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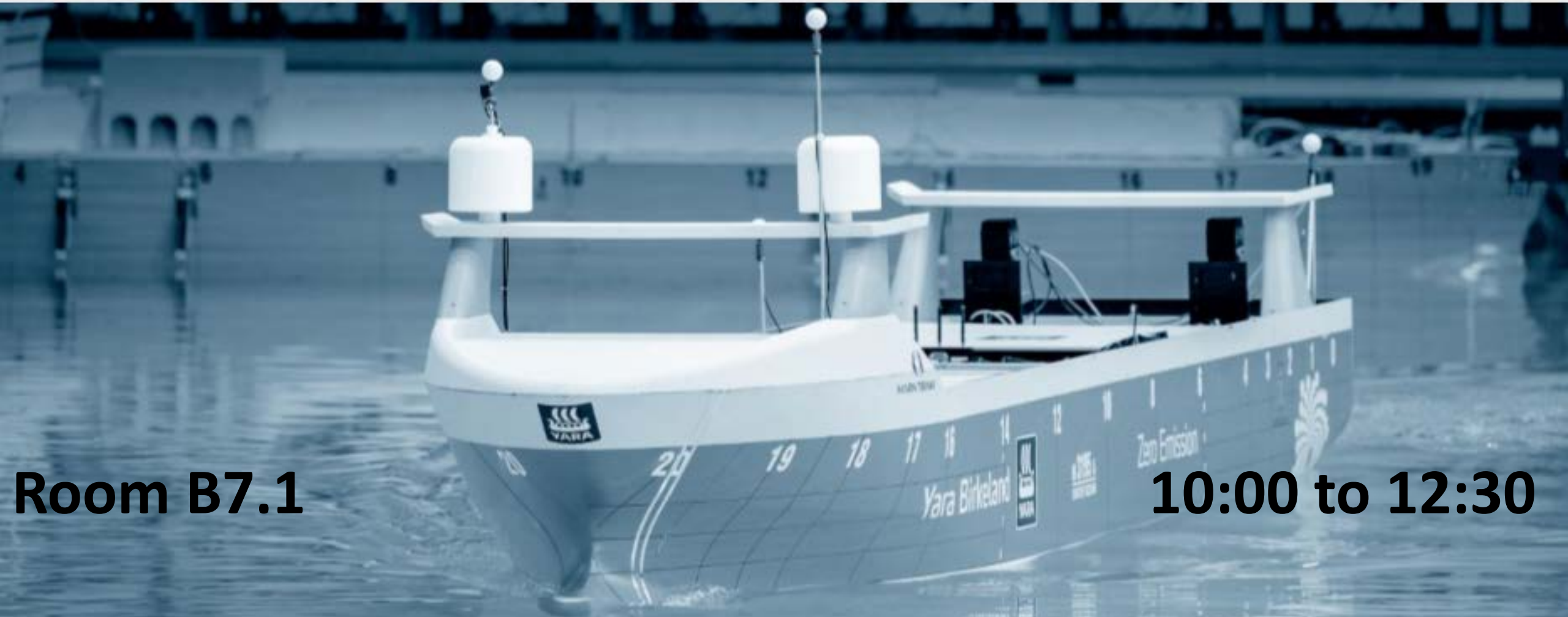
Making Shipping Smarter

- Future Developments in Autonomous Shipping



Room B7.1

10:00 to 12:30

Title	Speaker
1000: Autonomous ship research priorities in SINTEF.	Ørnulf Rødseth, Senior Research Scientist
1020: Cost and benefits of autonomous ships in short sea transport	Håvard Nordahl, Research Scientist
1040: Ship design aspects of autonomous and unmanned vessels.	Kourosh Koushan, Senior Adviser
1100: Break	
1120: The model-simulation-experiment triangle: a new capacity in hybrid marine power systems.	Anders Valland, Research Manager
1140: Development of a future marine energy system: Model centric approach.	Kevin Koosup Yum, Research Scientist
1200: How to use CFD to cost-effectively reduce fuel consumption.	Anders Östman, Senior Research Scientist

AUTONOMOUS SHIP RESEARCH PRIORITIES IN SINTEF

Ørnulf Jan Rødseth, Senior Scientist, SINTEF Ocean
OrnulfJan.Rodseth@sintef.no

SINTEF Ocean

From January 2017, a merger of:

- MARINTEK
- SINTEF Fisheries and Aquaculture
- SINTEF Environmental Technology

Not-for-profit, independent

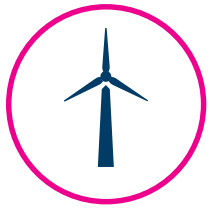
Contract research

360 employees

Part of SINTEF, 2000 employees

Applied research, technology and innovation

Expertise from ocean space to outer space:



Renewable energy

Ocean space

Industry

Buildings and infrastructure

Materials

Micro-, nano- and biotechnology

Climate and environment

Oil and gas

Health and welfare

Society

Digitalization

Transport

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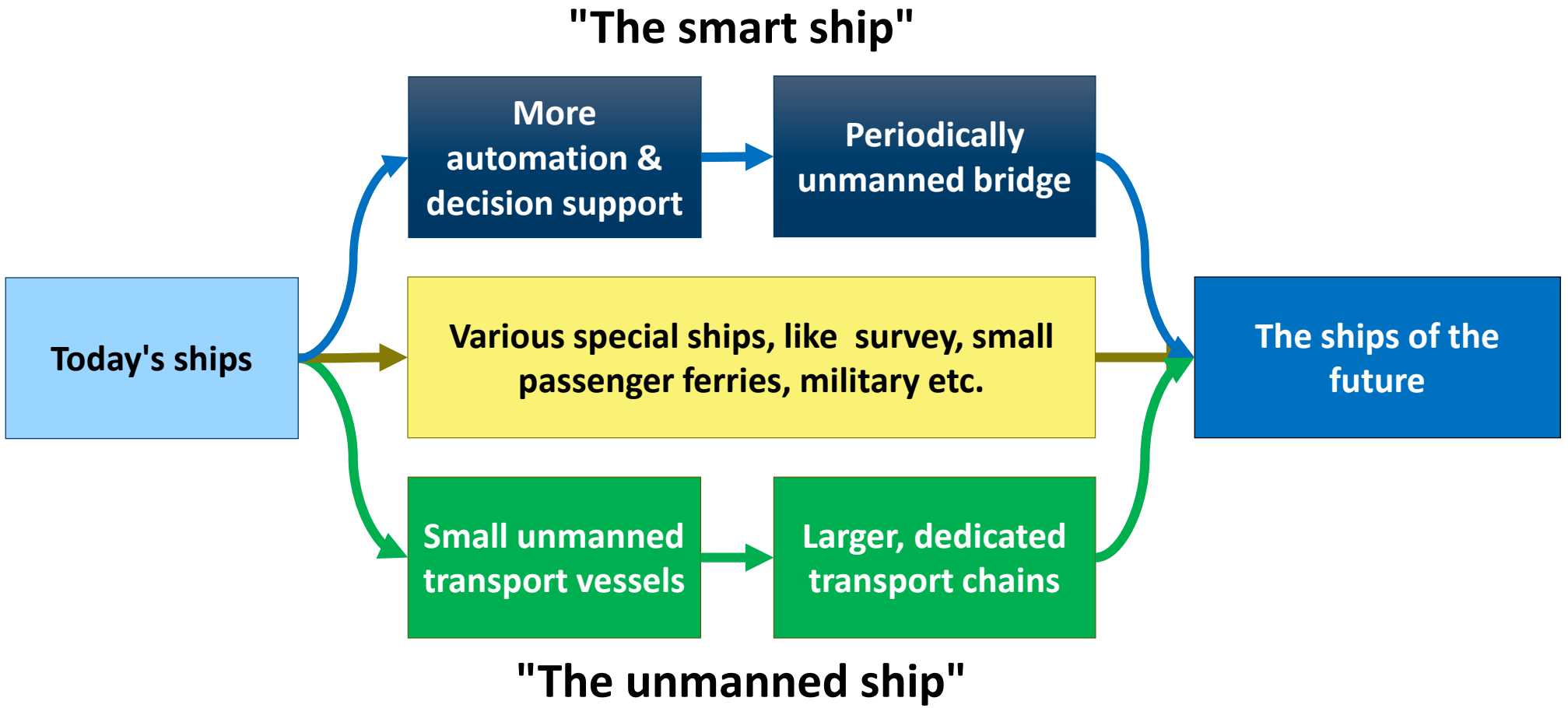
Why autonomous ships?

