SINTEF

imat

Integrated Maritime
Autonomous Transport Systems

Integrated Maritime Autonomous Transport Systems

Kay Fjørtoft, SINTEF Ocean

massterly
a Kongsberg Wilhelmsen joint venture

KONGSBERG

SINTEF

NTNU

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Integrated Maritime
Autonomous Transport Systems

The main purpose is to define the minimum shore-based infrastructure, in order to conduct safe and cost effective integrated maritime transport operations.

Project focus areas:

- ❑ Verification and integration of land-based sensor data with sensor data from autonomous vessels.
- ❑ Adaptation of land-based surveillance technology for data fusion and automatic transfer of navigation data between infrastructure installations, control centres and vessels.
- ❑ Ensure the human-in-the loop when implementing new technology.
- ❑ Standardization of messages and technology, interaction procedures, robust technology for digital information exchange between the systems and parties.
- ❑ Development of new guidelines for interaction, new regulations and standards for information exchange.

massterly a Kongsberg Wilhelmsen joint venture · KONGSBERG · SINTEF · NTNU

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Autonomous Transport Systems

SINTEF Ocean in brief

- Part of SINTEF, with more than 2000 employees
- SINTEF Ocean have about 370 employed
  - Energy and Transport
  - Seafood technology
  - Environment and new resources
  - Ship and ocean structures
- Main office in Trondheim Norway, but also located in Ålesund, Tromsø, Hirtshals, Oslo, Bergen and Frøya
- One of the pioneers within autonomous shipping. Are currently leading the NFAS and INAS forums.

World leading laboratories

Ocean laboratory

Plankton centre

Towing tank

Oil laboratory

Robot laboratory

Full scale aquaculture site

Flume tank

Construction lab

Research for ocean industries

Aquaculture

Maritime

Bio marine resources

Oil and gas

Process industry

Environmental technology

Fisheries

Offshore wind

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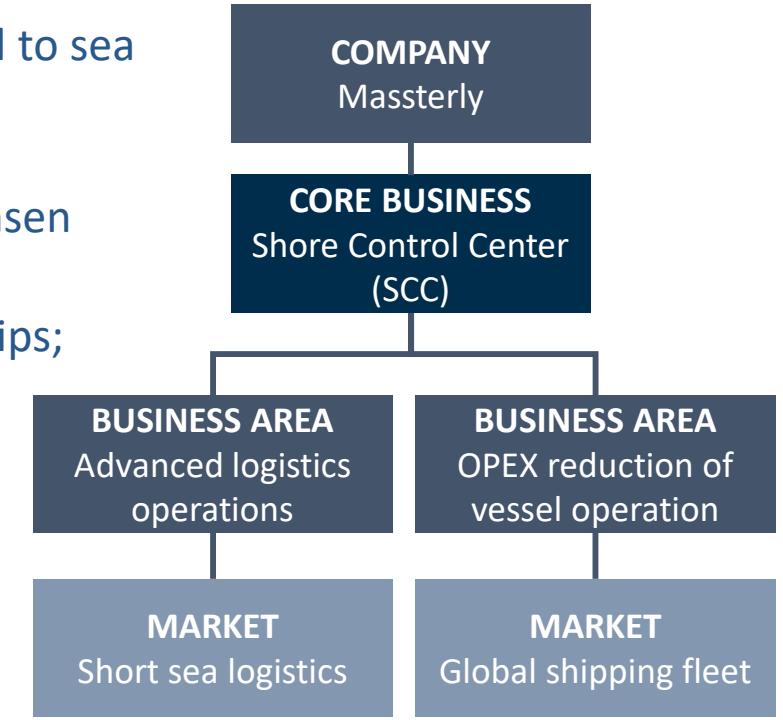
Integrated Maritime Autonomous Transport Systems

