MASS Nav PT Work package 2-6 report template

Member State: Canada

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

- Canadian Hydrographic Service (CHS) procured 4 Autonomous Hydrographic Surface Vehicles from Searobotics (2.5m) (2 in March 2017, and 2 in March 2018).
    - 2 are fully active and integrated in CHS data acquisition processes.
        - Degrees 1 to 3 of autonomy: pre-planned survey autonomy, assisted, and real time fully controlled. No use of S-100 data for navigation, the only incoming real-time data used is related to detection of obstruction around the vehicle (lidar/camera).
        - An interesting feature: the bathymetric acquisition module allows for input from acquired data to update survey plan (limited artificial intelligence).
- CHS converted one survey launch (8m) to a dual-manned/unmanned mode (Autonomous Hydrographic Survey Launch) with technology from ASV Global (June 2017).
    - Degrees 1 to 3 of autonomy: pre-planned survey autonomy, assisted, and real time fully controlled. Lots of issues, not efficient technology because bathymetric equipment and navigation controls do not interact. High logistical burden. No use of S-100 data for navigation, the only incoming real-time data used is related to detection of obstruction around the vehicle (lidar/camera/radar).
    - CHS was never permitted to use the AHSL in full unmanned mode (always 2 people on board) due to legislation restrictions and lack of confidence in the system.
    - Supplementary financing and human resources were required to exploit and experiment but never awarded.
    - Due to system faults, the unmanned module was removed from launch in 2021.
- CHS contracted out 1 survey in Ontario (CSMart 2020), AHSV type (autonomous survey and/or partially controlled remotely, degrees 1 to 3 of autonomy). No use of S-100 data for navigation.
- CHS produces S-102 data (S-104 & S-111 to come) in specific areas:
    - St-Lawrence River test bed with Corporation of Lower St-Lawrence pilots: No navigation autonomy, just integrating dynamic S-100 data in Portable Pilots Units (SEAIq). Interaction with water levels through API. Data available : https://cartes.gc.ca/data-gestion/index-eng.html#s100

    - In collaboration with PRIMAR, Teledyne CARIS and SEAIq, there is an opportunity to test S-100 Products for a 3-month free trial period. In 3 areas: Vancouver Harbour, St-Lawrence river and St-John Harbour : https://www.primar.org/#/S-100
- CHS St-Lawrence channel virtual surveys:
    - No autonomy (launch staff on board, but hydrographers are virtual)
    - surveys are conducted partially in virtual mode. Either bathymetric data acquisition and/or processing is done virtually.
    - Communication links are tested as well as processes: Real-time Remote interaction access to network/computer/equipment.
- S131: digitization of port infrastructure and logistical information: upcoming projects with port of Montreal, Halifax and Vancouver. Canada will also finance IHO NIPWG project. No autonomy : development of technologies, data structuration.
- Canadian Coast Guard E-NAV infrastructure in development:
    - No degree of autonomy envisioned, but centralize all information required for navigation safety. (S-200, S-400, S-100)
- Cyber Security Research for MASS, Memorial University
  Computer Security & Cybersecurity | Research | Faculty of Engineering and Applied Science | Memorial University of Newfoundland (mun.ca)
- Intelligent Maritime Corridors International Council: offers a structure solution path by creating an ecosystem of research and innovation and particularly a promising avenue for development in the Quebec part of the St Lawrence commercial corridor and the Great Lakes system. Collectively working at developing it as a high-performance innovation zone for next generation of ships and testing them on short sea shipping routes.
- Canadian National Research Centre sponsors several projects for the development of technologies related to MASS:
    - Use of Machine Learning for Identification and Characterization of Vessel Operational Best Practices
    - Digital Twin Technology for Autonomous Operation in Harsh Environment
    - Prediction of Ice in the St. Lawrence Waterway Using Artificial Intelligence
    - Ship Situational Awareness in Ice
    - St. Lawrence Seaway Autonomous Marine Testbed
    - Extension of Driving Automation Research Activities at NRC to the Marine Use Ca
- Canadian MASS Interdepartmental Working Group: trying to establish test bed areas/sites for (physical) experimentation and testing of autonomous technologies
- Canadian S-100 Interdepartmental Working Group: regroups all federal departments responsible for S-100 data stream production and development.
- Companies, organizations:
    - CSmart- bathymetric data acquisition with small launches
    - ALGOMA Central :introducing automation to their Lakers
    - Robert Allen: automation to their fireboat
    - Memorial University: autonomous small vessel procurement
    - University of British Columbia: autonomous sailboat procurement

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

- CHS is producing S102 data (S104-S111 to come): WP2
- CHS St-Lawrence channel virtual surveys: WP2
- S131: WP2
- Canadian Coast Guard ENAV infrastructure in development: WP2

Have any data limitations been identified?
Software development is slow and often needs to be financed by government $, interoperability of data streams is lacking, availability of data streams requires high bandwidth, data is not always up to date (ex: chart updates).

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.

- Policy on the Oversight of Small Maritime Autonomous Surface Ships (SMASS policy) sets requirements for vessels:
    - not more than 12 metres in length as defined in the Small Vessel Regulations, or not more than 15GT
    - Remotely controlled (level of autonomy 3 as defined by IMO)
    - The policy does not apply to MASS that have crew on board or that are tethered to a mother vessel or a shore install
    - Policy highlights:
        - Vessel to be fitted with a Class A or B AIS system
        - SMS for the control centre
        - Collision avoidance, surveillance, communications and operating systems
        - Emergency pollution response plan
        - Sufficient liability insurance coverage
        - Towing plan
        - Remote control centre staffed at all times with a qualified person
        - Risk analysis

- Small MASS, including pleasure craft, of not more than2 metres in length and 100 kg displacement must:
    - Be operated within sight
    - During daylight and good visibility
    - Means of towing in place
    - PCO competency or higher
    - Registered and marked
    - Be operated away from other vessels or persons, outside of prohibited navigation areas
    - Not contain any pollutants

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

- Canadian MASS Interdepartmental Working Group :
    - Regroups Canadian governmental departments, agencies, + partners
    - create a technology roadmap for enabling MASS in Canadian waters,

    - coordinating all MASS-related research and activities,
    - develop a multi-party project to increase enabling MASS technologies created in Canada,
    - establish Canada as the global leader in testing and evaluation of MASS technology.
- Canada is targeting smaller vessels (e.g.: fishing boats, tugs…), and targeting the development of enabling technologies (under the blue economy program umbrella: Clean, Quiet and Connected)
- The Facility for Intelligent Marine Systems (FIMS):
    - federal collaboration between the Department of Fisheries and Oceans (DFO), Natural Resources Canada and Defence Research and Development Canada/Department of National Defence. Located in Dartmouth, Nova Scotia.
    - Leverage Government of Canada's infrastructure, equipment and resources from multiple Science based Departments and Agencies (SBDAs) to achieve real property efficiency, collective opportunities and scientific synergies in supporting government funded marine science programs.
    - Will support the use of state-of-the-art unmanned surface and underwater data collection platforms and nurture the development and testing of new systems to observe Canada's marine environment (e.g., Unmanned Underwater Vehicles, Unmanned Surface Vehicles, gliders, and moored and floating sensor arrays).

Have any data limitations been identified?
No early stage only

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.

- Projects with pilotage corporations and different research projects from CNRC (very early stage and pre-MASS)

Have any data limitations been identified?

Comments from pilots: Systems and protocols are not yet interoperable. The communication infrastructure necessary to sustain data exchange is not reliable and affordable. The GAP is huge and not addressed properly by legislators and technology providers yet.