BUREAU VERITAS MARINE & OFFSHORE

EXPANDING S-123 OBJECT LIST FOR REMOTE OPERATIONS

NIPWG INPUT PAPER

MONACO, 2023

INPUT PAPER IS CO-SPONSORED BY ORGANISATIONS RELATED TO AUTONOMY & ENCs

Bureau Veritas
Marine & Offshore

Norwegian Forum for
Autonomous Ships (NFAS)

One Sea Association

NAVTOR AS

Norwegian Coastal
Administration

Electronic Chart Centre

Robosys Automation Ltd.

Seafar NV

SINTEF

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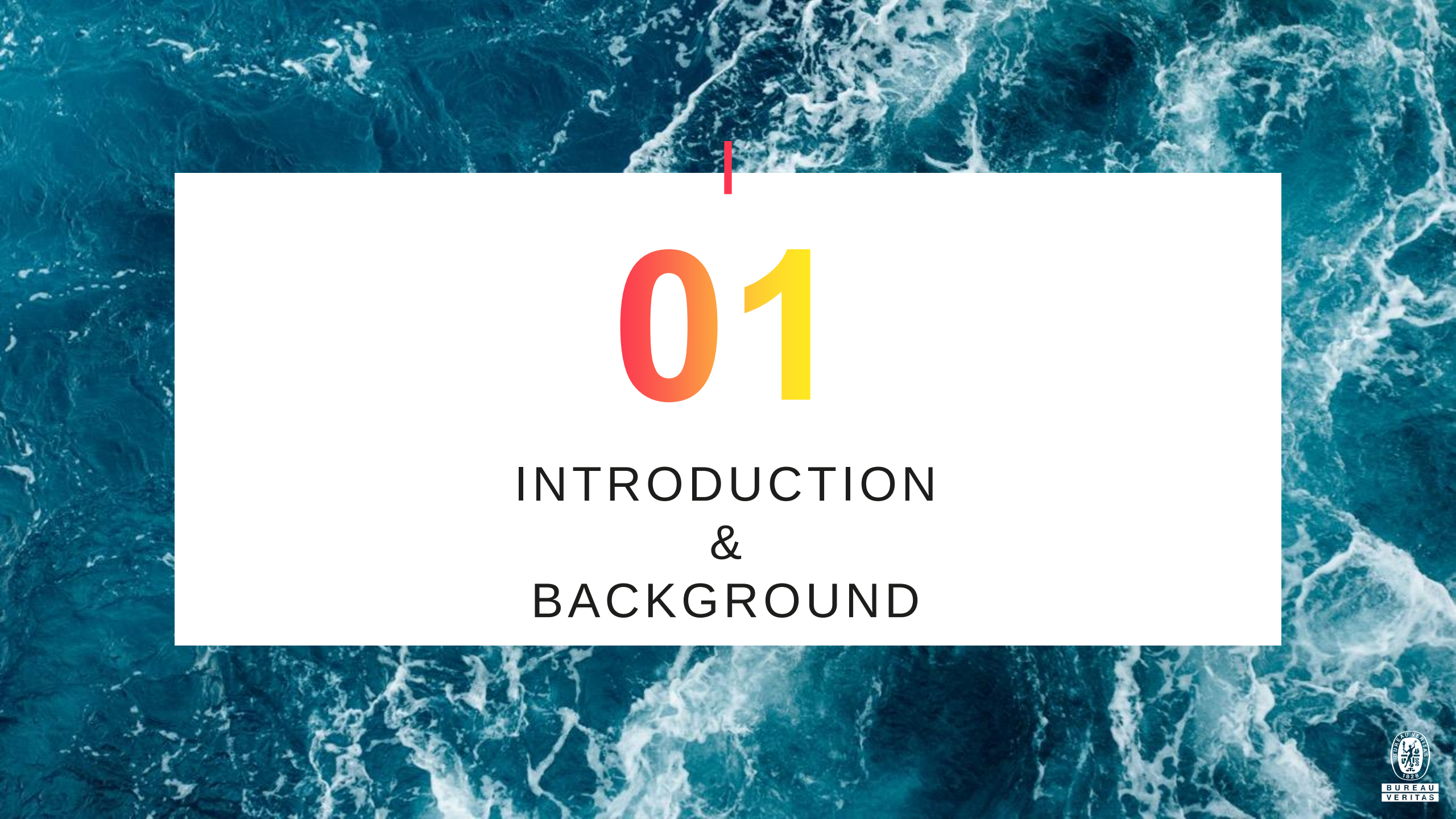
BUREAU VERITAS



01

INTRODUCTION & BACKGROUND

ROLE OF CLASSIFICATION SOCIETIES

TASK

- Autonomous and remotely operated shipping is progressively developing worldwide while there is a need to guarantee that the systems are safe and robust

APPROACH

- Classification societies, like Bureau Veritas Marine & Offshore, provide design approval, initial and periodical surveys setting a technical assurance framework recognised by Flag States

HELPING CLIENTS AND PUBLIC AUTHORITIES PROTECT ASSETS

200
YEARS
OF CLASSIFICATION EXPERTISE

100

FLAG STATE ADMINISTRATIONS

Recognize Bureau Veritas to approve ship security plans, perform audits, and issue international ship security certificates

130

FLAG STATE ADMINISTRATIONS

Delegate authority to Bureau Veritas to verify MARPOL and SOLAS compliance

150

FLAG STATE ADMINISTRATIONS

Trust Bureau Veritas to perform statutory surveys and audits on ships and offshore units

REGULATORS WORKING GROUPS FOR AUTONOMOUS VESSELS

IMO – GOAL BASED CODE FOR MASS

BV M&O fully involved in all steps with French Flag and in 9 sections of the Code

IACS – DEFINITION OF HIGH LEVEL IACS POSITION ON MASS

BV M&O involved in IACS EXPERT GROUP on Marine Autonomous Surface Ships.

