2021
모의IMO총회
The 2021 Mock IMO Assembly

Proposal to the New Standard of the Degrees of Autonomy for MASS Operations

Team: MASSive

Contents

Abstract

New Requirements

Degrees of Autonomy

IMO Instruments

MASS Code

SOLAS Convention

for MASS Operations

SD 2: Integrate new and advancing technologies in the regulatory framework

New Output: Development of a goal-based instrument for maritime autonomous surface ships (MASS)

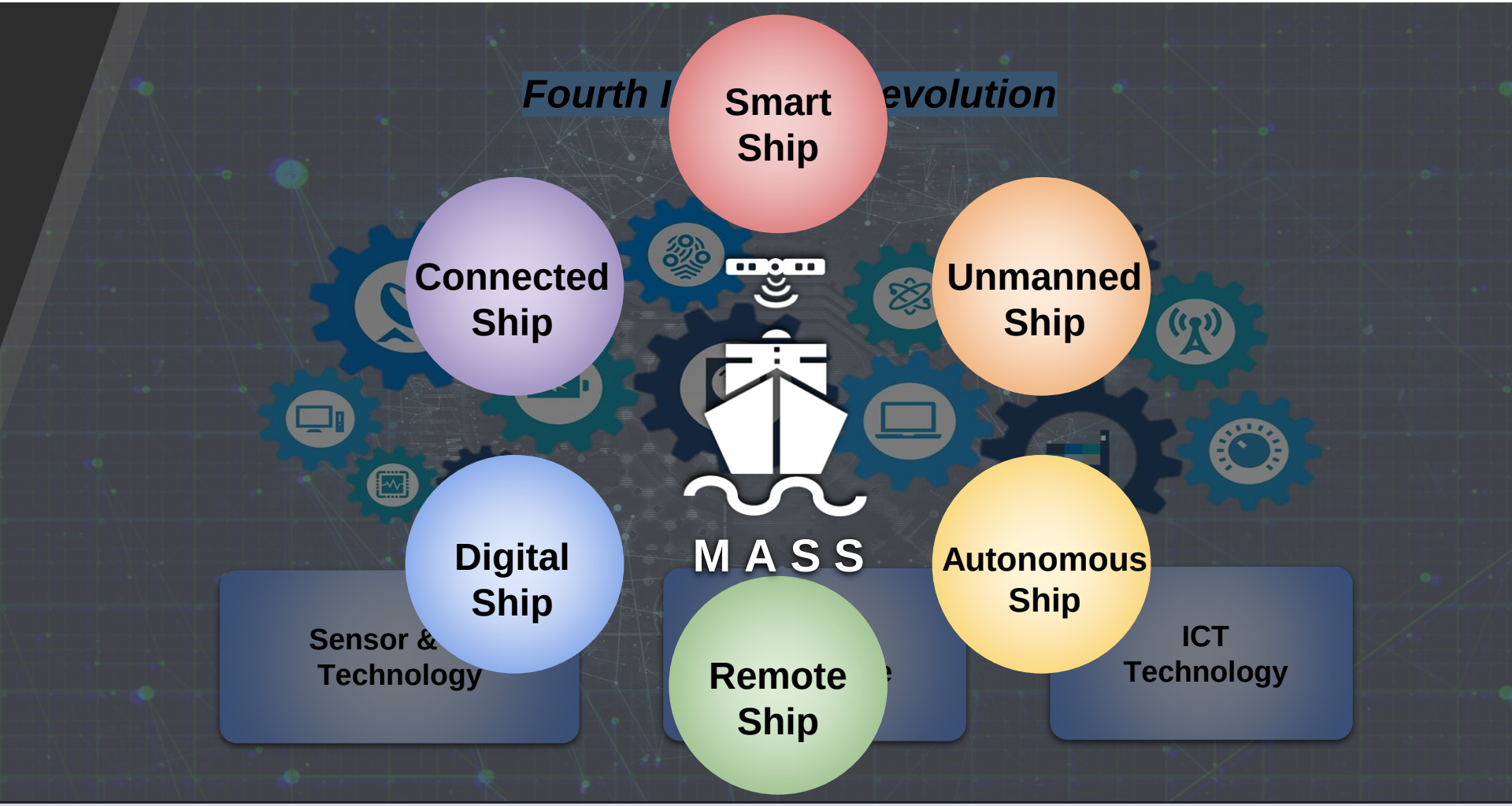
Source : Resolution A.1131(31) LIST OF OUTPUTS FOR THE 2020-2021 BIENNIUM

Introduction

1. Background
2. Trends in the IMO

Introduction

Background - Advances in Technology



Introduction

Background - Trends in Other Countries

EU

- **MUNIN** : Maritime Unmanned Navigation through Intelligence in Networks

FINLAND

- **AAWA** : The Advanced Autonomous Waterborne Applications
- **OneSea** : Finnish ecosystems for autonomous maritime transport

NORWAY

- **Yara Birkeland** : First fully electric and autonomous container ship
- **AUTOSEA** : Sensor Fusion and collision avoidance for advanced ship
- **ReVolt**