Unmanned and Smart ships



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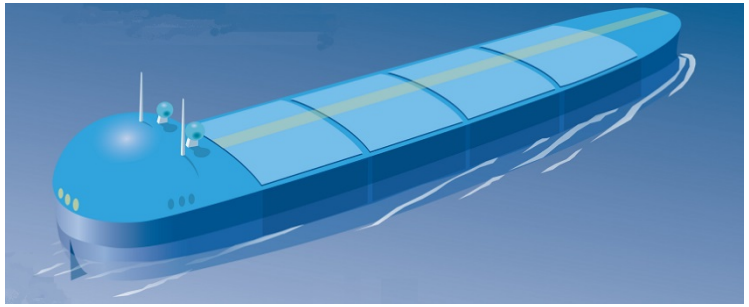
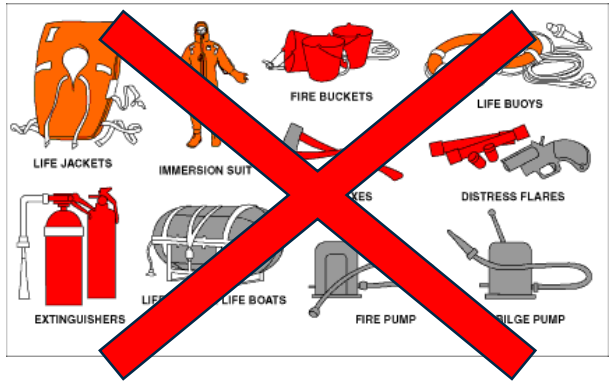
Unmanned gives the most interesting benefits



No accommodation

Less power

More cargo



No safety equipment

No voluntary speed loss

New constructions

Enables completely new

transport system concepts

No crew

No crew related costs

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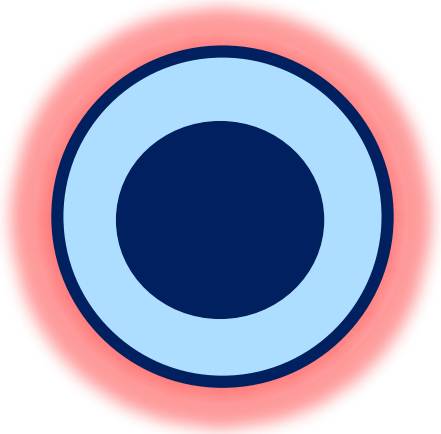
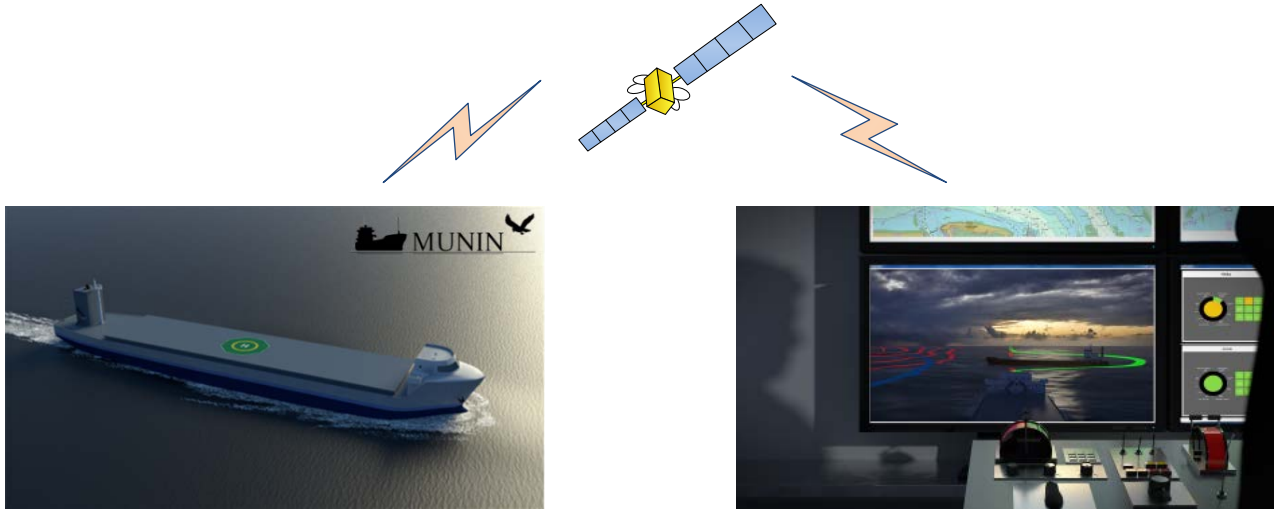
Shore Control Centre (SCC) is normally needed



Constrained autonomy



There is normally a human in the loop!

- Simplifies technology, increases safety and security
- Simplifies transitions from todays legislation to unmanned operation
- Keeps high value assets under close control

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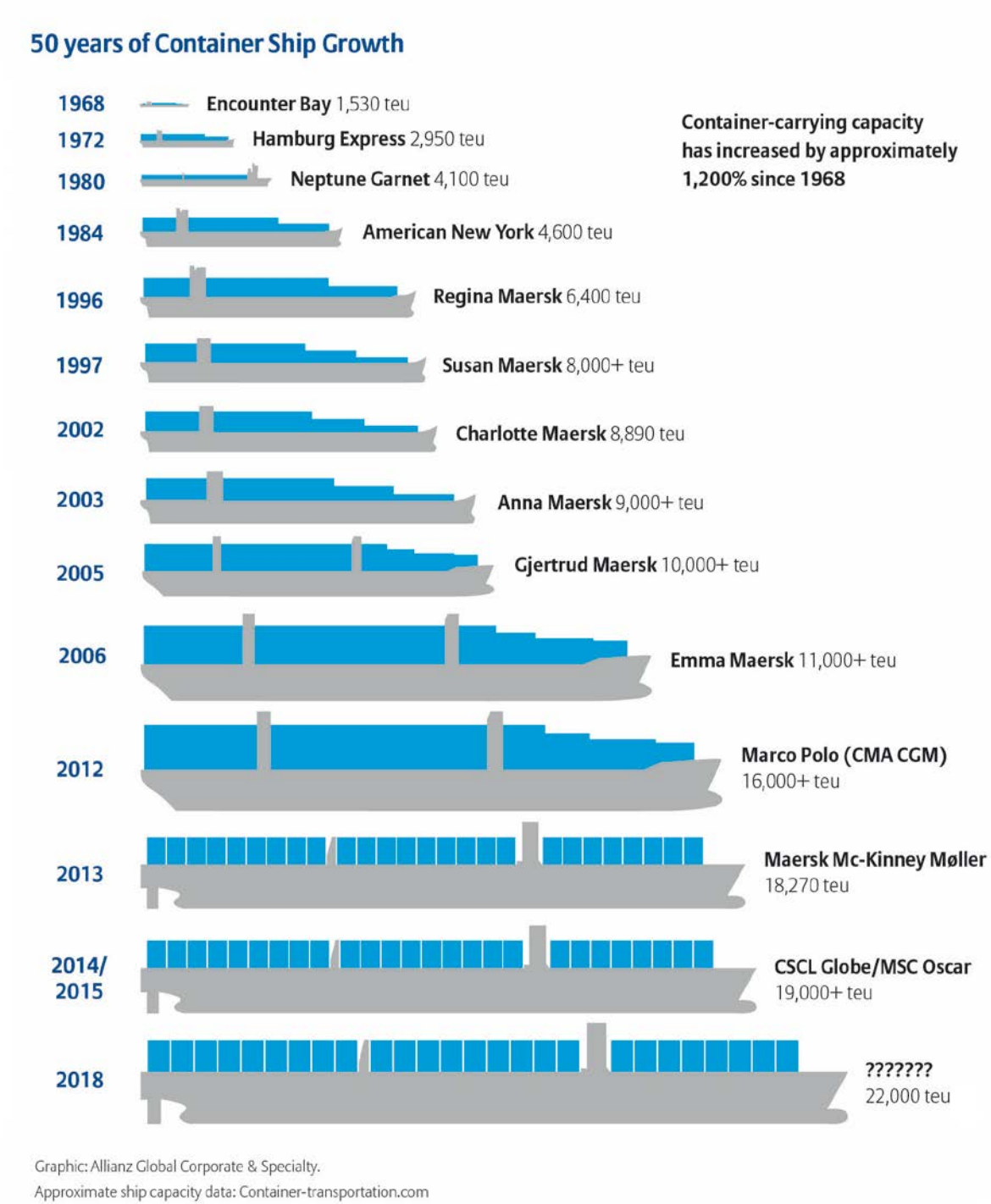
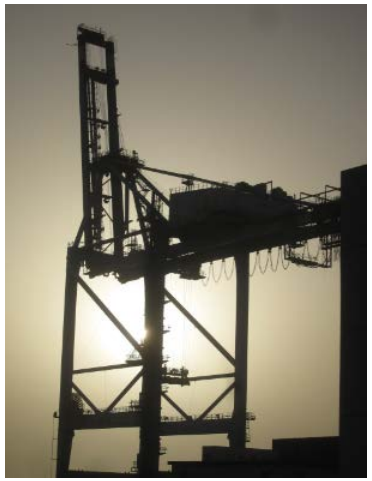
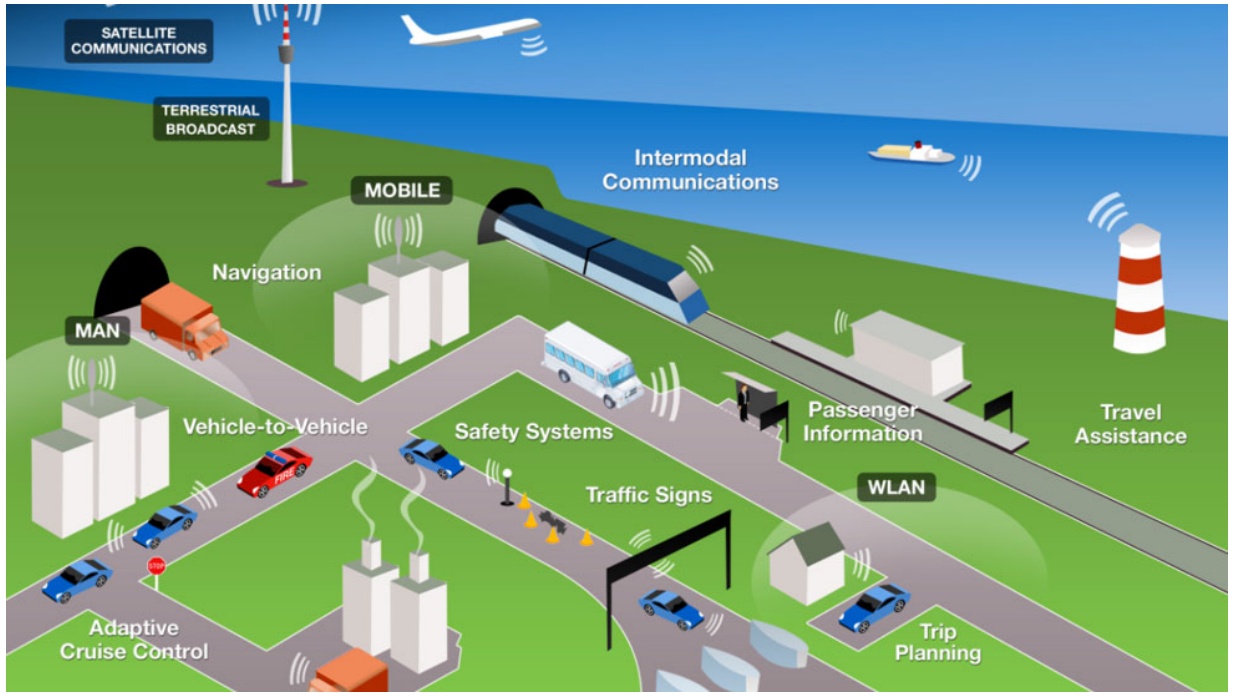
Defeats economy of scale



