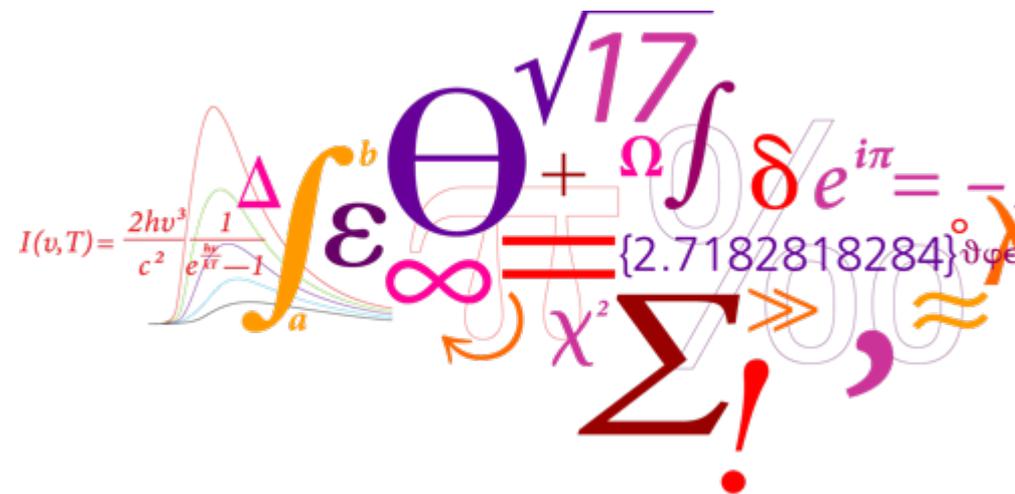


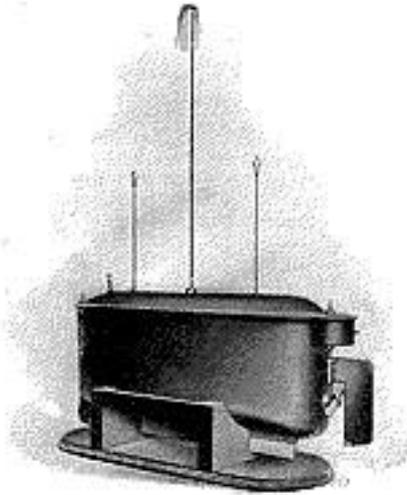
Is UNCLOS ready for autonomy?

Dr. Michael Linden-Vørnle

Head of DTU Space DroneCenter

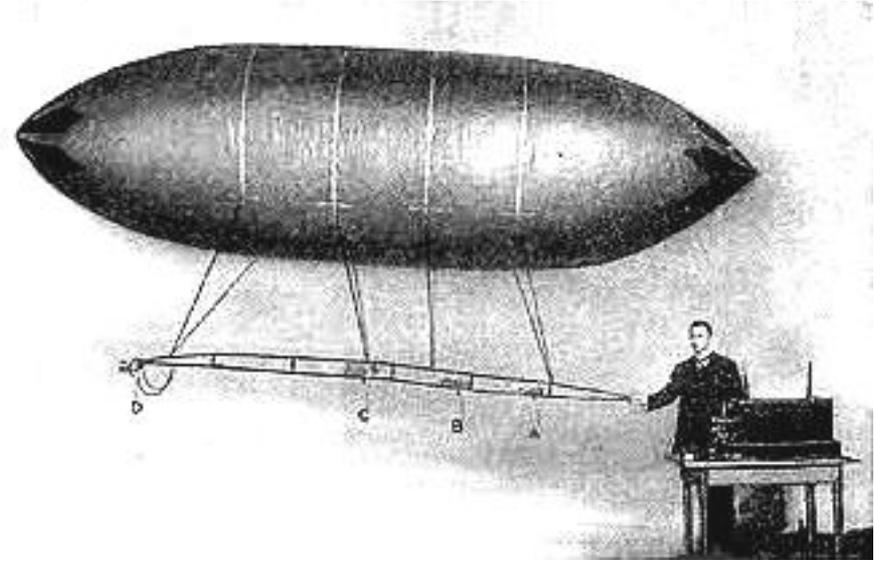
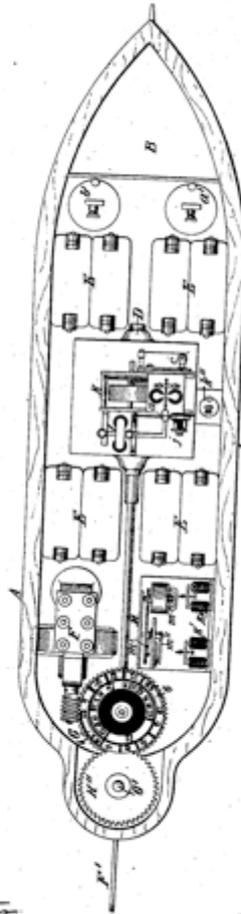
DTU Space
National Space Institute





