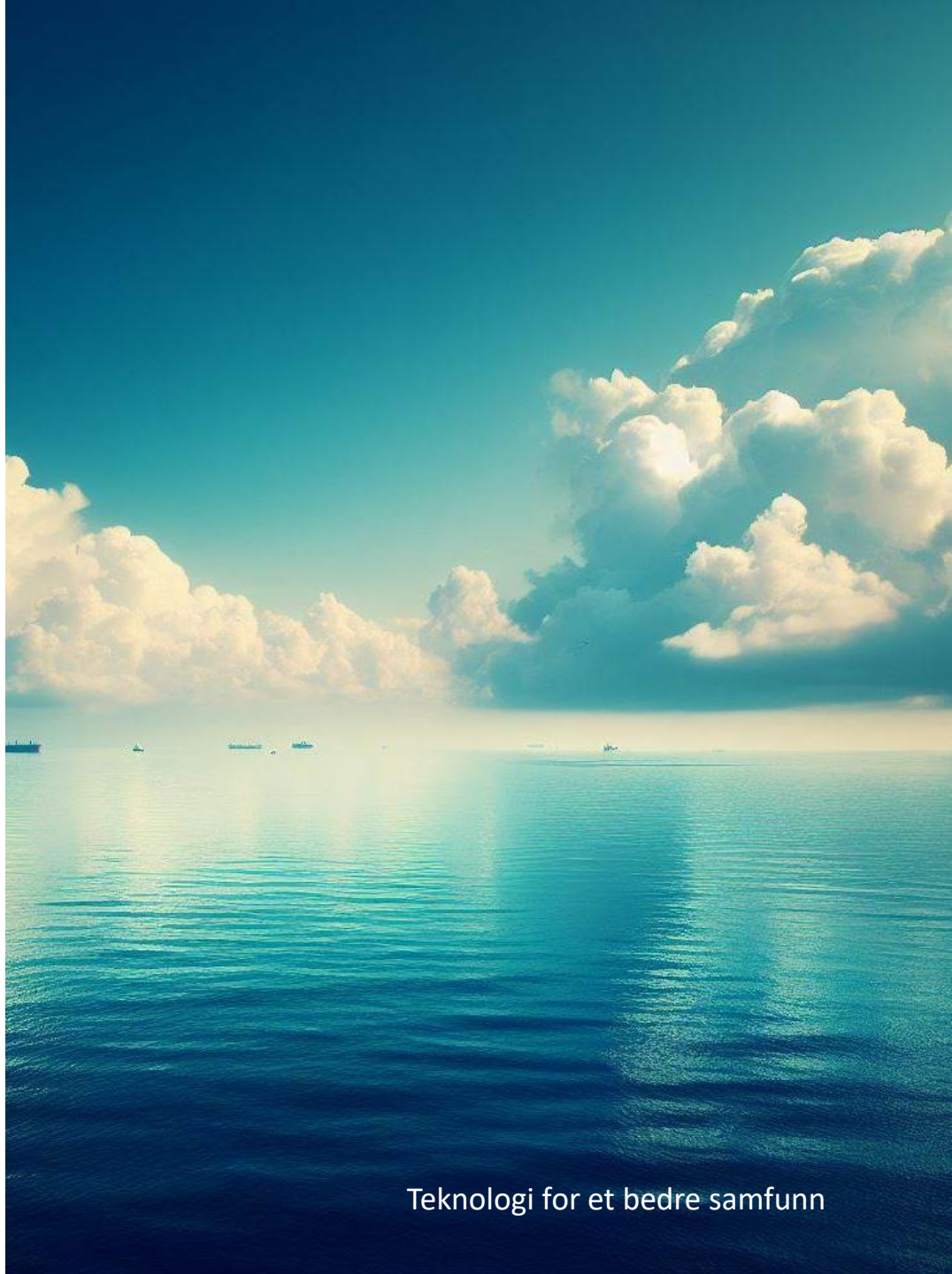
Formell beskrivelse av samhandling mellom ROC og automasjon.

Lars Andreas Lien Wennersberg, SINTEF Ocean

Åpen fagdag - Norsk forum for autonome skip, 16. November 2023.

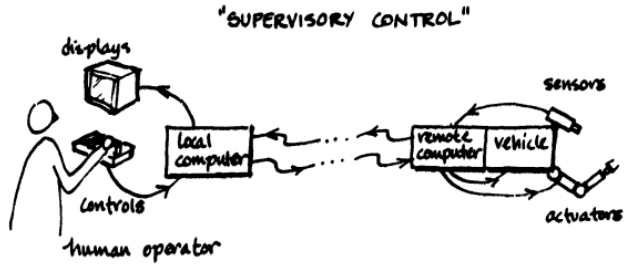
Agenda

- Hva innebærer begrepet autonomi for teknologiutvikling og dokumentasjon?
- Konsepter for beskrivelse av MASS og samhandling mellom ROC og automasjon. Hvor autonomt?
- Eksempel fra prosjektet Smartere Transport Møre og Romsdal.



Hva er autonomi?