USA

- **Mayflower project**
- **ACTUV** : ASW(Anti-Submarine Warfare) Continuous Trail Unmanned Vessel

CHINA

- **Green-Dolphin project (2015~)**
- **China Unmanned Cargo Ship Development Alliance**

JAPAN

- **SSAP** : Smart Ship Application Platform (2012~2017)

Photo: Rolls-Royce

Introduction

Background - Necessity for IMO Instruments for MASS

International Regulation

IMO
International
Maritime
Organization

International Standards

ITU
International
Telecommunication
Union

IHO
International
Hydrographic
Organization

ISO
International
Organizations for
Standardization

IEC
International
Electrotechnical
Commission

Industrial Standards

3GPP
3rd **G**eneration
Partnership
Project

IALA
International
Association of
Lighthouse
Authorities

RTCM
Radio
Technical
Commission for
Maritime Service

NMEA
National
Marine
Electronics
Association

Introduction

Trends in the IMO - Progress of Discussion

MSC 95 (‘15. JUN)	The need for guidelines and regulations for the use of MASS emerged.
MSC 98 (‘17. JUN)	Agreed upon "Regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS)" (~2020)
MSC 99 (‘18. MAY)	Started to develop a framework for the RSE and defined the aim, the objective, the preliminary definition of MASS and degrees of autonomy.
MSC 100 (‘18. DEC)	Approved the framework for the RSE, which contained definitions, a methodology consisting of a two-step approach and a plan of work and procedures.

Introduction

Trends in the IMO - Progress of Discussion

MSC 101 ('19. JUN)	Developed and approved Interim guidelines for MASS trials. (MSC.1/Circ.1604)
ISWG/MASS ('19. SEP)	Considered and agreed on the result of the 1st step of the RSE, and commenced the 2nd step.
MSC 102 ('20. NOV)	Owing to the COVID-19 pandemic, MSC 102 deferred consideration of this matter to MSC 103.
MSC 103 ('21. MAY)	Finalized the RSE and approved the outcome.

Introduction

Expectation of Development for MASS Code

6 PRIORITIES FOR FURTHER WORK

6.1 Given the complex and extensive output of the RSE (section 4 and appendix 2), establishing priorities for further work is important. This section has been developed by using the available information in appendix 2, to identify the priorities of work on several issues cutting across a number of individual IMO instruments. The main high-priority items include the need to consider the development of a new instrument, review of terminology and definitions and consideration of high-priority common gaps and themes. It should be noted, however, that the identified priorities are non-exhaustive.

Development of a new instrument

6.2 In line with the [illegible] operations" in appendix [illegible] several instruments, could preferably be addressed holistically through a new instrument [illegible] to conventional ships. Therefore, a MASS instrument, instead of amending individual instruments, may be considered which can be made mandatory by means of amending an existing IMO convention, such as SOLAS. This instrument could preferably be developed following a goal-based approach,[4] in line with the Guidelines developed by the Organization.[5]

6.3 In order to facilitate the operation of MASS at an early stage, establishing interim guidelines for MASS may be beneficial for ensuring safe, secure and environmentally-friendly MASS operations.

Issue		Planned activities and result
1	**Consideration of a holistic approach to MASS operations in IMO instruments**	
	Development of a goal-based MASS instrument	Consideration on how to develop a new MASS instrument and draft amendments to the applicable instruments through which it can be made mandatory
	Definition of MASS	Consideration on the need to revise definition and/or degrees and if revision is deemed necessary, agreeing on the definition and/or degrees
	Terminology for MASS operations in the IMO regulatory framework	Consideration on the need of establishing terminology, and if deemed necessary, agreeing on such terminology
	High-priority common gaps and themes in relation to MASS operations and IMO regulatory framework - Meaning of Master, crew or responsible person - Remote control station/centre - Remote operator designated as seafarer	Consideration of the high-priority common gaps and themes
	Non-mandatory instrument	Consideration of the development of guidelines for MASS operations such as guidelines for installation and guidelines for system application

Table 6: Addressing MASS operations in IMO instruments under the remit of the Maritime Safety Committee

Thus, **a new instrument** *for MASS operations* is **expected to be developed.**

Source : IMO document MSC.1/Circ.1638 "OUTCOME OF THE REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS)"

Analysis of Issue

1. RSE for the Use of MASS
2. The Methodology of the RSE
3. The Outcome of the RSE
4. Top Priority Issue

Analysis of Issue

RSE for the Use of MASS

ANNEX

FRAMEWORK FOR THE REGULATORY SCOPING EXERCISE

Aim

1 The aim of the regulatory scoping exercise is to determine how safe, secure and environmentally sound Maritime Autonomous Surface Ships (MASS) operations might be addressed in IMO instruments.

Objective

2 The objective of the regulatory scoping exercise on MASS conducted by the Maritime Safety Committee is to assess the degree to which the existing regulatory framework under its purview may be affected in order to address MASS operations.

Glossary

3 For the purpose of the regulatory scoping exercise, "Maritime Autonomous Surface Ship (MASS)" is defined as a ship which, to a varying degree, can operate independent of human interaction.

4 To facilitate the process of the regulatory scoping exercise, the degrees of autonomy are organized as follows:

Degree one: ***Ship with automated processes and decision support:*** Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.

