

Enabling Technologies for Maritime Autonomous Surface Ships

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MTEC 2019

International Maritime and
Port Technology and
Development Conference



The 2nd International
Conference on
Maritime Autonomous
Surface Ship - ICMASS



Trondheim, Norway - November 13th and 14th 2019

Motivation for improving Maritime Transport Operations



- Reduction of operating costs for transportation of humans and goods.



- Increase efficiency of supply chain and logistics operations



Supply Chain

- Improve maritime safety
- Protect the environment



Canadian Forum for Maritime Autonomous Surface Ships



Chaired by Transport Canada

Representation from:

- Federal and Provincial Governments
- Ports & Pilots
- Shipowners & Operators
- Technology Providers
- Research Community

Forum with three sub-committees

1. Testing, Research & Development
2. Domestic and International Framework Development
3. Strategic Orientation and Multilateral Cooperation



CANADA'S DIGITAL SEAWAY

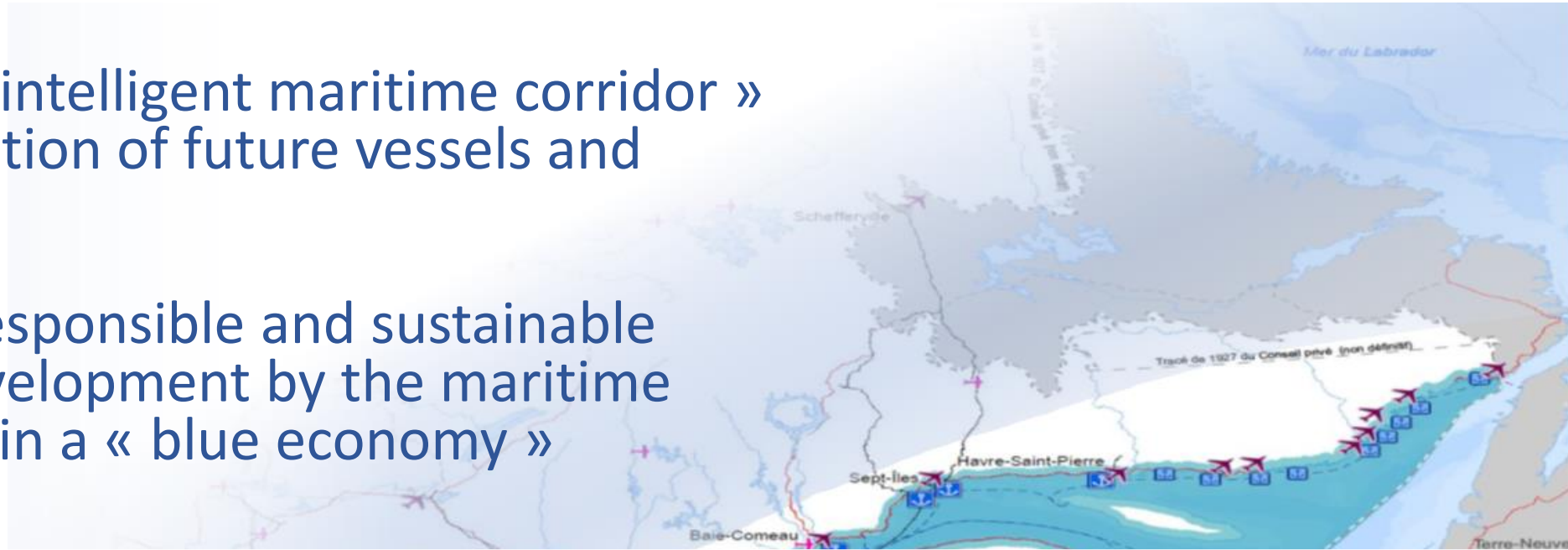
Creating the world's first digital inland waterway –
from the ocean to the Great Lakes



Quebec Saint-Lawrence Seaway Maritime Vision

Economic, Social Development and Environmental Protection

1. Develop an « intelligent maritime corridor » for the navigation of future vessels and supply chains
2. Stimulate a responsible and sustainable economic development by the maritime communities in a « blue economy »