They can increase automation of processes and data: Better integration into supply chain



Ship and terminal operations



Connected and Automated Transport (CAT)

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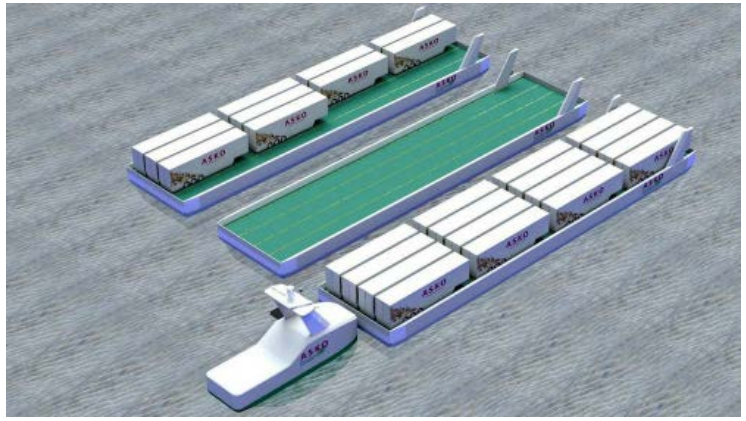
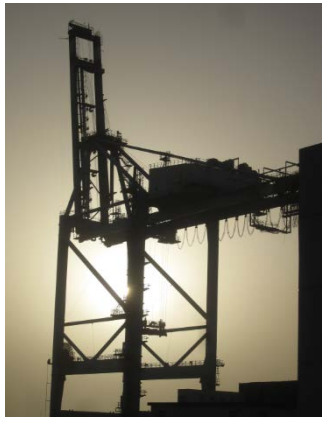
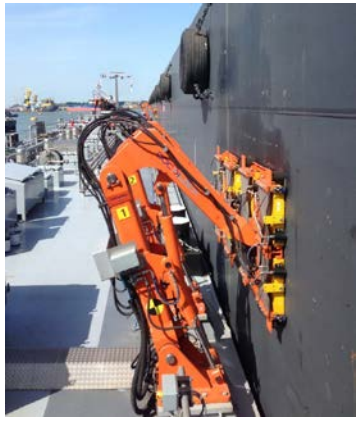
Applications being investigated now

Improving logistics systems







Reducing total logistics costs and environment impact:

- More flexible transport, smaller ports – more frequent
- Less storage in port, warehouse on ship, less cargo lifts
- Integrated logistics, ship is only one component
- More automation, less crew, less occupational hazards

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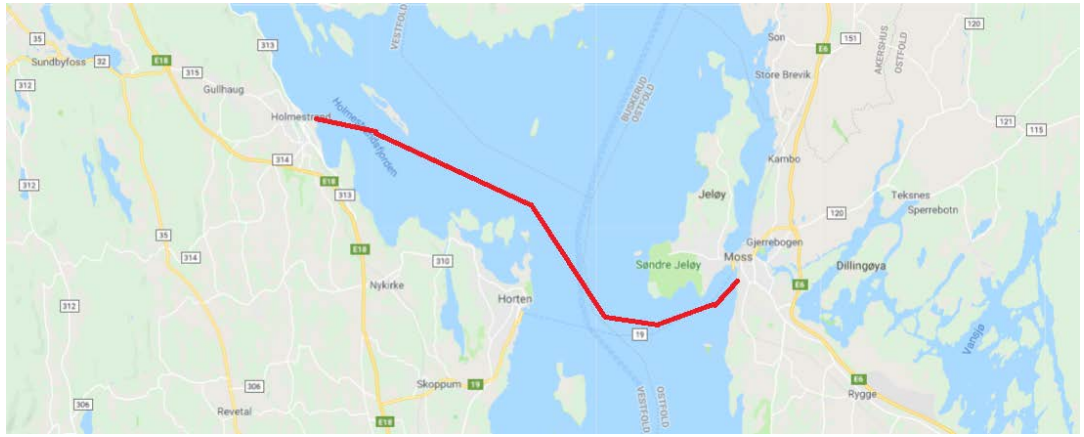
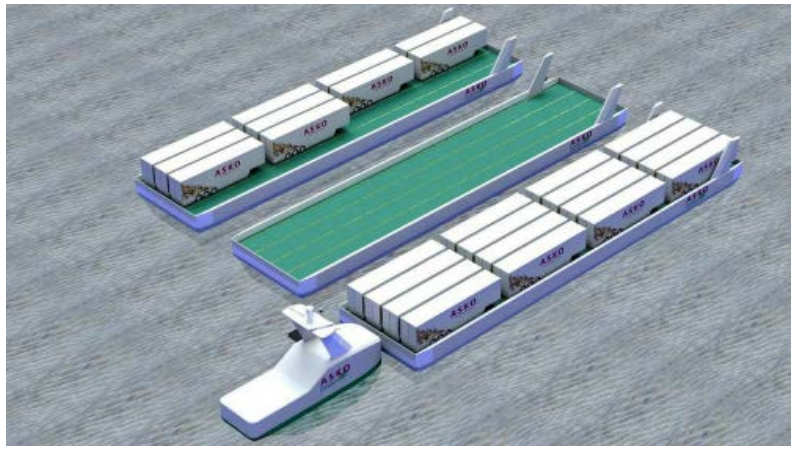
New logistics systems – ASKO cargo ferry

- Connects storages at the opposite sides of the Oslo fiord
- Three "push-barges"
- One "push-tug"
- Parallel loading/unloading of one barge at the opposite sides all the time





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Transfer cargo from road to waterborne

- More flexible transport systems
- Smaller, battery operated daughter vessels
- Higher frequency
- Towards door-to-door transportation


Short Sea Pioneer

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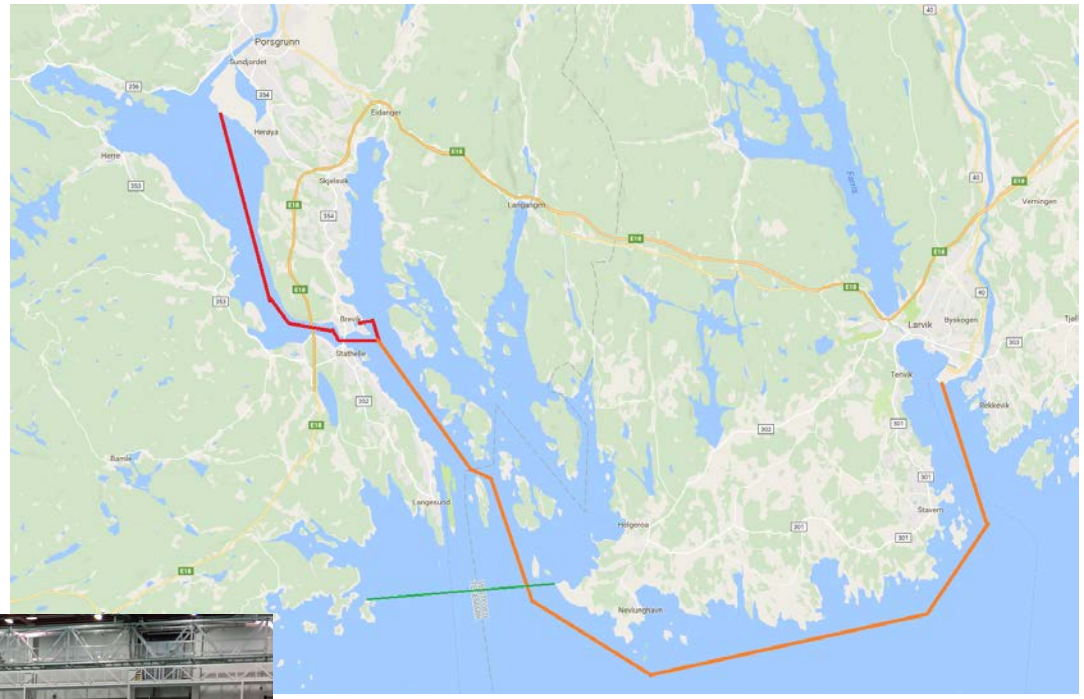
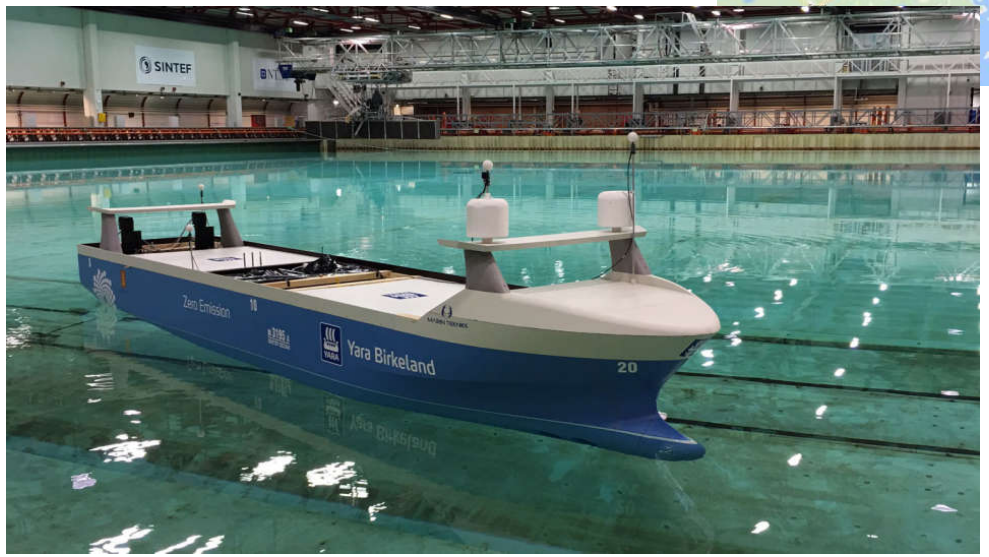
Yara Birkeland

