

PROPOSED DEFINITION OF LEVELS OF AUTOMATION IN INLAND NAVIGATION

Workshop «Autonomous shipping and inland
Navigation»

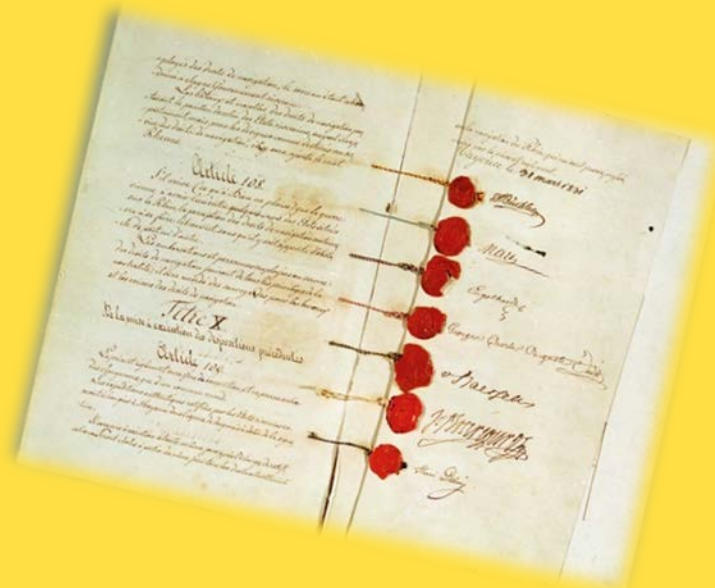
Working party SC3.WP3
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CENTRAL COMMISSION FOR THE NAVIGATION OF THE RHINE

- Intergovernmental organisation, oldest in the world
- 5 member states 
- Legal basis Mannheim Convention 1868
- Missions - *Guaranteeing freedom of navigation and Promoting navigation on the Rhine*
- Leading regulator for inland navigation (regulations binding for member states, model for EU and beyond)



- Intensive cooperation with EU Commission, UNECE, other countries, industries
- Strong expertise in safety regulations (e.g. technical & operational requirements), economics, infrastructure for inland navigation



BACKGROUND

- **CCNR's strategic guidelines and presidency orientations (Dec 2017)**
 - => address new challenges facing inland navigation, through innovation and digitalisation
 - => real-world regulations open to innovation, including automated navigation
- **Police Regulations Committee's work programme (2018-2019)**
 - => "Monitoring developments in automated navigation and consideration of the possible need for regulatory measures"
 - => CCNR's current requirements based on the boat master's responsibility

NEED OF DEFINITION OF AUTOMATION LEVELS

- Automated navigation covers a very wide range of technical solutions and use cases
 - => from simple navigation assistance to fully automated navigation
- Unlike other modes of transport, no international definition of automation levels in inland navigation
- Definition of automation levels is prerequisite for future analysis of responsibilities

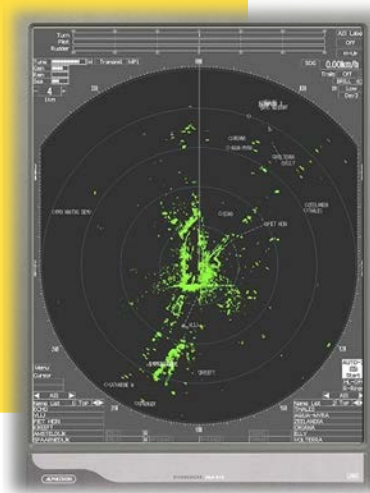


No AUTOMATION

Level 0

the full-time performance by the human helmsman of all aspects of the dynamic navigation tasks, even when enhanced by warning or intervention systems

E.g. navigation with support of radar installation



Vessel command (steering, propulsion, wheelhouse, ...)	Monitoring and responding to navigational environment	Fallback performance of dynamic navigation tasks
		



STEERING ASSISTANCE

Level 1

the context-specific execution by a steering automation system using information about the navigational environment and with the expectation that the human helmsman performs all remaining aspects of the dynamic navigation tasks

E.g. rate-of-turn regulator

E.g. trackpilot (track-keeping system for inland vessels along pre-defined guiding lines)



<p>Vessel command (steering, propulsion, wheelhouse, ...)</p>	<p>Monitoring and responding to navigational environment</p>	<p>Fallback performance of dynamic navigation tasks</p>
		



PARTIAL AUTOMATION

Level 2

the context-specific execution by a navigation automation systems of both steering and propulsion using information about the navigational environment and with the expectation that the human helmsman performs all remaining aspects of the dynamic navigation tasks