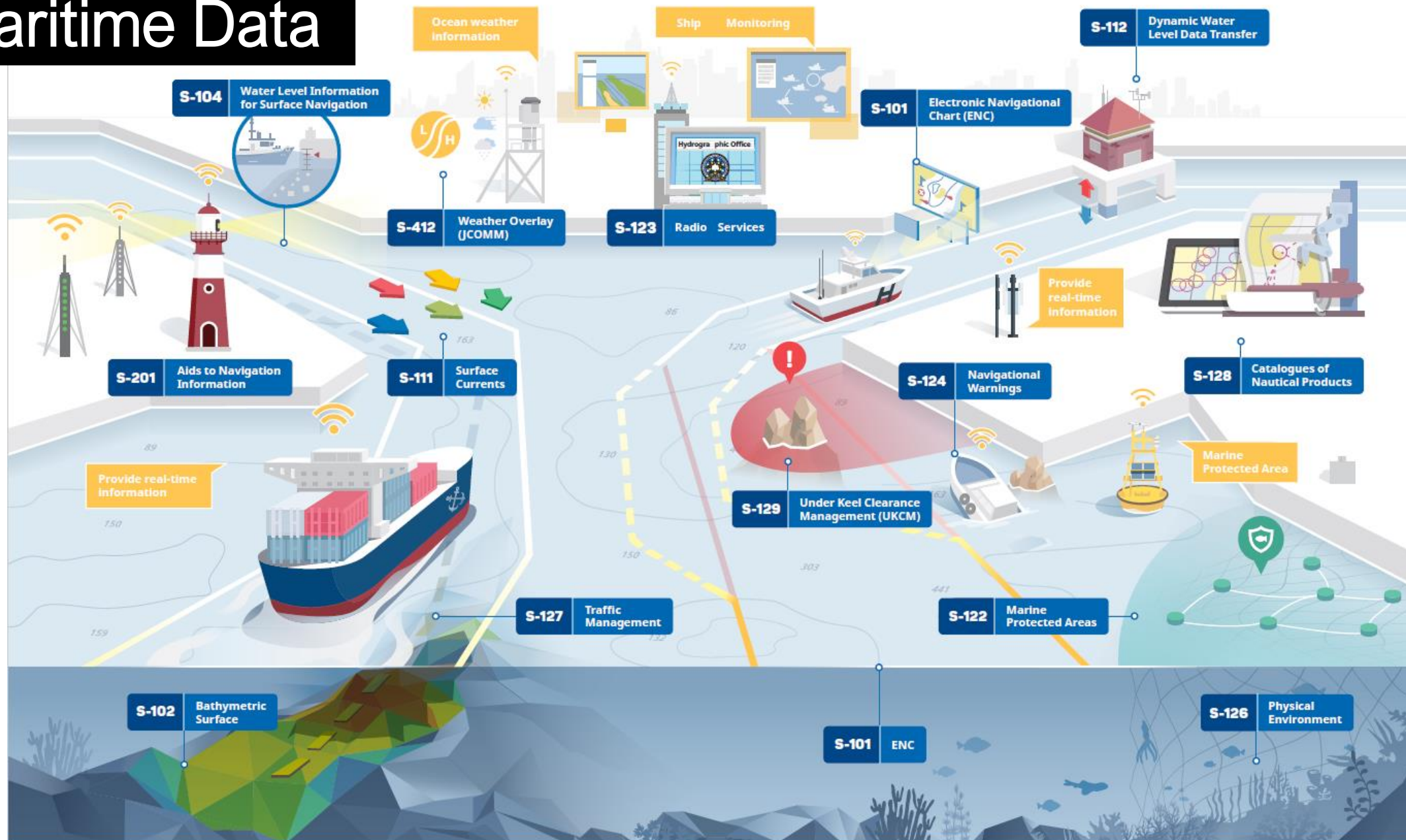


Port modernization | Intermodality | Consolidation of industrial ports & logistics hubs
Increase the efficiency and the fluidity of trade using artificial intelligence