Sheridan and Verplanck (1978)



Autonomy Levels for Unmanned Systems (ALFUS) Framework

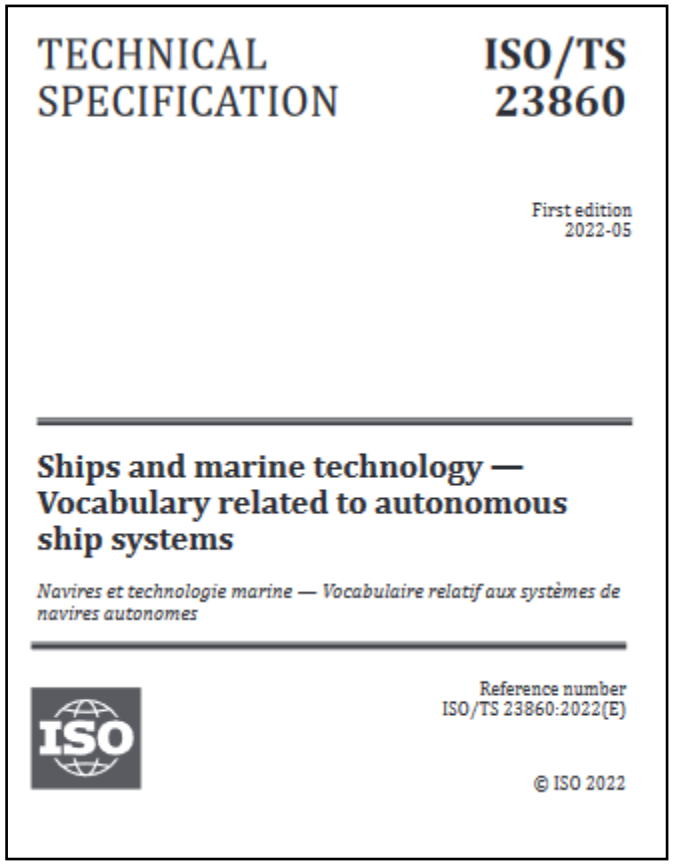
Volume I: Terminology
NIST Special Publication 1011
Version 1.1

Automasjon muliggjør autonomi

automatic
process or equipment that, under specified conditions, can function without human control

autonomy
one or more of a ship system's processes or equipment, under certain conditions, is designed and verified to be controlled by *automation*, without human assistance

Automation enables autonomy, but autonomy adds additional requirements for the design and verification of the automation.


TECHNICAL SPECIFICATION

ISO/TS 23860

First edition
2022-05

Ships and marine technology — Vocabulary related to autonomous ship systems

Navires et technologie marine — Vocabulaire relatif aux systèmes de navires autonomes

ISO

Reference number
ISO/TS 23860:2022(E)

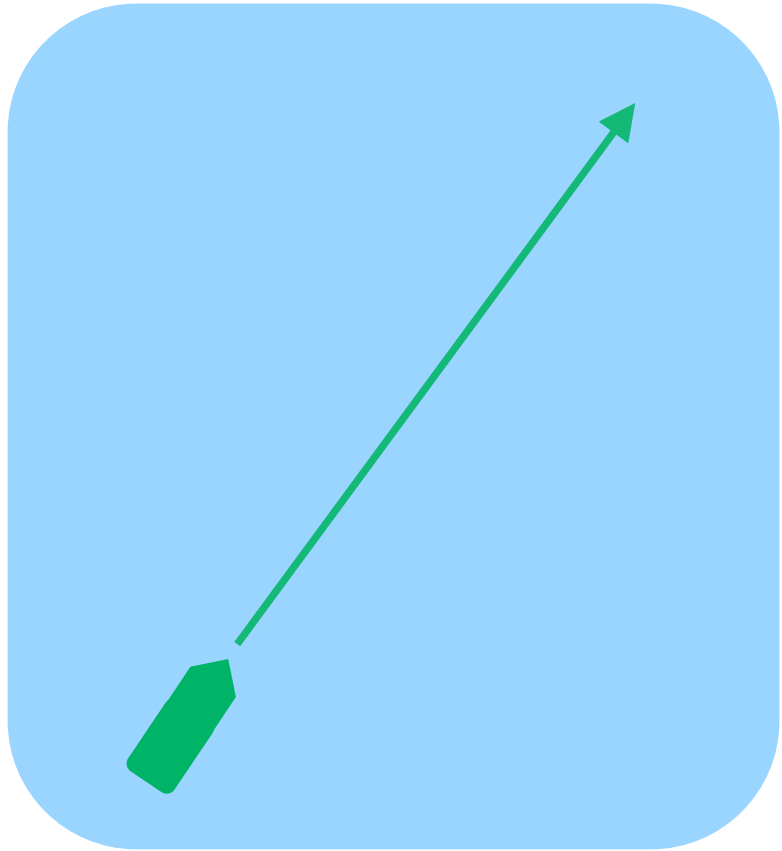
Autopilot – Automatisk eller autonom?

Automatic:

"Processes or equipment that, under specified conditions, can function without human control."

Autonomous:

"Processes or equipment that, under certain conditions, are designed and verified to be controlled by automation, without human assistance."



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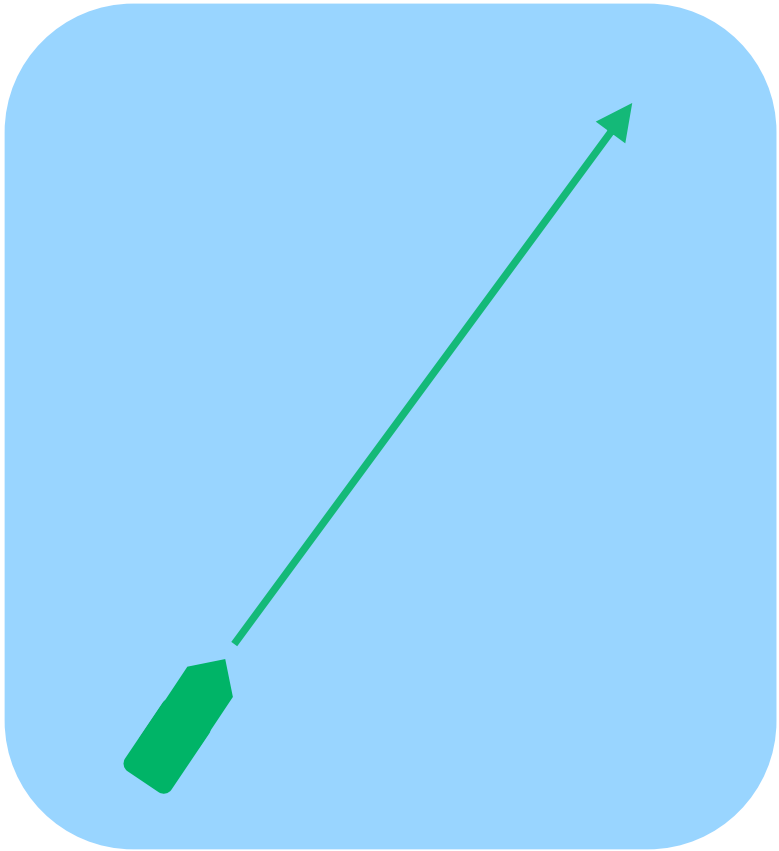

