Cars and MASS: Which are safe enough?

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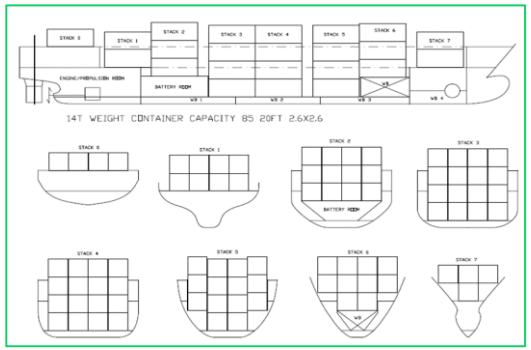
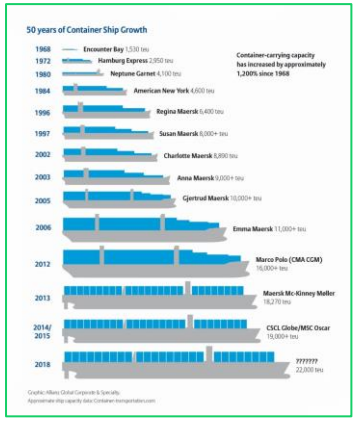
September 7th , SMM Hamburg

Uncrewed ships can improve transport systems



Less energy/cargo unit



Defeat economy of scale

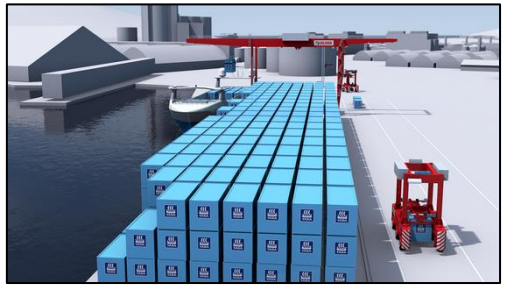
Feeder services

Small island services

Urban waterway transport

Reduce road transport

Increase resilience



Improve port efficiency

Autonomy in cars versus ships

Can shipping learn from autonomous cars?