Degree two: ***Remotely controlled ship with seafarers on board:*** The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.

Degree three: ***Remotely controlled ship without seafarers on board:*** The ship is controlled and operated from another location. There are no seafarers on board.

Degree four: ***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

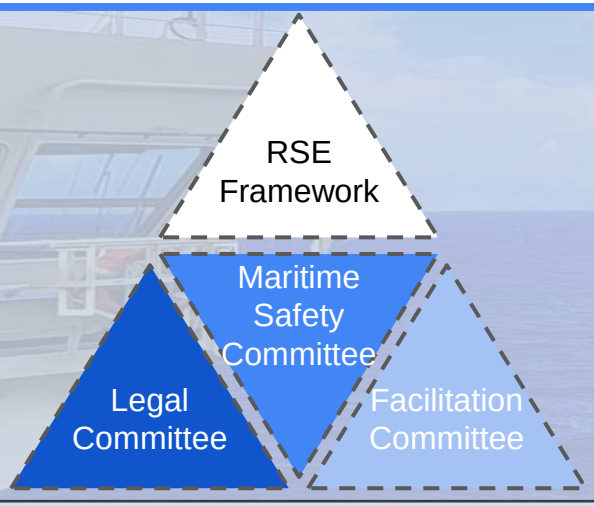
5 The above list does not represent a hierarchic order. It should be noted that MASS could be operating at one or more degrees of autonomy for the duration of a single voyage.

Instruments

6 The list of mandatory instruments related to maritime safety and security to be considered as part of the regulatory scoping exercise is set out in appendix 1. These instruments should be reviewed on a regulation or rule level. Subsidiary mandatory instruments established under each parent instrument should also be considered to the level necessary to establish how they will be affected.

Regulatory Scoping Exercise(RSE)

The work to identify measures that might arise when the existing conventions are applied to MASS, as a preliminary work to develop international standard regulations for the use of MASS.



Source: M.C Jo et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 929 012014,
IMO document MSC 100/WP.8 "REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS) "

Analysis of Issue

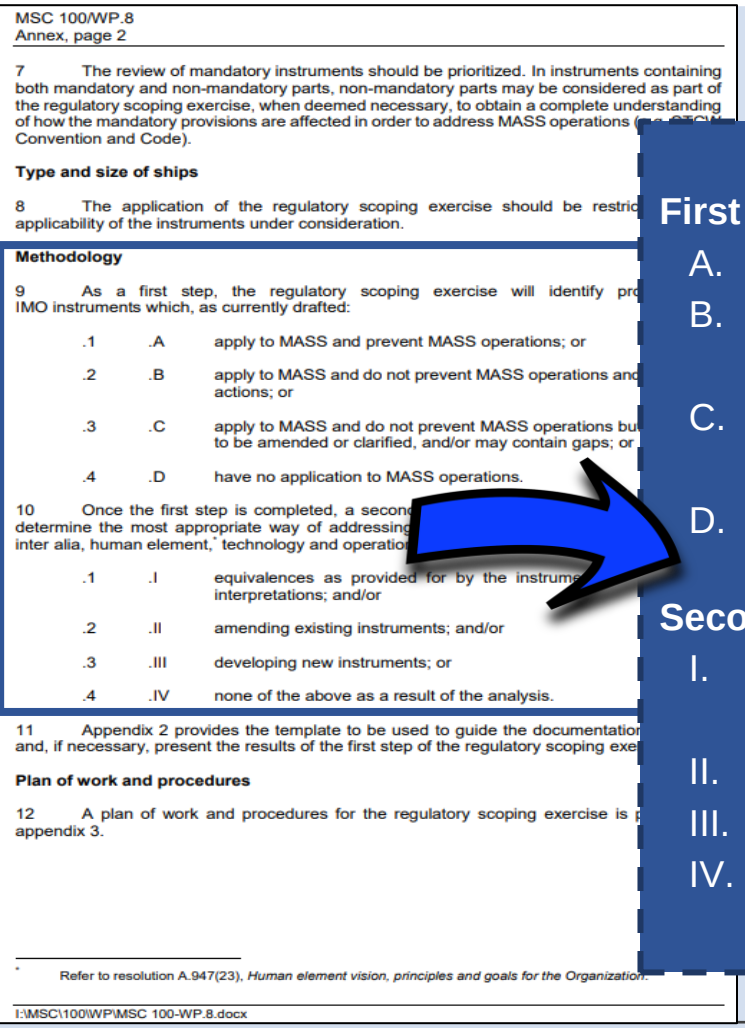
The Methodology of the RSE

MASS Degrees of Autonomy	
Degree One	***Ship with automated processes and decision support:*** Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.
Degree Two	***Remotely controlled ship with seafarers on board:*** The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.
Degree Three	***Remotely controlled ship without seafarers on board:*** The ship is controlled and operated from another location. There are no seafarers on board.
Degree Four	***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

Source: IMO document MSC 100/WP.8 "REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS) "

Analysis of Issue

The Methodology of the RSE



MSC 100/WP.8
Annex, page 2

7 The review of mandatory instruments should be prioritized. In instruments containing both mandatory and non-mandatory parts, non-mandatory parts may be considered as part of the regulatory scoping exercise, when deemed necessary, to obtain a complete understanding of how the mandatory provisions are affected in order to address MASS operations (e.g. STCW Convention and Code).