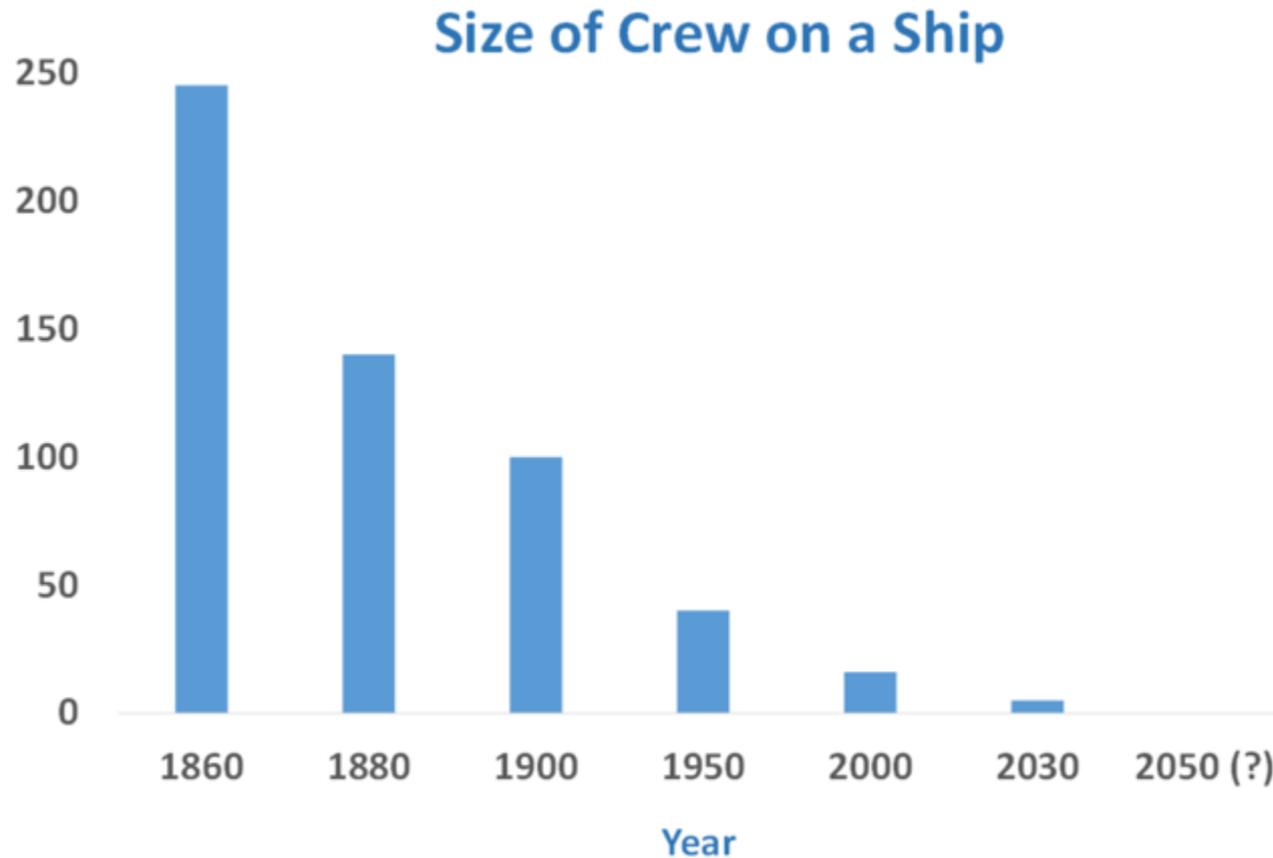
19. N. TESLA. Patented Nov. 8, 1898.
AND APPARATUS FOR CONTROLLING MECHANISM OF
OR VEHICLES.

Fig. 1



Witnesses:
Raphael Petter
George Scheff

Inventor
Nikola Tesla



Wang (2017)

UNCLOS and autonomy?