ISO – TERMINOLOGY RELATED TO AUTONOMOUS SHIP SYSTEMS

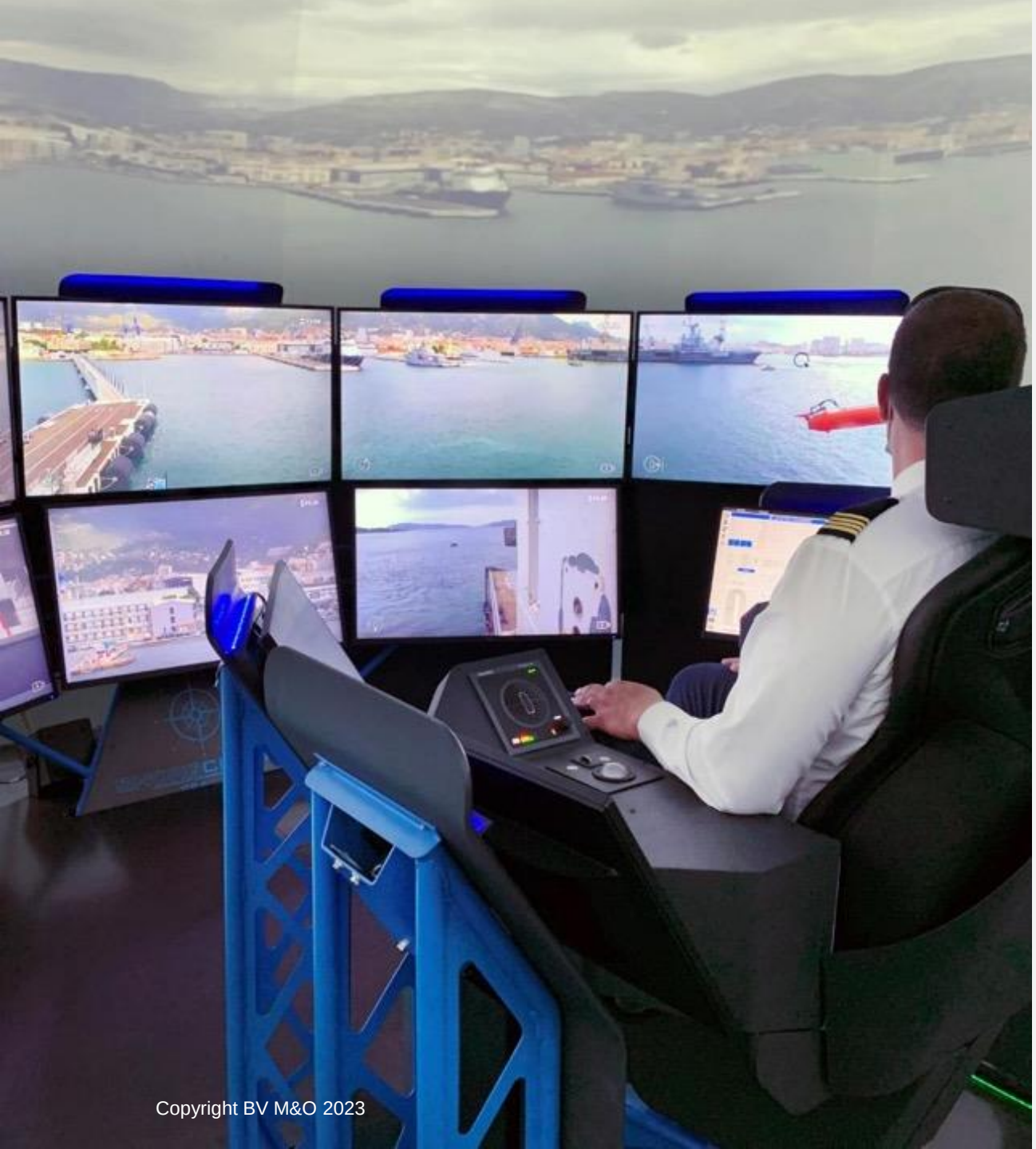
BV M&O involved in ISO/DTS 23860 development (TC 8 / WG10)