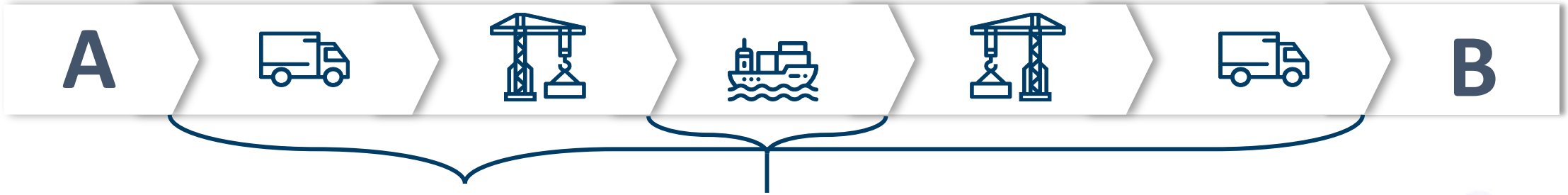
Massterly in brief

The world's first company set up to operate autonomous vessels

- We deliver environmentally friendly logistics enabling the shift from road to sea
- 50/50 joint venture between the leading maritime technology provider Kongsberg Maritime and the strong shipping and logistics group Wilhelmsen
- Service offering for the customers' entire value chain for autonomous ships; from vessel design and approval from all authorities, to control systems, logistics services, vessel operations, insurance and financing
- By leveraging our two owners' strong organizations we offer the skills, resources and experience needed to provide a full-service offering



Massterly scope for different short sea customers:



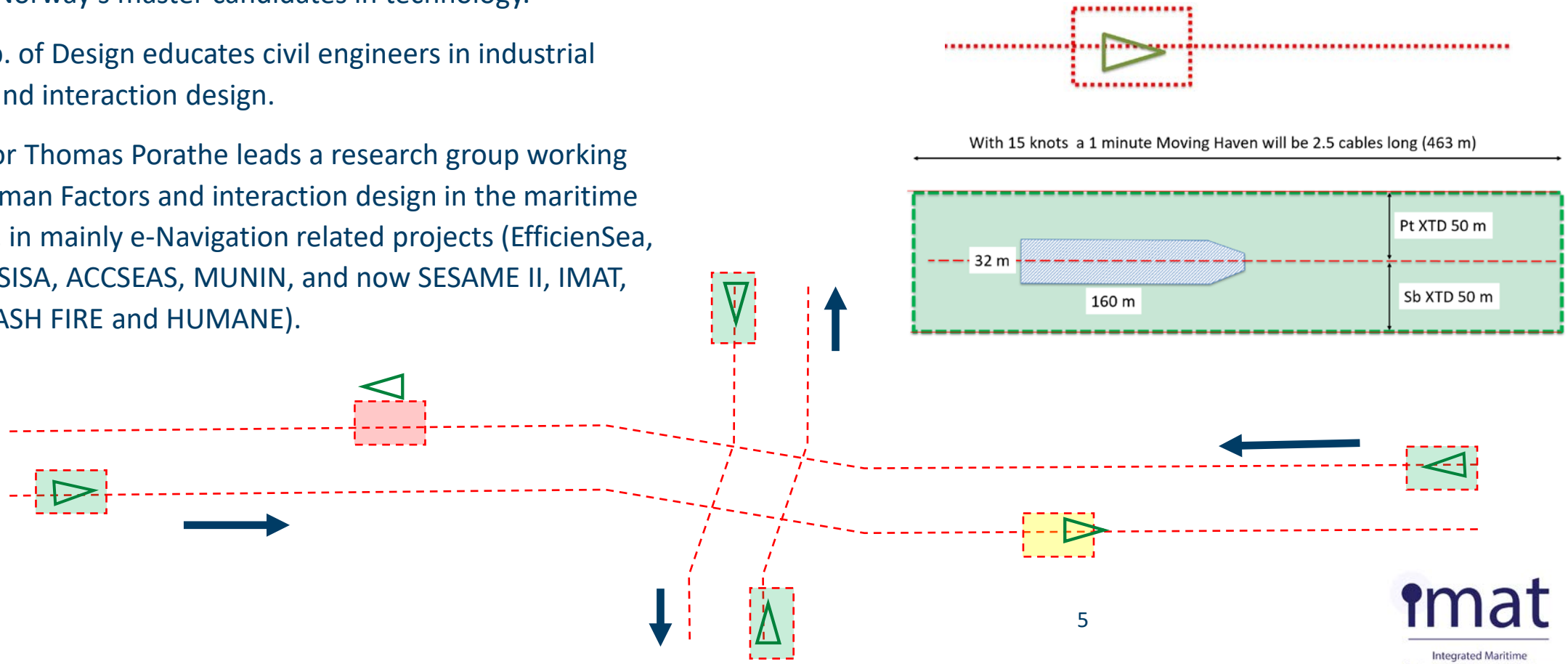
NTNU in brief
Norwegian University of Science and Technology