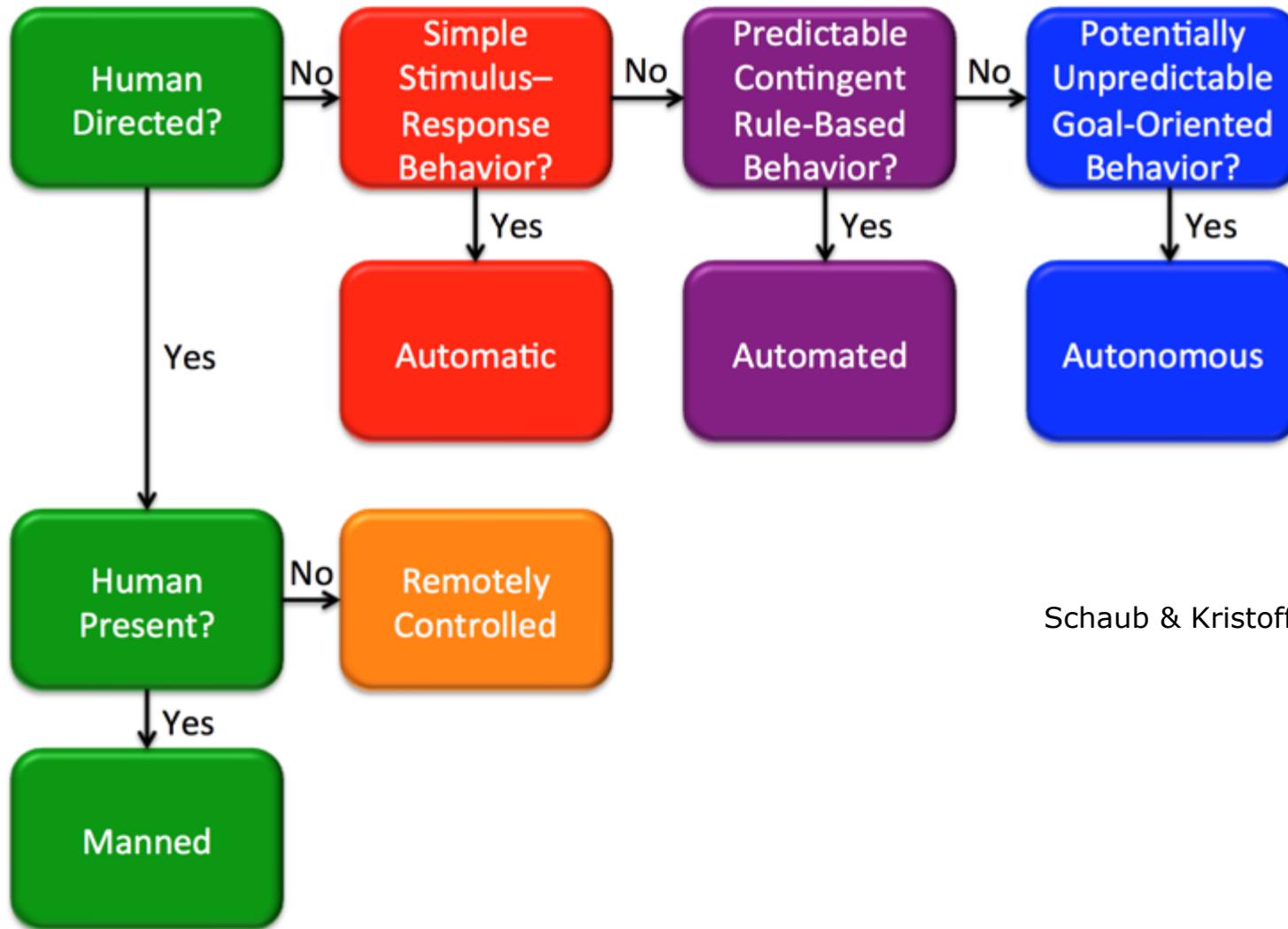
Article 94, paragraph 4

- (a) that each ship, before registration and thereafter at appropriate intervals, is surveyed by a qualified surveyor of ships, and has on board such charts, nautical publications and navigational equipment and instruments as are appropriate for the safe navigation of the ship;
- (b) that each ship is in the charge of a master and officers who possess appropriate qualifications, in particular in seamanship, navigation, communications and marine engineering, and that the crew is appropriate in qualification and numbers for the type, size, machinery and equipment of the ship;
- (c) that the master, officers and, to the extent appropriate, the crew are fully conversant with and required to observe the applicable international regulations concerning the safety of life at sea, the prevention of collisions, the prevention, reduction and control of marine pollution, and the maintenance of communications by radio.