INSA – NAVAL BOAT CODE REVIEW

Participation in the working group on Unmanned Systems

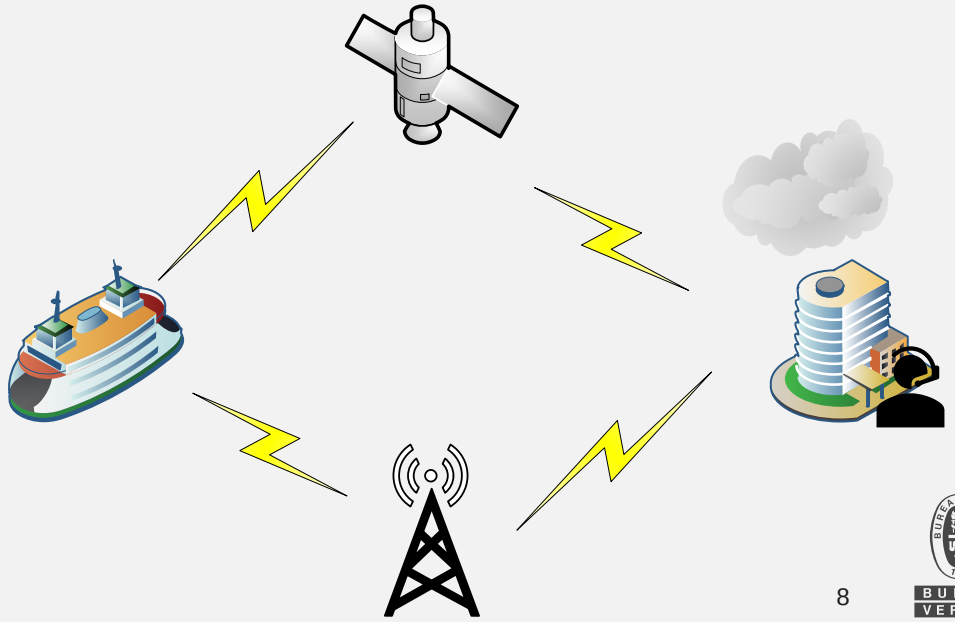
IMCA – SAFE & EFFICIENT USE OF USV, INSPECTION/AUDIT PLAN

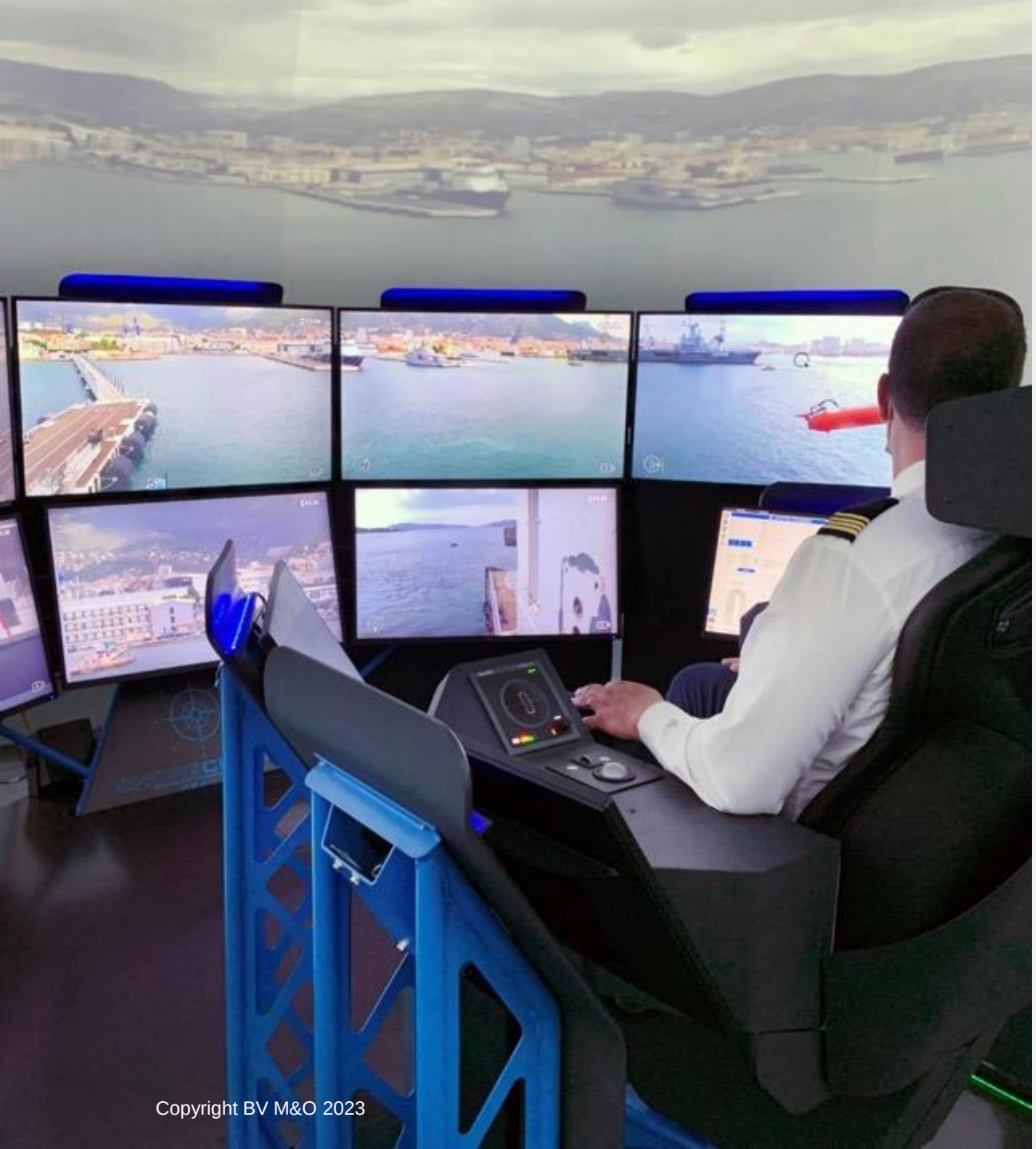
Participation in the USV working group



REMOTE OPERATIONS CENTRE

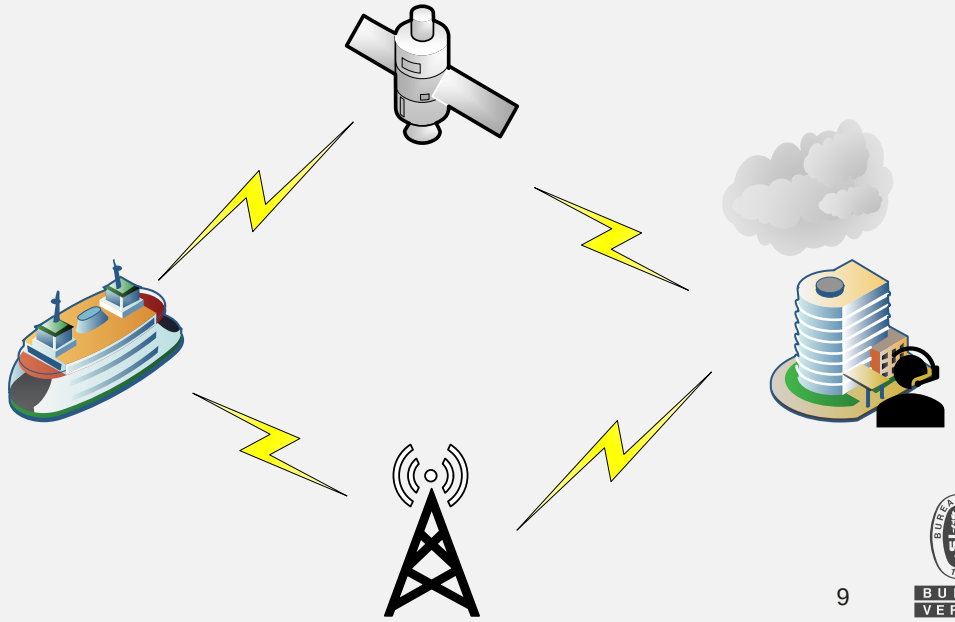
