# Managing and Adapting New Technologies for Maritime Autonomous Surface Ships

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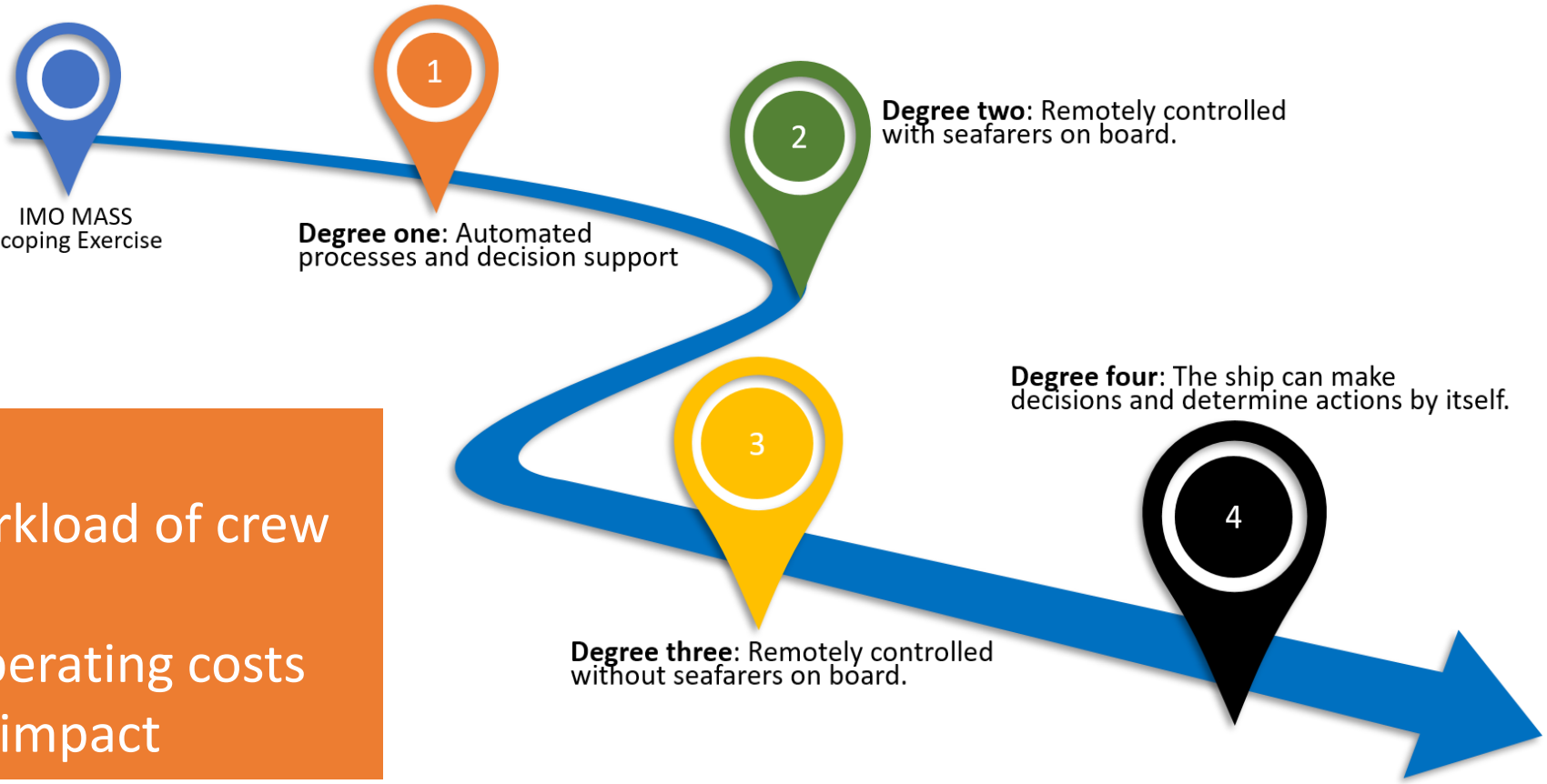
# MASS - The Path Toward Increasing Levels of Autonomy