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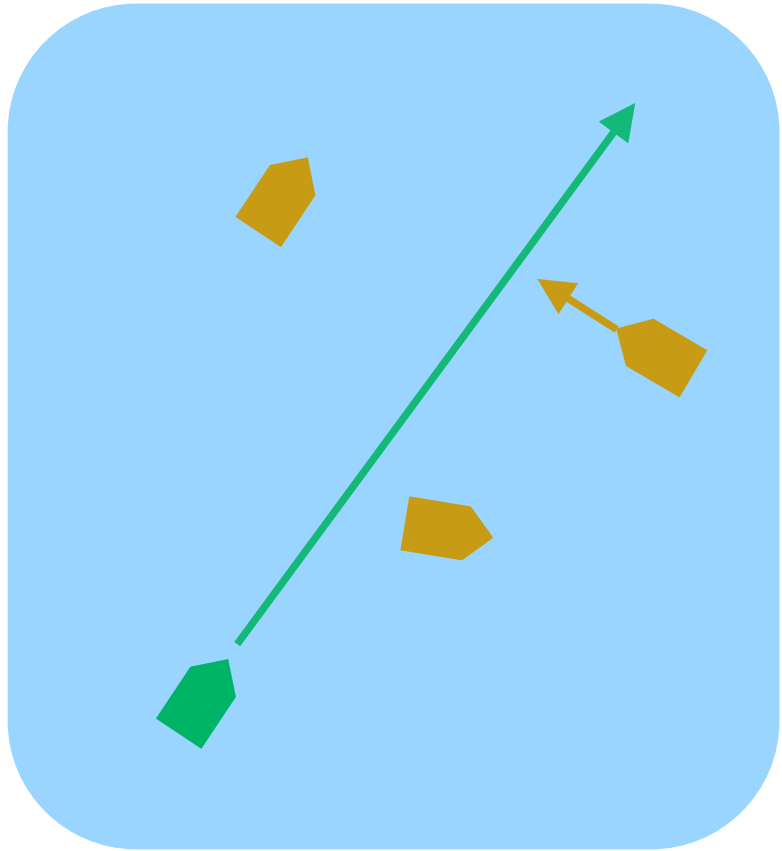

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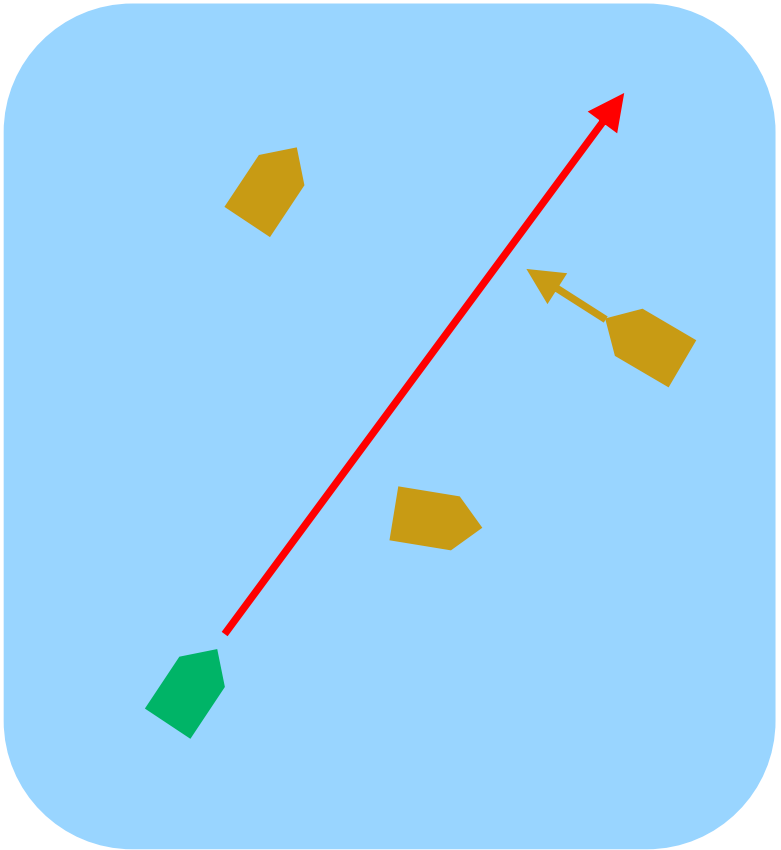