NTNU is Norway's largest university with 42.000 students. Specialization in technology and the natural sciences. 75 per cent of Norway's master candidates in technology.

The Dep. of Design educates civil engineers in industrial design and interaction design.

Professor Thomas Porathe leads a research group working with Human Factors and interaction design in the maritime domain, in mainly e-Navigation related projects (EfficienSea, MONALSISA, ACCSEAS, MUNIN, and now SESAME II, IMAT, LOAS, LASH FIRE and HUMANE).

Route exchange, intended routes, suggested routes, and for STM "**Moving Havens**"



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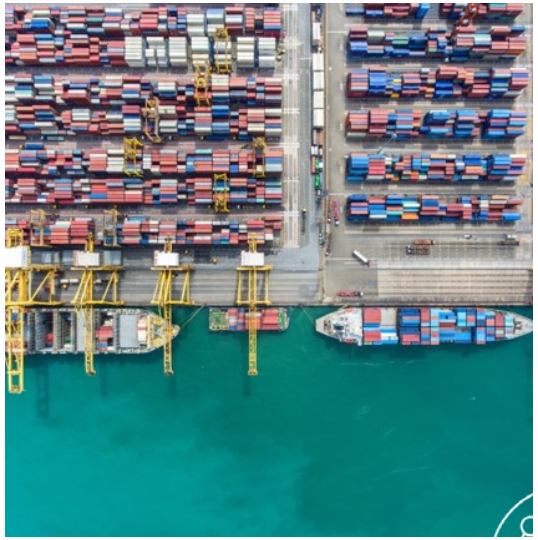
Kongsberg Norcontrol in brief

- Ports & harbours
- Coastal & EEZ
- Oil & gas / renewables
- Inland waterways



- Decision Support
- Information Management
- Design and Operation of Shore Centres
- AIS Network
- Radar Extractor and Tracker

Kongsberg Seatex in brief

KONGSBERG

Kongsberg Seatex develops and supplies products and solutions for

- **accurate positioning,**
- **communication,**
- **motion measurement**
- **and situational awareness.**

The products and solutions are used for applications such as navigation and manoeuvring, offshore oil and gas, marine seismic, hydrography, surveying, maritime transport, autonomous ships, as well as communications and positioning infrastructure and NewSpace satellite payloads for maritime applications.

- **Established in 1984**
- **Situated in Trondheim**
- **120 employees**
- **Owned by Kongsberg Maritime**

