MAUSOM

A Business Process Framework and Operations Map for Maritime Autonomous and Unmanned Shipping

| Dr. J. van den Broek

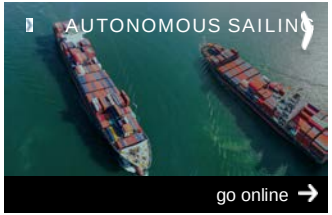
TNO innovation for life

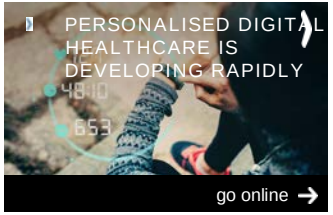
INTRODUCTION HANS VAN DEN BROEK

- Applied Research Professor Human Factors in maritime automation @ the Rotterdam University of Applied Sciences, RDM-campus, Heijplaat, Rotterdam
  - Remote navigation
  - Resilience and Safety
  - Smart Shipping

- Senior Human Factors Researcher @TNO, Soesterberg, The Netherlands.
  - Adaptive Maritime Automation
  - Shore Control Centres
  - Conceptual design of effective operations

TNO SHOWCASES





FIRST AUTONOMOUS MANOEUVRING VESSEL TRIALS HELD ON NORTH SEA

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JOINT INDUSTRY PROJECT: AUTONOMOUS SHIPPING

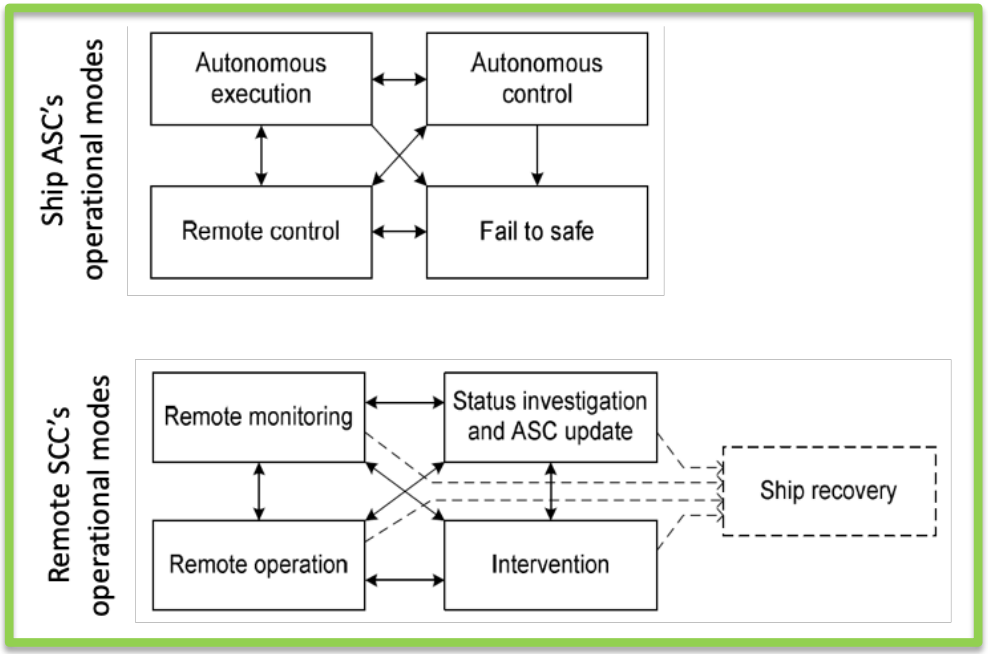
A Business Process Framework and Operations Map for Maritime Autonomous and Unmanned Shipping: MAUSOM

H J M (Harrie) Bastiaansen PhD [1], E (Elena) Lazovik MSc [1]