Wikimedia commons: Rmhermen

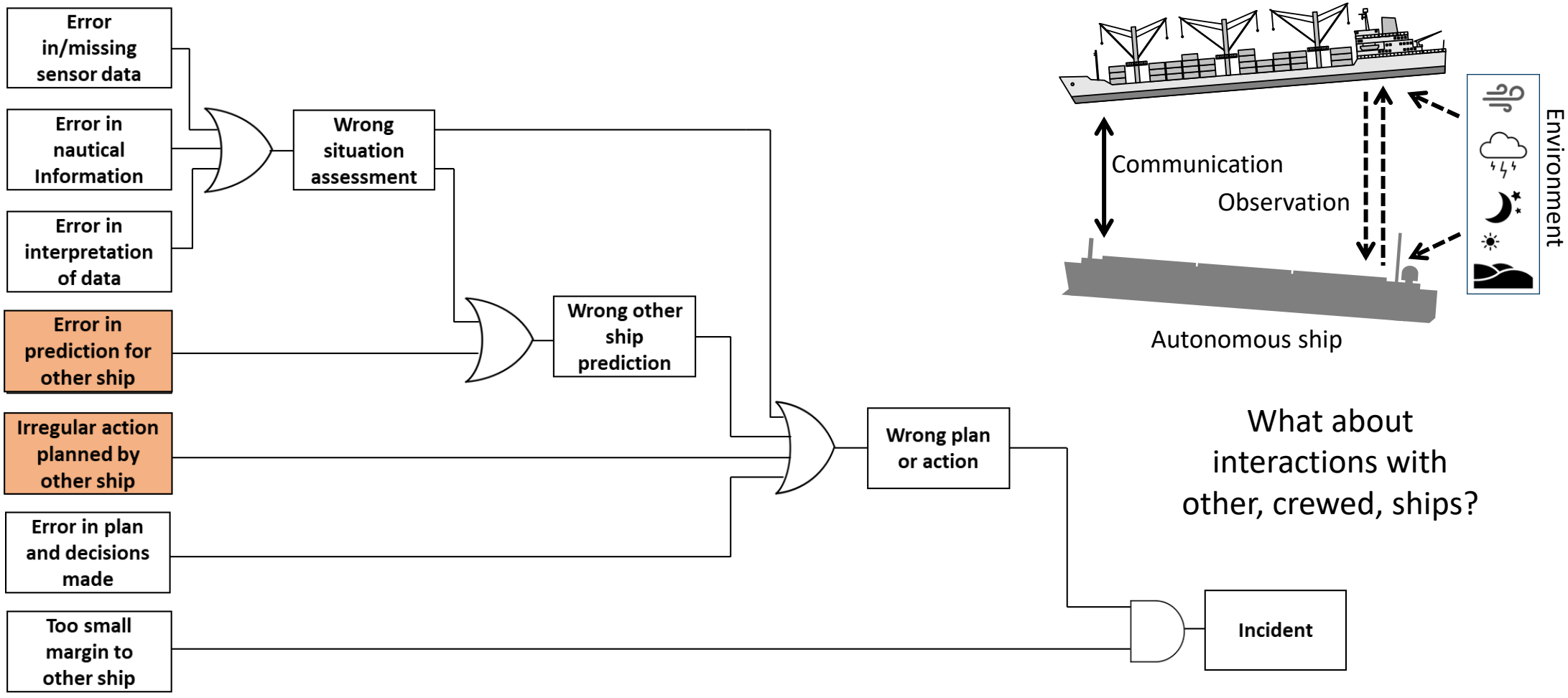
There are important differences

	Cars	Ships
Cost (€)	20 000	20 000 000
Voyage duration (days)	<1	1-45
Crew	1	~10
Typical transit speed (km/h)	100	30
Digital communication distance to base	500 m	5 000 km
Obstacle detection range	50 m	6 000 m
Crew reaction time	2 sec	12 min
Legal framework	National	International
Number of vehicles in the world	1 300 000 000	96 000

It is cost-effective to use an RCC for ships

It is possible to use humans to assist automation in ships

MASS will not be fully independent of human



This may also apply to cars?

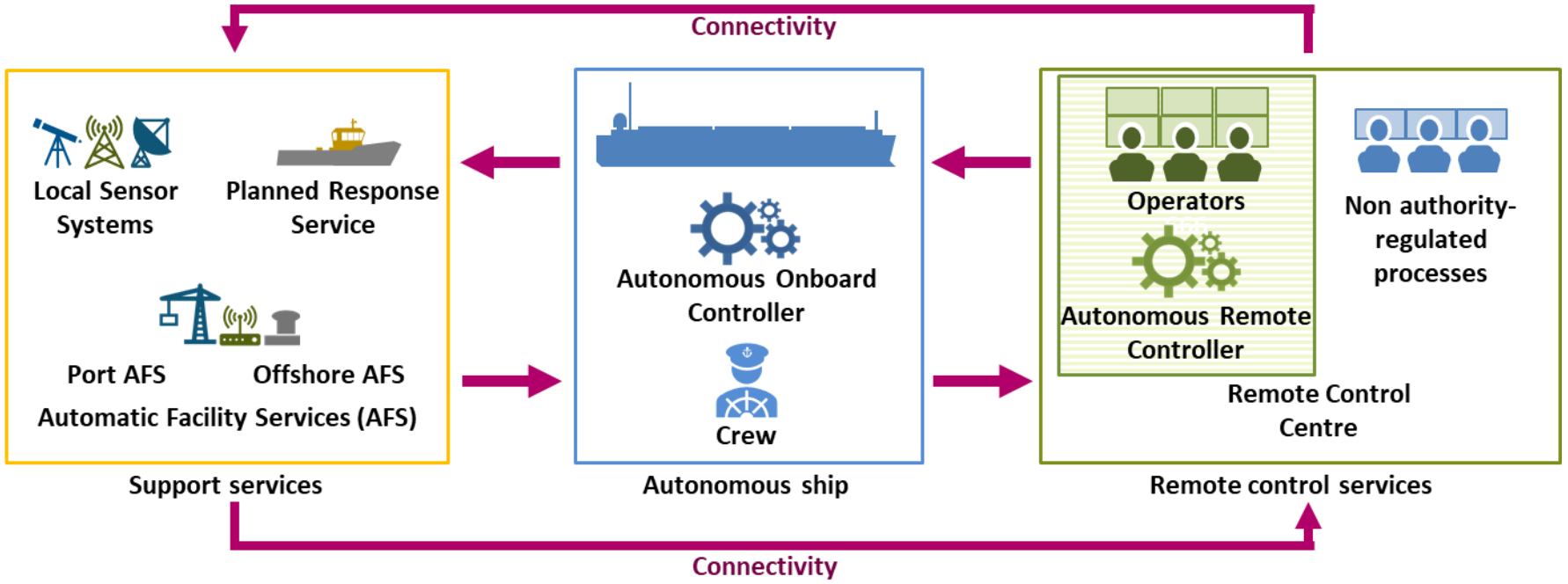
- DDT: Dynamic driving tasks.
- OEDR: Object and Event Detection and Response, part of DDT.
- ODD: Operational Design Domain: What the automation can do.