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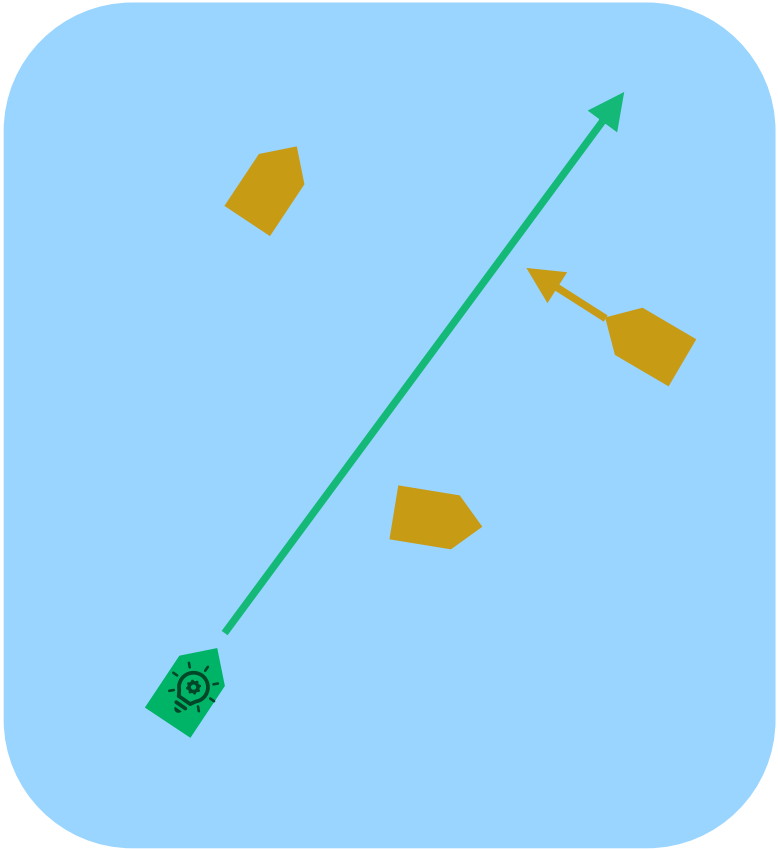

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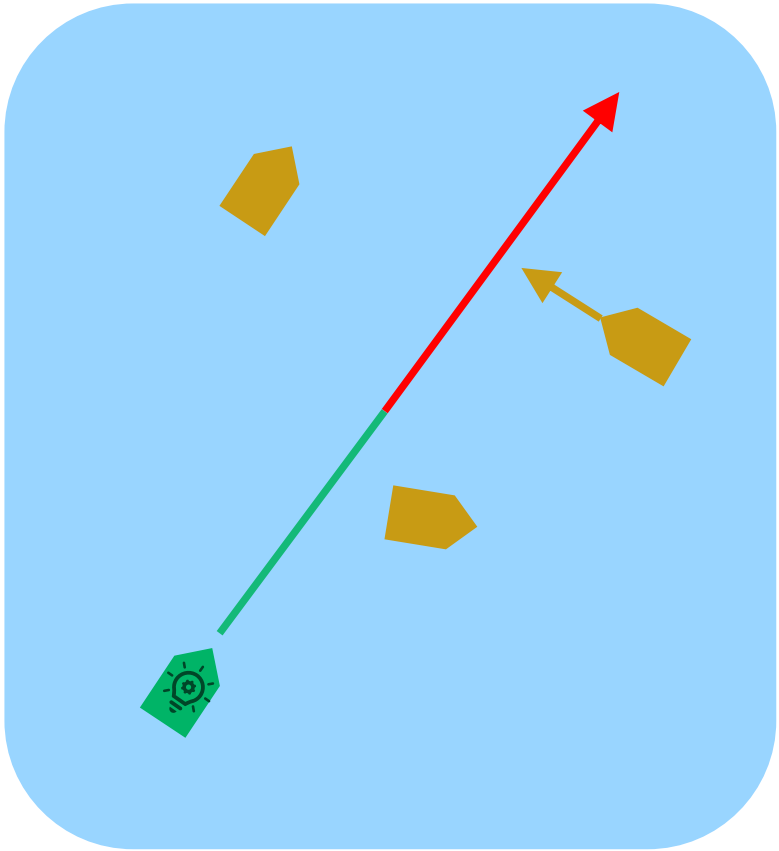


Autonomi er enten eller.

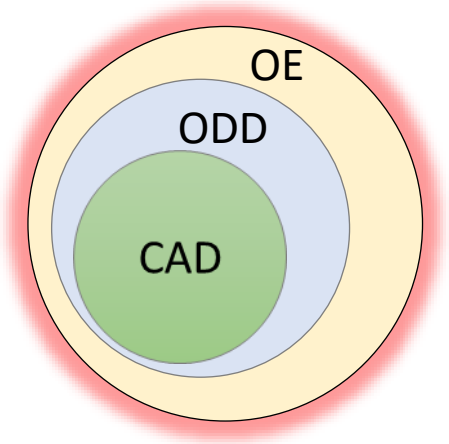
- Utvikle automasjonssystemer til et nivå hvor de klarer seg selv uten tilsyn fra oss mennesker.
- Utvikle grensesnittet og samhandling mellom automasjonssystemer og mennesker slik at vi kan bistå når teknologien "ikke strekker til" eller hvor det ikke er hensiktsmessig å automatisere prosesser.
- Lage metoder som gjør at vi kan dokumentere dette, inkludert under hvilke betingelser og hva som skjer når "alt feiler".

Hvor mye autonomi?

Beskrivelse av MASS og samhandling med ROC

Teknologi for et bedre samfunn

Beskrivelse av "tilstandsrom" for MASS



Operational Envelope (OE):

"The specific conditions and scenarios under which a given autonomous ship system is designed to function. The operational envelope needs to consider, e.g. geography, environmental conditions and the different mission phases."

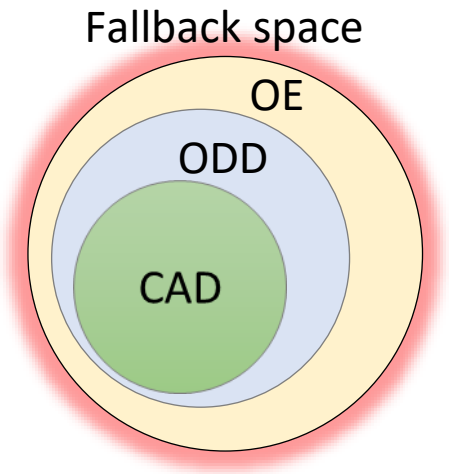
Operational Design Domain* (ODD)

“Operating conditions under which a given driving automation system or feature thereof is specifically designed to function...”