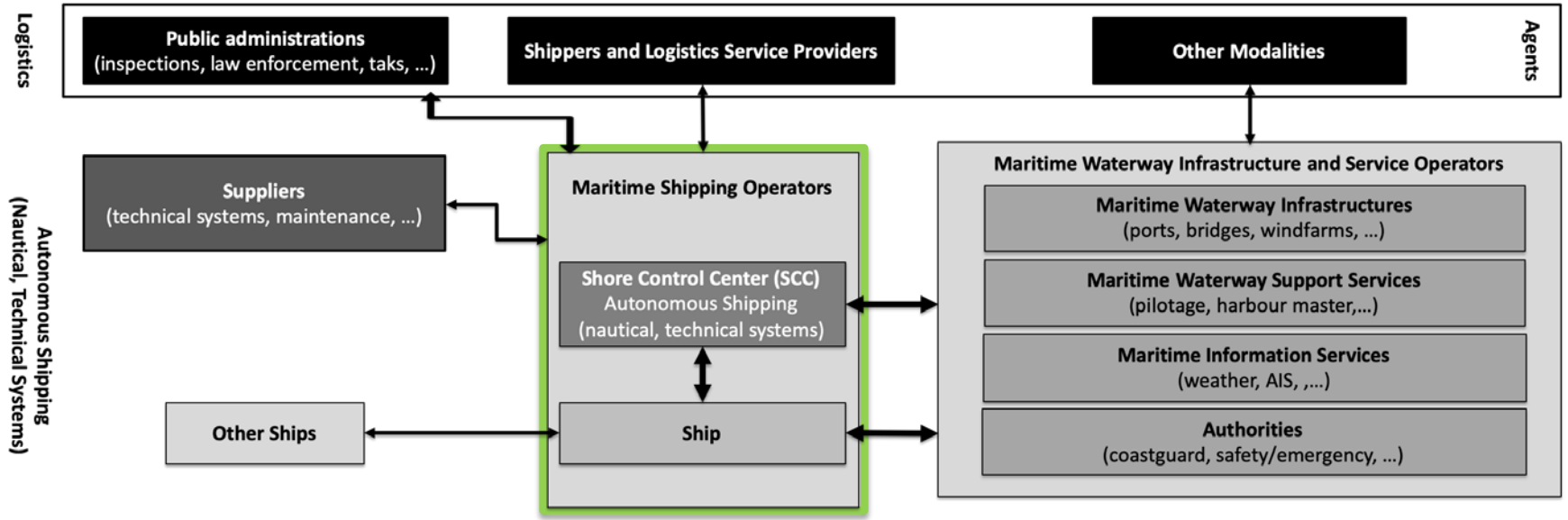
E (Eric) den Breejen MSc [2], J (Hans) van den Broek PhD [3]

The Netherlands Organisation for applied scientific research (TNO)
[1] Eemsgolaan 3, 9727 DW Groningen, The Netherlands
[2] Oude Waalsdorperweg 63, 2597 AK The Hague, The Netherlands
[3] Kampweg 55, 3769 DE Soesterberg, The Netherlands