- Not defined exactly when driver needs to take over, except level 5 (never).

#	Name	DDT basic	OEDR	Fallback	ODD
0	No automation				
1	Driver assistance				
2	Partial driving automation				
3	Conditional driving automation				
4	High driving automation				
5	Full driving automation				

British Standards Institute (2020). *BSI/PAS 1883:2020 Operational Design Domain (ODD) taxonomy for an automated driving system (ADS) –Specification*, BSI

MASS: Maritime autonomous ship system



The Autonomous Ship System:

- The ship
- The automation
- The humans
- The support systems
- The connectivity

Autonomous ship: New paradigm in human-automation interface!

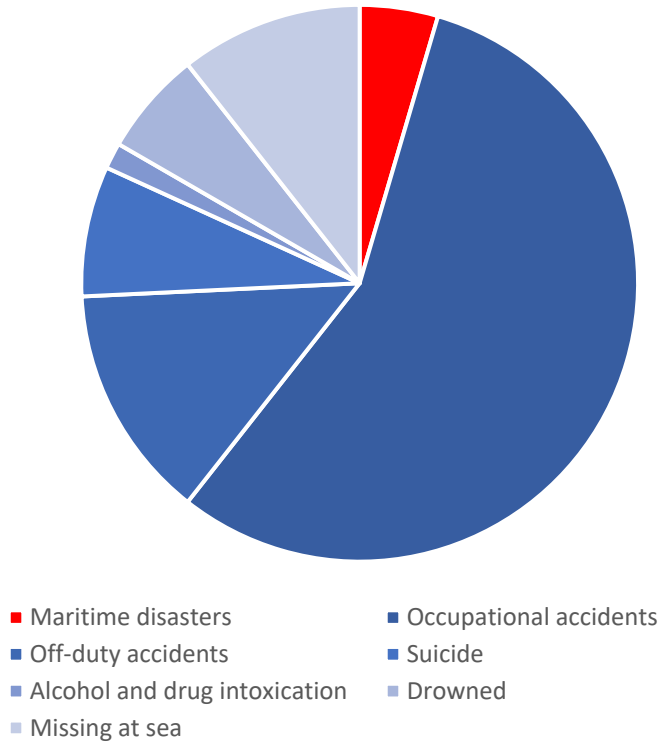
- Automation and human cooperates! Both can be in control, but only one at a time.
- When automation is in control, it has to be in control!
- Must safely hand over control: Trust in automation!

Will this work for autonomous cars?

At least as safe as …

Most fatalities from occupational accidents!

Seafarer fatality UK 2003-2012



S. E. ROBERTS *ET AL*.: Fatal ACCIDENTS AND INJURIES IN MERCHANT SEAFARERS

European Maritime Safety Agency

The following main points should be noted:

- There were 108 fatalities and 568 people injured in the study period (2011-2019), with a percentage variation between 2019 and 2018 showing a decrease for both fatalities (-73%) and a much less pronounced decrease in injuries (-15%).
- Around 80% of the marine casualties and incidents concerned a “fall of persons”, “loss of control of equipment” and “body movement”.

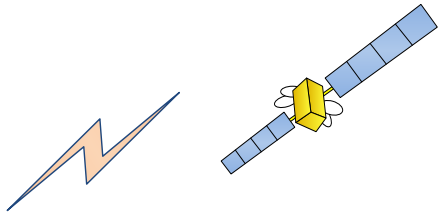
EUROPEAN MARITIME SAFETY REPORT 2022

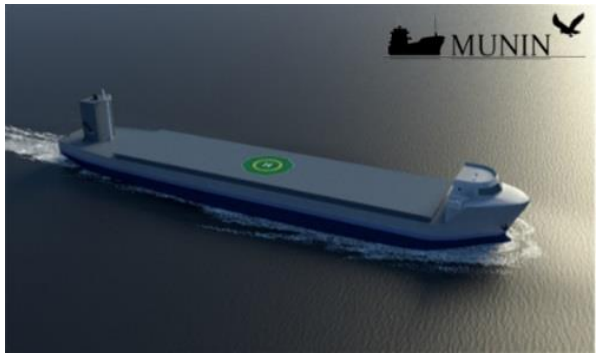
EMSA

There is also a human in the loop to handle complex or unexpected problems

- Unlikely that larger ships is operated without RCC.
- It is difficult to automate all forms of ship operations, so RCC operators will assist.
- Proper design of human-automation interface is required!