Constrained Autonomous Domain (CAD)

"The conditions under which the automation system can safely control a ship process and reliably alert the operator in time to safely take over control when these conditions change"

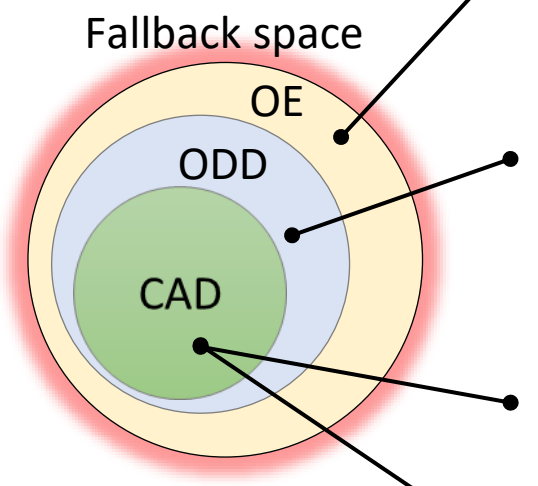
Tilstandsrombeskrivelse



Fallback space

"Elements outside of the Operational Envelope resides in the fallback space, which is a collection of predefined fallback states that are entered when it is not possible for the MASS to stay within the Operational Envelope, e.g., due to environmental or technical conditions that exceed the operational envelope's limits."

Samarbeid mellom automasjon og ROC



Operator control:

An operator may be assisted by the automation but is in control and needs to be immediately able to intervene.

Operator assisted:

The automation can control the ship but needs continuous attention by the operator. The operator is in control but can use own judgement to leave the control position for shorter periods.

Constrained autonomous:

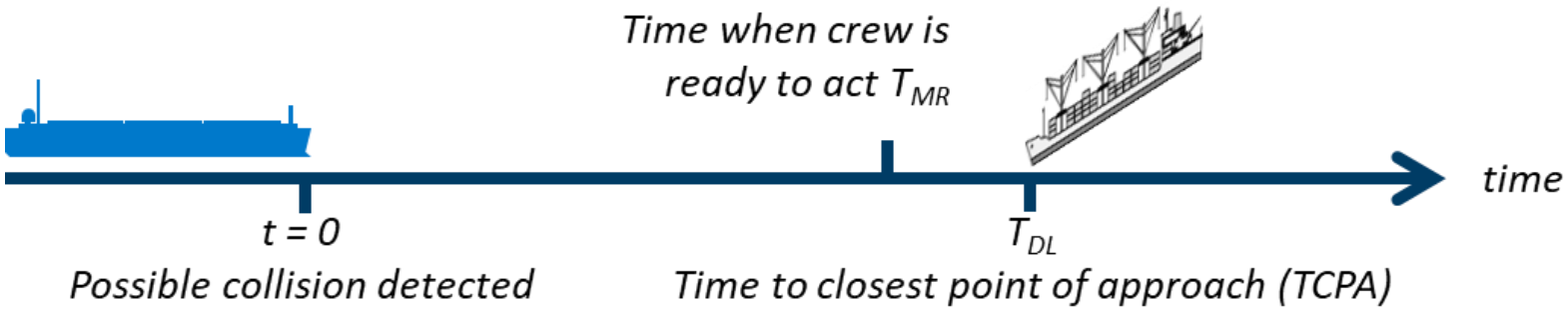
Automation is safely in control and will alert operator before intervention is needed.

Fully autonomous:

No operator is needed at any time during the ship's operation.

Alternativ kvantifisering av autonomi

"Processes or equipment that, under certain conditions, are designed and verified to be controlled by automation, without human assistance."

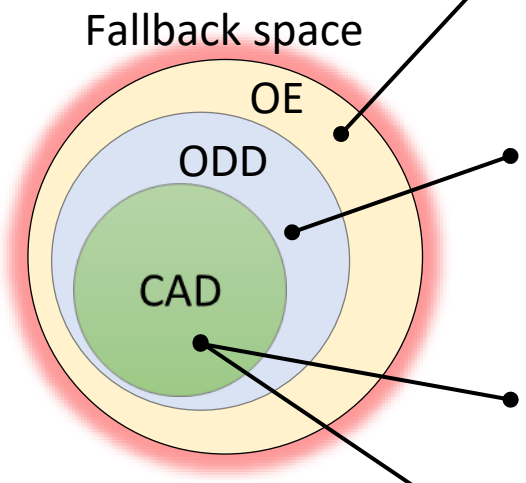


***T_{MR}*: Maximum response time.**
The maximum time the operator needs to be ready to act safely.

<

***T_{DL}*: Response deadline.**
The minimum time that the automation can maintain safe operation.

Samarbeid mellom automasjon og ROC med krav til responstid



Operator control: ($T_{DL} = 0$, $T_{MR} = 0$)

An operator may be assisted by the automation but is in control and needs to be immediately able to intervene.

Operator assisted: ($T_{DL} \geq 0$, $T_{MR} = 0$)

The automation can control the ship but needs continuous attention by the operator. The operator is in control but can use own judgement to leave the control position for shorter periods.

Constrained autonomous: ($T_{DL} > T_{MR} > 0$)

Automation is safely in control and will alert operator before intervention is needed.