## Maritime Autonomous Surface Ships (MASS)

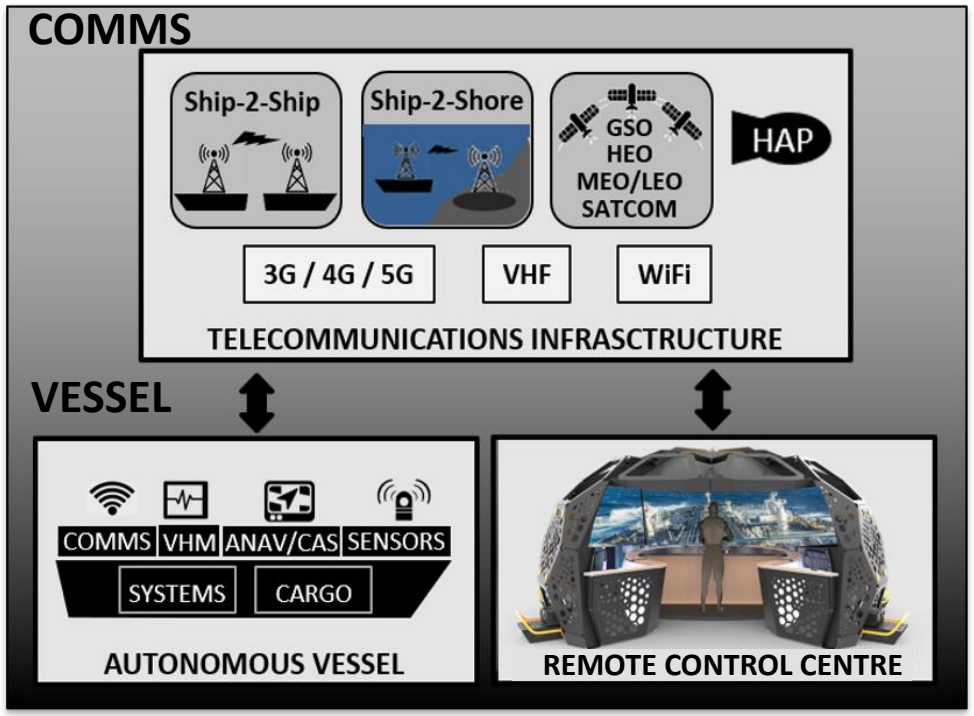



**BENEFITS of MASS**

- Reduced fatigue and workload of crew
- Improved safety
- Potential for reducing operating costs
- Reduced environmental impact

See, e.g., International Maritime Organisation (IMO) Strategic Plan (2018-2023)
*"Integrate new and advancing technologies in the regulatory framework"*