Dynamic Positioning Reference Systems

Attitude Determination Systems

Communication Solutions

Sensor Solutions Autonomous Vessels

Marine Seismic Positioning and Control

Space related activities

Navigation and Infrastructure

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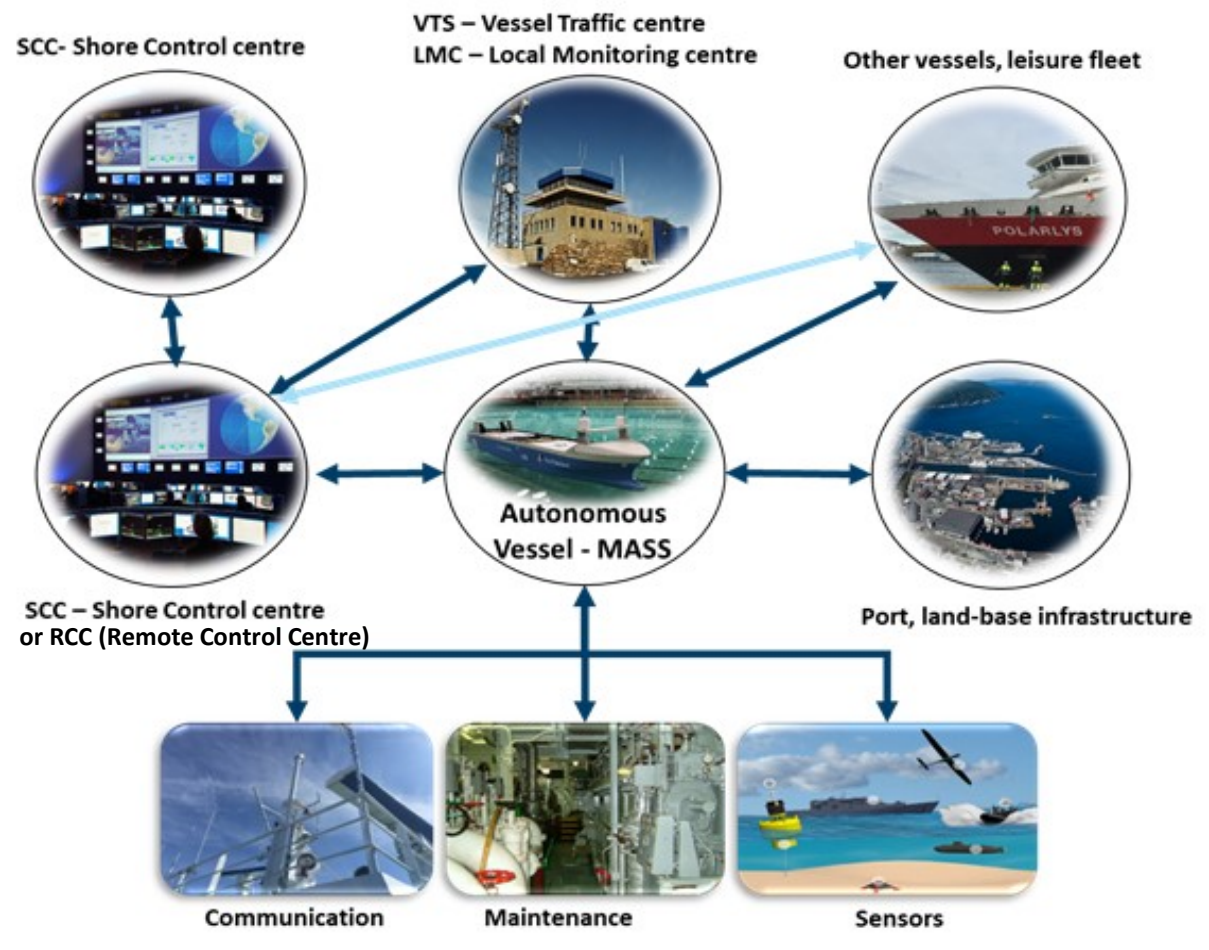


⇒ *It is about the transport system, not only the vessel*

⇒ *Autonomous shipping needs digital infrastructure*

⇒ *Autonomous shipping must be safer than conventional*

⇒ *The humans must be is in the loop*

⇒ *An autonomous vessel has nothing to do in a "stupid" infrastructure that can not support operations*

