

Green and Autonomous Shipping Technologies

DNV GL

Why this is important....

“By 2025 a large share of new commercial ships will probably include some degree of hybridization”



Will this be permitted in the future?



- Batteries can eliminate or significantly reduce;
- emissions in emission sensitive areas
 - noise in populated areas

Energy sources and emission ranking

Energy source						
Emission type	Diesel	Diesel+LNG (Dual-fuel)	LNG (Gas)	LNG+Battery (Hybrid)	Electricity (Battery)	Hydrogen
NO _x	H	M	L	~ 0	~ 0	~ 0
SO _x	H	M	~ 0	~ 0	~ 0	~ 0
CO ₂	H	H ³	M	L	~ 0 ⁴	~ 0 ⁵
CH ₄	L	M	H	M	~ 0	~ 0
PM	H	M	~ 0	~ 0	~ 0	~ 0

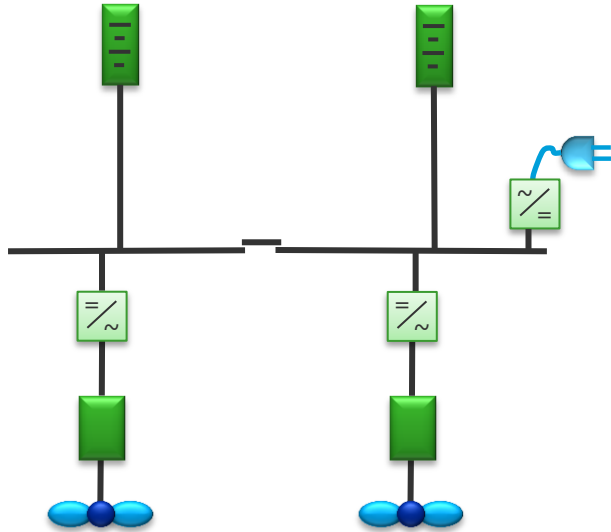
(H=High, M=Medium, L=Low)

³ - Perceived as "High" based on the assumption that gas mode is mostly used in ECA zones and ports. Dependent on sailing pattern, LNG tank capacity, LNG price and availability etc.

⁴ - Dependent on the used CO₂-factor for electricity.

⁵ - Dependent on how the hydrogen is produced. If the hydrogen is produced by the use of electricity from the grid it should be set to the same ranking as "Electricity" for CO₂.

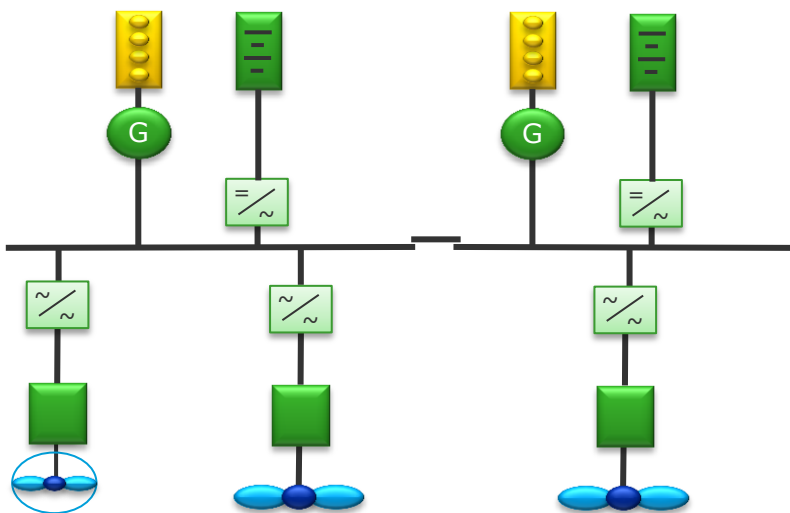
Ships for pure battery operation



✓ Ships with frequent stays in port and relatively low energy needs

- Ferries, passenger and harbour vessels - coastal and inland shipping
- Available port power and sufficient charging time, 5 to 10 minutes
- Max 60 minutes crossing and max 20 knots
- Savings in fuel costs: 30% to 85% in Norway
- Pay back depending on electricity prices and investments on land