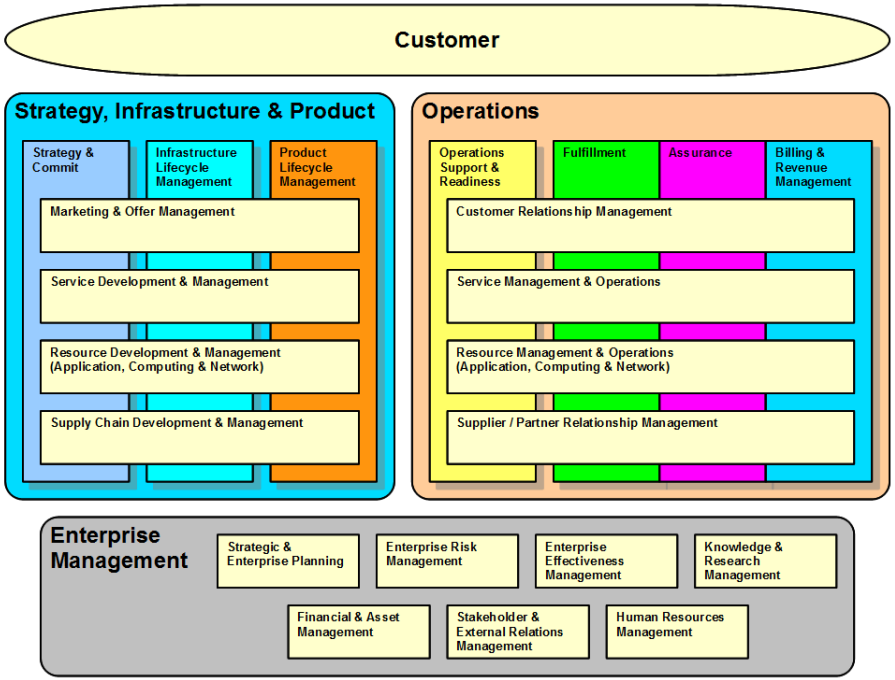
SAILING OPERATIONAL MODES



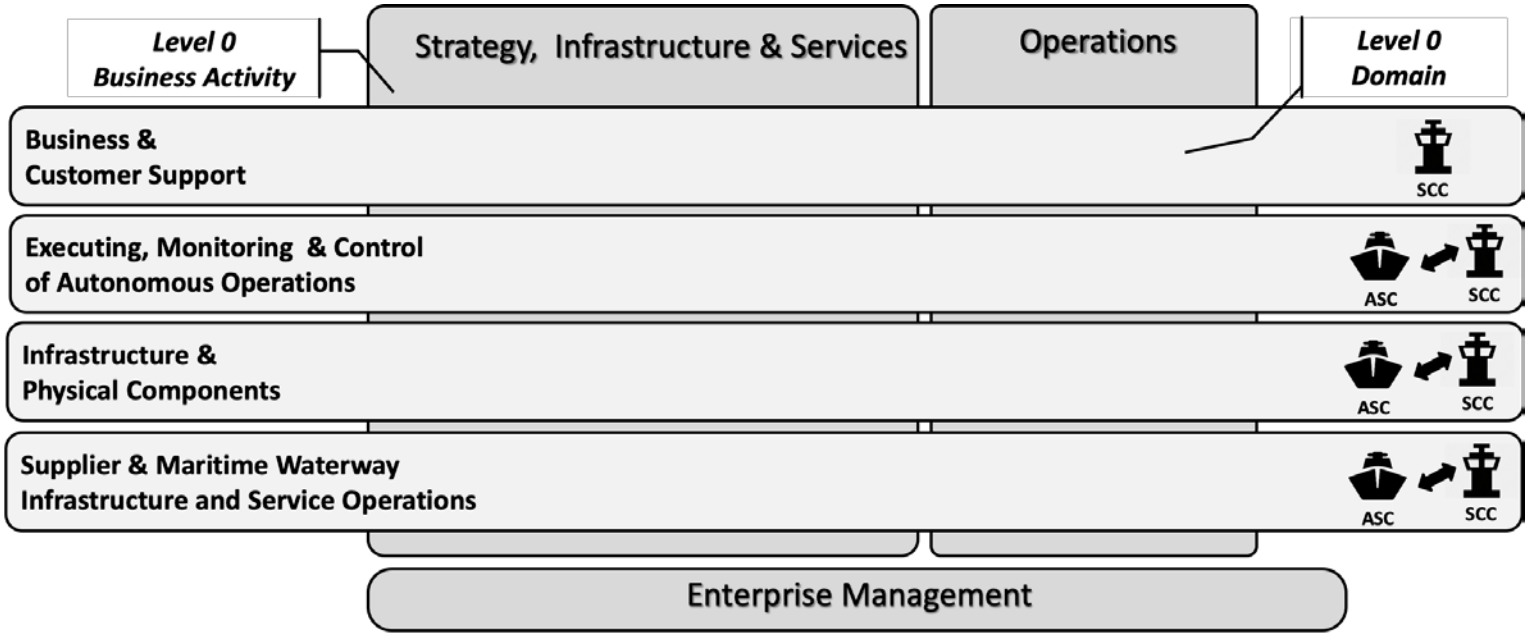
THE OPERATIONAL ROLE MODEL FOR MASS EMBEDDED WITHIN THE OVERARCHING LOGISTICS DEPLOYMENT PROCESSES.



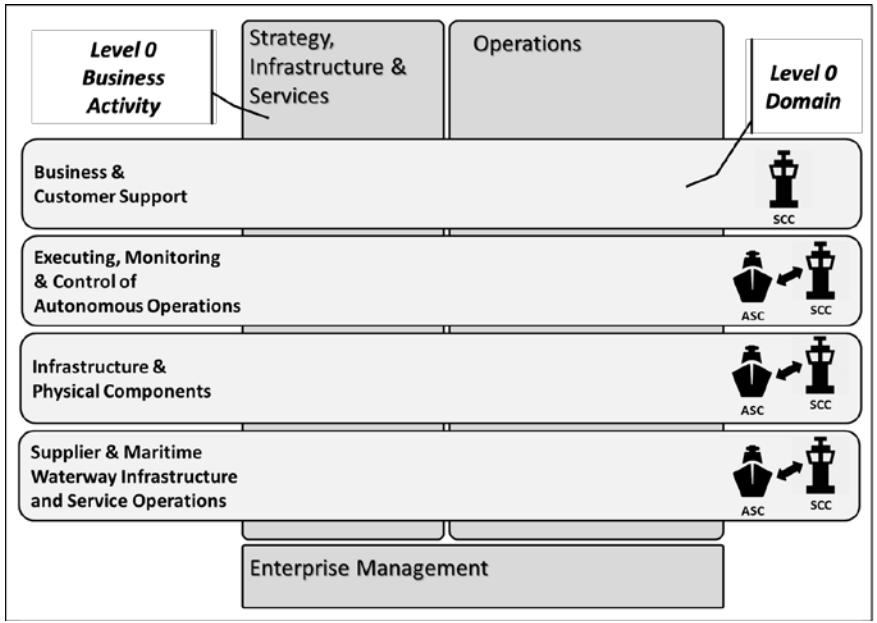
ENHANCED TELECOM OPERATIONS MAP (ETOM)