Introduction to the IMAT concept

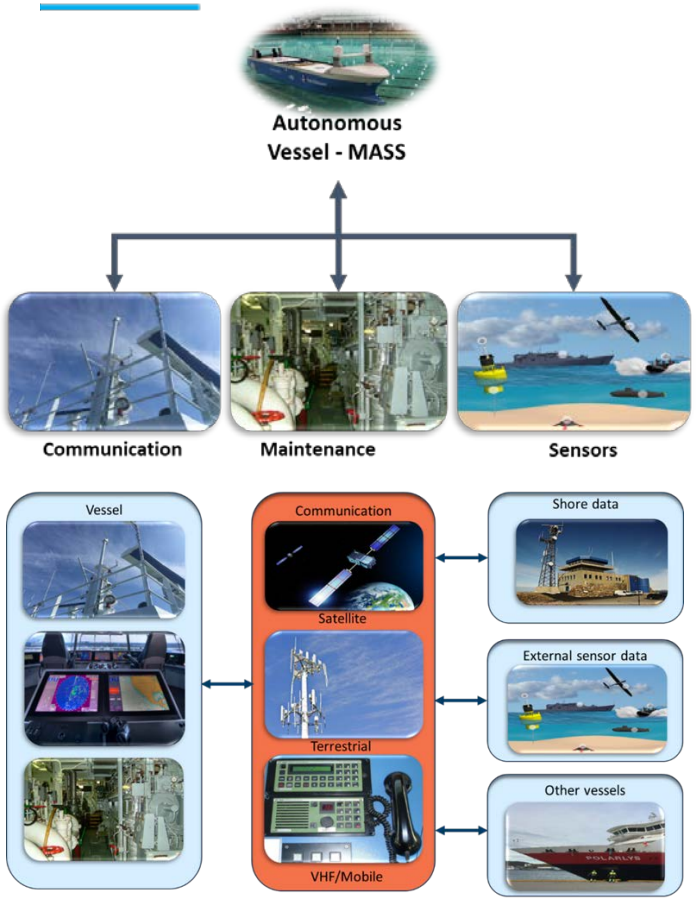
Integrated Maritime
Autonomous Transport Systems

1. Sensors and communication infrastructure
2. Local monitoring and information Centre
3. Shore Control Centre
4. Collaboration

"A fully autonomous vessel will be without crew on board. How can we operate a MASS as good as, or even better than a conventional vessel with crew and how can land based infrastructure assist?".

Integrated Maritime
Autonomous Transport Systems

Sensor and communication infrastructure



- Sensors
  - On board the vessel
  - Sensor infrastructure
- Communication
  - On board the vessel
  - With other vessels
  - With the infrastructure
  - With the Control Centre