- Yara fertilizer
- Kongsberg partner
- Replaces 40 000 truck trips a year





- Features
  - 100-150 TEU, 70 m x 15 m
  - Batteries – Fully electrical
- Staged implementation
  - Manned after 1 year
  - Remote after 2 year
  - Autonomous after 3 year
- Operational area
  - Herøya-Brevik – 7 nm
  - Herøya-Larvik – 30 nm
  - Within Brevik VTS area

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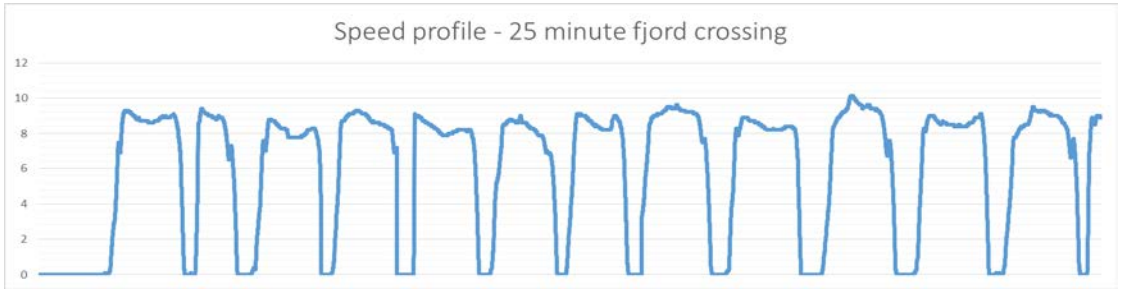
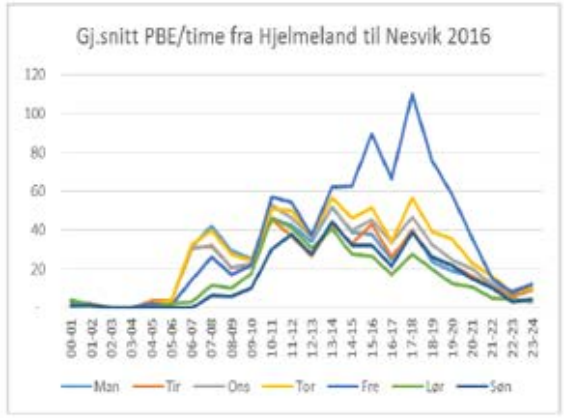
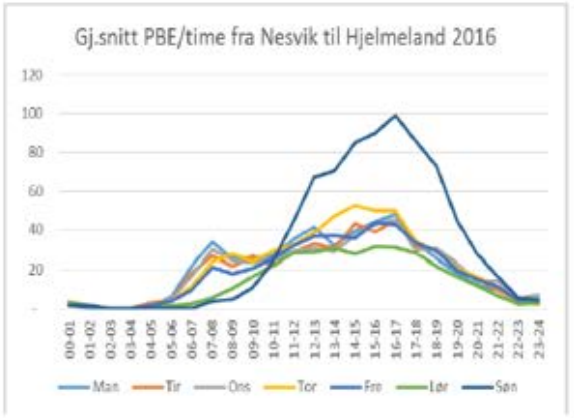
Autonomous highway car ferries







Statens vegvesen

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Better transport services in rural areas

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Better utilization of inland waterways

EFRO: "Autonoom varen in de Westhoek"

Real life demonstration of the state-of-the-art equipment:

- Technical design
- Legal design
- Pilot demonstrations

AGENTSCHAP INNOVEREN & ONDERNEMEN

EFRO EUROPEES FONDS VOOR REGIONALE ONTWIKKELING

Europese Unie

west-vlaanderen de gedreven provincie

West-Vlaanderen, ondernemen op hoog niveau

KU LEUVEN

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Better use of urban waterways

- Avoid bridges
  - Blocks other ships
  - Costly
- Flexible and lower cost
  - On-demand operations
  - 24x7 operation without crew
- Environment
  - Battery operation
  - Silent, no congestion
  - Better use of infrastructure

Amsterdam Roboat, Fotocredits: Moyan Br

Contributes to non-carbon transport solutions

Li-Ion battery: © PBES

1 ton Li-Ion ~ 30 kg oil

Hydrogen fuel cell
© CommScope/Flickr

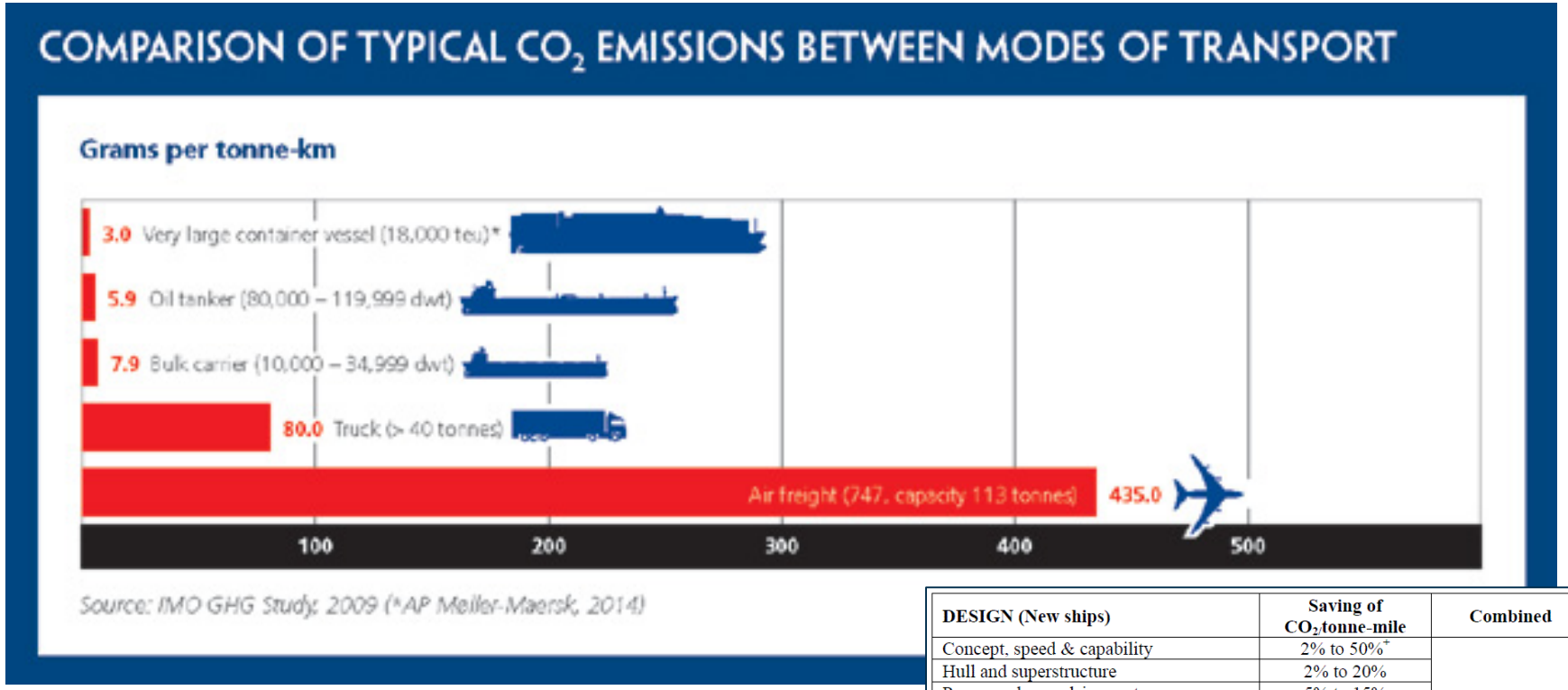
6 liter H_2 (700 bar) ~ 1 liter oil

Green energy generally have low energy density.