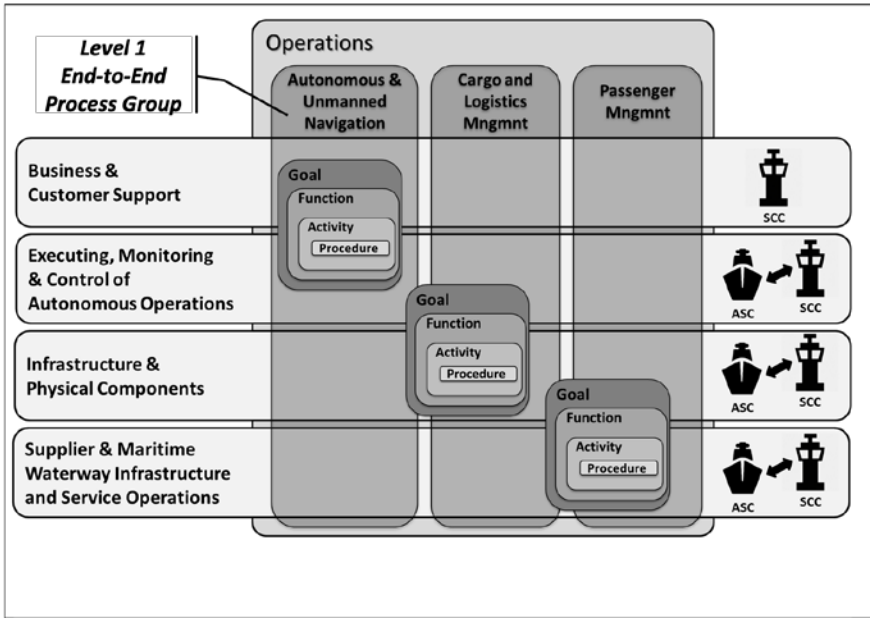


LEVEL 0

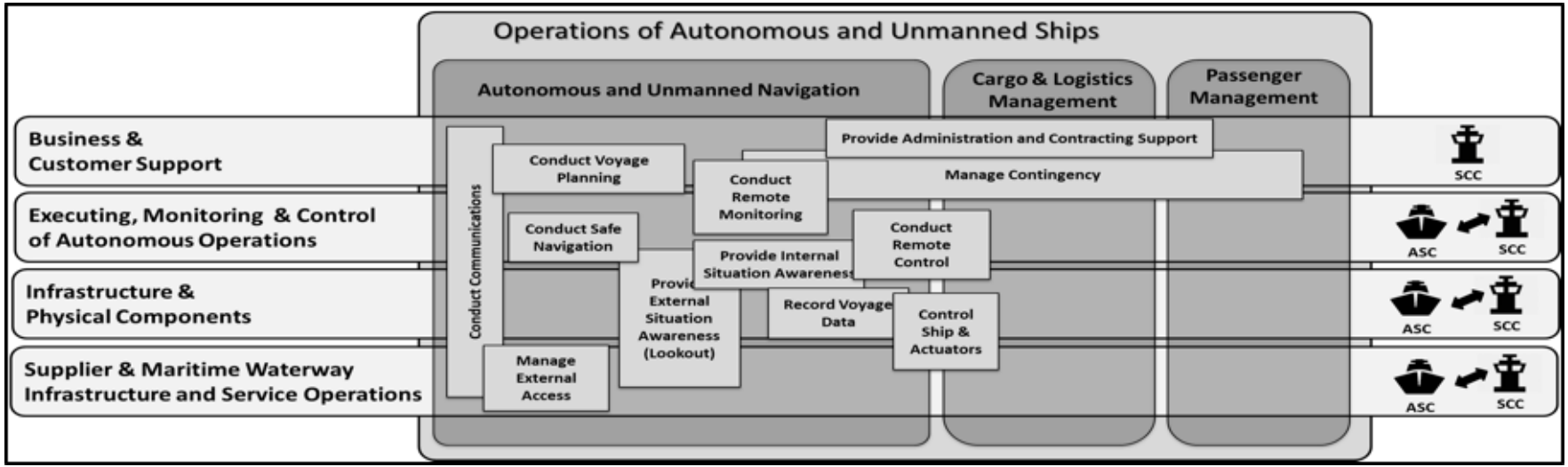

Level 0
Business Activity
Strategy, Infrastructure & Services
Operations
Level 0
Domain
Business &
Customer Support
SCC
Executing, Monitoring & Control
of Autonomous Operations
ASC
SCC
Infrastructure &
Physical Components
ASC
SCC
Supplier & Maritime Waterway
Infrastructure and Service Operations
ASC
SCC
Enterprise Management

LEVEL 1


Level 0 Business Activity
Strategy, Infrastructure & Services
Operations
Level 0 Domain
Business & Customer Support
SCC
Executing, Monitoring & Control of Autonomous Operations
ASC
SCC
Infrastructure & Physical Components
ASC
SCC
Supplier & Maritime Waterway Infrastructure and Service Operations
ASC
SCC
Enterprise Management

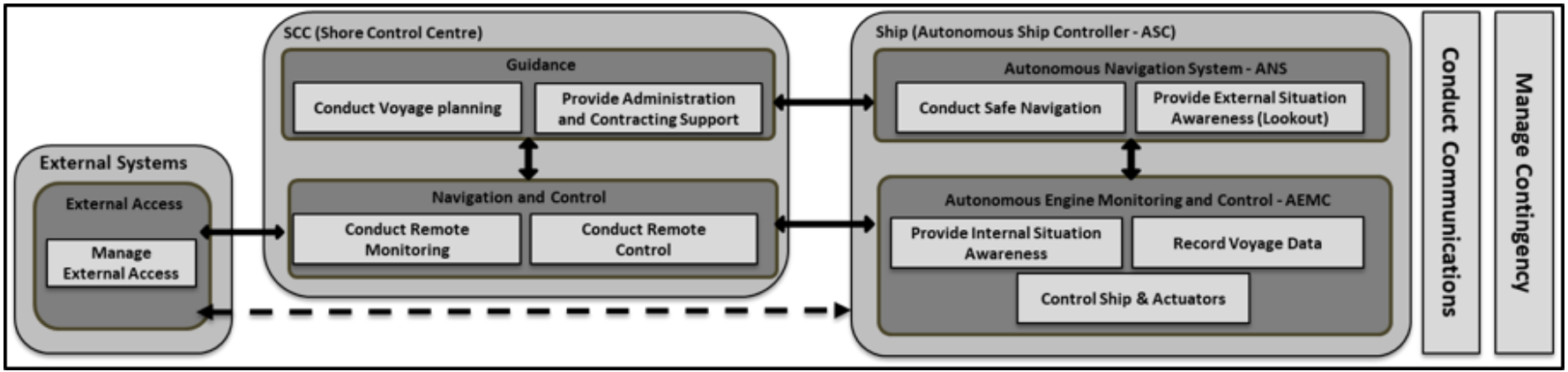

Level 1 End-to-End Process Group
Operations
Autonomous & Unmanned Navigation
Cargo and Logistics Mngmnt
Passenger Mngmnt
Business & Customer Support
Goal
Function
Activity
Procedure
SCC
Executing, Monitoring & Control of Autonomous Operations
ASC
SCC
Infrastructure & Physical Components
Supplier & Maritime Waterway Infrastructure and Service Operations

LEVEL 2


Operations of Autonomous and Unmanned Ships
Autonomous and Unmanned Navigation
Cargo & Logistics Management
Passenger Management
Business & Customer Support
Executing, Monitoring & Control of Autonomous Operations
Infrastructure & Physical Components
Supplier & Maritime Waterway Infrastructure and Service Operations
Conduct Communications
Conduct Voyage Planning
Conduct Safe Navigation
Manage External Access
Provide External Situation Awareness (Lookout)
Conduct Remote Monitoring
Provide Internal Situation Awareness
Record Voyage Data
Conduct Remote Control
Control Ship & Actuators
Provide Administration and Contracting Support
Manage Contingency
SCC
ASC
SCC
ASC
SCC
ASC
SCC