What if communication is lost?





- Jamming is the easiest cyber attack.
- If ship stops when communication is lost, this becomes an attractive attack point.
- It will be necessary to create fallbacks where ship continues as long as the automation deems it safe.

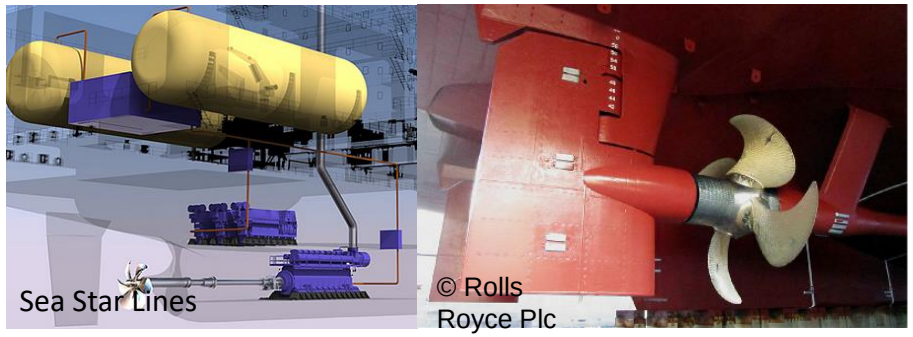
What if other main function is lost?

Smit salvage

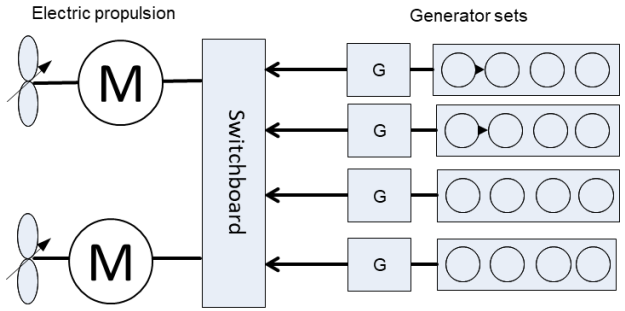

CHC helicopters

- This happens also to other ships.
- Autonomous ships will use less maintenance intensive technology.
- Anchors still work.
- A matter of minimizing salvage costs.

What about maintenance?



No HFO, more redundancy

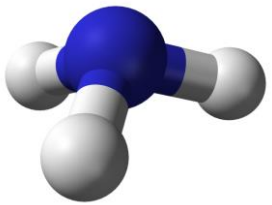


Electric propulsion, replaceable GC

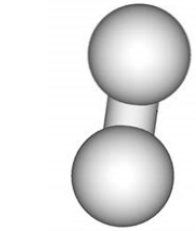
- Ships will be built for no maintenance under operation
  - Batteries, better fuels
  - Electric propulsion
  - Fewer rotating machinery
  - Rapid replacement in port

- However, it has to be cost effective.
  - Trade-off with cost of salvage.

Uncrewed: Total loss may be acceptable!



Ammonia

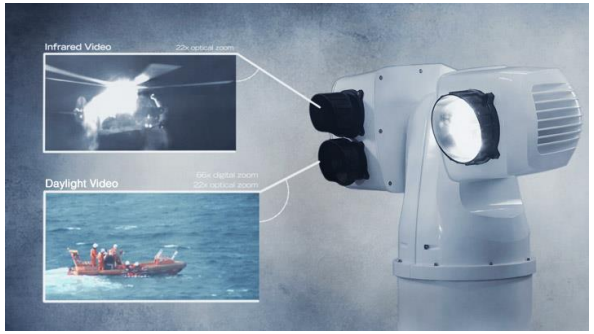


Hydrogen

- No crew: No loss of life
- No harmful substances: Limited environment impact

- New dangerous fuels like H_2 and NH_3 may also better be used on uncrewed ships.