Type and size of ships

8 The application of the regulatory scoping exercise should be restric applicability of the instruments under consideration.

Methodology

9 As a first step, the regulatory scoping exercise will identify pro IMO instruments which, as currently drafted:

.1 .A apply to MASS and prevent MASS operations; or

.2 .B apply to MASS and do not prevent MASS operations and actions; or

.3 .C apply to MASS and do not prevent MASS operations bu to be amended or clarified, and/or may contain gaps; or

.4 .D have no application to MASS operations.

10 Once the first step is completed, a secon determine the most appropriate way of addressing inter alia, human element,* technology and operatio

.1 .I equivalences as provided for by the instrume interpretations; and/or

.2 .II amending existing instruments; and/or

.3 .III developing new instruments; or

.4 .IV none of the above as a result of the analysis.

11 Appendix 2 provides the template to be used to guide the documentatio and, if necessary, present the results of the first step of the regulatory scoping exe

Plan of work and procedures

12 A plan of work and procedures for the regulatory scoping exercise is appendix 3.

* Refer to resolution A.947(23), *Human element vision, principles and goals for the Organization*.

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First step: Identification of provisions in IMO instruments

A. apply to MASS and prevent MASS operations; or
B. apply to MASS and do not prevent MASS operations and require no actions; or
C. apply to MASS and do not prevent MASS operations but may need to be amended or clarified, and/or may contain gaps; or
D. have no application to MASS operations

Second step: Analysis of the most appropriate way

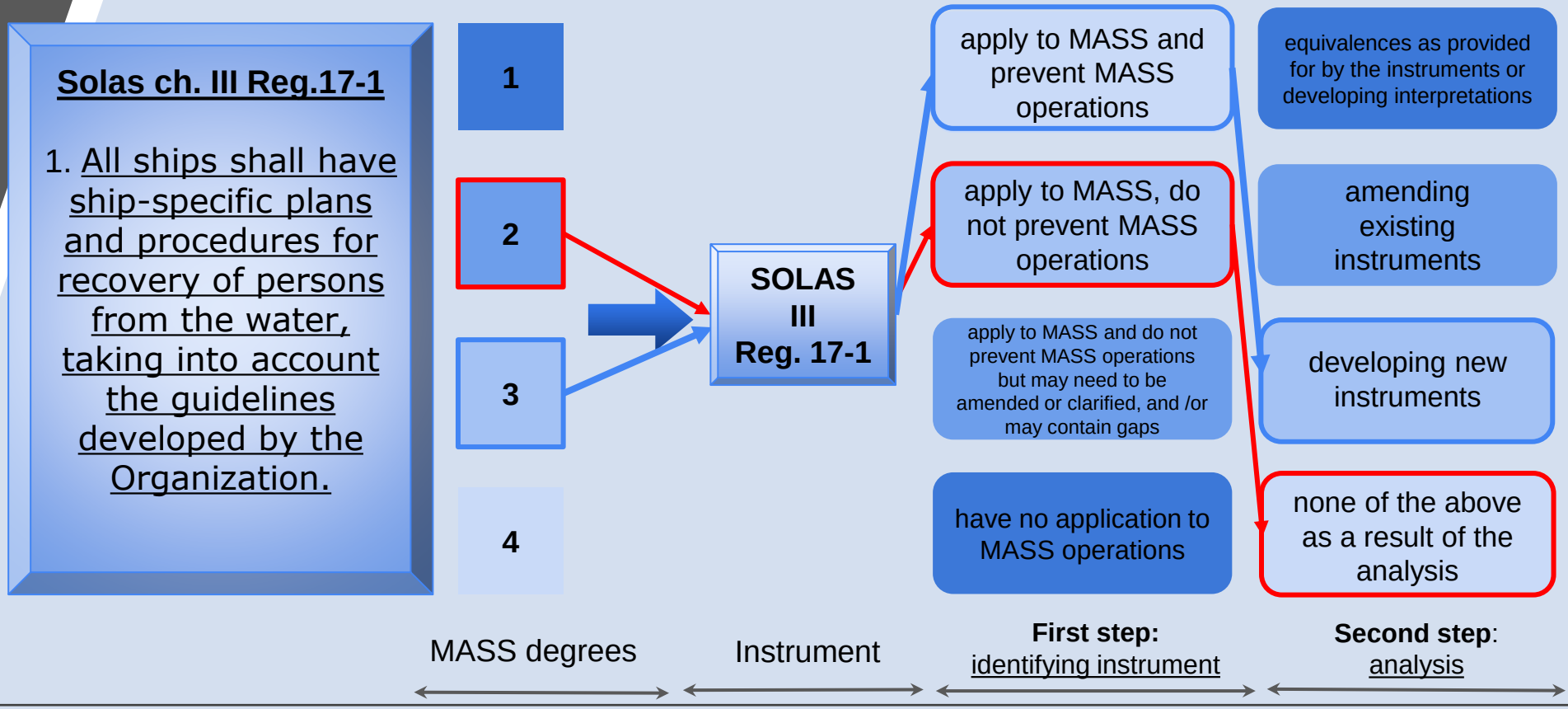
I. equivalences as provided for by the instruments or developing interpretations; and/or
II. amending existing instruments, and/or
III. developing new instruments; or
IV. none of the above as a result of the analysis