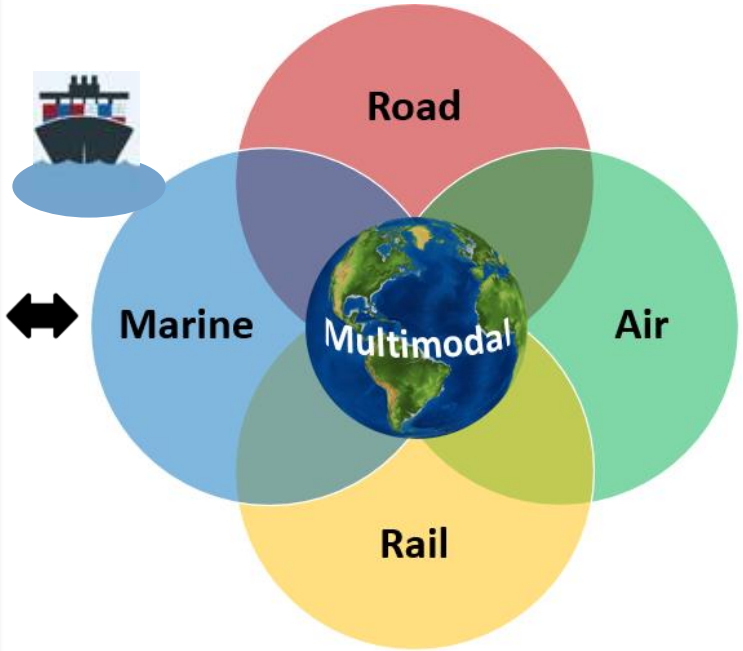
# Smart Shipping/MASS Ecosystem




RCC is an extension of Vessel Bridge

LAND-BASED INFRASTRUCTURE

Vessel Traffic Services

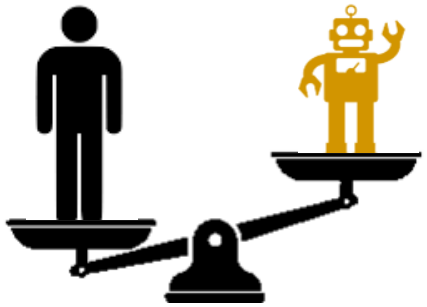



The Remote Control Centre is an extension of the autonomous vessel

The Autonomous Vessel is part of a Multimodal Supply Chain

# Judicious use of AI in Safety-Critical Systems

- **Automated information flows**
- **Object detection, classification**
- **Enhanced situational awareness**
- **Automated decision-making**



**Today:** *Humans are better than machines for most complex decision-making tasks.*

**Short/Medium term:**
*Humans will remain primary decision-makers*

Even if AI were able to effectively and reliably perform complex decision-making in safety-critical systems (which it really can't do yet), the testing, validation, certification and legal frameworks are not yet mature enough.
If in doubt, consider Military Human-Autonomy Teaming initiatives !

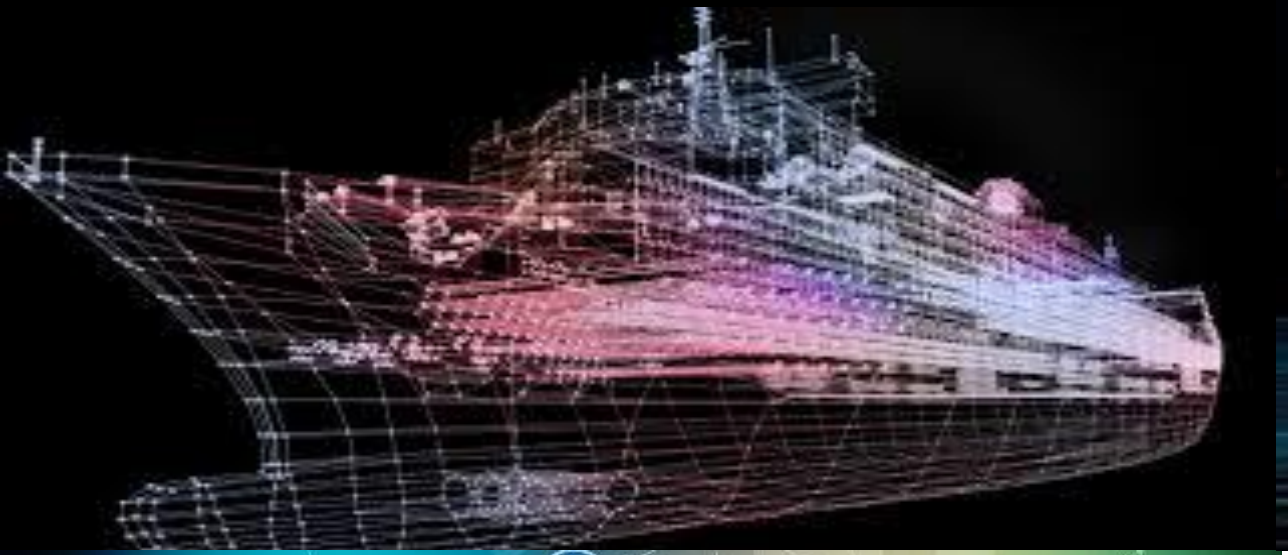
# MASS Ecosystem : Insurance & Liability Perspectives