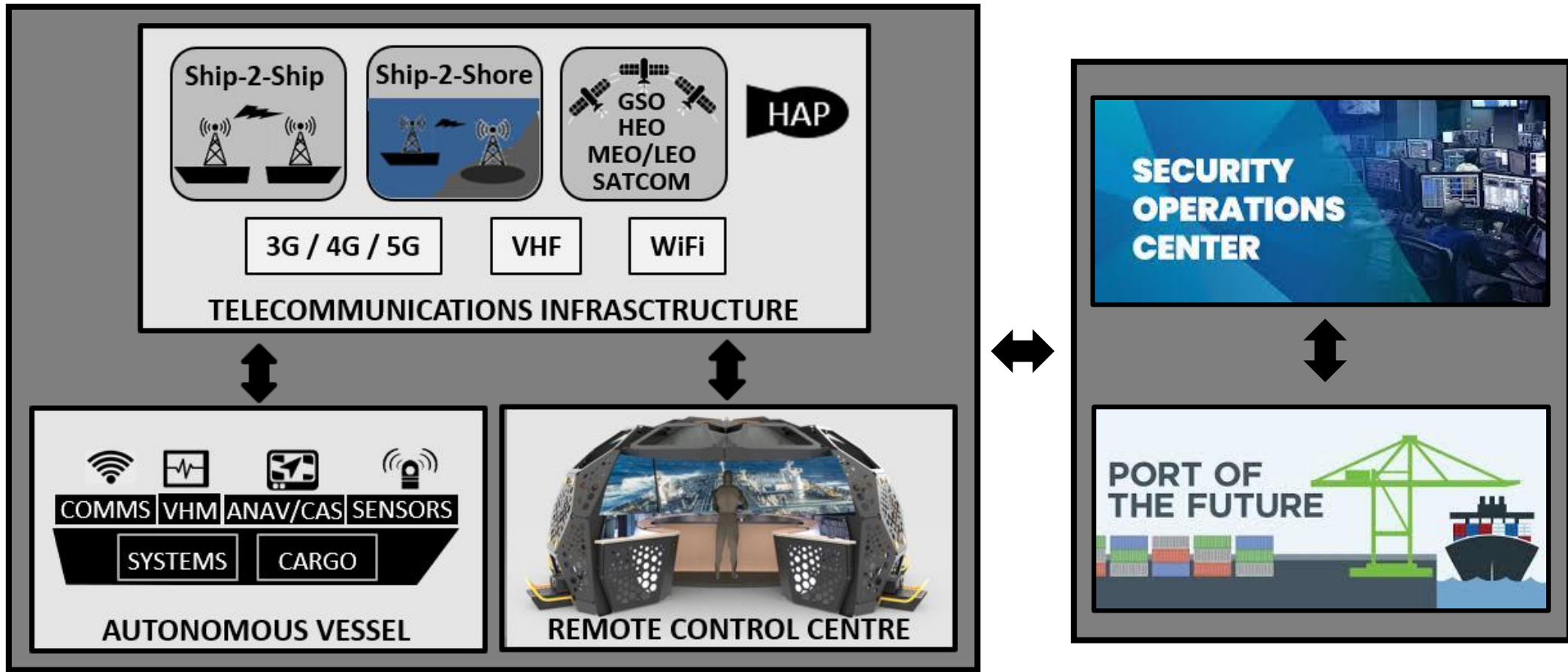


https://www.transports.gouv.qc.ca/fr/ministere/role_ministere/colloques-congres-conferences/tournee-secteur-maritime/Documents/brochure-Strategie-maritime.pdf

S-100 Maritime Data



MASS Concepts



The Remote Control Centre is an extension of the autonomous vessel

Some MASS Challenges (1/2)

MASS operations and integrated intermodal supply chain logistics require sharing data. But:

Data Issues

1. Some data is missing.
2. Some data is not usable.
3. Some data is not readily shareable.
4. Data needs to be protected.
5. Interoperability is required for data to flow and information to be usable and actionable.
6. Data transmission within distributed, safety-critical systems requires a reliable telecommunications infrastructures.

