be moved to pop-up windows or be replaced by graphic presentation on display?
Menu may become visible when marker is moved to side of screen like Windows tool bars.

Integrated intelligent alarm system:

Integrated intelligent alarm systems may be necessary to avoid information overload.
For instance the beep alarms could be replaced by voice alarms – e.g. BEEP!: CPA to [Vessel name] 0,3 nm in 5 minutes.

Display modes:

Idea is to display information relevant to the task:

- Planning
- Navigation
- Approach
- Harbour
- Anchoring
- Weather

Planning mode:
Planning (automatic?) taking into account:

- Weather
- Current
- Draft restrictions, Under Keel Clearance (UKC)
- Rules and regulations, e.g. Traffic Separation Schemes, Nature reserves, special regulations for tankers, etc.
- Congestion in port of arrival
- Recommended routes (corridors as known from aviation may be introduced)

Navigation mode:
Display setup and information shown relevant to navigation.

Approach mode:
Information relevant to maneuvers in more confined waters is shown.

Harbour mode:
Information relevant for berthing and navigation in very confined waters, e.g. the SSPA Dynamic Predictor, is shown.
View is changed to detailed 3D presentation.
The winds effect on vessel is calculated from draft and input from cargo on deck.

Anchor mode:
Vessel going to anchor gets relevant information for this operation. Detailed bottom view, current, wind, other vessels estimated departure time, detailed information on wrecks, lost anchors and other obstructions in the area, etc.

Weather mode:
Detailed weather information is available.
Analysis, forecasts and warnings are linked to vessels route and progress in navigation.

Ideas for VTS

CPA/TCPA and Collision avoidance tools:

CPA and TCPA are shown on vessels course lines/route lines.

Exchange of routes:

VTS Centers receive routes from vessels on their display and VTS operator may send route suggestions to vessels as well as suggestion to change speed.

Search and Rescue Coordinators may send search areas and search patterns to participating vessels. At the same time a geographic presentation will give an overview of areas still to be searched.

VHF identification and communication:

When transmit button is activated onboard a vessel the vessel will be identified on VTS operators display. This could be obtained by sending MMSI when transmit button on VHF handset is activated.

Connection to vessels is obtained by clicking the vessel on the display.

When a vessel cross a reporting line or enters an area an automatic communication system could send a synthetic voice message on VHF to the navigator – e.g. when entering VTS area a welcome message including a description of services in the area could be send.

Risk assessment tool:

A system giving VTS operator information on present and future risk level. Risk includes risk of both collision and grounding. It should be possible to see which vessels and what areas are causing an increase in the risk level and a trial or automatic remedy tool should be included.

SSPA Dynamic Predictor (SHIP AND VTS):

The predicted track from the Dynamic Predictor onboard vessels are send to the VTS center to give the operator an idea of intentions and make it possible for the operator to see if vessels are maneuvering or keeping course and speed. Important information in close quarter situations and when maneuvering to avoid collision.

Other e-Navigation services

Other than INS or VTS features.

AIS on AtoN's

Mounting AIS transponders on AtoN's will give a number of possibilities:

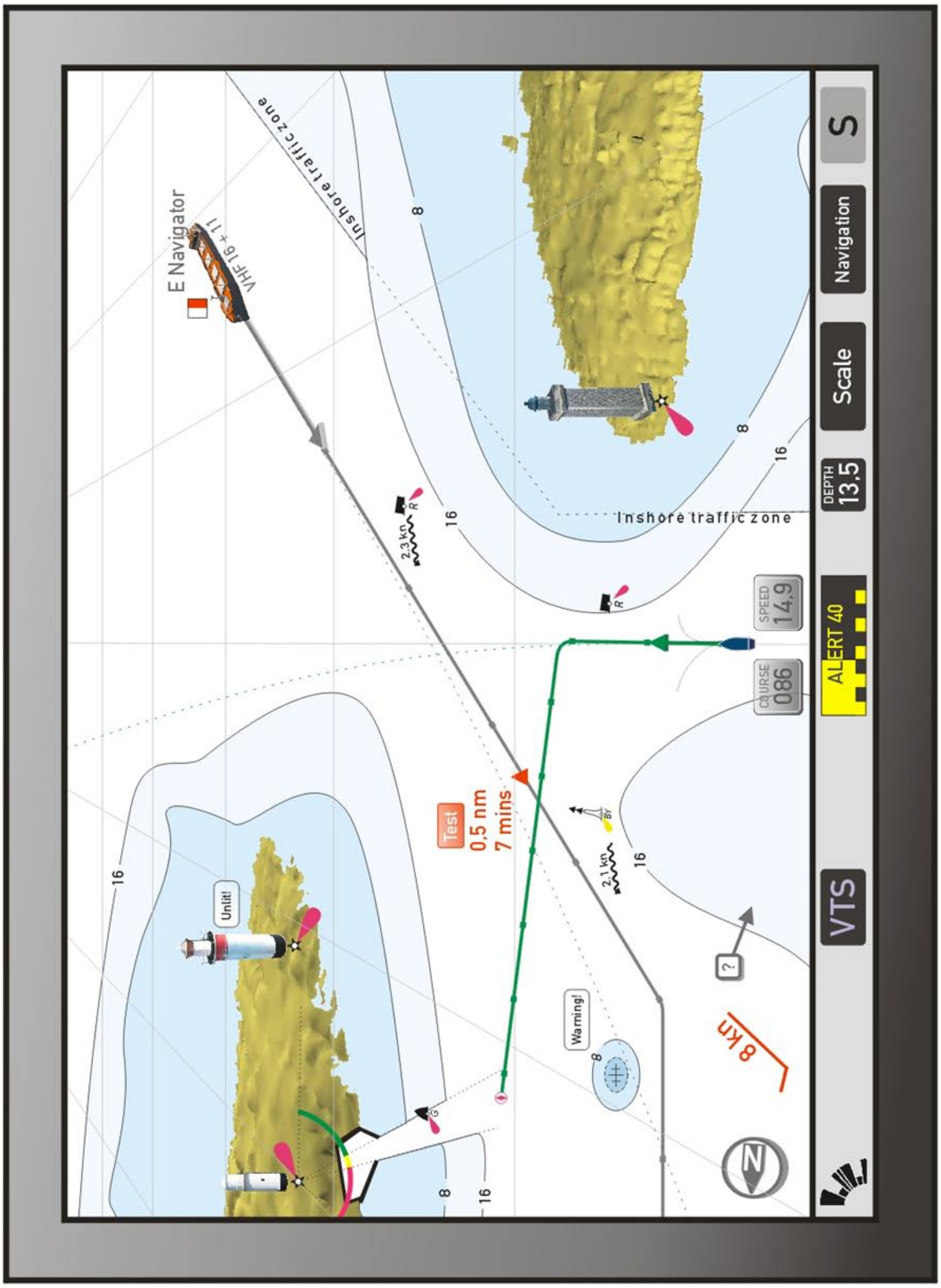
They will be visible as AIS targets on instruments capable of displaying such

METOC sensors on the AtoN will be able to transmit data to shore and possibly to ships by means of AIS

Other data may be transmitted using the AtoN as a "middle station

Diagnostic messages from light on AtoN and different measuring devices can also be transmitted to shore

Appendix A – Mock-up, example 1



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Appendix B – Mock-up, example 2