Fully autonomous: ($T_{DL} = \infty$)

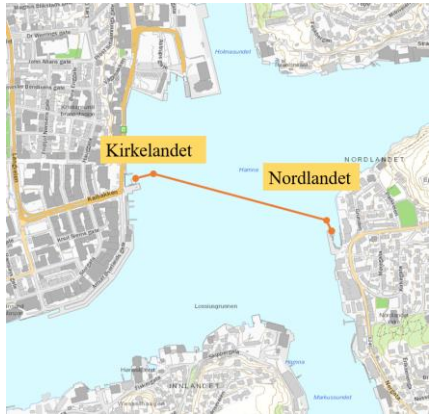
No operator is needed at any time during the ship's operation.

Eksempel

Smartere Transport
Møre & Romsdal

Teknologi for et bedre samfunn

Forbedret mobilitet med sjøbasert transport



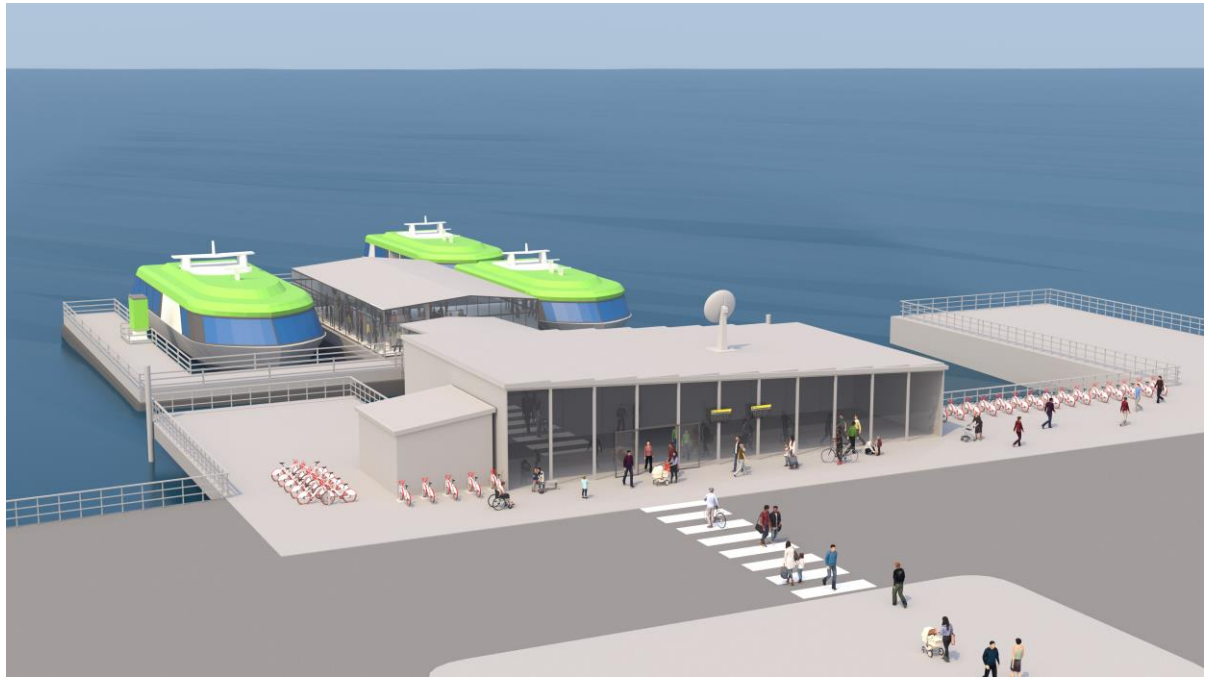

Illustrasjon: Møre Maritime


Illustrasjon: Brødrene Aa

+

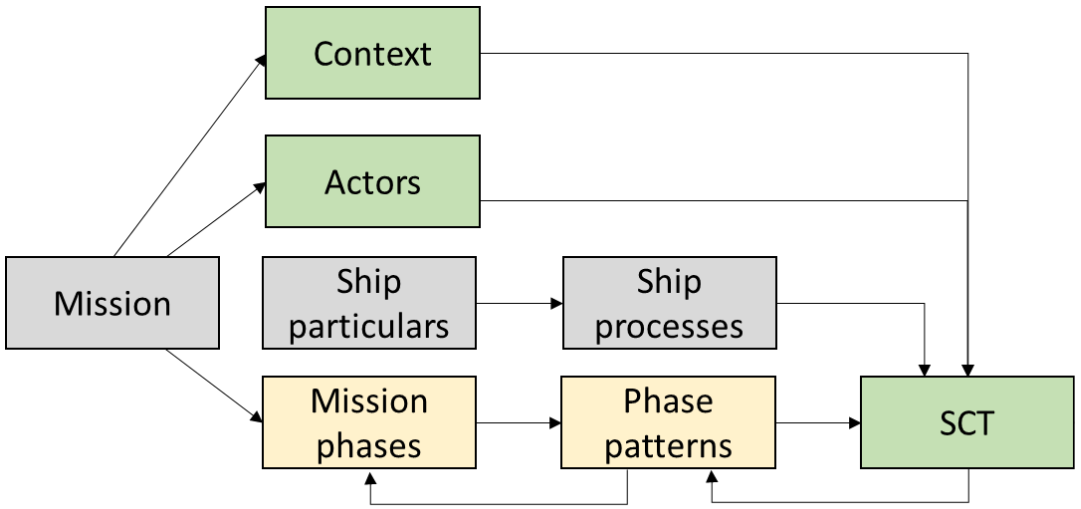

Illustrasjon: NTNU

Studiespørsmål og krav til operatører



- Hvor mange kontrollromsoperatører er det behov for.
- Hva skal en kontrollromsoperatør gjøre?
- Krav: sikkerhet og operabilitet.

Fremgangsmåte



System control tasks (SCT*):

"Mission phases mapped to functions and distribution of these amongst humans, automation, ship, remote operation centre and other infrastructure."