Some MASS Challenges (2/2)

MASS operations and integrated intermodal supply chain logistics require sharing data. But:

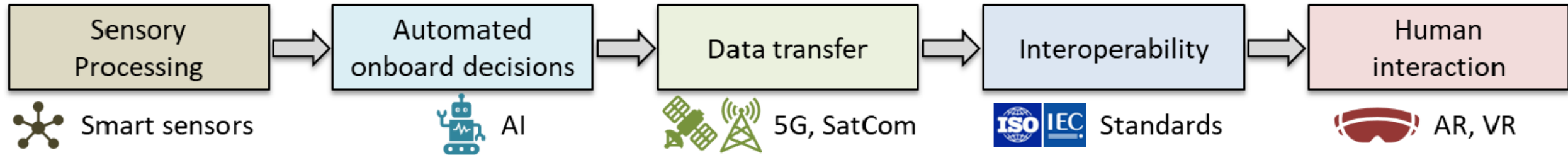
Control Issues

1. Exact role and requirements for Remote Control Centre for some use cases still TBD.
2. RCC need to provide different views and information depending on the phase of operations and the operational context.
3. Integrated Remote Ship Control is complex.
4. Extended use of current display technologies can lead to operator fatigue and other adverse effects in some situations.

MASS Ecosystem : Insurance & Liability Perspectives

SHIPOWNERS	YARDS & SYSTEM SUPPLIERS	REMOTE OPERATORS	CLASSIFICATION SOCIETIES	INSURERS
<ol style="list-style-type: none">1. Overall function unchanged2. Relation to remote operators3. Goods, ship & incident Liability	<ol style="list-style-type: none">1. Services2. Compliance3. Maintenance4. Connectivity5. Product Liability	<ol style="list-style-type: none">1. Multiple operational concepts2. Division of existing duties & obligations3. Operator Liability	<ol style="list-style-type: none">1. Verification & Certification of MASS2. Drive regulatory development	<ol style="list-style-type: none">1. Insurability2. Risk associated with higher levels of autonomy3. Access to operational data4. Cyber risk management

Enabling Technologies



Smart
Sensors



2G/3G/4G



Emerging technologies that contribute to simultaneous information production & consumption for MASS and intermodal supply chain applications

Smart Sensors

Some Examples of Smart Sensors

Wireless Concrete Sensor



Low-cost Portable LiDAR



High-Res Mobile Mapping

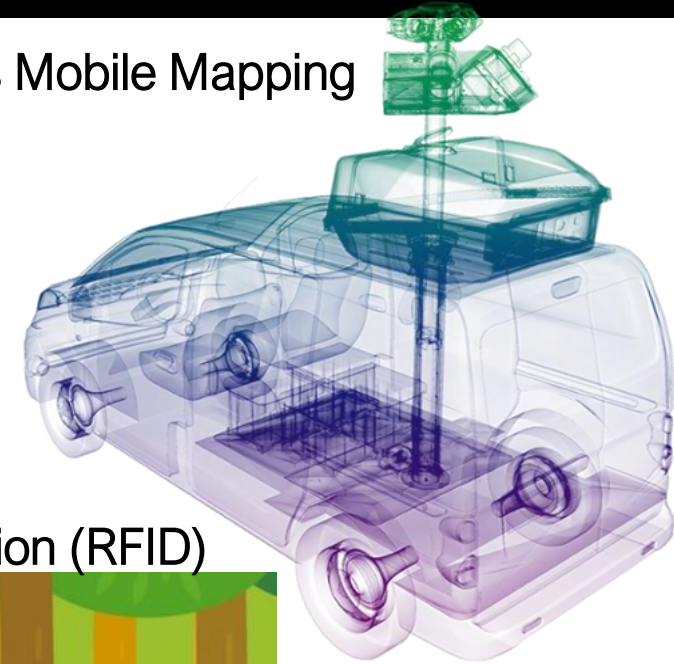


IMAGE: www.jakarta.com

SmartBuoy monitoring 24/7



Search and Rescue



Weather Service



Vessel Traffic Service



Authorities



Maritime

Radio Frequency Identification (RFID)



SOURCE: [MIT engineers configure RFID tags to work as sensors](https://www.mit.edu)

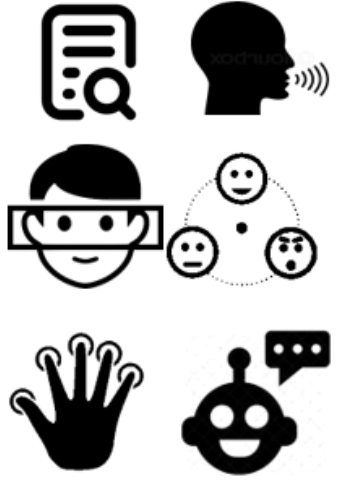
SOURCE: <https://seahow.sivuviidakko.fi/navigation-buoys/smart-buoys.html>