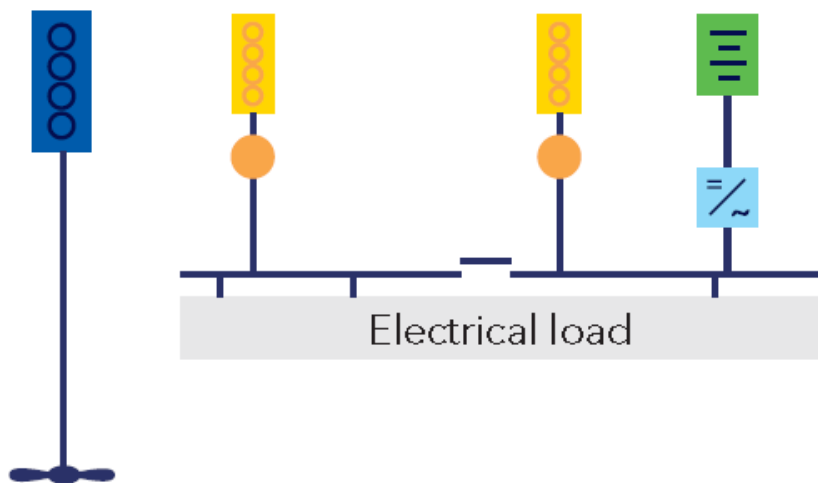
Ships for battery-hybrid operation



✓ Ships with low engine utilisation in periods, or ships with large power variations

- Ferries
- Offshore Vessels
- Tugs
- Dry cargo with cranes
- Shuttle tankers
- HSLC
- Wind Vessels
- Passenger ships
- FPSO
- Military
- Research ships
- Special ships
- Auxiliary engines in deep sea shipping

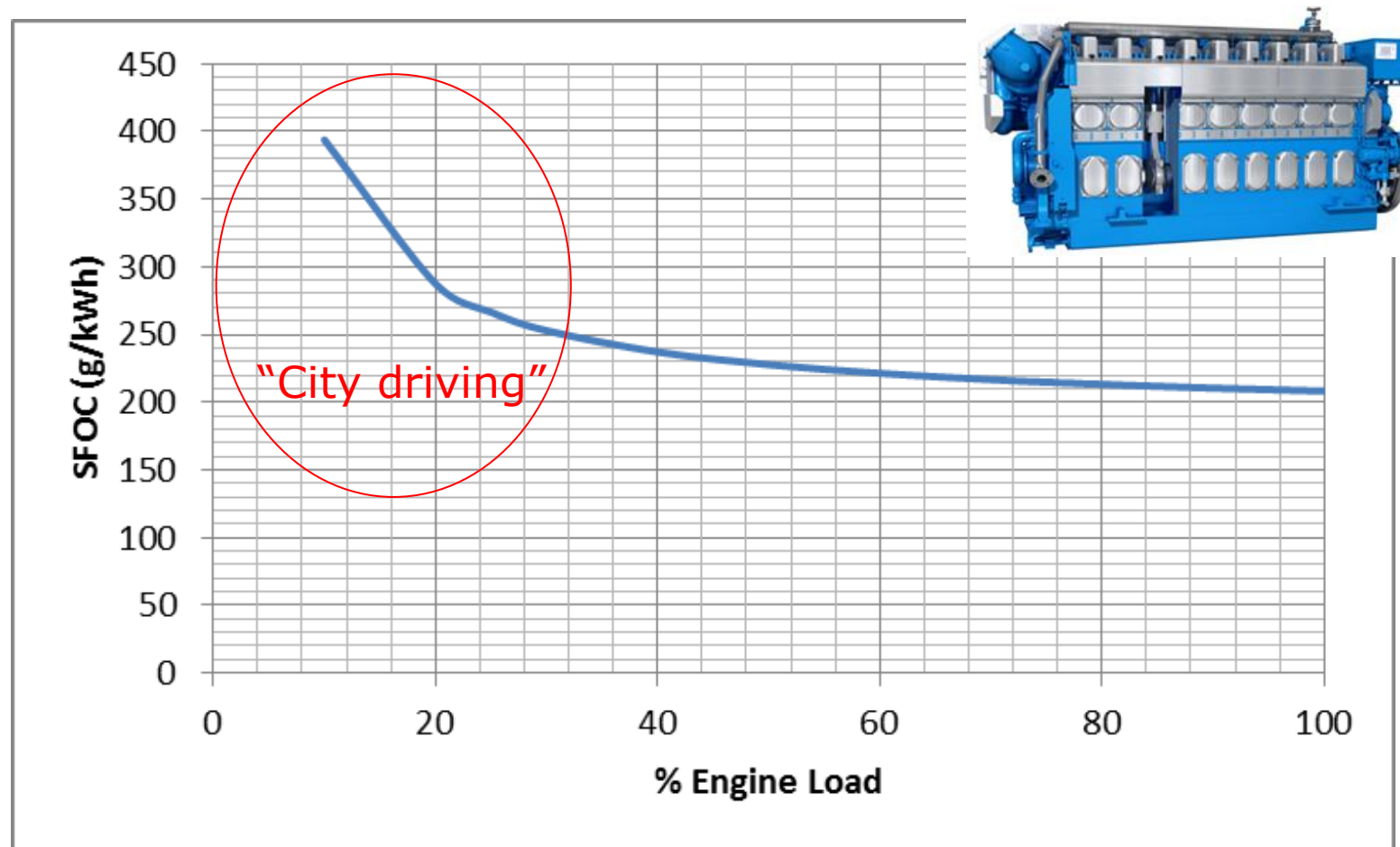
Mechanical propulsion with battery hybrid power plant