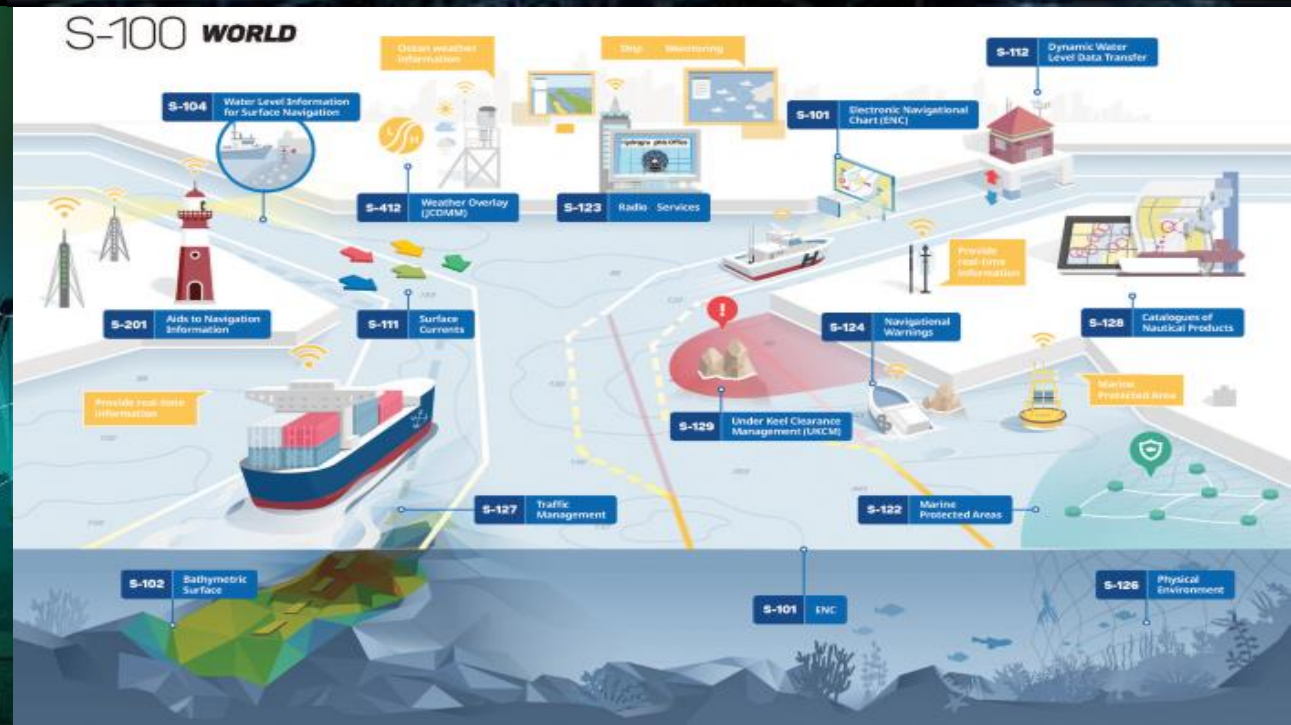
| Shipowners | Yards & System Suppliers | Remote Operators | Classification Societies | Insurers |
|---|---|---|---|---|
| 1. Overall function unchanged<br>2. Relation to remote operators<br>3. Goods, ship & incident Liability | 1. Services<br>2. Compliance<br>3. Maintenance<br>4. Connectivity<br>5. Product Liability | 1. Multiple operational concepts<br>2. Division of existing duties & obligations<br>3. Operator Liability | 1. Verification & Certification of MASS<br>2. Drive regulatory development | 1. Insurability<br>2. Risk associated with higher levels of autonomy<br>3. Access to operational data<br>4. Cyber risk management |

Risk Management is going to determine how and when MASS become operational!