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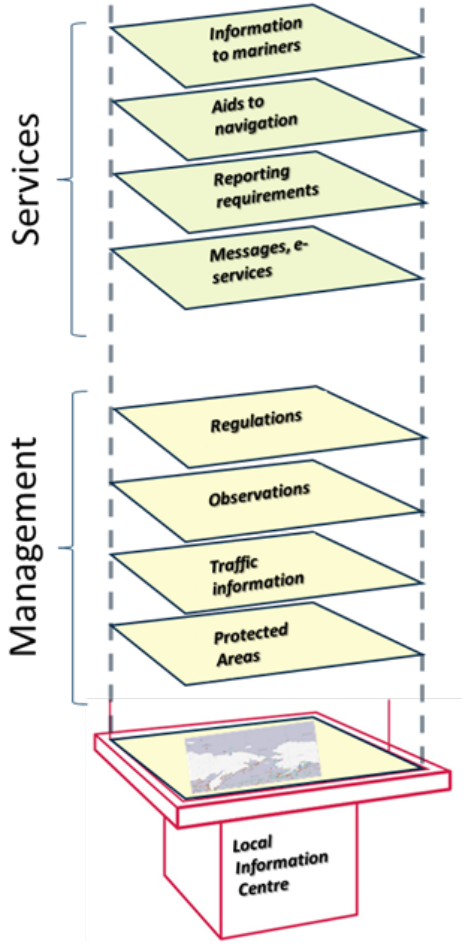
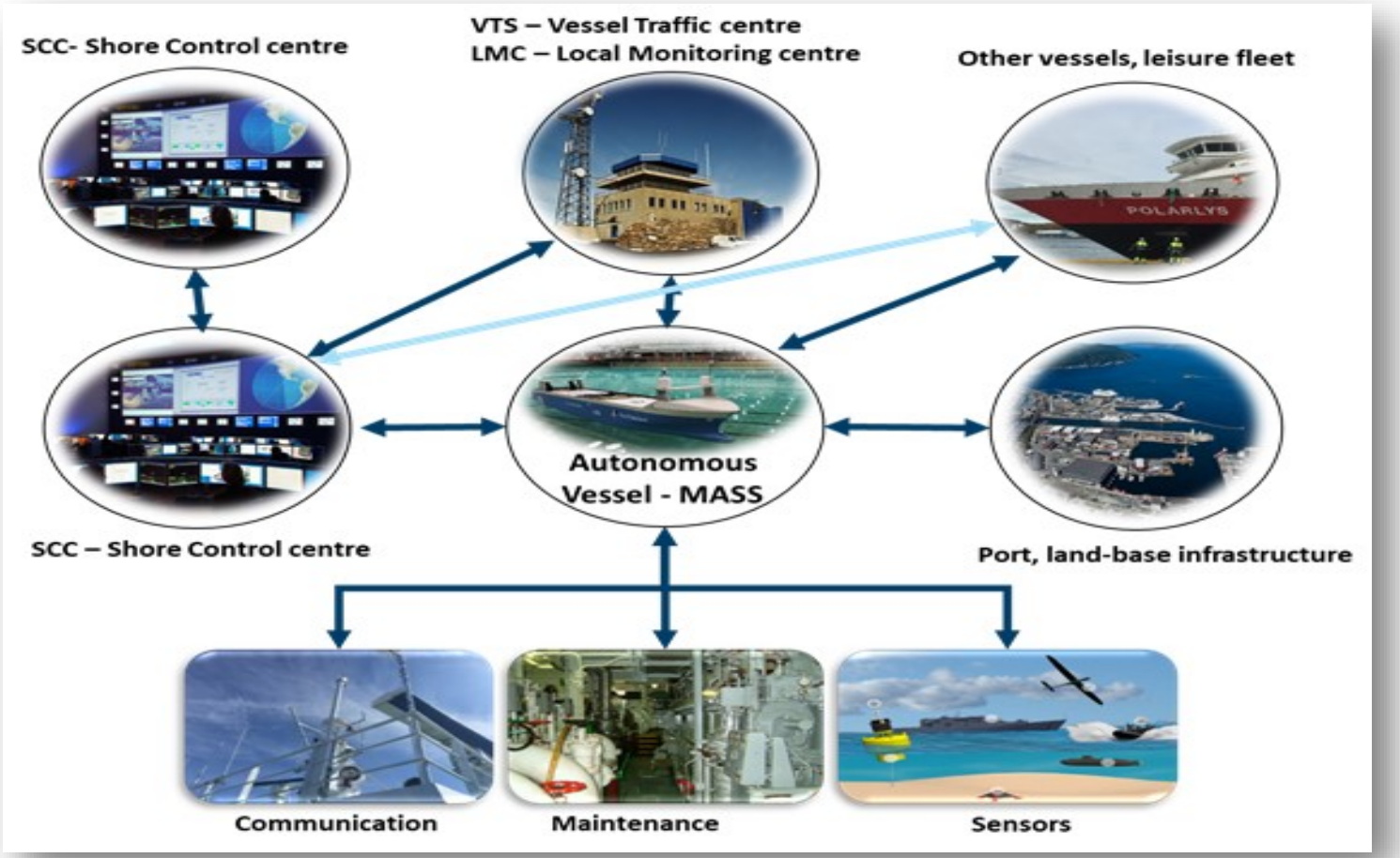
Local monitoring and information centre