Source: IMO document MSC 100/WP.8 "REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS) "

Analysis of Issue

The Methodology of the RSE

Example of the RSE regarding Solas chapter III Reg. 17-1 on level 2, 3 MASS



Analysis of Issue

The Outcome of RSE

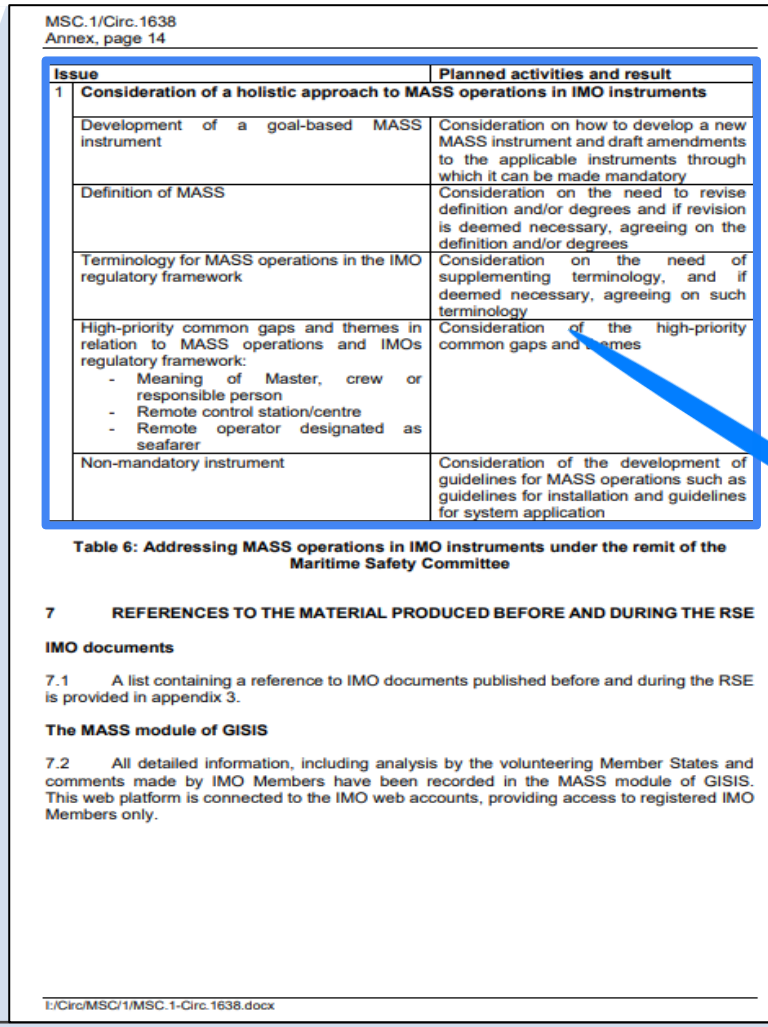
IMO Instruments	The most appropriate way(s) of addressing MASS operations			
Degree of Autonomy	One	Two	Three	Four
SOLAS chapter XIII	IV	IV	IV	IV
SOLAS chapter XIV	IV	IV	IV	IV
CSC Code	IV	IV	IV	IV
ESP Code	IV	IV	IV	IV
RO Code	IV	IV	IV	IV
FTP Code	IV	IV	IV	IV
Polar Code	IV	IV	IV	IV
LSA Code	IV	IV	IV	IV
ISM Code	IV	IV	IV	IV
ISPS Code	IV	IV	IV	IV
Standards for the evaluation of scantlings of the transverse watertight vertically corrugated bulkhead between the two foremost cargo holds and for the evaluation of allowable hold loading of the foremost cargo hold	IV	IV	IV	IV
Standards and criteria for side structure of bulk carriers of single-side skin construction	IV	IV	IV	IV

Table 5: List of low-priority instruments

Source: IMO document MSC.1/Circ.163

Analysis of Issue

The Outcome of RSE



MSC.1/Circ.1638
Annex, page 14

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Table 6: Addressing MASS operations in IMO instruments under the remit of the Maritime Safety Committee

7 REFERENCES TO THE MATERIAL PRODUCED BEFORE AND DURING THE RSE

IMO documents

7.1 A list containing a reference to IMO documents published before and during the RSE is provided in appendix 3.

The MASS module of GISIS

7.2 All detailed information, including analysis by the volunteering Member States and comments made by IMO Members have been recorded in the MASS module of GISIS. This web platform is connected to the IMO web accounts, providing access to registered IMO Members only.