# Digital Information Sharing – The key to successful MASS Integration

# Digital Twins of Vessels, Infrastructure and Waterways





# Standardization & Interoperability

**Organizational Interoperability :**

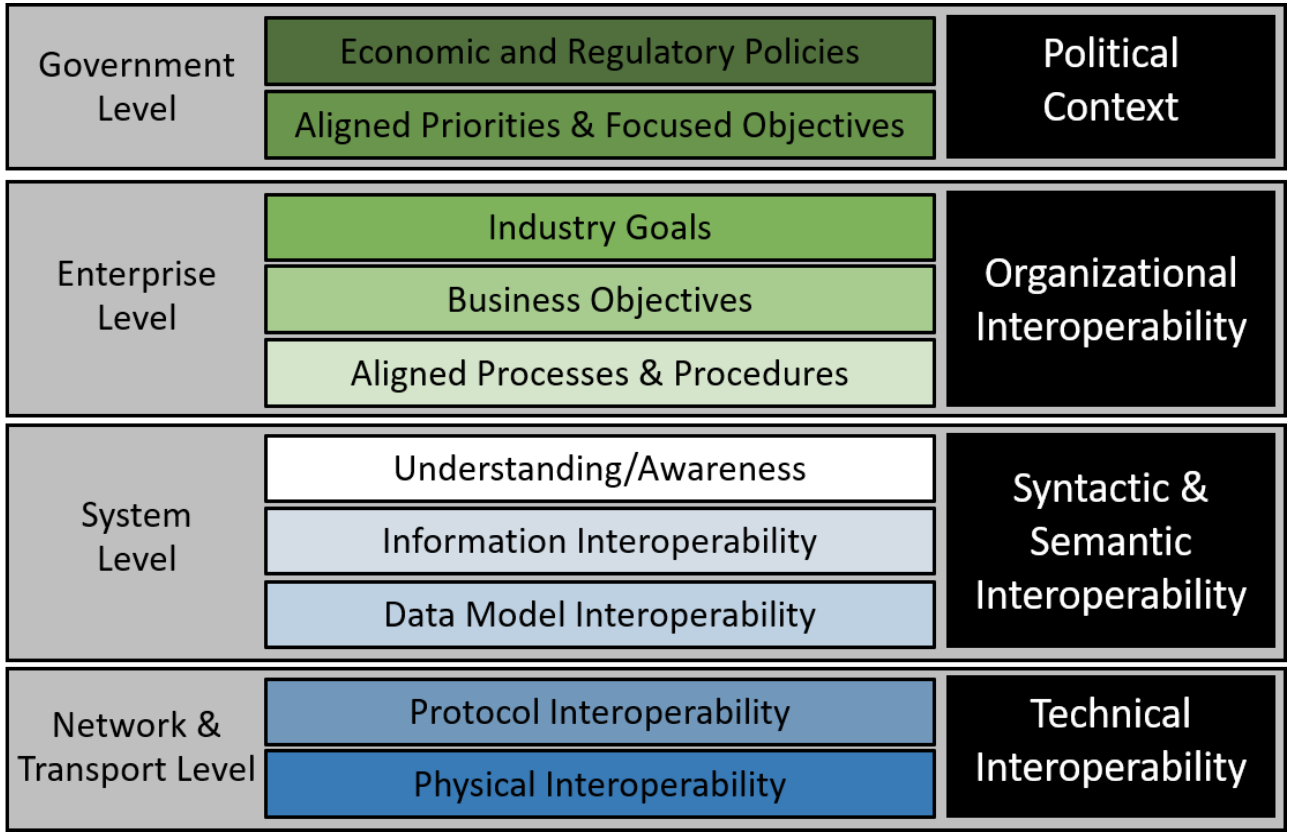
The ability of groups or organizations to work together to achieve common goals.

**System Interoperability :**

The ability of computer systems or software to exchange and make use of information.

**Technical Interoperability :**

Ensures the interconnection of systems and data exchange via standardized transmission protocols and data formats.




Standardization can contribute to achieving interoperability.