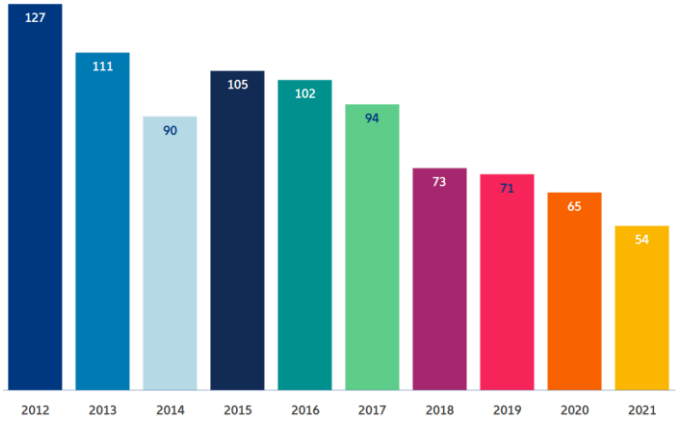
What about small crafts (leisure/fisheries)?



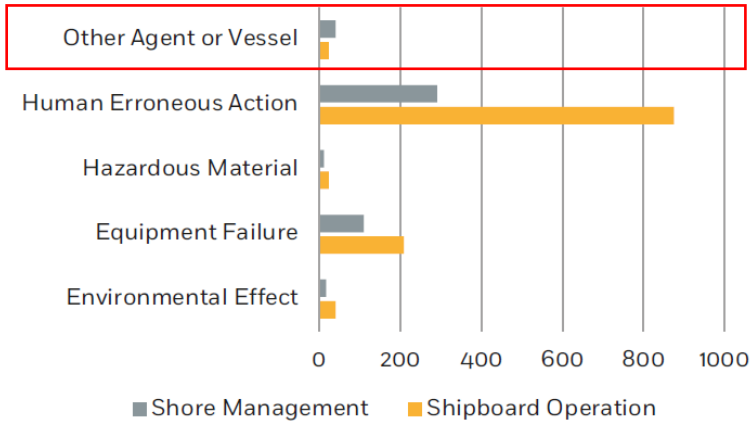
- Better sensors
- RCC as backup when in doubt

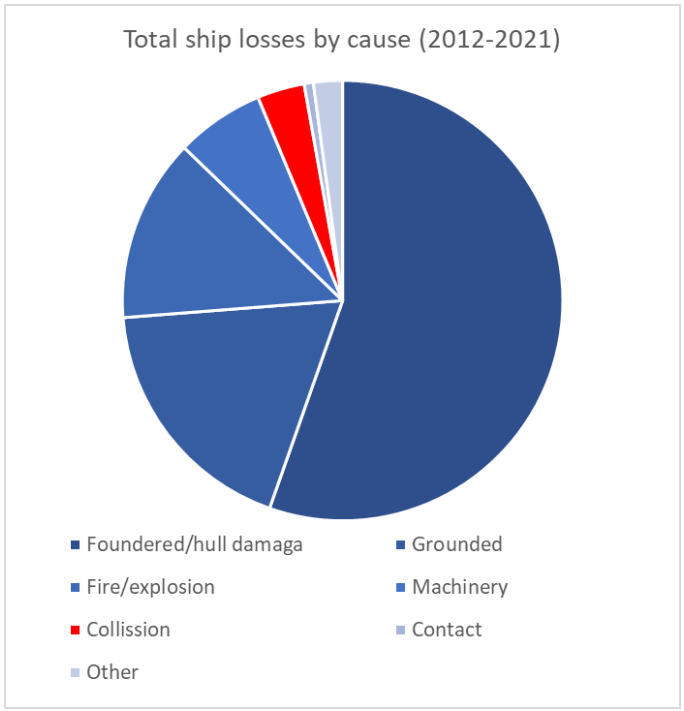
- Large ships have limited manoeuvrability
- Smaller ships must take care also today

Safe enough, at a reasonable cost



Total losses/year (Lloyd's List/Allianz)