I:\Circ\MSC\1\MSC.1-Circ.1638.docx

Development of MASS Instruments

1. **Definition of MASS**
2. **Terminology**
3. **High-priority common gaps and themes**
4. **Non-mandatory instrument**

Source: IMO document MSC.1/Circ.1638 "OUTCOME OF THE REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS)"

Analysis of Issue

Top Priority Issue

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Degree four: ***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

The ***definition*** of MASS can still be ***applicable*** since the human intervention of the automated ships is ultimately unnecessary.

Source: IMO document MSC.1/Circ.1638 "OUTCOME OF THE REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS)", MSC 100/20/Add.1 "Report of the Maritime Safety Committee on its one hundredth session", Annex 2, Appendix 2 "Plan of work and procedures for the regulatory scoping exercise", MSC 104/15/36 "Comments on documents MSC 104/15/17, MSC 104/15/25, MSC 104/15/26 and MSC 104/15/29"

Analysis of Issue

Top Priority Issue

Degree one:	***Ship with automated processes and decision support:*** Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.
Degree two:	***Remotely controlled ship with seafarers on board:*** The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.
Degree three:	***Remotely controlled ship without seafarers on board:*** The ship is controlled and operated from another location. There are no seafarers on board.
Degree four:	***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

However, ***Severe loopholes*** exist within the original

Remain

OR

Thus,

The degrees of autonomy should be ***re-evaluated***?

Re-evaluate

Problem Analysis

1. Unclear Roles of the Seafarers
2. Unclear Application of Regulations
3. No Concept of Remote Maintenance
4. Absence of Autonomous Mechanisms

Problem Analysis

Unclear Roles of the Seafarers

Degree One	***Ship with automated processes and decision support:*** Seafarers are on board to operate and control shipboard systems and functions.

1. Unclear roles of the seafarers and crew! (Degree Two)

	controlled and operated from another location. There are no seafarers on board.
Degree Four	***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

Problem Analysis

Unclear Application of Regulations

Degree One	***Ship with automated processes and decision support:*** Seafarers

2. No clear distinctions between degree three and four in their regulation! (Degree Three and Four: unmanned ship)

Degree Four	***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

Problem Analysis

No Concept of Remote Maintenance

Degree One	***Ship with automated processes and decision support:*** Seafarers are on board to operate and control shipboard systems and functions.

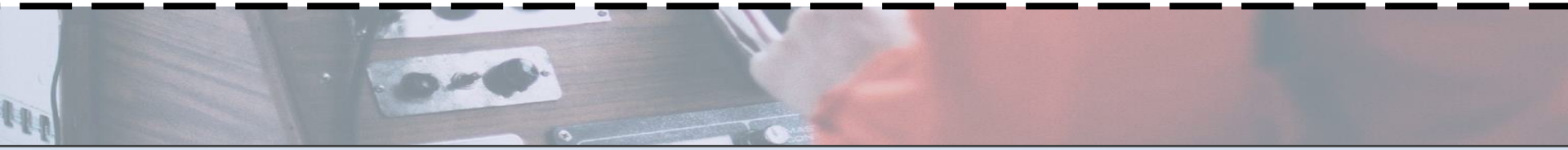
3. No concept of remote maintenance!
(Degree Three)

	controlled and operated from another location. There are no seafarers on board.
Degree Four	***Fully autonomous ship:*** The operating system of the ship is able to make decisions and determine actions by itself.

Problem Analysis

Absence of Autonomous Mechanisms

4. Only considered the navigation system
Who handles the engine system?
In the case of degree 3 and 4, an electronic machinery capable of remotely control would be needed for the automation of engines.



Proposal

1. New Standard of the Degrees of Autonomy
2. Requirements for IMO Instruments
3. Conclusion
4. Expected Outcome

Proposal

The New Requirements of the Degrees of Autonomy and IMO Instruments for MASS Operations

