MASS Nav PT Work package 2-6 report template

Member State: Norway

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

Much work is being done in Norway related to the development and testing of autonomous vessels an associated infrastructure

Test Areas:

Five test areas have been established in Norway:

1. Trondheim's Autonomous Vessel Test area: Worlds first established in 2016
2. Ålesund –Storfjorden
3. Horten
4. Haugesund – Newest opened in August 2021
5. Tromsø- Arctic University of Norway Project.

Aims

- To be used in the development of autonomous vessels.
- Facilitate knowledge gathering.
- Stimulate the development of new technology and innovation.
- Develop rules and standards for autonomous vessels.
- Test and verify solutions and concepts.
- Collaborate with other test areas and initiatives.

Projects:

IMAT – Integrated Maritime Autonomous Transport Systems Project

- 3-year Project (2019-2022) funded by the Norwegian Research Council
- Partners, Kongsberg, Massterly, NTNU, Sintef Ocean.
- The main project objectives are to define, develop, adapt and test infrastructure that supports maritime autonomous transport systems and has the following focus areas:
  - Sensor and communication infrastructure
  - Local Monitoring Centre (LMC)
  - Shore Control Centre (SCC)

    - Collaboration
- Project Paper

AutoSea

- Main goal of the project is to develop methods for guidance and navigation of autonomous ships. A central component of this is collision avoidance, also known as sense-and-avoid.
- Sensor fusion and collision avoidance for MASS.
- Technology developed and used as foundation for Autoship project.

AUTOFERRY -Autonomous all –electric passenger ferries for urban water transport

- Project aiming to develop small autonomous passenger ferries for use in urban water transport.
- Predicts that the 'Captain' will be just as important as with manually controlled ships' – the job will just look a bit different.
- Working on developing 'Shore Control Lab' for use in remote operations.
- Mission: 'keep humans in the loop.
- **Focus on Autonomy Grade 3**

NAVISP –Navigation Innovation and Support Program

- Project financed by the European Space Agency (ESA).
- Investigating ways to improve Satellite navigation, alternative position and new navigational service and applications.
- Positioning sensors, satellite navigations and Artificial Intelligence used to help establish the Trondheim Autonomous Vessel Test area.
- Final presentation of project 28.2.2022.

Hull –to-Hull Project (H2H)

- Project ran 2017-2020
- Cconcepts of hull to hull positioning and uncertainty zones used to assist navigators and operators to perform safe navigation.
- Data from position sensors and geometry (2D/3D) shared between vessel's/land to help calculate distances between objects and avoid collisions
- The concept will support safe navigation of vessels and objects which are in close proximity of each other. H2H will assist mariners in making correct navigation decisions.
- Data exchange protocols will be based on IHO S-100 Standards

Vessel Testing:

Unmanned Surface Vessels (USVs) - Maritime Robotics

- Being trialed in Trondheim's test area
- *The Otter* – Portable USV solution
- Remotely controlled from either the vehicle Control Station (VCS) or mobile phone app – **Autonomy Grade 3**
- *The Mariner* Larger multipurpose USV system

- Remotely operated from the VCS which features electronic charts, engine and navigation info. The operator can monitor the surrounding sea areas and get collision avoidance warnings based on AIS, radar and video information.

Autonomy Grade 3

Ocean Space Drones 1 & 2

- Unmanned vessels equipped with ECDIS, Radar GNSS, AIS camera, VHF, MBR (Communication)
- Used for testing Collison avoidance systems.
- **Autonomy Grade 3**

Yara Birkeland

- World first fully electric autonomous container vessel.
- Will be put into operation 1st April 2022
- Initially it will start a two-year trial to become autonomous and certified as an autonomous, fully electric container vessel. Before it is put into operation,
- First phase of testing will include a degree of autonomy 'auto docking' and 'auto crossing' but crew on board – **Autonomy Grade 1-2**
- 2024/25 – aim to be fully unmanned and remotely operated – **Autonomy Grade 3**

Asko Autobarge

- Unmanned electric barges being developed by Kongsberg Maritime
- Same timeline as Yara Birkeland:
- First phase of testing will include a degree of autonomy 'auto docking' and 'auto crossing' but crew on board – **Autonomy Grade 1-2**
- 2024/25 – aim to be fully unmanned and remotely operated – **Autonomy Grade 3**

Zeabuz in collaboration with NTNU

- MilliAmpere Project - 2 x Autonomous and electric passenger ferries.
- Vessels to be put into public operation in 2022.
- **Autonomy Grade 1-4**

Reach Remote

- Project focusing on developing autonomous and remote solutions for offshore operations.
- Testing of Reach Remote Unmanned Surface Vehicles (USVs) began in 2021 expected delivery of first two vessels 2023
- **Autonomy Grade 3**

General comments from interviews:

- "Autonomous does not mean without human interaction"
- The four grades of autonomy are perhaps to narrow.
- Fully autonomous vessels are unrealistic except in very simple cases – there will still need to be some form of human control to differing degrees.
- Two of the biggest problems for full autonomy are potential errors in predicting other ships movements and irregular action by other ships.
- Much of the testing has focused on a mixture of grades of autonomy- different degrees at different stages of voyage with a focus on achieving autonomy grade 3.

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

1. Traditional navigation sources are being used for route planning and route monitoring from control centres – ECDIS, ENCs Paper charts (in some cases)
   - RTZ recommended routes and fairways published by Coastal administration

2. Key focus on the real time data from:
- AIS Data Bank
- ATONS
- DGNSS
- GNSS
- Rader
- Weather Data

3. Also key focus on development and use of sensors to provide situational awareness and avoid collisions.

Have any data limitations been identified?

- Need for full bathymetric coverage datasets/DTM
- Need for a better standardisation and accessibility to harbour infrastructure datasets.

WP4: Report what navigational data each member states' regulators are specifying should be used for MASS navigation in either trials or operations of MASS

The Norwegian Maritime Authority and The Norwegian Coastal Administration are jointly responsible for regulating both the trials and operation of MASS in Norway.

A formal regulatory framework in in the process of being prepared in tandem with the relevant testing activities taking place.

Navigational data requirements are the same as non-autonomous vessels.
-ENCs/ECDIS
-AIS
-VTS
- Coastal administration has created a network of 'Recommended Sailing Routes' for Norway these are available in RTZ format and are used in testing activities.

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

The Norwegian Hydrographic Service has been following developments in MASS in Norway very closely and is an active member of several groups including:

- ISTS Norway – Intelligent Sea Transport Systems Norway
- NFAS – Norwegian Forum for Autonomous Shipping

NHS is not currently not providing any additional data to that already available but have begun discussions to determine specific user needs and to determine if we can begin to supply test data.

- Have established a production system for HD ENCs and S-102 for selected harbours and it is believed these products will assist MASS testing.
- Also, in process of establishing S-111 production.
- In addition, we have worked to improve the quality of data in or ENCs covering the recommended routes determined by the Coastal Administration.

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.

S-100 Demonstrator Project

- To define how the new standards combined can create value for the maritime industry
- How new and improved products can be designed and developed based on the new standards.
- Focus on the use of:

    - S-101 (ENC)
    - S-102 (Bathymetry)
    - S-104 (Water Level information)
    - S-111 (Surface Currents)
    - S-129 (Under Keel Clearance Management)

- Autonomous shipping will rely on precise secure and official data combined with local sensor defined information to secure safe and precise operations and voyages.
- Through the S-100 demonstrator project ECC is developing an effective S-100 data delivery service that can support autonomous navigation.

S-100 Demonstrator Project Link

-