High energy efficiency is critical for use of the technology.

Small size ships also helps!

Further improve efficiency of ship transport



DESIGN (New ships)	Saving of CO_2/tonne-mile	Combined	Combined
Concept, speed & capability	2% to 50%+	10% to 50%+	25% to 75%+
Hull and superstructure	2% to 20%		
Power and propulsion systems	5% to 15%		
Low-carbon fuels	5% to 15%*		
Renewable energy	1% to 10%		
Exhaust gas CO_2 reduction	0%		
OPERATION (All ships)			
Fleet management, logistics & incentives	5% to 50%+	10% to 50%+	
Voyage optimization	1% to 10%		
Energy management	1% to 10%		

+ Reductions at this level would require reductions of operational speed.
* CO_2 equivalent, based on the use of LNG.

Aim is to make it 50% more effective by 2050

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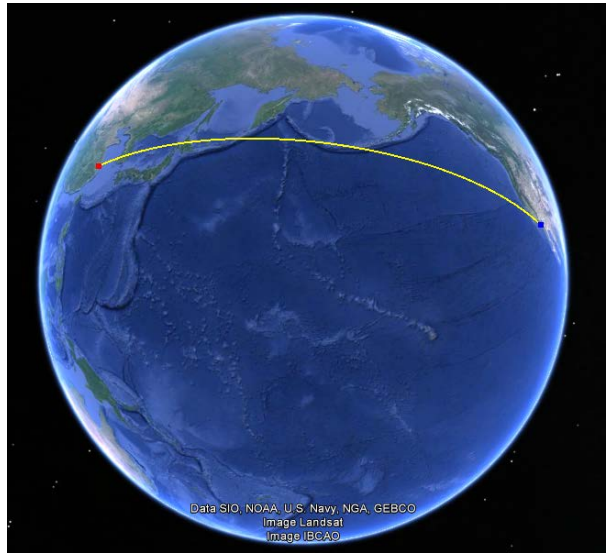
Deep sea is feasible, but not first mover ?

- 10 000 TEU container vessel
- Shanghai – Los Angles
  - Two states involved
  - 6000 nm, open sea
  - No channels
  - Short port approach
  - Remote control to port
- Dual propulsion systems
- Two stroke diesels
- Biofuel, methanol …



… but, autonomous ships are <u>not</u> conventional ships without crew.

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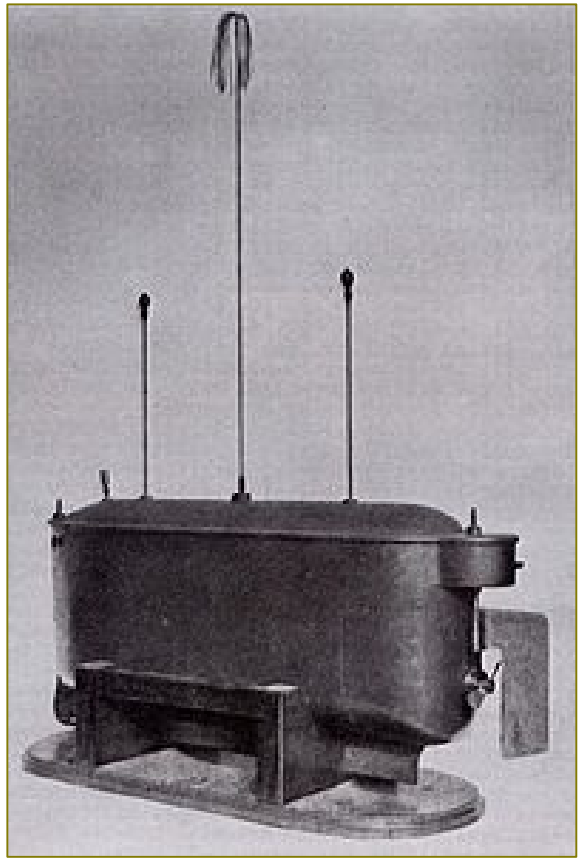
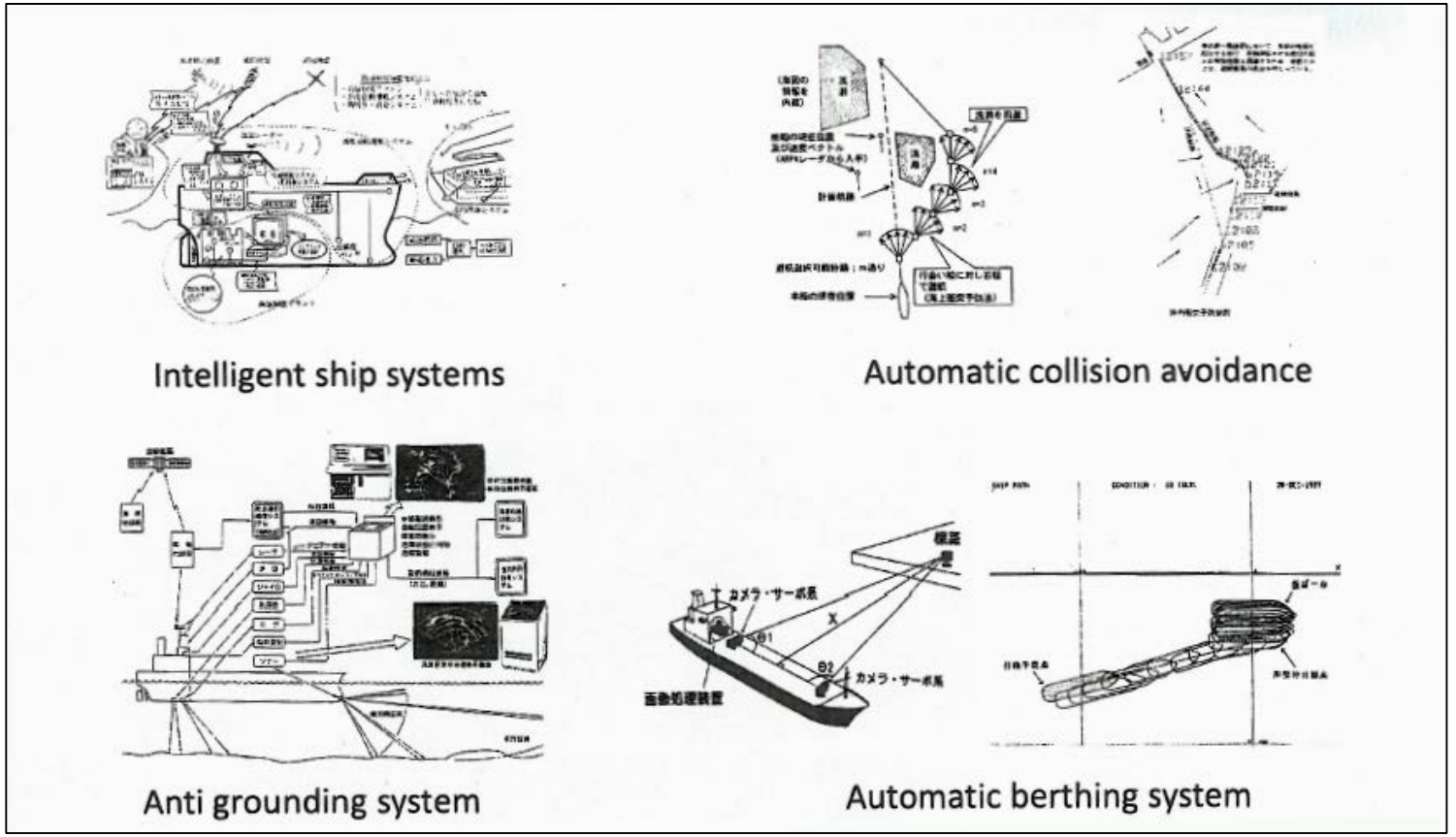
Why now ?

Remote controlled ships are not new!



Nikola Tesla 1898

Various papers in "Bulletin of the Society of Naval Architects of Japan", Vol 721-729



Japan 1982-1988: Highly reliable intelligent ship project

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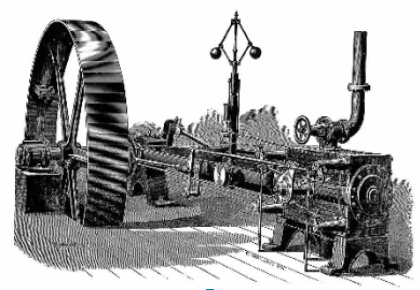
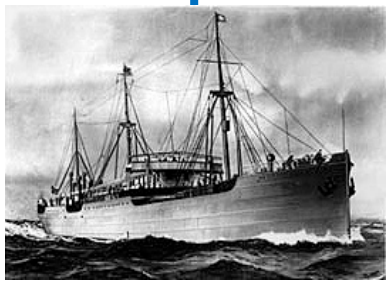
The fourth shipping revolution is on



1800 1900 1970 2010

1. Mechanized Power



2. Mass Production

3. Computerized Control

4. Shipping 4.0

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Shipping 4.0 and game changers

Enabling technology

Technology with impact

Game changers

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MUNIN: A concept study for a fully unmanned handymax dry bulk carrier on intercontinental voyage.