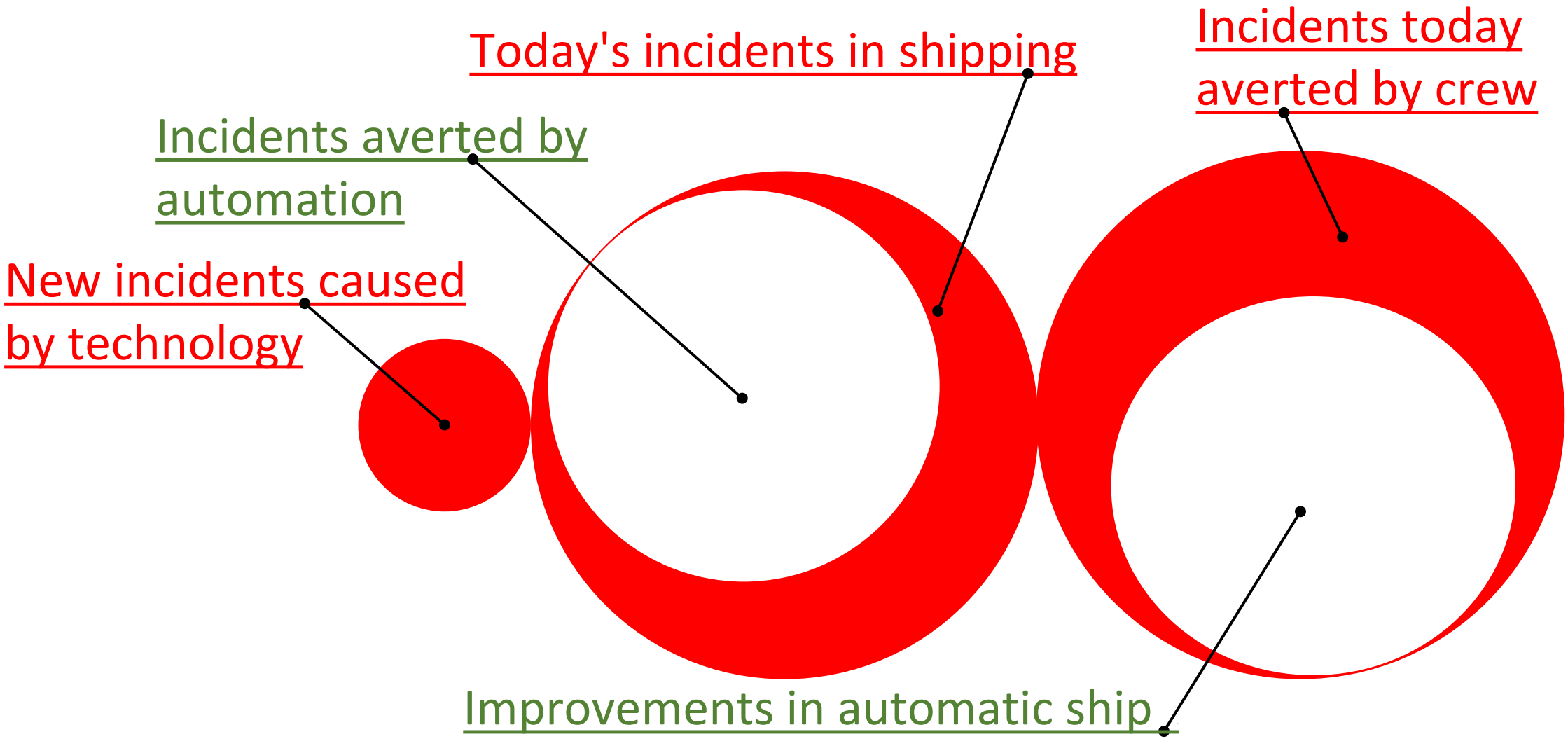


Causes for total losses

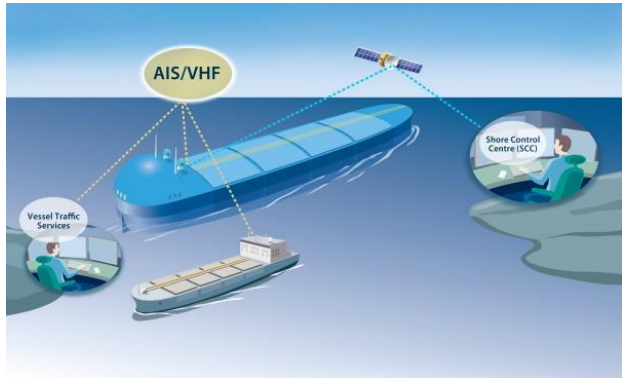
- Safety is increasing with modern ships and operation
- Problem seems mainly to be on own ship
- How to avoid that external causes increase with autonomous ships?

EMSA: Annual Overview of Marine Casualties and Incidents 2016 – Root cause of accident

However, we do not have the full picture



Conclusions



- Ship autonomy has merit and will be more useful than autonomy for cars today
- Ship autonomy requires **cooperation** between humans and automation
- Autonomous ships must be safe enough, but cost needs to be considered
- Still unanswered questions with respect to the role of humans

SINTEF

Thank you for your attention!

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