a site remote from the ship that can control ship system processes (ISO 23860:2022) via the ship-shore communication system that uses a secure connectivity link.

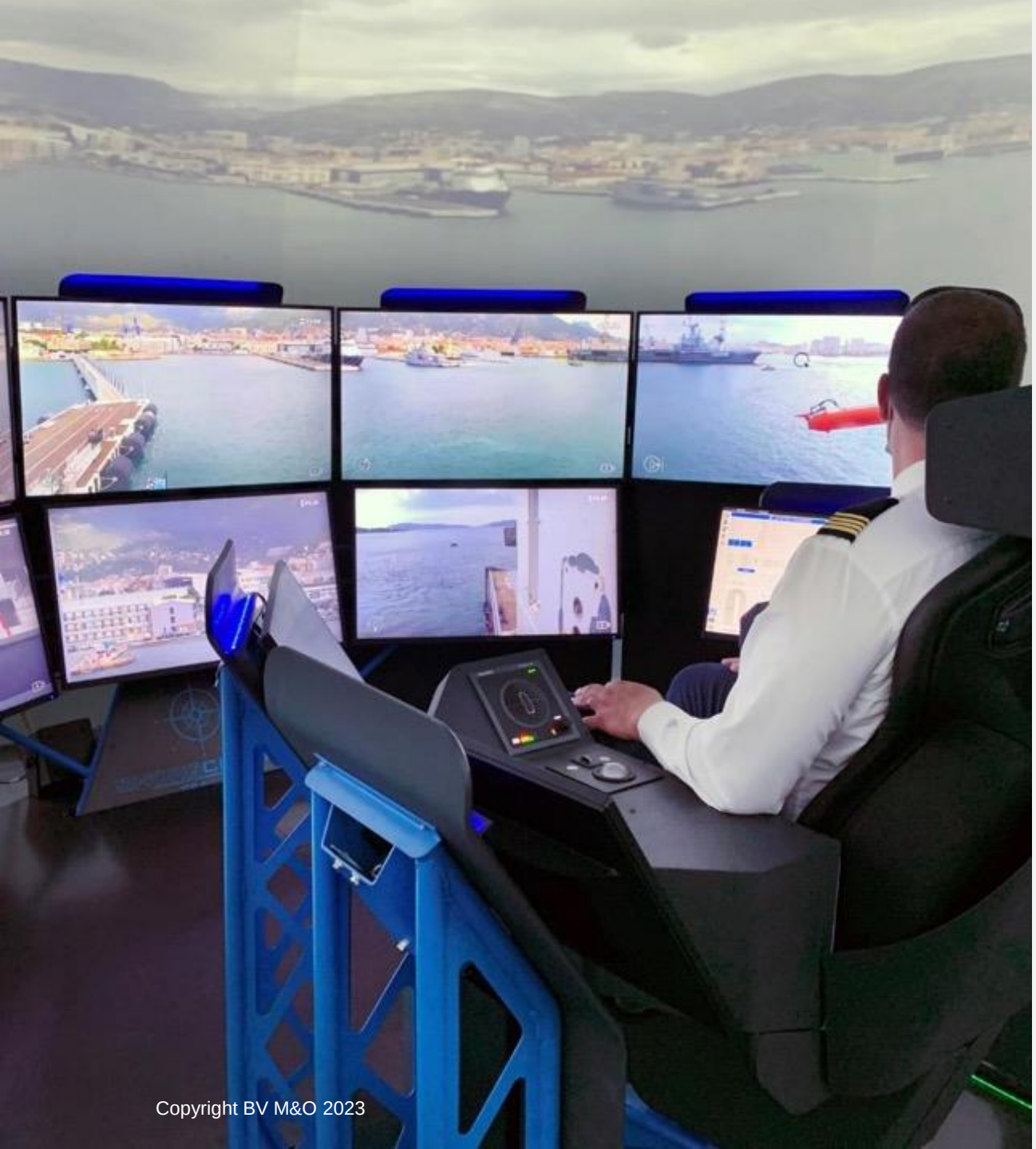




REMOTE OPERATIONS CENTRE

IMO definition as per MASS-JWG 2/WP.1
“*a location remote from the MASS that can operate some or all aspects of the functions of the MASS (Maritime Autonomous Surface Ship).*”