- Duration: 01.09-2012 – 31.08.2015
- Funding: 2.9 million EUR of budget 3.8 million EUR
- Activity code: SST.2012.5.2-5: E-guided vessels - the 'autonomous' ship

http://www.unmanned-ship.org/munin/

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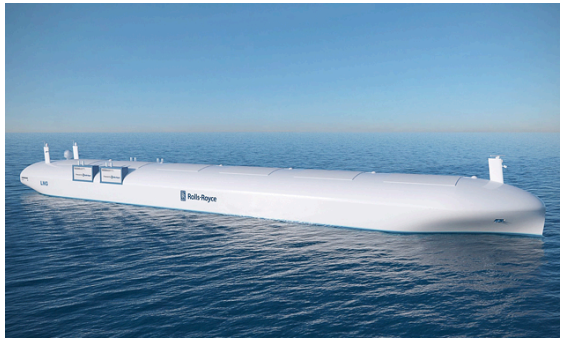
Followed by high interest and new concepts



Naval Architects

Discussions Promotions Jobs Members Searc

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Rolls-Royce is building Unmanned ships

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Rolls-Royce is buildir

Maritime news - Vess

Holding of Rolls-Royc

vessels (drones), whi

controlled by real ship captains, through

NDR Das Beste am Norden

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Can Futuristic Unmanned Cargo Ships Sail Without Seafarers?

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data into invaluable insight

CURITY » YOUR SAY ON 'UNMANNED SHIPS'

Your say on 'unma

Electronics Weekly.com

Breakthrough Technology

News Blogs Multimedia Companies

here: Electronics Weekly > News > Business > Viewpoints > Unmanned

DIE WELT

Unmanned, networked, intelligent ships navigate familiar water

no comment david manners 7th March 2014 Get news by email

Bloomberg

Newsweek

WORLD BUSINESS TECH & SCIENCE CULTURE SPORT NEWSWIRE THIS WEEK"

Meet the Sponsors Behind the People Already in Line

Court Rules Yelp Can Manipulate Ratings for

Pirated Copies of The Sims 4 Contain a 'Nudity Glitch'

Fake Cell Towers Allow the NSA and Police to

Hamburger Abendblatt

eNav INTERNATIONAL

Are Unmanned Vessels the Future for the Ocean?

By Michael Carroll / July 3, 2014 5:09 AM EDT

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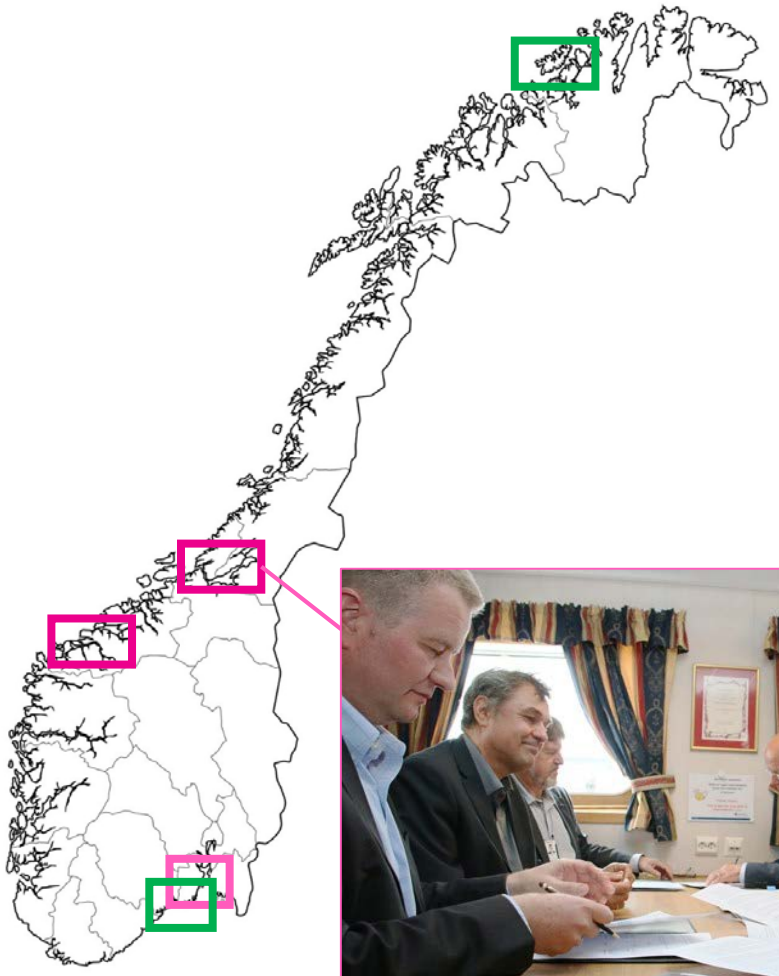
Test area Trondheimsfjorden



- **Established September 30th 2016**
  - Industry, university, research
  - Port of Trondheim
  - Norwegian Maritime Administration
  - Norwegian Coastal Administration

- **Area covers Trondheimsfjorden**
  - Permits
  - Instrumentation and communication
  - Exchange of experience

http://navtar.no/

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Norwegian Forum for Autonomous Ships

- Established October 4th 2016
- Operated as a joint industry project at SINTEF Ocean.
- General Manager is Mr. Ørnulf Jan Rødseth.
- A board of governors overseeing operations. General assembly approves budgets and strategies.
- 45 Institutional Members
  - Including Industry, authorities, class, insurance research, universities, ports …
  - 2 other institutions as personal members

NFAS Norsk Forum for Autonome Skip

http://nfas.autonomous-ship.org

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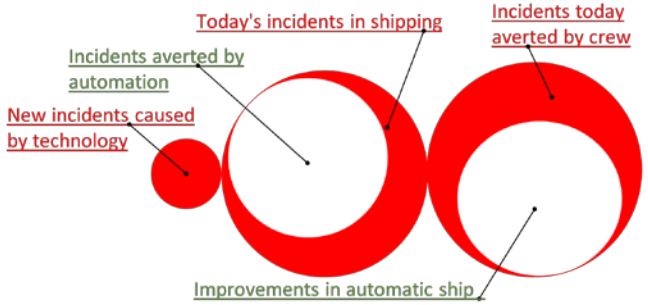
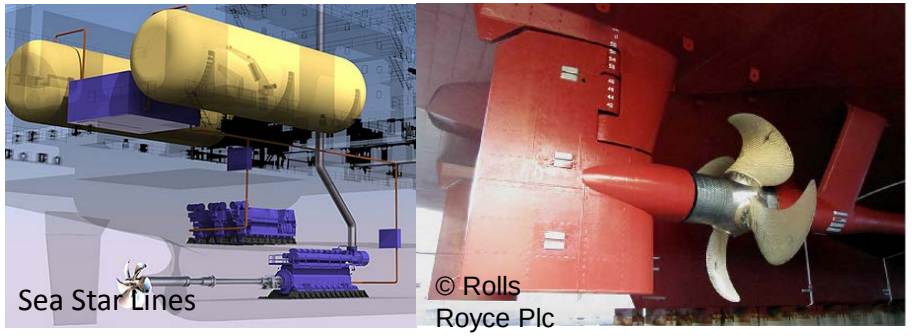
What are the limitations?

Unmanned ships come at a cost …

More expensive sensors and control system – cyber security

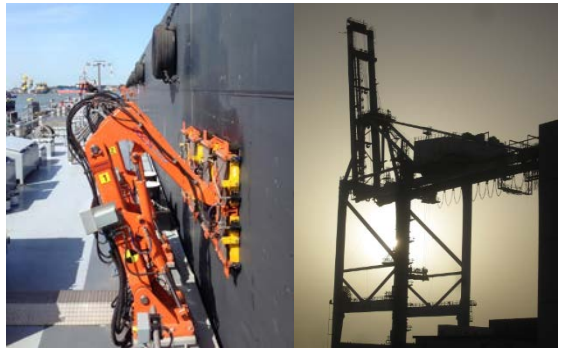


Unclear risk picture and higher safety requirements



No crew onboard: No HFO, more redundancy, more costly maintenance

Continuously manned shore control centre



More and automated shore infrastructure

Long time until international legislation is in place.

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It rules out tramp/voyage charters!

Because:

- Needs special infrastructure in port
- Needs trained personnel
- Needs agreement with port state and port
- Modifying this type of ship is too expensive

However, these factors will change with time!

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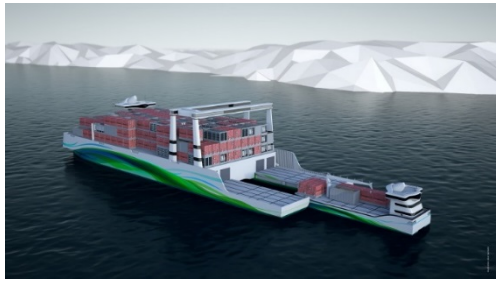
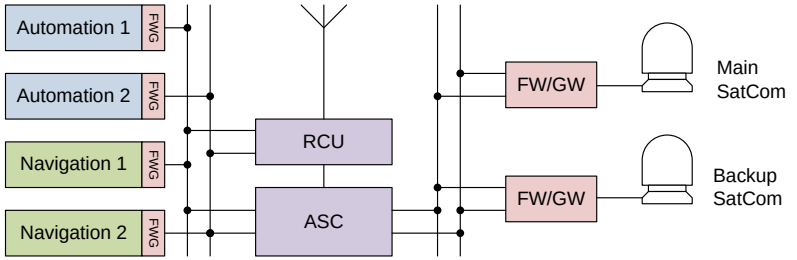
We need a good business case!