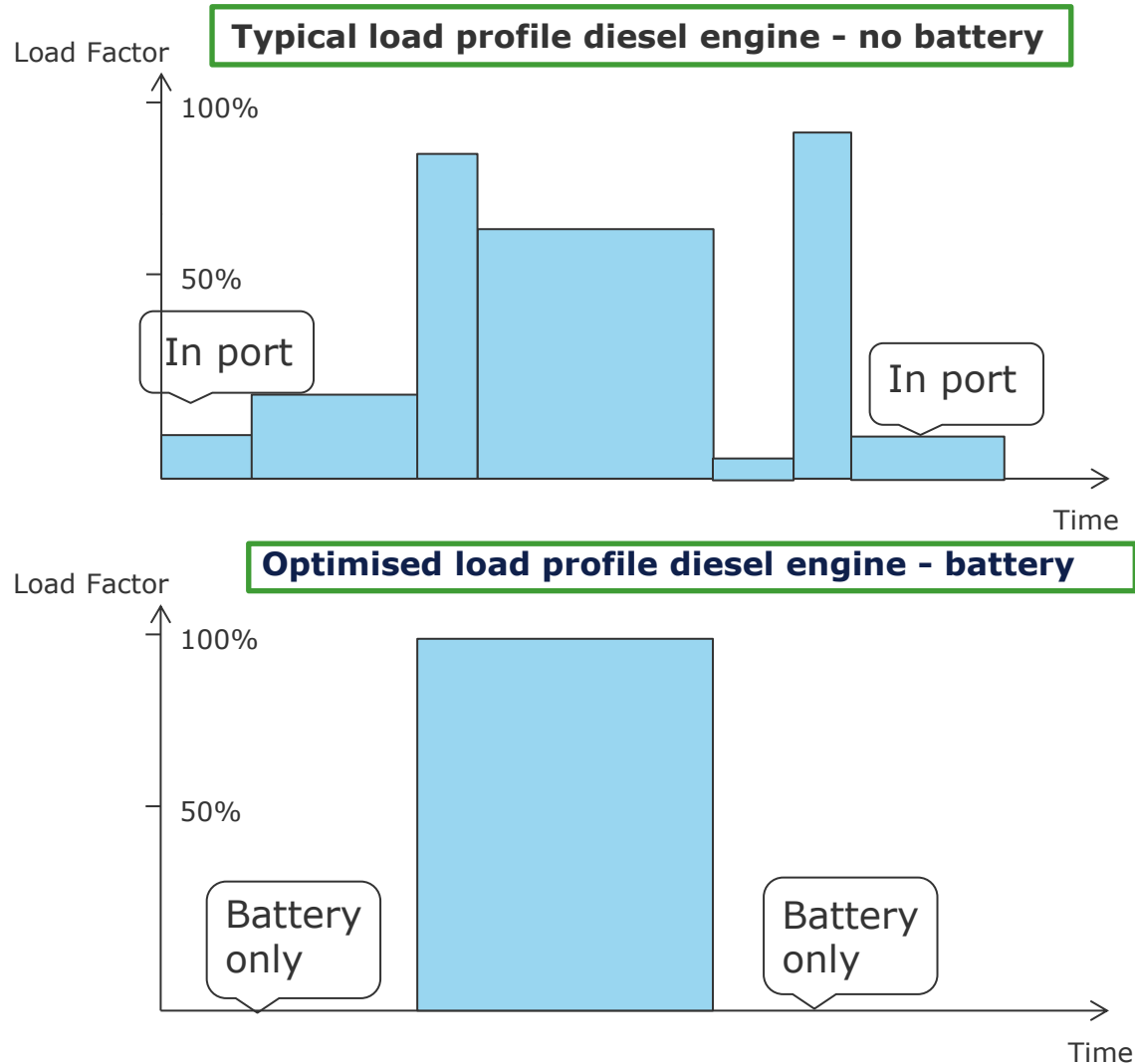
✓ Ships with variable electric power demand