DEGREE OF CONTROL

Technology with a different degree of remote control may be deployed with regard to the interaction with the Remote Operations Centre (ROC), e.g. as per BV M&O NI641 Guidelines:

Degree RC1 - Available remote control

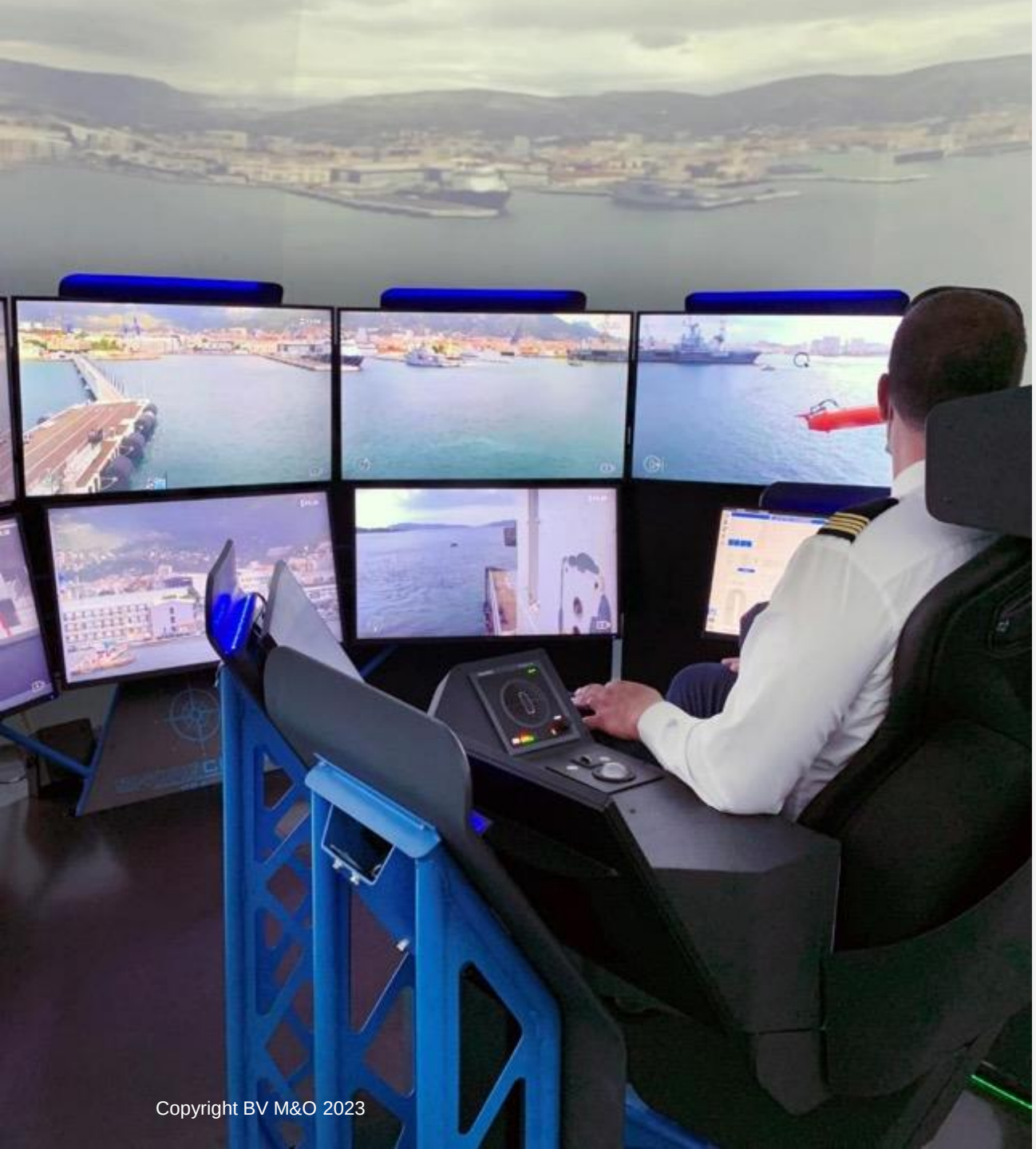
Operators are available in a ROC outside the ship, ready to take control in case of warning or alert from the system, but they may be not at the control station (e.g. periodically unmanned remote control station).

Degree RC2 - Discontinuous remote control

The system or ship is monitored and controlled by operators from a ROC outside the ship. But monitoring and control may be discontinuous during a short period. Operators are always available at the remote control station, ready to take control in case of warning or alert from the system

Degree RC3 - Full remote control

The system or ship is actively monitored and controlled at any time by operators from a ROC outside the ship



DISCONTINUOUS CONNECTIVITY

It should be noted that depending on the designed interaction level of the autonomous vessels, they **may operate without a need of continuous connectivity** with the Remote Operations Centre (ROC) allowing them to exit the connectivity coverage areas.

However, the measures to reach a **fallback state** (defined in ISO 23860:2022) following an emergency situation may include the passage to the **nearest area with guaranteed connectivity coverage**.

A VARIETY OF OPTIONS EXISTS FOR CONNECTED VESSELS

COMMUNICATION DEVICES

- 4G, 5G, LTE,
- Ku-band, Ka-band, L-band,
- MN-MANET,
- VDES, WiMax, etc

LINK THROUGH

- satellite constellations
- land-based relay stations
- ship-to-ship proximity-based maritime Internet of Things, e.g. NB-IoT (out of scope of the present input paper)

LIMITATIONS

- geographic area of coverage depends on the electromagnetic spectrum in use, placement of relay stations, subscription , etc.
- bandwidth, latency and other Quality-of-Service (QoS) parameters depending on subscription

ACHIEVE CONSISTENT RISK CONTROL

ANTICIPATE OUTAGES WITH CONTINGENCY PLANS

CONNECTIVITY COVERAGE MAPPING AS AN ENABLER FOR AUTONOMOUS NAVIGATION

Mapping of connectivity coverage enables the **identification of no-go** areas where

- there is no signal or
- where the Quality-of-Service (QoS) is not guaranteed.