Remote operator tasks:

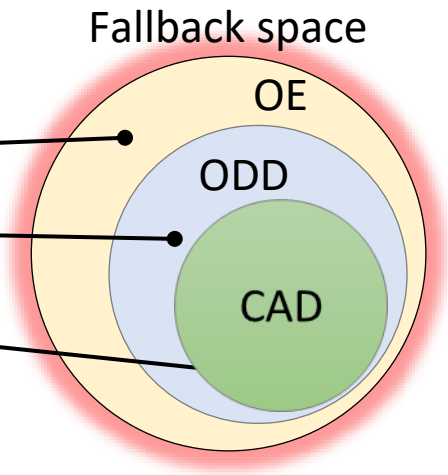
"Subset of the SCTs that the remote operator will execute together with the ROC systems."

*ISO. 2022. 'ISO/TS 23860:2022 Ships and Marine Technology — Vocabulary Related to Autonomous Ship Systems'. https://www.iso.org/standard/77186.html.

Hagaseth M., Rødseth Ø.J., Meland P.H., Wille E., Meling P., and Murray B., 'Methodology for Approval of Autonomous Ship System CONOPS'. COMPIT, 2022.

Oppgavebeskrivelse for kontrollromsoperatør

Høy kompleksitet	OC	Operator Control
Middels komplesiktet	OA	Operator Assisted
Lav kompleksitet	CA	Constrained Autonomous



	Systemoppgaver	Fasemønster					
		Kailigge	Lading	Ankomst	Avgang	Transitt	Nattligge
Funksjoner	Navigasjon			CA			
	Planlegging og avvikshåndtering			OC			
	Nautisk kommunikasjon			OA			
	Fortøyning	OA		CA			
	Stabilitet og skrogintegritet	CA					
	Maskineri og tekniske system	CA					
	Sikkerhet og krisehåndtering			OC			
	Vedlikehold						
	Passasjerhåndtering						

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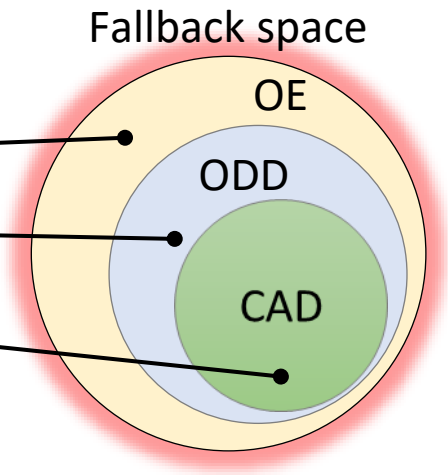

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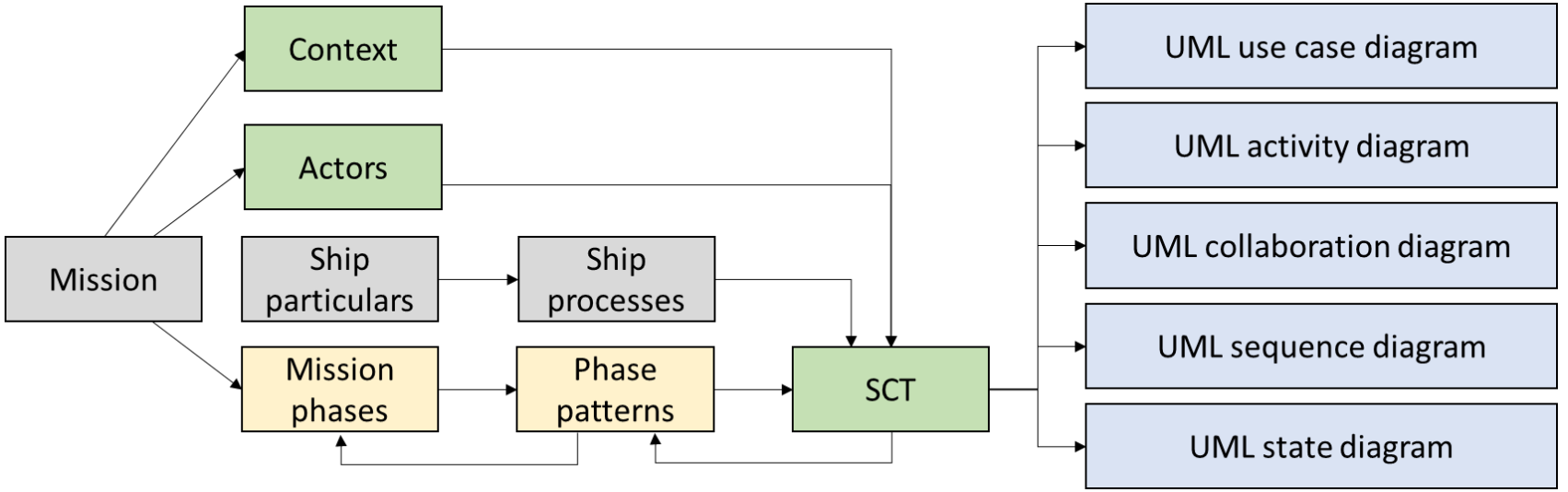
		Kailigge	Lading	Ankomst	Avgang	Transitt	Nattligge
Funksjoner	Navigasjon			$T_{DL} > T_{MR} > 0$			
	Planlegging og avvikshåndtering			$T_{DL} = 0, T_{MR} = 0$			
	Nautisk kommunikasjon			$T_{DL} \geq 0, T_{MR} = 0$			
	Fortøyning	OA		$T_{DL} > T_{MR} > 0$			
	Stabilitet og skrogintegritet	CA		$T_{DL} > T_{MR} > 0$			
	Maskineri og tekniske system	$T_{DL} > T_{MR} > 0$					
	Sikkerhet og krisehåndtering			$T_{DL} = 0, T_{MR} = 0$			
	Vedlikehold						
	Passasjerhåndtering						

Fremgangsmåte - nå også med modellering



Bruk og nytteverdi

Kontekst, komponenter, aktører

Interaksjoner og ansvar

Kommunikasjon (og oppførsel)

Kommunikasjon (mld.utveksling)

Detaljert oppgavebeskrivelse

Hagaseth M., Rødseth Ø.J., Meland P.H., Wille E., Meling P., and Murray B., 'Methodology for Approval of Autonomous Ship System CONOPS'. COMPIT, 2022.