- Battery effective for smoothing the electrical load and helping to handle large load steps
- When large load steps are reduced, the number of auxiliary engines may also be reduced
- In cases where the load can regenerate power, such as in cranes, the battery can be used to harvest this energy

Low fuel efficiency in the low power area



Battery hybridisation – low engine utilisation



- Battery-only mode
 - In waiting situations
 - In environmental or noise sensitive areas
 - In port
- Diesel engines run at optimal load
- Engines can be fewer or smaller
- **Batteries can reduce fuel consumption, maintenance, emissions of CO₂, NO_x, SO_x and particles**

Sustainable shipping – zero emission with plug-in hybrid vessel



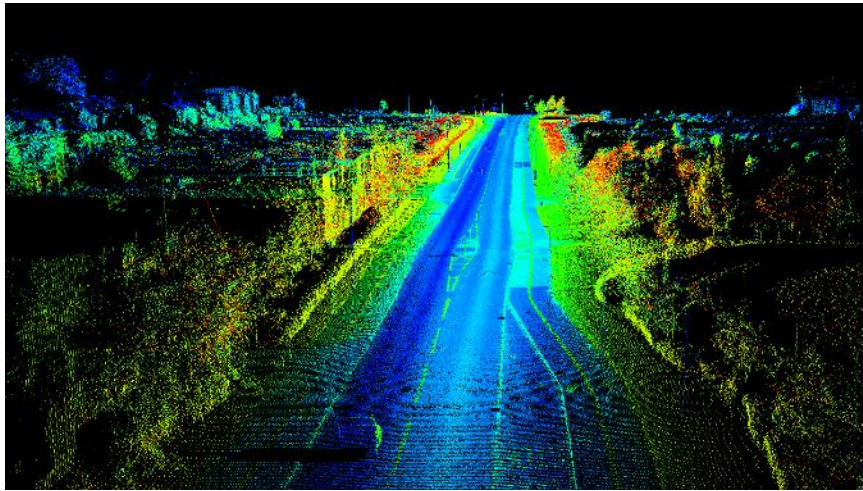
Length 160 m, 2000 passengers, 500 cars, to be delivered in 2019

Route: Sandefjord (Norway) to Stromstad (Sweden)

Plug-in hybrid: batteries are charged from shore power or from generators

Zero-emission operation in approaches

Industry 4.0



Key digital trends shaping the maritime industry's future

Internet of Things

- Sensors everywhere
- 1 trillion connected devices in 2025
- 11 trillion USD revenues