Previously Bureau Veritas Marine & Offshore published “Guidelines for autonomous shipping” NI641, where Sec 1, [2.10.3] and Sec 3, [8.2.3] refer to latency as one of QoS parameters and to the situational awareness about the range of the communications.

- *Sec 1, 2.10.3 The remote **operators should be aware of the latency** due to the communication that cause a delay between his/her action and the actual ship reaction.*
- *Sec 3, 8.2.3 In the case of remote control, it is **the responsibility of remote operators to ensure that the ship remains within the range of its means of communication** at all times and under all circumstances. When a ship is no longer within the range of its means of communication allowing its control, this ship should be able to enter into a failure sequence on its own.*

EXPANDING S-123

Availability of a standardized approach for mapping the corresponding connectivity coverage objects can improve the safety for autonomous and remote operated shipping.

Therefore, it is proposed to consider **including the connectivity coverage and QoS data objects into S-123 “Marine Radio Services” Product Specification**.

S-123 specifies objects indicating the

- location, availability, type of radio communications,
- frequencies and content of radio services for navigational information and
- other maritime radio communications.

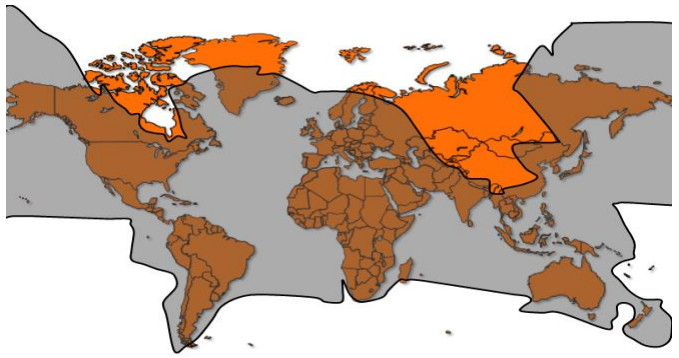
02

ANALYSIS & DISCUSSION

ISSUE AT THE LEVEL OF CONNECTIVITY PROVIDERS

The satcom providers are **not yet offering**

- QoS data in a unified format
- Geographic coverage in an ENC format easily compatible with ECDIS



EXAMPLE OF SPECIFYING QOS

ETSI 3GPP standards for the cellular networks (LTE, 4G, 5G, etc.), e.g. ETSI TS 123 203 V17.2.0 [6.1.7], Table “Standardized QoS characteristics”.

QCI	Resource Type	Priority Level	Packet Delay Budget (NOTE 13)	Packet Error Loss Rate (NOTE 2)	Example Services
1 (NOTE 3)	GBR	2	100 ms (NOTE 1, NOTE 11)	10^{-2}	Conversational Voice
2 (NOTE 3)		4	150 ms (NOTE 1, NOTE 11)	10^{-3}	Conversational Video (Live Streaming)
3 (NOTE 3, NOTE 14)		3	50 ms (NOTE 1, NOTE 11)	10^{-3}	Real Time Gaming, V2X messages Electricity distribution - medium voltage (e.g. TS 22.261 [51] clause 7.2.2) Process automation - monitoring (e.g. TS 22.261 [51] clause 7.2.2)

GBR mentioned in the table stands for a Guarantee Bit Rate service where an information transmission path is used for which the capacity, delay and bit error rate are guaranteed by the external connectivity provider.

OTHER QUALITY OF SERVICE PARAMETERS RECOMMENDED

QoS parameters should also include, but not limited to,

- bandwidth of uplink and downlink,
- reliability of communication, i.e. a measure of probability for communication break,
- susceptibility to jamming

Challenge for the industry

The lack of detailed and accurate information on the coverage and on QoS forces the Shipowners to measure and plot the signal availability on their own,

when planning and testing new autonomous or remotely operated services and routes.

ISSUE AT THE LEVEL OF ENC PROVIDERS

Satcom and cellular connectivity coverages are **not explicitly mentioned as dedicated vector objects** in S-57 or S-123.

The existing coverage features listed in the S-123 vector model include

- transmission power (applicable for land-based comms)
- GM_Point, (applicable for land-based comms)
- GM_OrientableCurve (applicable for land-based and satellite-based comms)
- GM_OrientableSurface (applicable for land-based and satellite-based comms)
- Estimated range of transmission (applicable for land-based comms).

USE OF INFORMATION FOR ROUTE PLANNING AND EXECUTION

LAYER IN ECDIS

The boundaries of the connectivity service coverage and its expected impact on QoS can be used as a layer in ECDIS.

COLOUR-CODING

The coverage map could be colour-coded based on expected received signal strength at any given location, seen in relation to the expected QoS performance for the communication system in question.

SAFETY CONTOUR

Created from bathymetric grid data, and connectivity service coverage, and based on values set by the user

USE CASES

safety contour may be used for :

- route planning when automatically validating a route in ECDIS

- execution of passage to prevent a loss of connectivity.

SAFETY CONTOUR

Users in Remote Operations Centres (ROC) could benefit from a safety contour created from the following datasets and user settings:

DATASETS
bathymetric grid data
connectivity service coverage

USER SETTINGS
safety contour depth value
redundant configuration of the connectivity system
communication device (antenna) in use
height of the communication device above the water
level of interaction between the ship and the ROC related to a mode of control
active subscription.