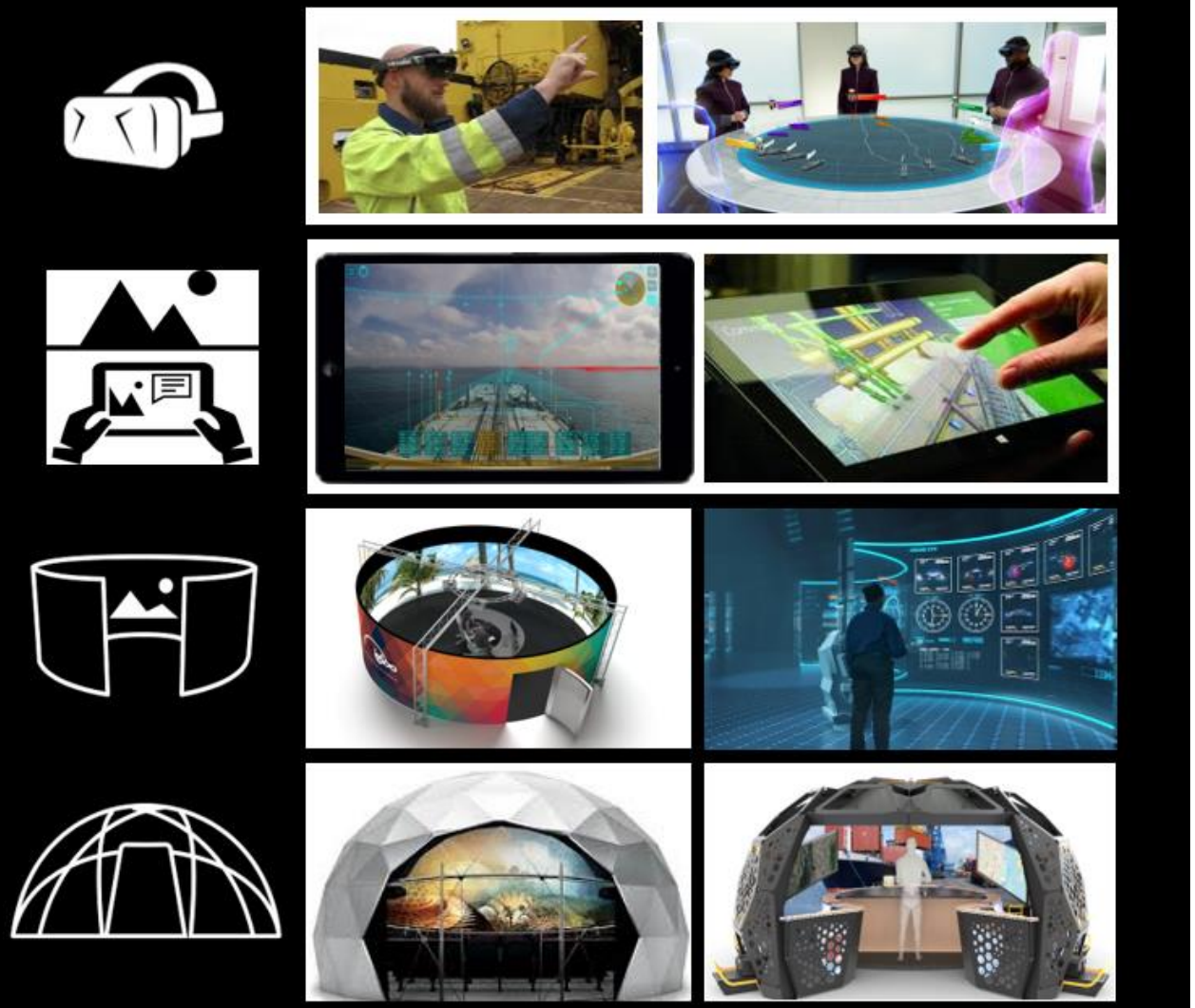
# Intelligent Transport Systems – Architecture Frameworks

US ARC-IT 8.3

Canadian ITS
Reference Architecture

Current ITS frameworks are very ground transportation centric,
but they represent a way forward for specifying MASS infrastructure.

# Virtual Reality (VR) & Augmented Reality (AR)



- Already commercially available today
- Ubiquitous, low-cost VR/AR Headsets
- Address many (but not all) needs
- Technology gaps still exist !

**SOURCE:** readwrite: Feb 6, 2019
https://readwrite.com/2019/02/06/6-ways-to-implement-ar-vr-into-your-business-today/

# VR & AR : What's next ?

*Realistic 3D Immersion without adverse side effects*

## 3D Interactive, Immersive Display Systems

**SOURCE:** Imagine-4D Inc., http://www.imagine-4d.com

For RCC Experimentation Testbeds

Highly Reconfigurable

Support Digital Twin Concept

Suited for Operational Use

- Realistic operator shift duration (e.g. 8 h)
- High level of accuracy and realism, suitable for critical tasks, e.g., berthing and navigation in confined waters.
- Ease of viewing (no fatigue)
- No nausea, dizziness or headaches

This type of display system could be useful for use as part of experimentation testbeds as a part of the risk analysis and mitigation activities.

# Conclusions

Interoperable, cybersecure shared data services are essential to enabling future MASS operations and intermodal supply chain applications.

Developing and promoting interoperable data standards and information exchange models will contribute to the implementation and deployment of shared data services for MASS ops.

A reliable digital information sharing infrastructure also is required, and 5G capabilities may be useful in certain locations, e.g., Ports.

RCC are an extension of the vessel and should be considered as such when designing MASS systems. Remote control of autonomous vessels is complex and the role of the RCC in some cases is still unclear. **Experimentation is needed !**

Novel immersive AR/VR display technologies seem be well-suited for building reconfigurable RCC for use as experimentation testbeds and for operations.