Proposal

New Standard of the Degrees of Autonomy

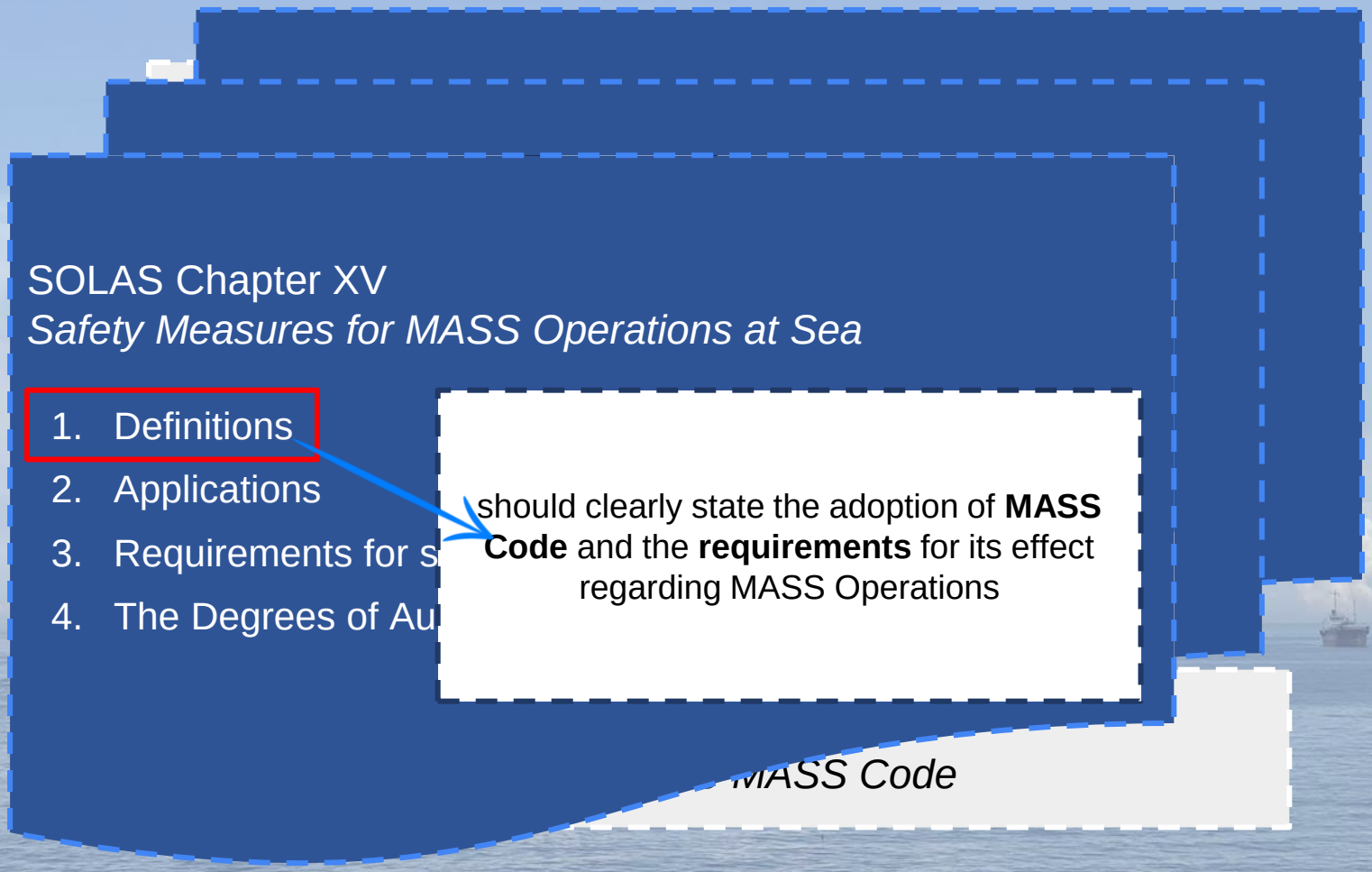
Operational Requirements - Degree Four	
Seafarer onboard	No
Navigation	By complete AI system
Ship maintenance	Remotely maintenance - examination by system itself, remotely maintenance through robot or drone from the land
The role of the seafarer	Control from the land

Degree Four

Fully Autonomous Ship: The operating system of the ship is fully autonomous with maintenance of the ship handled remotely. Remote operators are ready in case of emergencies and no seafarers are on board.

Proposal

Requirements for IMO Instruments - SOLAS Chapter XV



Proposal

Requirements for IMO Instruments - MASS Code

The International Code for MASS Operations at Sea

Table of Contents

- ❑ Preamble
- ❑ Introduction
  1. Goal
  2. Definition
  3. the Degree of Autonomy
  4. Structure of the Code
- ❑ Part I - Safety Measure for MASS Operations
- ❑ Part II - Remote Operation for Navigation
- ❑ Part III - Remote Operation for Machinery
- ❑ Part IV - Fully Autonomous Ship

Degree One	**Ship with automated processes and decision support**
Degree Two	**Partially Autonomous Navigation Ship**
Degree Three	**Autonomous Navigation Ship**
Degree Four	**Fully Autonomous Ship**

Proposal

Requirements for IMO Instruments - MASS Code

Part I - Safety Measure for MASS Operations

chapter 1. General

chapter 2. Construction - Ship Structure, Machinery and Electrical Installations, Fire Protection, Fire Detection and Fire Extinction