UNCLOS and autonomy?

Article 98, paragraph 1

1. Every State shall require the master of a ship flying its flag, in so far as he can do so without serious danger to the ship, the crew or the passengers:
 - (a) to render assistance to any person found at sea in danger of being lost;
 - (b) to proceed with all possible speed to the rescue of persons in distress, if informed of their need of assistance, in so far as such action may reasonably be expected of him;
 - (c) after a collision, to render assistance to the other ship, its crew and its passengers and, where possible, to inform the other ship of the name of his own ship, its port of registry and the nearest port at which it will call.



Schaub & Kristoffersen (2017)

Autonomy Levels (AL)

AL 0: Manual Steering

AL 1: Decision-support on board

AL 2: On-board or shore-based decision-support

AL 3: Execution with human being who monitors and approves

AL 4: Execution with human being who monitors and can intervene

AL 5: Monitored autonomy

AL 6: Full autonomy

Adapted from Lloyd's Register (2016)



ShipRight

Design and Construction

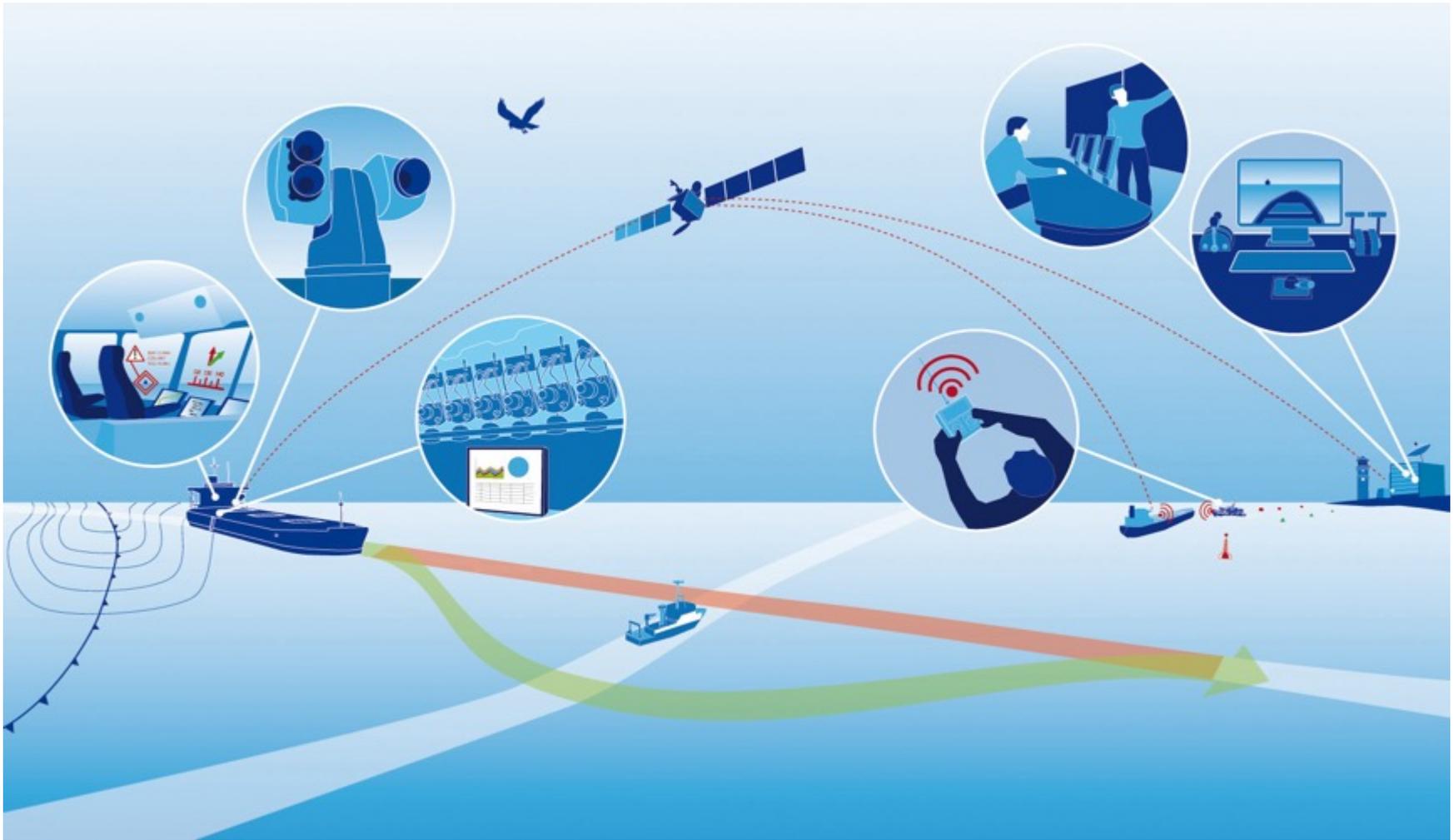
Additional Design Procedures

LR Code for Unmanned Marine Systems

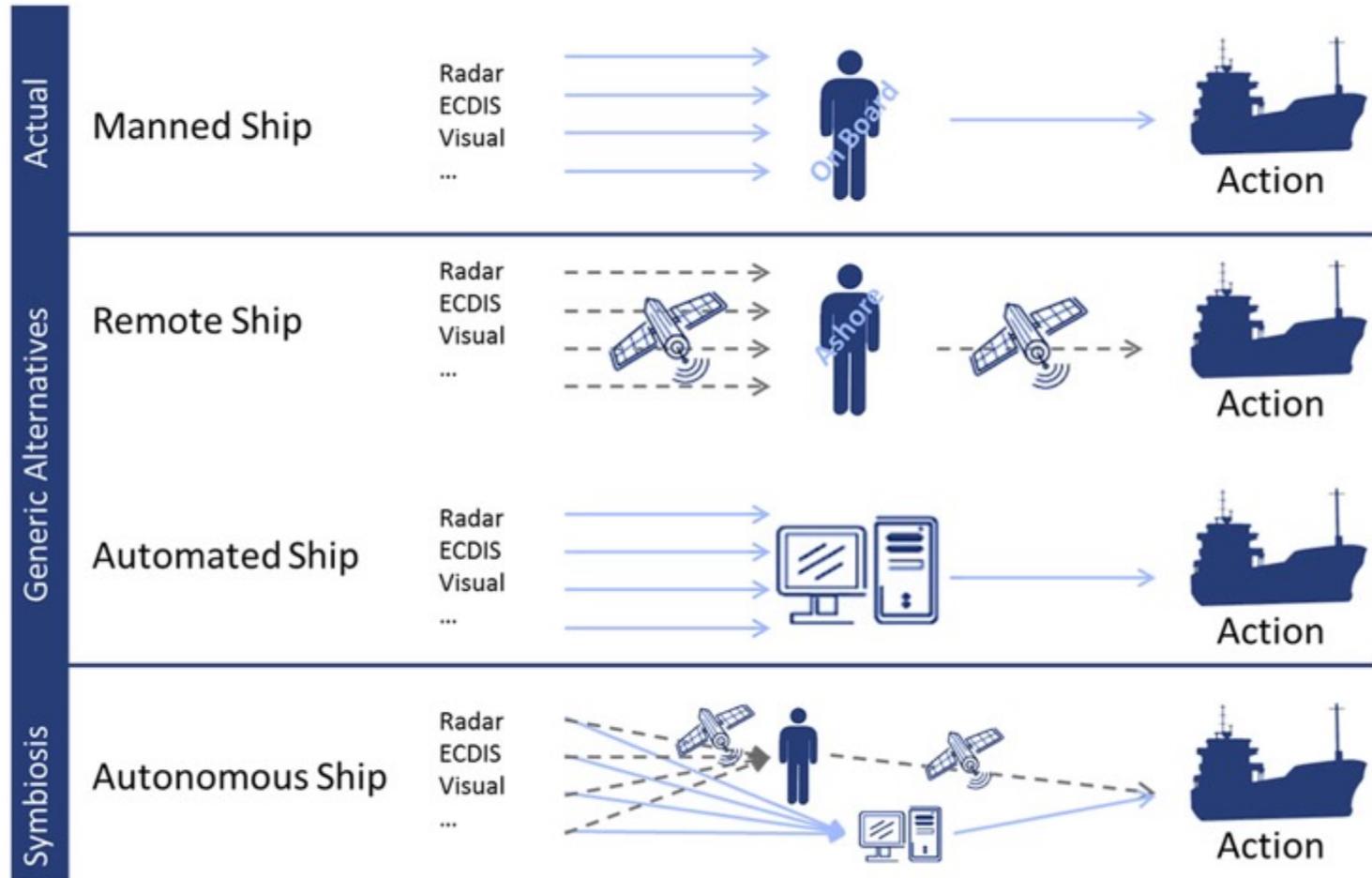
February 2017



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MUNIN Project (2016)