E.g. navigation automation systems which are designed to reduce fuel consumption


<p>Vessel command (steering, propulsion, wheelhouse, ...)</p>	<p>Monitoring and responding to navigational environment</p>	<p>Fallback performance of dynamic navigation tasks</p>
		



CONDITIONAL AUTOMATION

Level 3

the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the human helmsman will be receptive to requests to intervene and to system failures and will respond appropriately

<p>Vessel command (steering, propulsion, wheelhouse, ...)</p>	<p>Monitoring and responding to navigational environment</p>	<p>Fallback performance of dynamic navigation tasks</p>
		



HIGH AUTOMATION

Level 4

the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks and fallback operation, without expecting a human helmsman responding to a request to intervene

<p>Vessel command (steering, propulsion, wheelhouse, ...)</p>	<p>Monitoring and responding to navigational environment</p>	<p>Fallback performance of dynamic navigation tasks</p>
		





















FULL AUTOMATION

Level 5

the sustained and unconditional performance by a navigation automation system of all dynamic navigation tasks and fallback operation, without expecting a human helmsman will respond to a request to intervene

<p>Vessel command (steering, propulsion, wheelhouse, ...)</p>	<p>Monitoring and responding to navigational environment</p>	<p>Fallback performance of dynamic navigation tasks</p>
		





















Level	Name	Vessel command	Monitoring and responding to navigational environment	Fall-back performance of dynamic navigation tasks
0	NO AUTOMATION			
1	STEERING ASSISTANCE			
2	PARTIAL AUTOMATION			
3	CONDITIONAL AUTOMATION			
4	HIGH AUTOMATION			
5	FULL AUTOMATION			









Level	Name	Vessel command	Monitoring and responding to navigational environment	Fall-back performance of dynamic navigation tasks
0	NO AUTOMATION	<p>Helmsman performs part or all of the dynamic navigation tasks.</p>		
1	STEERING ASSISTANCE			
2	PARTIAL AUTOMATION			
3	CONDITIONAL AUTOMATION	<p>System performs the entire dynamic navigation tasks (when engaged).</p>		
4	HIGH AUTOMATION			
5	FULL AUTOMATION			



Level	Name	Vessel command	Monitoring and responding to navigational environment	Fall-back performance of dynamic navigation tasks
0	NO AUTOMATION			
1	STEERING ASSISTANCE			
2	PARTIAL AUTOMATION			
3	CONDITIONAL AUTOMATION			
4	HIGH AUTOMATION			
5	FULL AUTOMATION			



Level	Name	Vessel command	Monitoring and responding to navigational environment	Fall-back performance of dynamic navigation tasks
0	NO AUTOMATION			
1	STEERING ASSISTANCE			
2	PARTIAL AUTOMATION	<p>REMOTE CONTROL ? LEVELS 2 TO 5</p> <p>Subject to context specific execution, remote control is possible.</p> <p>It may have an influence on crew requirements (number or qualification).</p>		
3	CONDITIONAL AUTOMATION			
4	HIGH AUTOMATION			
5	FULL AUTOMATION			



CONCLUSIONS

Proposed definition to be discussed and improved

- in the competent CCNR Committees
- in the European committee for drawing up common standards in the field of inland navigation (CESNI)
- with the support of inland navigation sector (EBU/ESO, IVR, ETF, GERC, Sea Europe...)
- with the international project leaders (LAESSI, RAVEN, NOVIMAR...)
- with the international partner organisations (UNECE, River Commissions...)
- with you



Objectives and follow-up

- Establishing a comprehensive and stable international definition of automation levels
- Creating basis for future CCNR work on autonomous shipping (e.g. legal analysis) but also for work of other organisations
- Exploiting synergies with other activities, such as PIANC Task Group 204 on cybersecurity in inland navigation

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THANKS



SOURCES

- Project Adaptive (2015); Shared Automated vehicles and International transport forum (2016); Norwegian forum for autonomous ships (2017); Telematica (2017); Revised update of Cyber-enabled ships ShipRight procedure Lloyd's register (2017).

DEFINITIONS

- “Dynamic navigation tasks” are understood as the set of tactical vessel operations, such as operation of rudder apparatus, propulsion, anchor winches or elevating wheelhouse.
- “Context-specific” is understood as confined navigational conditions such as navigation on specific river waterway sections or lock crossing, as well as vessel arrangements with convoys or platooning.
- “Navigational environment” is understood as fixed and dynamic conditions such as the waterways' shape, water level, weather, visibility, vessel crossing, ...
- "Collision avoidance" is the critical task in responding to the environmental conditions (other vessels, bridges, ...).