New logistics

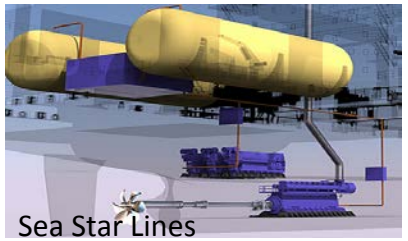


Improved operations

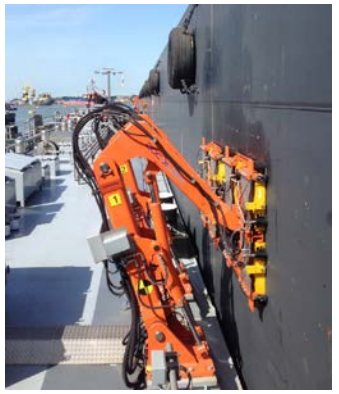
Some reduced costs



More complex ship systems



Reliability: No maintenance on board



Shore Infrastructure

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SINTEF Ocean's priorities

International networks

INAS
International Network for Autonomous Ships

NFAS Norsk Forum for Autonome Skip

UK Marine Industries Alliance

OZT Study Group Japan

"Smart Ship Coalition" in the Great Lakes region in USA and Canada

Strategic Transport Research and Innovation Agenda - STRIA

ONE SEA
AUTONOMOUS MARITIME ECOSYSTEM

KAUS

Korea Autonomous and Unmanned Ship Forum

Systems and Components for Autonomous Ships - SCAS

IMO scoping exercise correspondence group

ISO

Concepts and terminology for MASS

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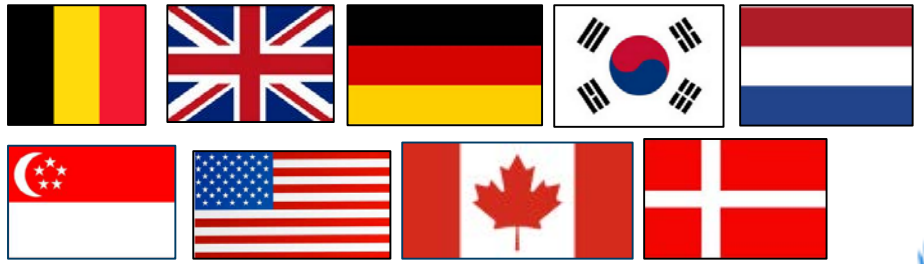
Participate in international developments

NFAS Norsk Forum for Autonome Skip

INAS International Network for Autonomous Ships



IEC ISO IALA UNECE

Consultancy, technical foresight, standards …

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International projects and networks

SKAS

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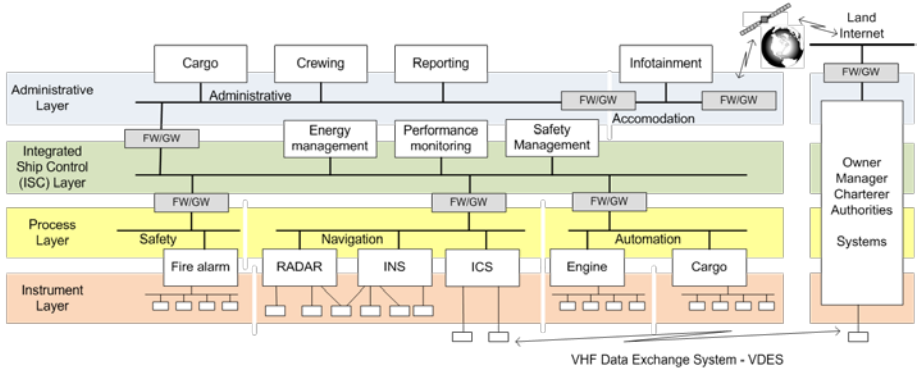
National projects

EU projects

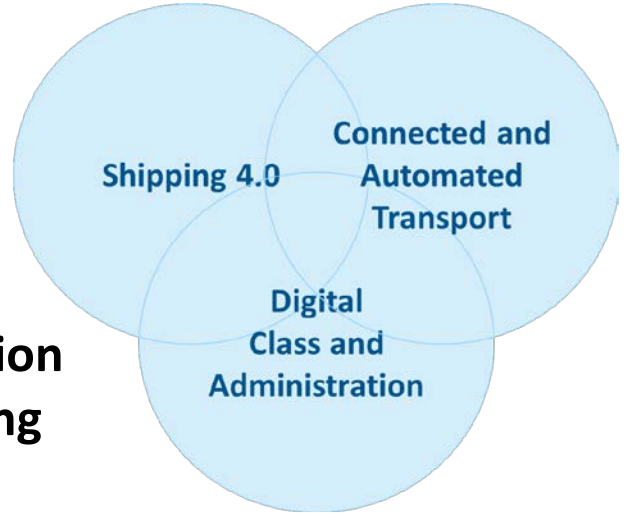
International alliances

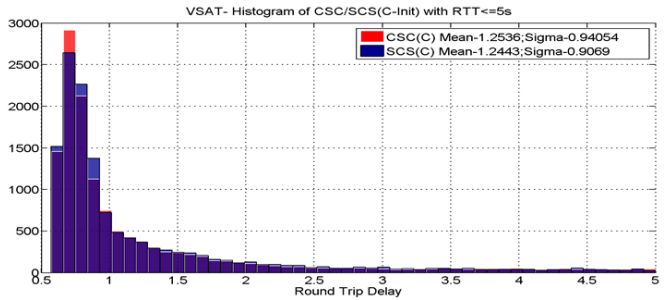
Technology development



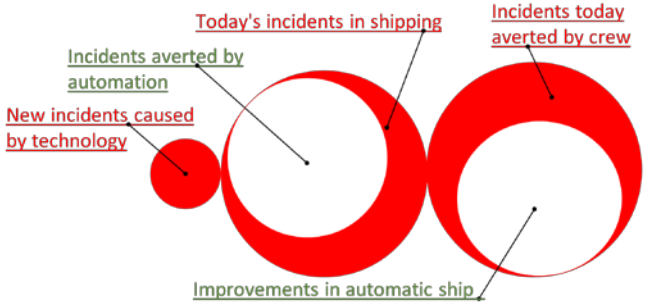
Integrated ship control

Information modelling

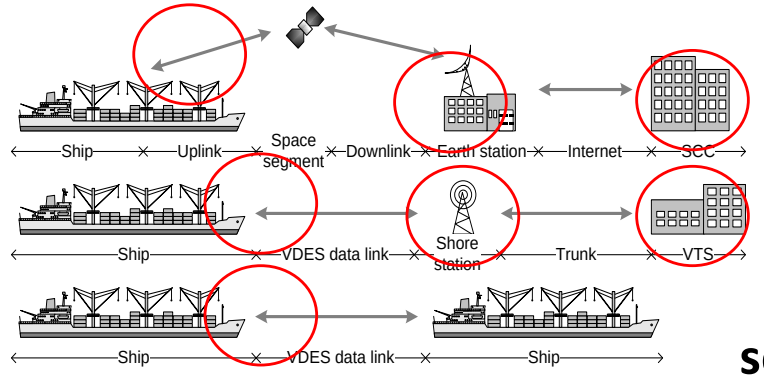




Satellite communication QoS



Technical and operational safety

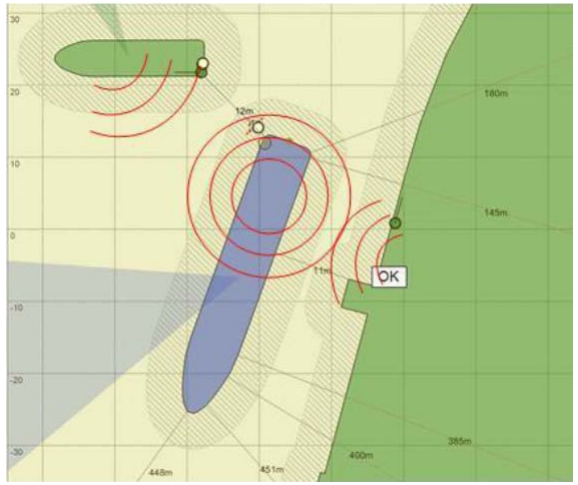


Cyber security

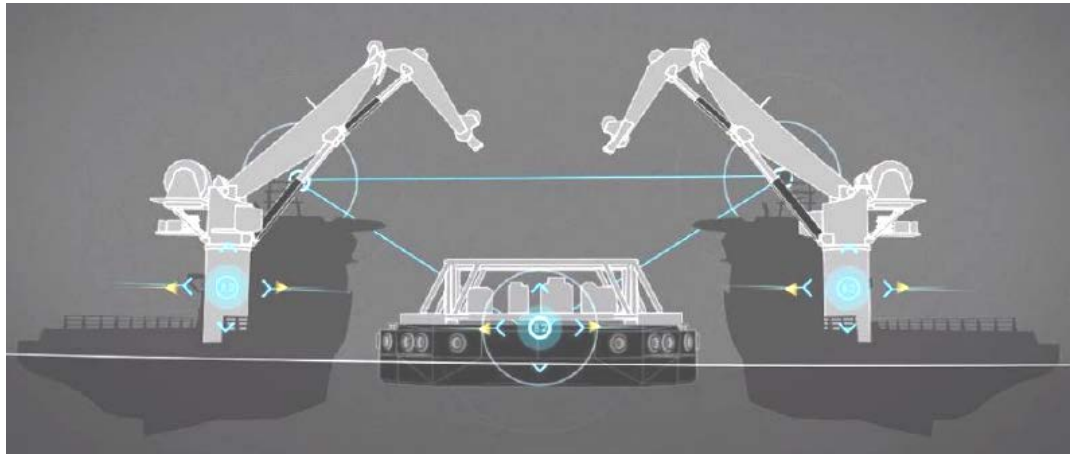
Together with other institutes in SINTEF.

