MASS Nav PT Work package 2-6 report template

Member State: Denmark, Danish Geodata Agency

WP2: Identify and report what test bed activities are happening in each member state's region and which degree of autonomy is predominantly used.

The list of current and recent activities in Danish waters.

Number	Name	Degree of Autonomy	Relevant for the report Y/N
1	Remote Controlled minor working vessel. - TUCO Yards, Faaborg & Sea Machines, USA, 2017-2018	2	No
2	Remote Controlled Tug vessel, Port of Copenhagen – SVITZER, 2018-2021	1/2	No
3	Autonomous Drone in Svendborg. Unmanned survey vessel – DanaDynamics, 2019-2021	4	Yes
4	Electronis lookout. Two ferries has been used as test vessels – Ærø ferry & Skarø/Drejøferry 2017-2018	1/2	No
5	"Cyber resilient Navigation for Highly Automated Surface Vessels". Technological University of Denmark and Danish Maritime Authority - Faaborg Fjord, 2020-2021	N/A	No
6	Autonomous Ferry "Fjordbussen" across Limfjorden, Aalborg - Center for Logistik og Samarbejde, 2019-2021	4	Yes
7	SeaMachines - Mission around the Danish Waters, september 2021	2/3	No
8	Test by land based pilotage by drone in Nyborg Fjord – DanPilot, 2019-2020	1	

Relevant comments from report published by Danish Maritime Authority related to this report.

- The four grades of autonomy are perhaps too few. The report suggest six grades of autonomy combined with four ways of reaction for the navigator.
- Fully autonomous vessels are for now on realistic in very simple cases – there will still need to be some form of human control in some grades of autonomy. The report mentions that small channel crossing ferries, service vessels for offshore platforms or barges more easily can be fully autonomous.

- Two of the biggest problems for full autonomy are potential errors in predicting other ships movements and irregular action by other ships. In the past research about creating a COLREG algorithm have been tried without success, and since there has not been a breakthrough in the development.

WP3: Report on what data MASS operators and MASS navigation systems are using today in each member state's region.

Regarding navigation, MASS developers use the usual navigation data such as ECDIS (ENC S-57). Some developers use raw bathymetric data. The raw bathymetric data is being converted into 'GO/NO-GO' areas where the ship can maneuvers within.

In addition to data provided by the Hydrographic Offices, a several different electronic optics are used. Here among IR optics, RADAR, LIDAR etc. The sensors are used to detect objects on the water surface. The objects are then correlated with objects (AtoNs) in the ENCs if possible. Then an analysis and calculation of maneuverability can be made in relation to COLREG but also in relation to the surrounding waters.

For situational awareness, AIS and radar are used to determine the movements of other ships, which is used to calculate maneuverability.

Regarding the use and usage of data and sensors, attention should be directed to the following link were Technical University of Denmark collect their reports on Autonomous Ship development and testing results:

https://www.researchgate.net/project/Autonomous-marine-surface-vessels-ShippingLab-Autonomy

A project plan and some results about the MASS development I Denmark can be found on:

https://shippinglab.dk/

As previously mentioned, the Technical University of Denmark has an important role in much of the development on going in Denmark. Much of their work is open source and can be read online. Through the attached links, you can read, among other things, how the S-57 DEPARE is automatically read and corridors are created for sailing. Subsequently, AIS tracks from ships with the same draft is added to the corridors, and so an optimal route can be planned.

Have any data limitations been identified?

It is already a fact that data for autonomy sailing must be of better quality or resolution than the S-57 data. This is especially relevant when autonomous ships are intended to operate or navigate close to shore, in ports or in areas where the under keel clearance is small.

WP4: Report what navigational data each member states' regulators (e.g. MCA in the UK) are specifying should be used for MASS navigation in either trials or operations of MASS.

The Danish Geodata Agency is not responsible for issuing regulations for autonomous shipping. This responsibility lies with the Danish Maritime Authority.

For now, there are no separate data requirements for autonomous ships compared to non-autonomous ships.

WP5: To what degree are member states Hydrographic Offices involved in MASS trials or operations and what data are they currently providing.

The Danish Geodata Agency is not deeply involved in MASS trials and development. The primary contribution is bathymetric data and ENC's (S-57). However, the Danish Geodata Agency works closely together with the Danish Maritime Authority and the Technological University of Denmark, especially on sparring and guidance in the use of hydrographic data.

Have any data limitations been identified?

Our bathymetric data and ENC's are not always adequately for the trials purpose.

WP6: Report on what trailing has been done with new navigation standards (e.g. S100) for MASS, or what research into machine readable data has been carried out in each member state's region.

Nothing to report.