AI-Enabled Smart Building Applications

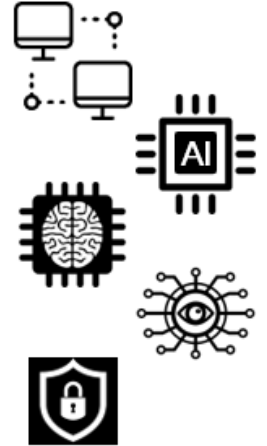
A Summary of AI-Related Technologies

HUMAN INTERACTIONS



Natural Language Processing
Natural Language Generation
Speech & Speaker Recognition
Emotion Recognition
Biometrics
Virtual Agents

MACHINE RESOURCES



Peer-to-Peer Networks
AI-Optimized Hardware
Machine Learning Platforms
Deep Learning Platforms
Image/Pattern Recognition
Cyber Defense

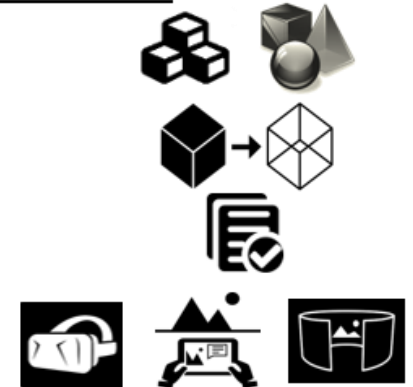
AI

ORGANIZATIONAL



Decision Management
Knowledge Worker Aid
Marketing Automation
Robotic Process Automation

OBJECT REPRESENTATION



Content Creation
Digital Twin/Modeling
Compliance
Visualization



Surveillance Cameras & Object Recognition

EXTRACTING INFORMATION FROM SURVEILLANCE CAMERAS



Live security camera Reykjavik Iceland
<https://www.insecam.org/en/view/802373/>



Live security camera Reykjavik Iceland
<https://www.insecam.org/en/view/802374/>



Standardization & Interoperability

What does it mean to the Maritime Transport Industry ?

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 :

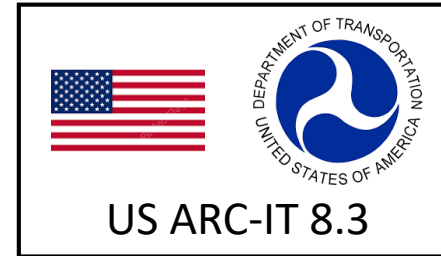
Ensures the interconnection of systems and data exchange via standardized transmission protocols and data formats.

Government Level	Economic and Regulatory Policies	Political Context
	Aligned Priorities & Focused Objectives	
Enterprise Level	Industry Goals	Organizational Interoperability
	Business Objectives	
	Aligned Processes & Procedures	
System Level	Understanding/Awareness	Syntactic & Semantic Interoperability
	Information Interoperability	
	Data Model Interoperability	
Network & Transport Level	Protocol Interoperability	Technical Interoperability
	Physical Interoperability	

Standardization can contribute to achieving interoperability.