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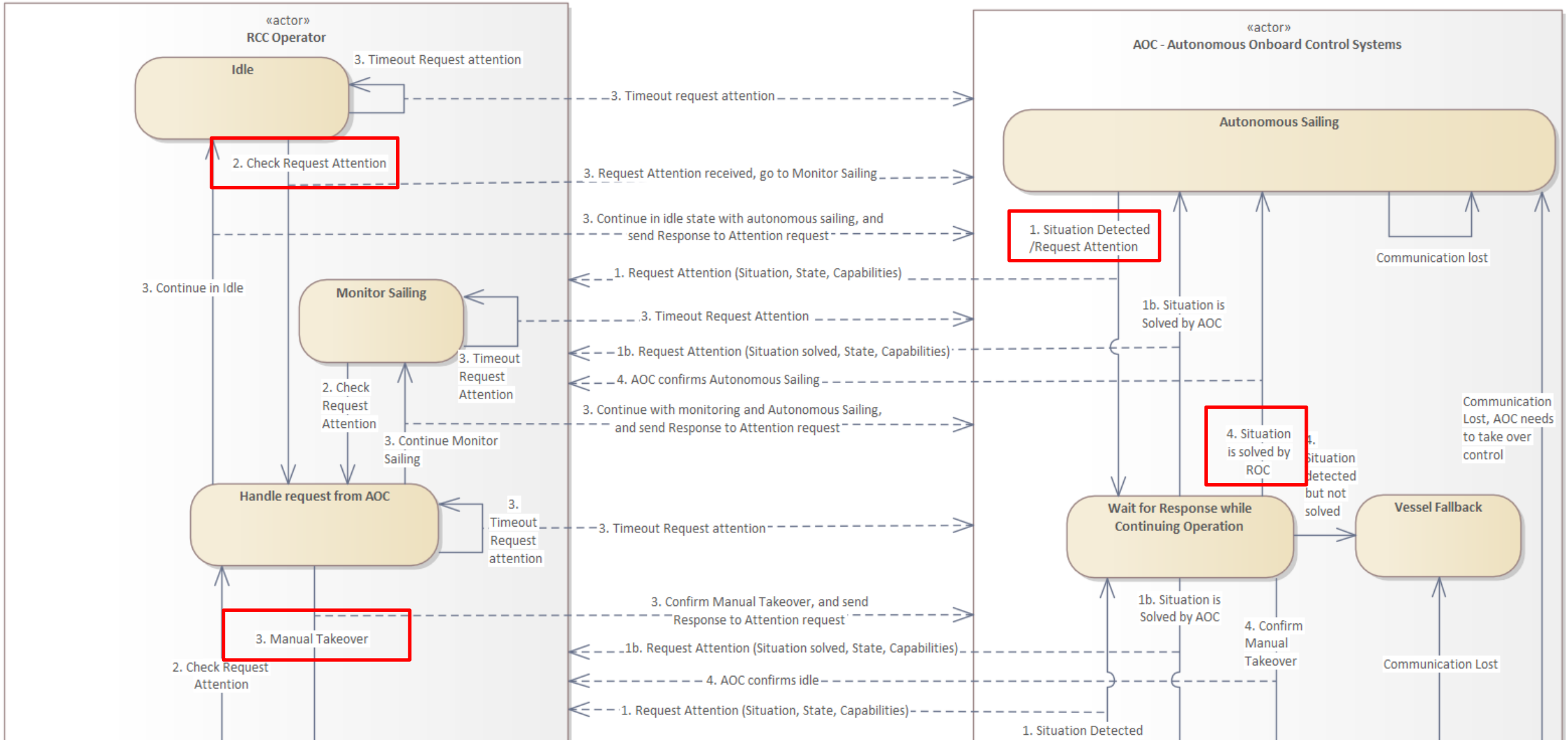

Smart transport Møre & Romsdal county authority

- Funded by the Norwegian Ministry of Transport
- Duration: 2018 – 2023
- https://mrfylke.no/om-oss/prosjekta-vaare/smartare-transport

AutoSafe (Automated safety solutions for passenger ferries)

- Funded by the Research Council of Norway
- Duration: 2021 – 2023
- https://www.sintef.no/projectweb/autosafe/

https://aegis.autonomous-ship.org

https://www.autoship-project.eu

The work presented here has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815012 (AUTOSHIP) and grant agreement No 859992 (AEGIS).

Konklusjoner

- Autonomi er et binært konsept som løses i samarbeid med mennesket.
- Alternativ kvantifisering av autonomi ved bruk av tid kan gi ett mulig krav til sikker operasjon.
- Avgrenset autonomi + grensesnitt mot menneske + dokumentasjon.

Takk for oppmerksomheten!

- Hagaseth M., Rødseth Ø.J., Meland P.H., Wille E., Meling P., and Murray B., 'Methodology for Approval of Autonomous Ship System CONOPS'. COMPIT, 2022.
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- Rødseth, Ø. J., & Wennersberg, L. A. L. (2023). A Criticism of Proposed Levels of Autonomy for MASS., Proceedings of the 33rd European Safety and Reliability Conference (ESREL 2023)
- Wennersberg & Holte, Smartere Transport Møre og Romsdal, L3.1 Landbasert kontrollrom, 2022.