IMPACTS

- The subject addressed by the paper concerns the standardisation of the nautical charts to **improve the safety of navigation** and, hence, is within the scope of IHO objectives.
- The subject of the paper is **within the scope of the current IHO work programme** on S-123 development.
- **S-123 can be used as an adequate industry standard** for implementing the proposal.
- The benefits of reducing the **risk of a loss of connectivity** for the remotely controlled vessels support the proposed action.
- Depending on the level of interaction and involvement required from the remote operator, a **loss of control might increase the risk of a collision and grounding** with the subsequent adverse effects for the humans, assets and environment

POTENTIAL COST IMPACTS ON THE MARITIME INDUSTRY, MEMBER STATES OR OTHER INVOLVED PARTIES

1 PRODUCING ENC COMPATIBLE OBJECTS

- Producing the ENC compatible objects may incur costs for the connectivity providers, e.g., if it is outsourced to national agencies specialised in marine geospatial data

2 MAINTAIN ENC COMPATIBLE OBJECTS

- Maintaining the coverage area mapping may be a cost for the connectivity service provider

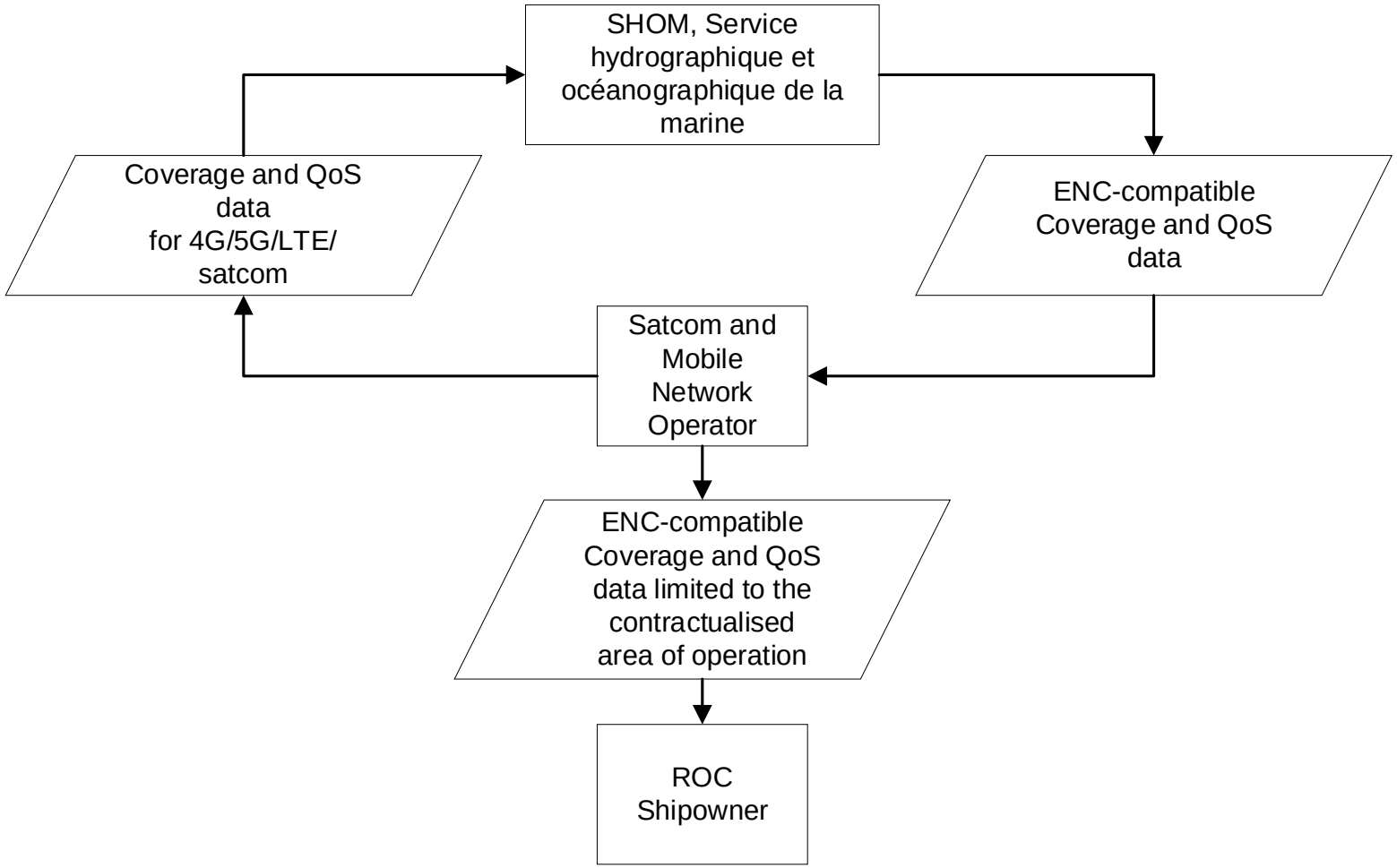
3 DISPATCH UPDATES TO SHIPOWNERS

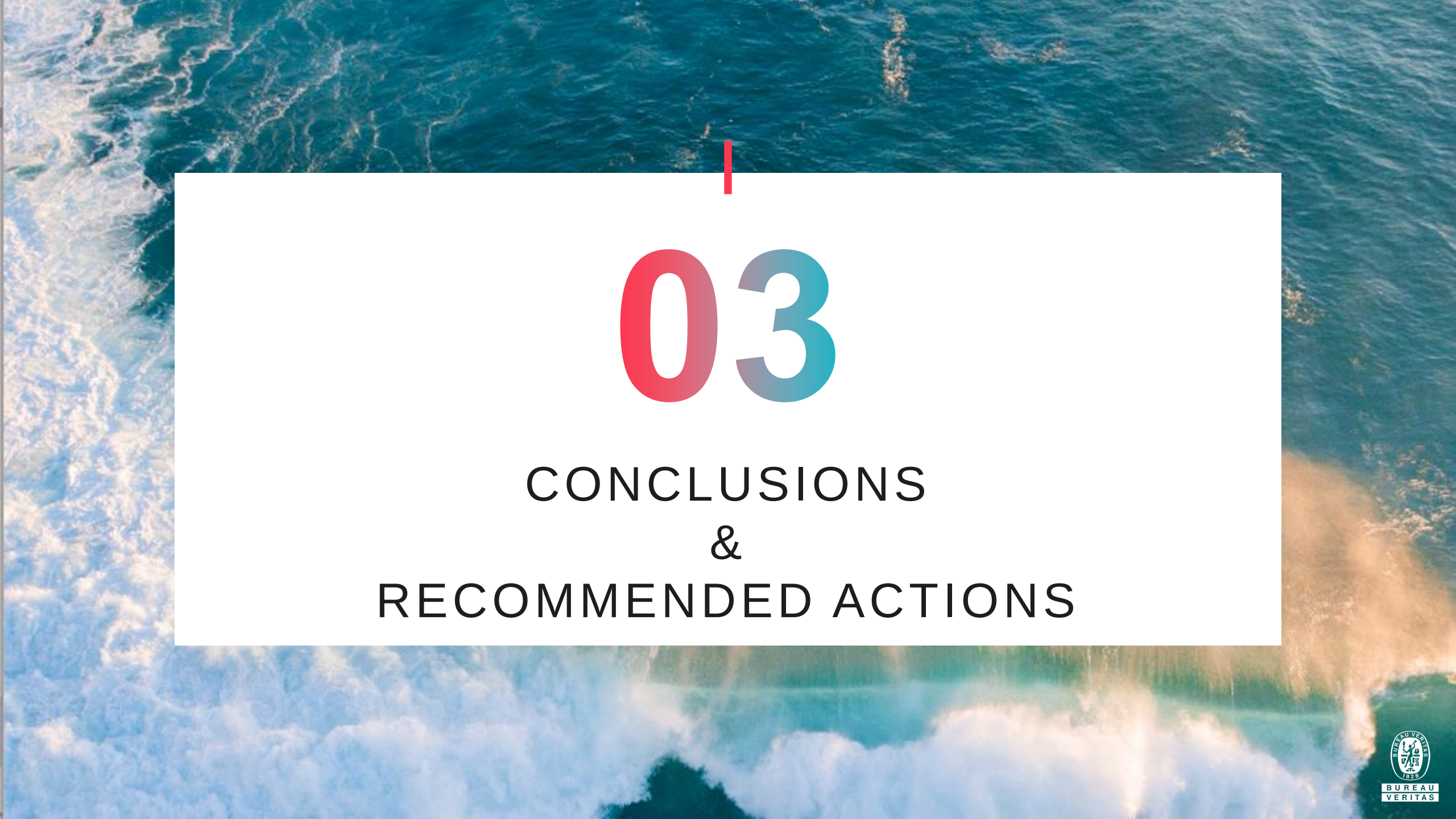
- Transmitting of the relevant ENC updates may incur additional costs, as the data may be confidential and may require a different access management than currently implemented for the ENC products, i.e. a license from a specific external connectivity provider required to plot the corresponding coverage in ECDIS

4 SUBSCRIPTION FEE

- Subscription for the updates may be a cost for Shipowners.

POSSIBLE INTERACTION FOR A MOBILE NETWORK OPERATOR





03

CONCLUSIONS & RECOMMENDED ACTIONS

CONCLUSIONS