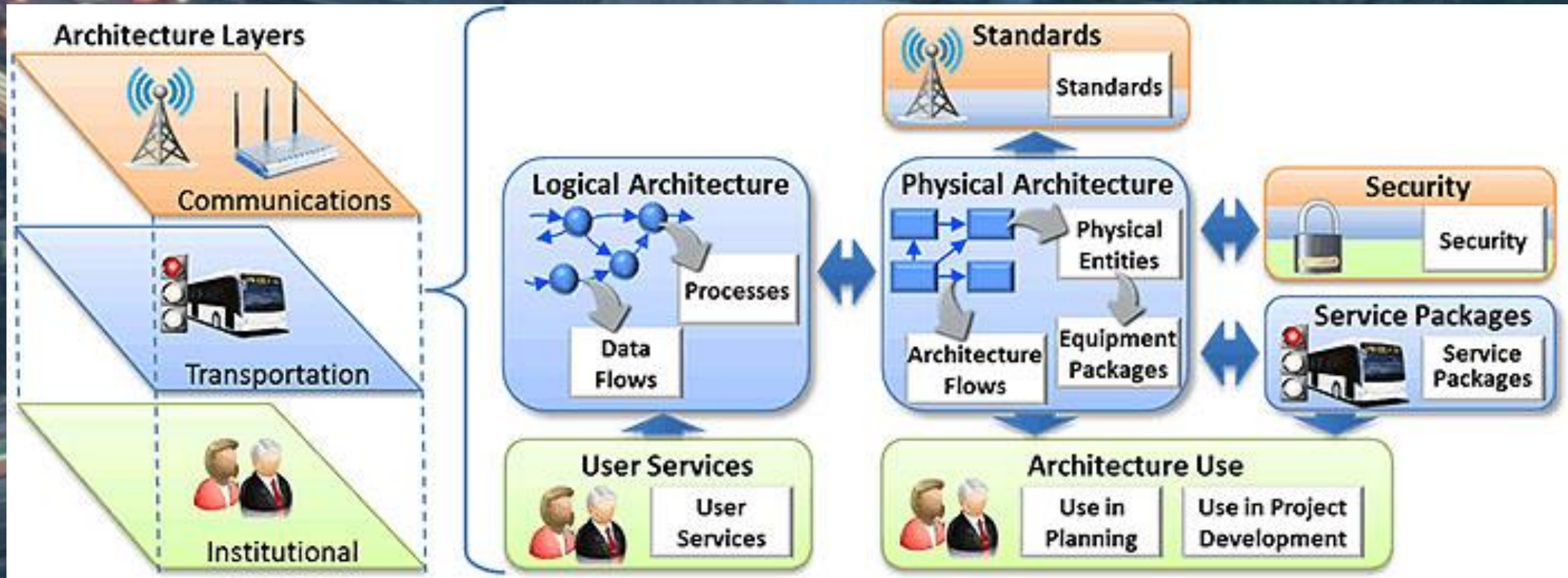
Intelligent Transport Systems – Architecture Frameworks



Current ITS frameworks are very ground transportation centric



Intelligent Transport Systems – Architecture Frameworks



Shared services and reliable infrastructure are central to ITS



Intelligent Transport Systems – Maritime Component

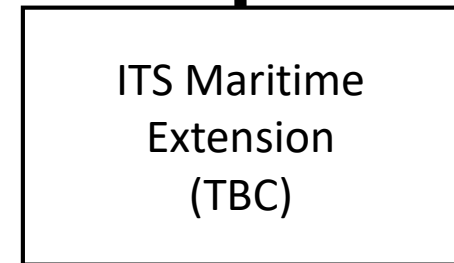
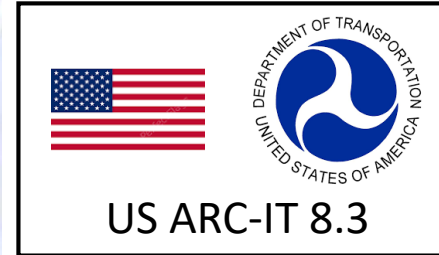


Intelligent Transportation Systems Applications for Ports



May 2, 2019

<https://www.pcb.its.dot.gov/t3/s190502/s190502 ITS ePrimer Port Operations presentation.pdf>





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/>



Virtual Reality (VR) & Augmented Reality (AR)

Do VR Headsets really work ?



Yes, for a subset of applications... but

- Depth perception limitations
- Adverse side effects
 - Nausea, headaches, dizziness, fatigue, seizures...
- Limited duration of use < 30 min.

The makers of the most popular VR headsets, the Oculus Rift and HTC Vive, recommend taking "at least a 10 to 15 minute break every 30 minutes, even if you don't think you need it."

SOURCE: Business Insider, Mar 4, 2018,

<https://www.businessinsider.com/virtual-reality-vr-side-effects-2018-3>



VR & AR : What's next ?