chapter 3. Life Saving Appliance and Arrangements

chapter 4. Radiocommunications

chapter 5. Safety of Navigation

chapter 6. Cyber Security

chapter 7. Manning and Training

Part II - Remote Operation for Navigation

chapter 8. Remote Navigation

chapter 9. Remote Control Center/Station

Part III - Remote Operation for Machinery

chapter 10. Electronic Machinery

chapter 11. Remote maintenance for Machinery

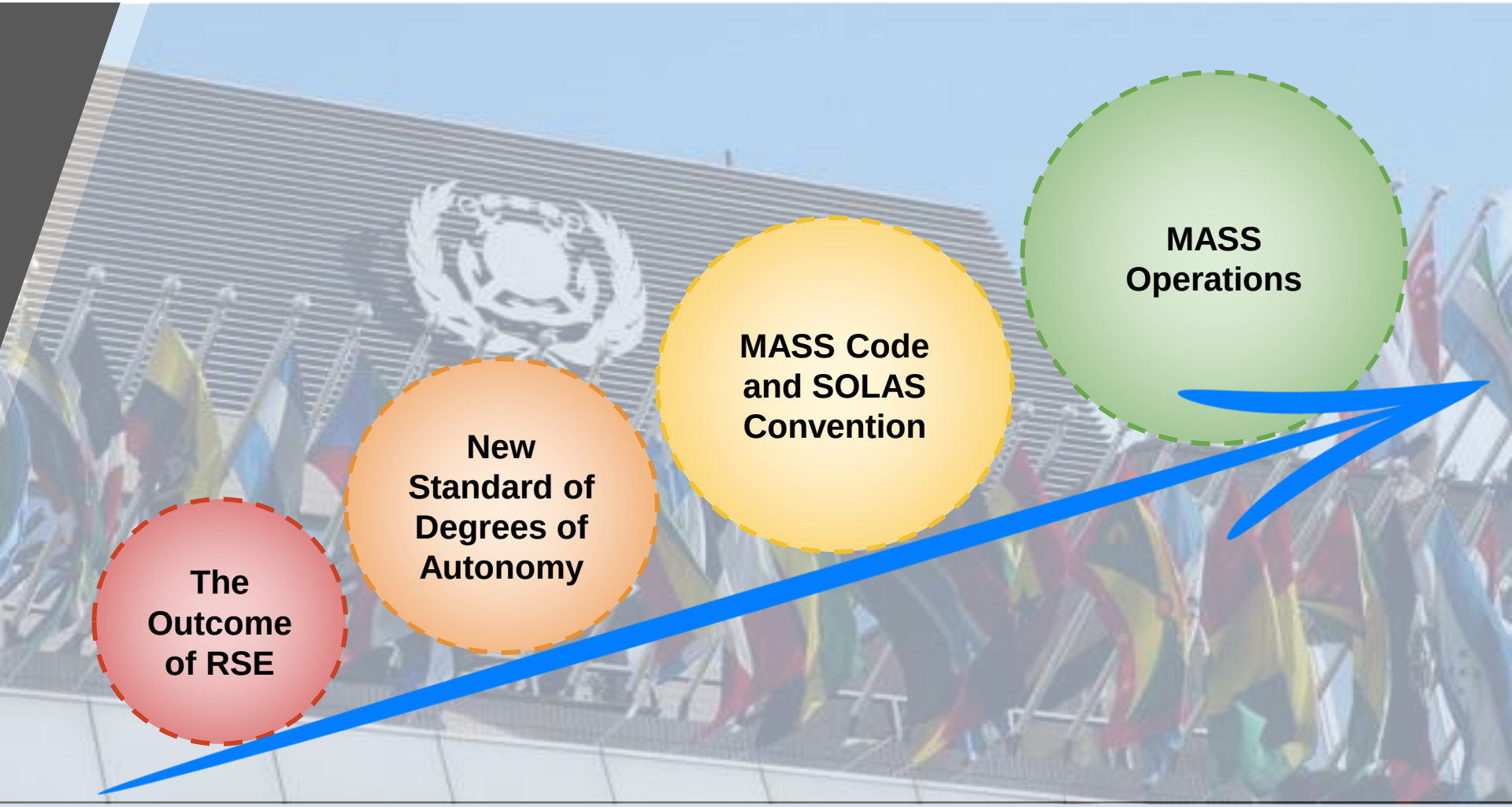
Part IV - Fully Autonomous Ship

chapter 12. AI Operation System

chapter 13. Autonomous Machinery System

Proposal

Conclusion



Proposal

Expected Outcome - International/Domestic Prospective

Domestic Perspective

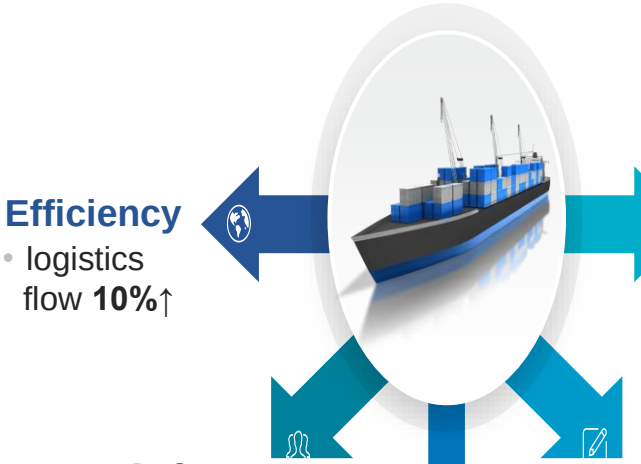
Economy

- **56 trillion KRW** → RIPPLE EFFECT
- Creation of **420,000 jobs**
- **103 trillion KRW** → front back industry

Social

- accidents by human error **75%** ↓
- **340 billion KRW** annual environmental benefits by reducing air pollutants

International Perspective



Efficiency
- logistics flow **10%**↑

Eco-friendly
- minimize the environmental pollution

Safety
- accidents by human error **75%** ↓

Economically
- operation cost **22%** ↓

Global market scale prediction
- '21(**$80 billion**)
- ↓
- '25(**$150 billion**)

Source : ROK Ministry Affairs and Fisheries, 2021

Proposal

Expected Outcome - International/Domestic Prospective

Domestic

International

MASS Operations

IMO Instruments

Technologies

Thank You