- The **safety issue related to the provision of the coverage zones for connectivity** used in remote control with a mapping in ENC is **pertinent** for the emerging autonomous and remotely operated shipping both inland and at sea.
- Creation of the dedicated data objects in S-123 is a **mitigation for the risk of the loss of remote control.**
- **Availability of the standardised Product Specification from IHO** and of a roadmap for the implementation is important for the industry.

RECOMMENDATIONS

It is proposed to consider a potential solution at the level of NIPWG that might include:

- **introducing the satellite connectivity object type in S-123** with the coverage, QoS parameters, frequency ranges, uncertainty level
- **adapting radio station object type in S-123** to reflect the coverage, QoS parameters, frequency ranges, uncertainty level for the cellular network base stations
- **issuing recommendation to satcom providers** to regularly share the updates of the coverage with the minimum requirements to the format of data to be shared on the satellite status
- **issuing recommendation to cellular network providers** to regularly share the updates of the coverage with the minimum requirements to the format of data to be shared on the network status per base station along the coast or inland waterways.

ACTION REQUIRED OF NIPWG

The NIPWG is invited to:

- **endorse** the input paper “Expanding S-123 object list with the connectivity coverage for remote operations”
- **agree on the new data objects** and a road map for their development within S-123
- **develop recommendations** on ENC datasets and implementation workflow for the connectivity service providers

DEVELOPMENT MAY INVOLVE

- ECDIS manufacturer
- Mobile Network Operator
- Satellite Communication Operator
- Short Sea Shipping Shipowner
- Inland Shipping Shipowner
- National agency specialised in marine geospatial data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