LEVEL 2 GOALS - LEVEL 3 FUNCTIONS

MAUSOM Level 2 Goals	MAUSOM Level 3 Functions
Conduct safe navigation: Plan and direct the course of a ship both under regular conditions and for special manoeuvres (e.g. docking or potential collision).	• Plan path • Keep track • Avoid collision
Provide external situation awareness: Generate a complete (current and predicted) external maritime picture of the navigational environment to support the navigation process, including tracking of ships and objects.	• Perceive extern. situation (Radar, AIS, Video, ...) • Build and predict maritime picture • Receive audio comms (e.g. voice, horn)
Record voyage data: Acquire, record and report of operational process data and the ship's technical systems.	• Record navigation and nautical data • Record sensor and system data
Provide administration and contracting support: Acquire, record and report of business-oriented process information, e.g. authority reporting, logbook, ...	• Report to authorities reporting • Log voyage • Administrate cargo/passenger operations
Conduct voyage planning: Define, update and describe (by a shore-based operator) of the vessel voyage from start to finish (berth-to-berth).	• Select ship • Define itineraries • Plan route & waypoints
Conduct remote monitoring: Remotely monitor and control the business and operational processes.	• Monitor ship route • Monitor vessel voyage • Monitor cargo/passenger operations
Conduct remote control: Remotely monitor and control the business and operational processes.	• Control ship • Control ship-to-ship operations
Control ship and actuators: Maintain and operate the ship (the hull, construction,...), its technical systems (the machinery, propulsion, rudder, thrusters, ...) and its ICT processing systems (the IT and communication infrastructure).	• Monitor (condition of) ship, technical systems, and ICT-systems • Detect/manage contingency constraints • Interact with ships and VTS in proximity
Provide internal situation awareness: Monitor, report and predict the internal ship technical status, and assess their impact on the ships sailing, manoeuvrability and contingency capabilities.	• Detect failures and alarms • Determine buoyancy and stability • Estimate maneuverability
Conduct communications: Manage the communications of the ship with the external environment (SCC, other ships, authorities, ...), incl. the connectivity links and prioritization of information flows under varying operational conditions.	• Manage internal communication • Manage external communication • Prioritize information flows
Manage contingency: Manage the robustness of the physical environment (personal, ship, environment), the ICT-systems and cyber resilience to anticipate, withstand and recover from both unanticipated events (anomalies) and from malicious (physical and cyber) threats and attacks, including y	• Monitor health of technical systems • Provide recovery procedures • Monitor ship, personal and environmental safety • Manage cyber security • Manage transitions of operational modes
Manage external access: Hand-over of autonomous and unmanned shipping monitoring and control to third parties for special activities, e.g. (un)docking and (un)mooring, tugs, remote piloting, helicopter approach, ...	• Provide Rendezvous Control Unit (RCU) services: pilot, tug, emergency, ... • Maintain Maritime Service Portfolio (MSP): harbour, VTS-control, ...


External Systems
External Access
Manage External Access
SCC (Shore Control Centre)
Guidance
Conduct Voyage planning
Provide Administration and Contracting Support
Navigation and Control
Conduct Remote Monitoring
Conduct Remote Control
Ship (Autonomous Ship Controller - ASC)
Autonomous Navigation System - ANS
Conduct Safe Navigation
Provide External Situation Awareness (Lookout)
Autonomous Engine Monitoring and Control - AEMC
Provide Internal Situation Awareness
Record Voyage Data
Control Ship & Actuators
Conduct Communications
Manage Contingency

THE MAIN MERITS INCLUDE

- Wide-scale adoption and development of MASS can be enormously facilitated and stimulated with an aligned, accepted and preferably agreed upon (standardized) overarching business process framework and operations map.
  - it provides a validated, complete and shared model for identifying all functions and tasks for autonomous and unmanned shipping,
  - it guides the task (re-)allocation process to either autonomous (sub-)systems or to human operators,
  - it enables interoperability between (sub-)systems and thereby reduces the costs of integration,
  - it forms the basis for a structured information model supporting system interconnectivity, and
  - it provides a blueprint for operational process and runtime use case (re-)design.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