SINTEF

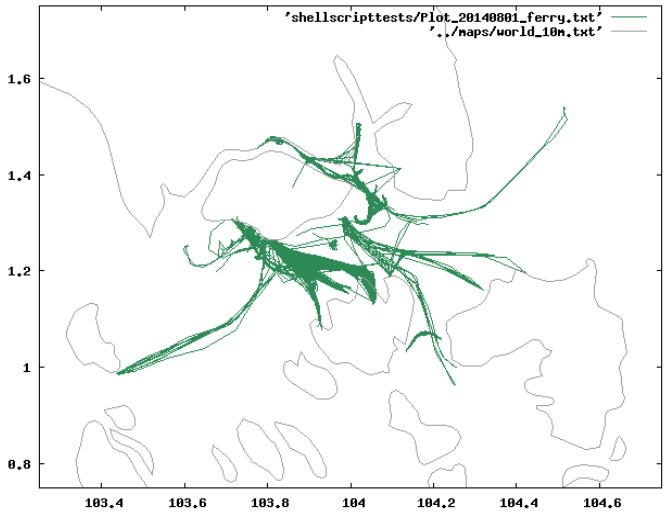
Advanced automatic control



Exact ship control



Ship-ship and ship-port interaction

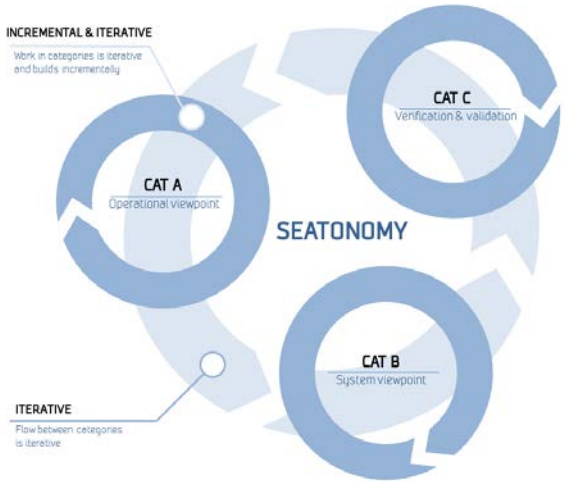


Prediction of other ship behavior

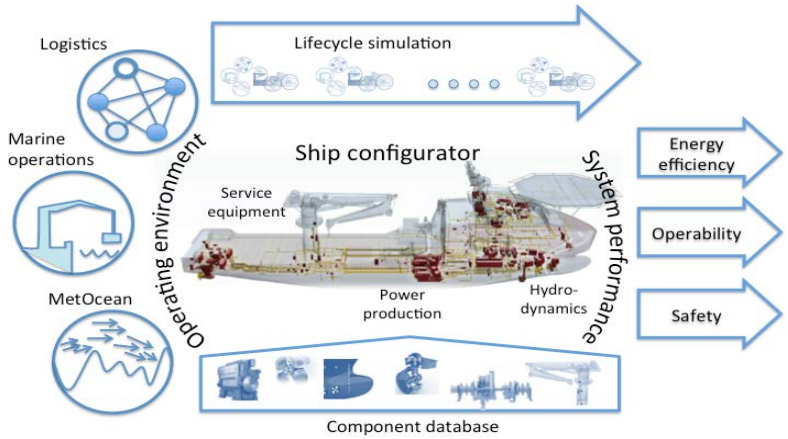
SINTEF

Concept analysis and early design

SEA TONOMY



Iteratively look at the operational issues in the context of the system design and vice versa.



Combined with operational simulations and CBA.

RISK OUTCOME
Low
Moderate
Significant
High

Likelihood	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain 5	5	10	15	20	25
Likely 4	4	8	12	16	20
Possible 3	3	6	9	12	15
Unlikely 2	2	4	6	8	10
Rare 1	1	2	3	4	5

Risk reduction methods covering both operation and design.

Provide good quality estimates of feasibility and general system design.

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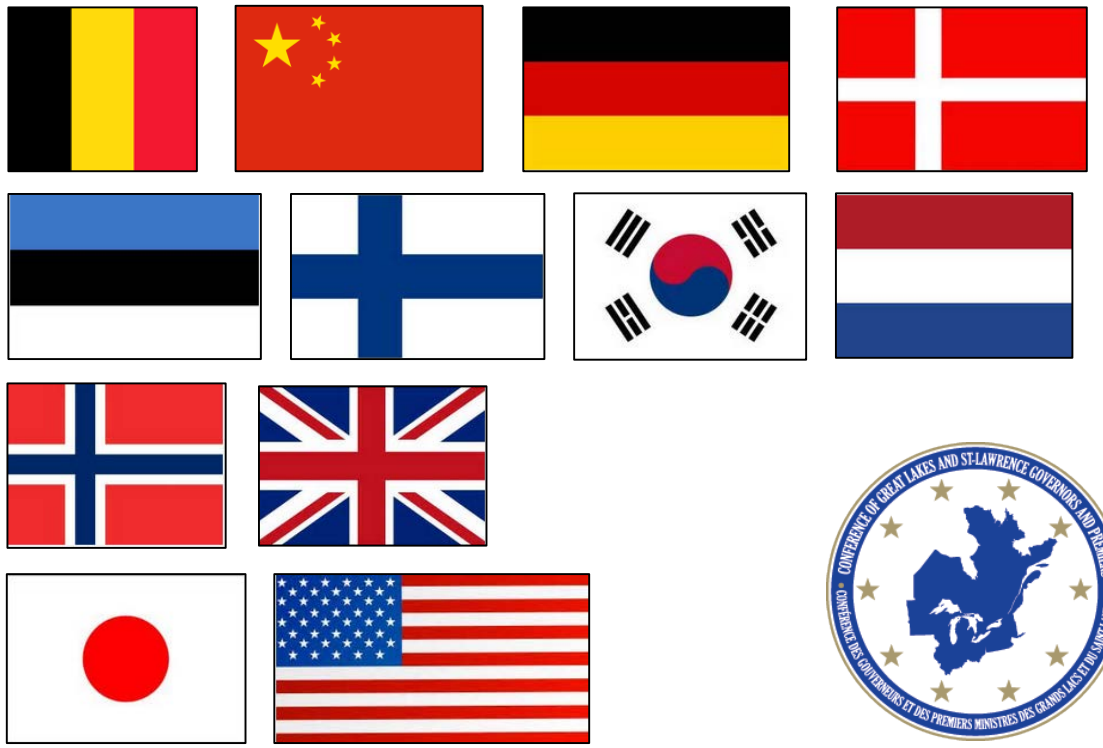
What's next?

International Network for Autonomous Ships

- Agreed on at meeting in Oslo Oct. 30th 2017
- Hosted by NFAS and SINTEF Ocean
- 22 participants at meeting
- 2 correspondent countries
- First inland meeting in Trondheim November 6-7



http://www.autonomous-ship.org/

The 1st International Conference on Maritime Autonomous Surface Ship (ICMASS 2018)

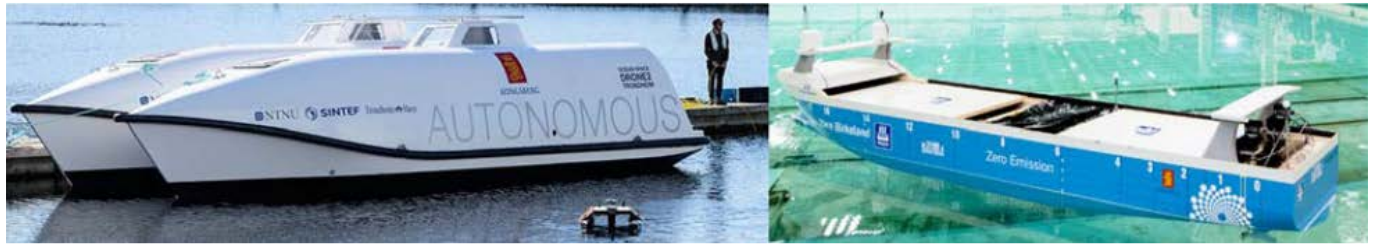
IMPORTANT DATES

September 1, 2018: are required to send an abstract (≤ 200 words, excluding author's name, affiliation, address, telephone number, email address, title of paper, and 5 key words) by this date. The abstract shall be submitted to leeki@kmou.ac.kr.

September 10 Acceptance notifications will be emailed by this date. If your paper is accepted, you have the opportunity to deliver a 20-minute presentation or prepare a poster.

September 30, 2018: Camera ready final papers (≤ 2 pages excluding references) must be submitted by this date.

November 8-9, 2018: ICMASS 2018 at Busan Exhibition and Convention Center (BEXCO), Busan, Republic of Korea.



www.icmass2018.org

www.autonomysummit.com

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