MUNIN Project (2016)

Svitzer Hermod



Rolls Royce Marine & Svitzer(2017)

YARA Birkeland



Kongsberg & Yara (2017)

YARA Birkeland

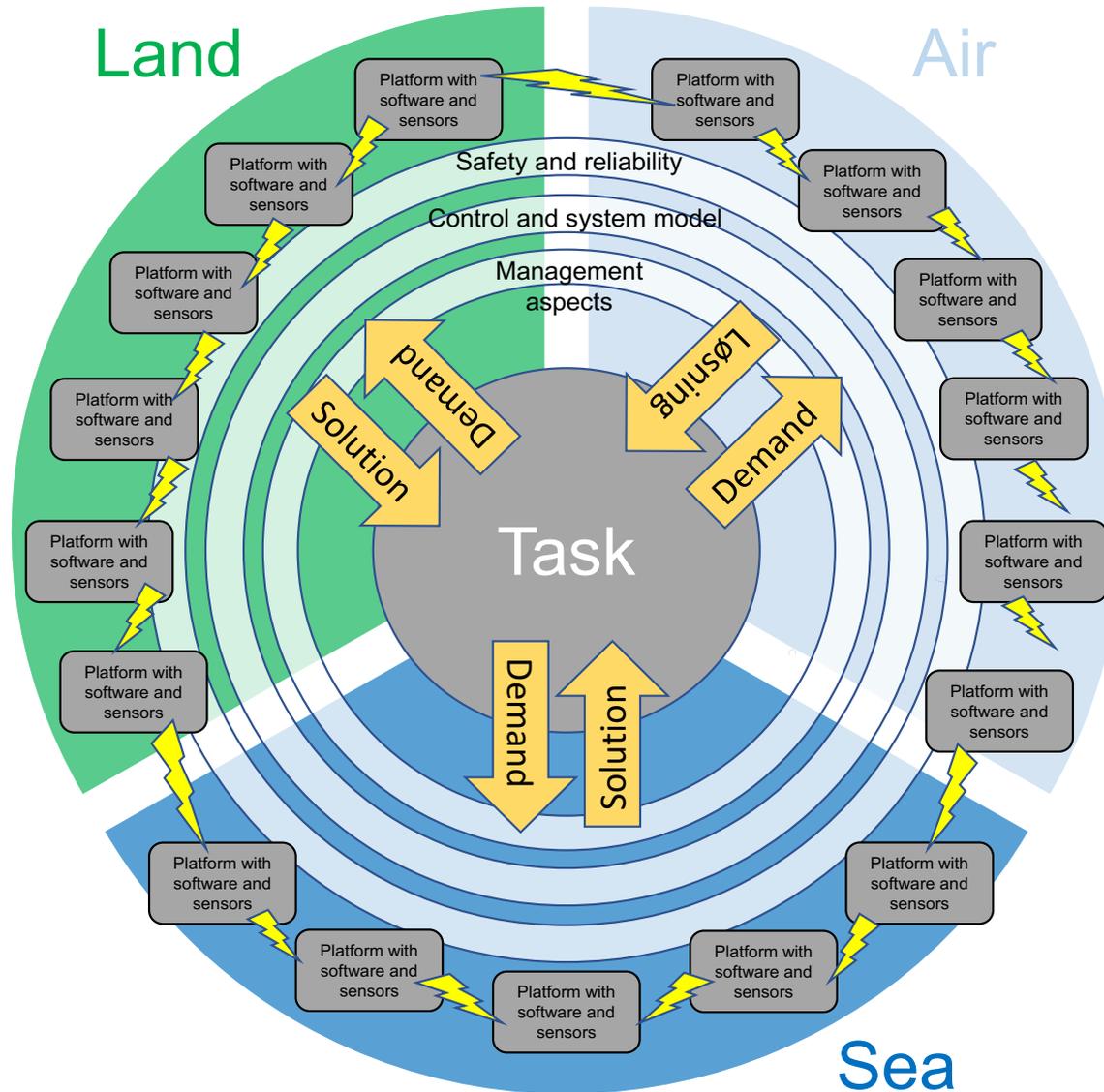


Kongsberg & Yara (2017)









Linden-Vørnle (2017)



Autonomous Ship
TECHNOLOGY
Symposium 2018

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