Bandwidth

- 5G terrestrial network with 10 Gbps
- 50 Mbps satellite network in 2025

Cloud

- Computing and storage on demand
- 50% of IT infrastructure in 2020

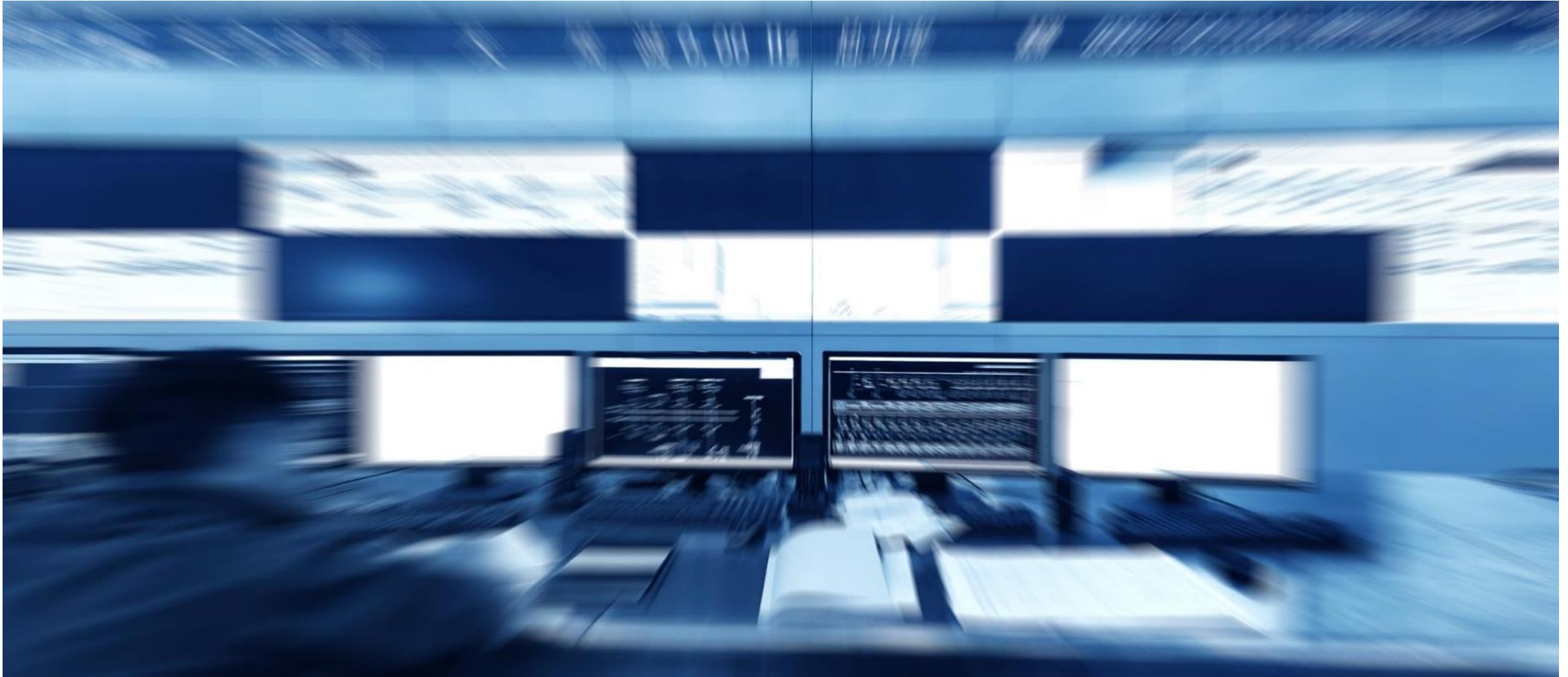
Machine learning

- Taking off now, driven by consumer applications (Siri, Alexa, Google Now)
- Essential to create insight from large data volumes