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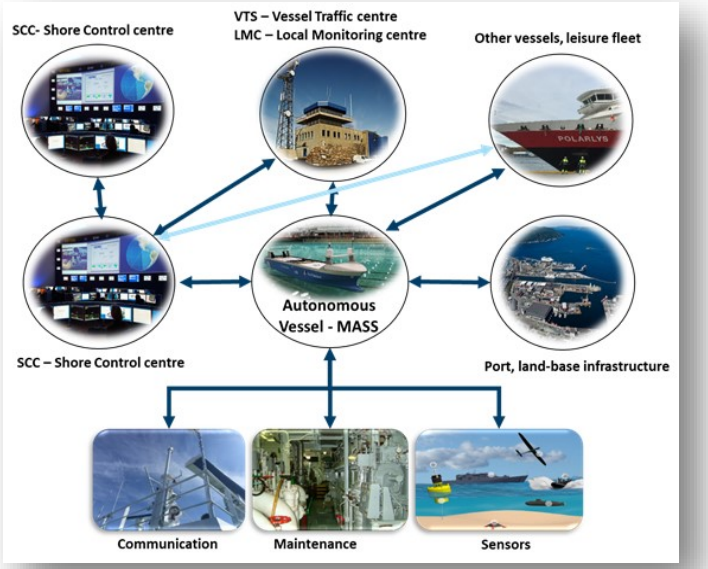
Shore Control Centre

A Concept of Operation (CONOPS) refer to the awareness of a situation. It gives the perception of an event with respect to time and condition, and the system behavior (actual and future). A CONOPS will address the human factors in the MASS operation aspect:

- Situation and automation awareness
- The understanding between automation and human role
- User experiences and usability of the solutions
- Trust in automation
- Graphical user interface and visualization
- Hazards reflections

There are several initiatives to standardize operational procedures, and to develop guidelines how to do operation of autonomous vessels

Collaboration



- Between technologies and sensors
- Between humans
- Between humans and machine
- Between organizations
- Between conventional and autonomous
- Between regulators and operators
- Between providers and users

The future will be more digital, and Machine to Machine integration will be normal procedure.

The humans will still be in the loop, but in "another loop".

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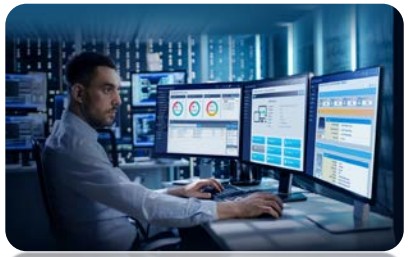
Integrated Maritime Autonomous System



Onshore Systems

Ship Systems

Remote Control

Shipping plan

Mission plan (SCC)

Transport to vessel

Loading and Stability

Sailing plan

Manning (SCC)

Maintenance & Reenergize

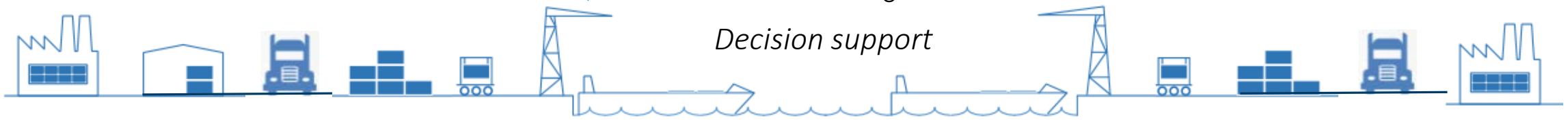
Transport to customer

Unloading and Ballast

Reporting

Remote Monitoring & Control

Decision support



PRODUCTION PACKING TRANSPORT TERMINAL TRANSPORT CRANE VESSEL TRANSPORT CRANE TRANSPORT TERMINAL TRANSPORT CUSTOMER

Source: Massterly

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Summary

Integrated Maritime
Autonomous Transport Systems

- The main objectives of the IMAT project is to define, develop and test the minimum land-based infrastructure
- It is essential to build confidence regarding safety
- Safe development must be done by focusing the:
  - Technology, standards, sensors and infrastructure
  - The information needs for decision making, and the human knowledge and the humans place in the loop
  - Regulations and operational requirements
- **Shore-based infrastructure will be important for the planning of a robust autonomous transport system**

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