

# Technology levels for maritime traffic coordination: towards the internet of intelligent ships

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# Technology levels for maritime traffic coordination – background

- Long projects on maritime human factors – almost a decade in total
  - UXUS – Rolls-Royce’s future ship bridge videos, unmanned ship studies and shore control center ideas
  - AAWA – unmanned ships development
  - Desing4Life – study on pilots’ navigational thinking
- Present study – mental exercise:
  - From ship-level thinking into traffic-level thinking
  - Results: six technology levels for maritime traffic coordination
  - Implications for unmanned ships roadmap visions: unmanned ships after internet of intelligent ships

# Coordinated maritime traffic – what is that?

- **Avoiding collisions:** includes localization of one's ship, other ships and the ground
- **Internal to ship:** active lookout, adhering to rules, expert decision-making, etc.
- **External to ship:** shared rules, sea-marks, VTS-service, etc.
- **Safe and coordinated traffic:** emerges as ships avoid one another following shared rules

# Results:

- **Level 0** – “I can see you”: non-technological coordination only
- **Level 1** – “I can see your flags”: shared rules and passive communication mediums
- **Level 2** – “My radar sees you”: signal-based detection, localisation and communication systems
- **Level 3** – “I can see data about you”: sharing digitally stored data
- **Level 4** – “My robot sees you”: smart coordination: fleet or ship-level coordination based on machine learning and other predictive technologies
- **Level 5** – “My robot sees what your robot sees”: internet of intelligent ships: AI uses globally shared data
- **Main message:** widespread use of fully autonomous ships only after the level 5 ‘internet of intelligent ships’

## Level 0 – “I can see you”

➤ visual assessment of trajectories,  
shared natural language, use of  
nature’s cues

# Level 1 – “I can see your flags”

- flags, lights and other ship-based communication devices, COLREGs
- sea-routes, light-houses, etc. visual navigational aids

## Level 2 – “My radar sees you”:

- Radar, VHS-radio communication, radar-reflectors...
- satellite connections, radio-signal based navigation

## Level 3 – “I can see data about you”

- AIS, waypoint/route-sharing, automatic data-sharing through VHS-radio / transponders (e-navigation)
- VTS service, fleet management systems



## Level 4 – “My robot sees you”

- On-board object detection through sensor fusion and neural networks, autonomous/automatic navigational decision-making, considering the environment and the other ships
- Land-based sensor systems support ships' navigational decision-making.

## Level 5 – “My robot sees what your robot sees”

- Internet of intelligent ships: data shared globally between the Level 4 smart ships (and land-based agents, e.g., harbors and seamarks)
- Routes optimized and decided-upon on the traffic-level: enough space between ships, ships in right place at right time, through automatic communication between ships.

# Autonomous ships – why after Level 5?

In principle Level 4 allows autonomous ships, but...

- It is easier to achieve "internet of intelligent ships" than widespread use of unmanned ships: **retrofitting possible for Level 5 but not for full (unmanned) autonomy**, due to maintenance needs
- AI for autonomy requires data – globally networked ships would enable massive amounts of shared data
- Learning about local areas and conditions beneficial: global network of ships sharing data would allow unmanned ships to go anywhere (not just between two ports)

# Critical considerations

If Level 5 comes before widespread use of fully autonomous ships...

- System-level technology development: designing the marine traffic instead of individual ships.
- Maritime IoT (internet of things) should be considered hand-in-hand with autonomous ship development
- 'Internet of intelligent ships' should be (and actually probably is) the primary aim of development, given the immediate benefits:
  - Route and speed optimization in view of other ships, ports and other logistics centers
  - Less queuing at the ports, fuel-savings through slow/moderate steaming

Take-away message vision / conversation starter:

**Internet of intelligent ships comes before widespread use of autonomous ships.**

Thank you!

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