Remote operations - Navigation



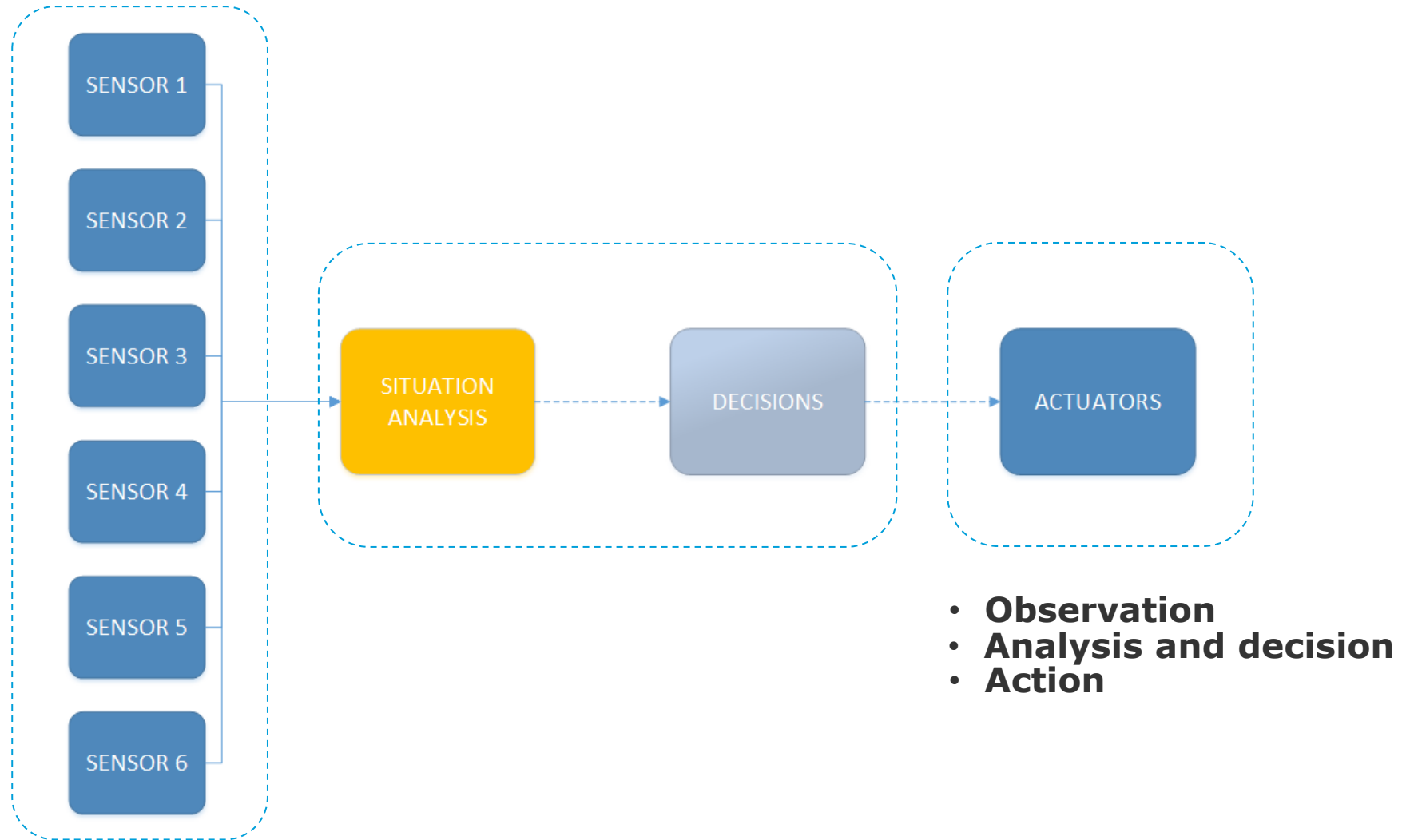
Remote operations - Machinery



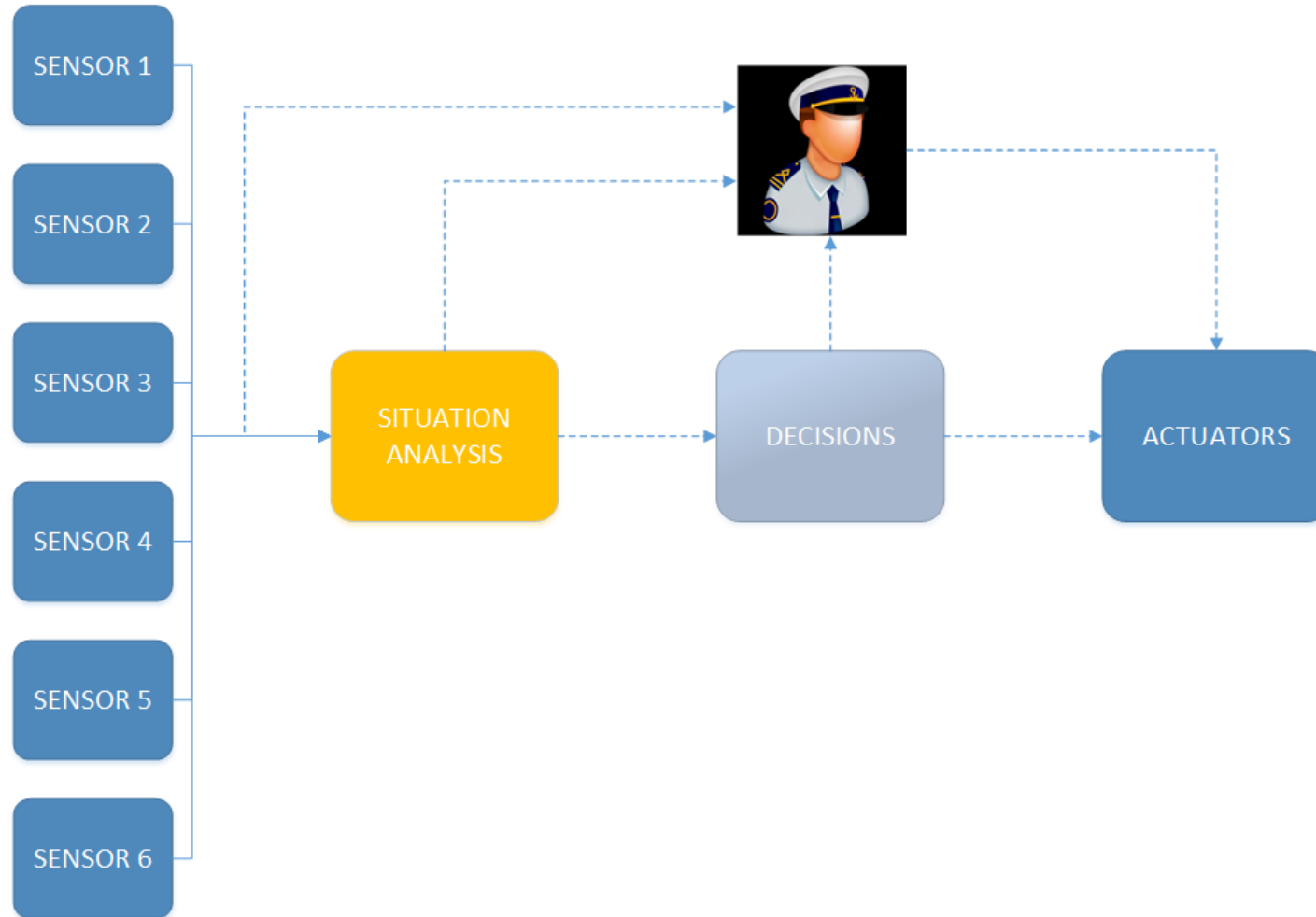
Autonomous operations



Autonomous operation



Man in the loop



Autonomous ships – current public funded R&D projects



AAWA – automated ferry demonstrator



SIMAROS – autonomous OSV



AUTOSEA – sensor fusion



ROMAS – remote controlled ECR

The ReVolt

A new inspirational ship concept



100 TEU

6 knots

Coastal traffic

200 km range

Battery 3 MWh

- A small, unmanned zero emission concept container ship
- Low speed, high propulsion efficiency, regularity and safety
- Designed to operate in coastal and inland waterways
- Full electric with battery operation and charging
- Power requirement 50KW plus sea margin 70KW
- A near maintenance-free power system solution
- Autonomy can reduce the number of accidents

Thank you for your kind attention

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SAFER, SMARTER, GREENER

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