Realistic 3D Immersion without adverse side effects

Unique Canadian Display Technology: *Depth Perception Corrections + Retinal Resolution*



Virtual/Augmented Digital Twins

Real-time 2D and 3D streaming

Suited for Operational Use

- Consistent with operator shift duration
- Extreme, realism
- Ease of viewing
- No nausea, dizziness or headaches

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



3D Immersion Station & System Integration Platform

3D Immersion
 Simulation engine support
 Live streaming capability
 Connected, Networked
 Reconfigurable & Adaptive

- Black box Integration
- Virtual Monitor Management

Intelligent Adaptive Interfaces

- Operator State Monitoring
- Adaptive Displays & Controls

Multimodal Interfaces

- Voice Commands
- Facial Analysis
- Gestural Control



Computing Complex



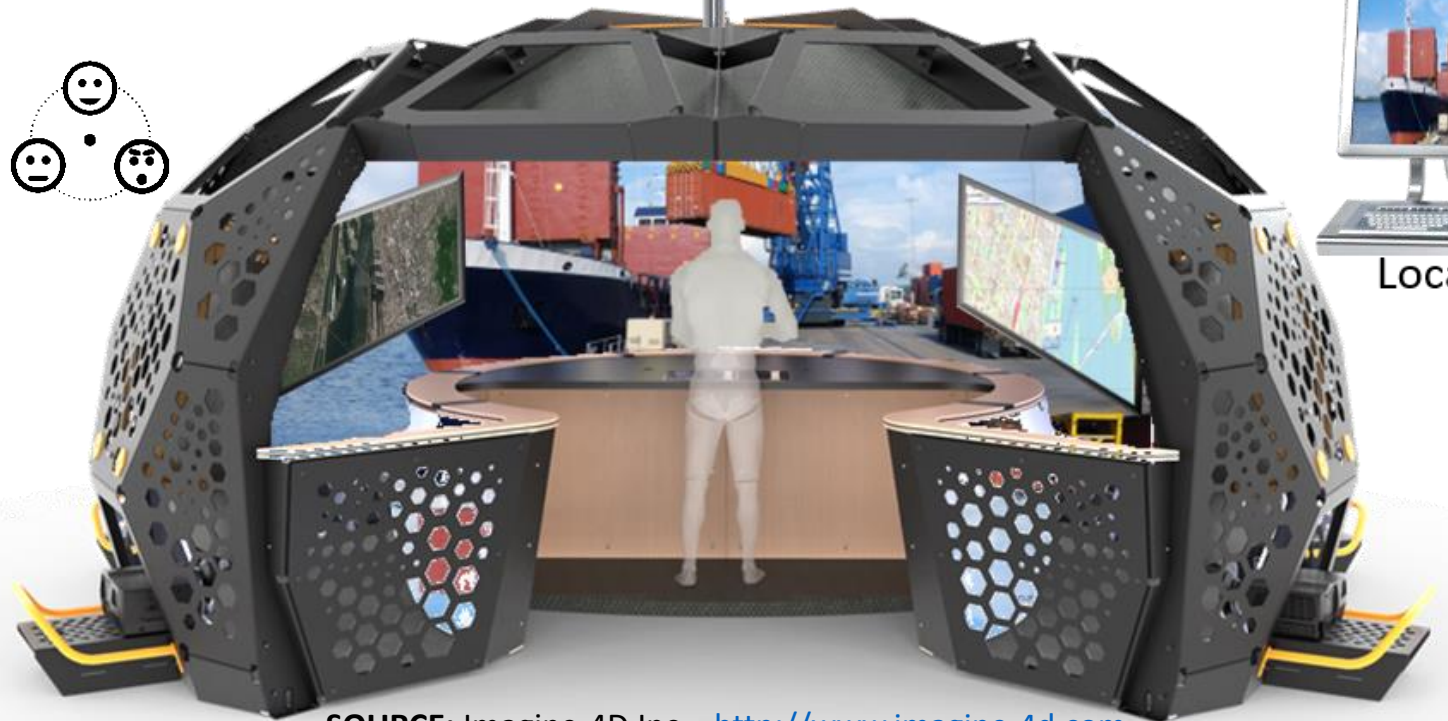
Remote



NETWORK



Local



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 telecommunications 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.

Novel immersive AR/VR display technologies seem be well-suited for building reconfigurable RCC.