# Automated Ship-to-Ship operation blueprint

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Aegis

Advanced, Efficient and Green Intermodal Systems

http://aegis.autonomous-ship.org/

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# Table of Contents

# Executive Summary

In the Horizon programme, among many other things, the EU is supporting the development of short-sea and inland waterway transportation to reduce road congestion and offer more environmentally friendly transportation networks. In order to achieve this goal, the AEGIS consortium was formed.

This document is the AEGIS work package deliverable D3.4 *Automated Ship-to-Ship operational blueprint* and the fourth deliverable in Work Package 3 of the project. The objective of this deliverable is to describe the possibilities of ship-to-ship loading of containers compared to other viable options and to elaborate on the possibilities of minimising the use of land-based infrastructure by utilising AEGIS concepts based on use case A.

Ship-to-ship (STS) transfer of cargo has been performed for many years. The main advantage of STS transfer is that it provides flexibility for cargo owners at a relatively low cost. STS operations are therefore becoming more popular in various parts of the world. One of the consequences of the increased frequency of STS operations is that the incidence of structural damage caused during cargo operation prior to the commencement of such operations has increased. Most often, the damage has been of a minor nature, but could have been much worse if the circumstances had been only marginally different. [1] Most ship-to-ship transfers concern liquid cargo and there are very few container vessels that engage in ship-to-ship transfer. However, the main principles of good seamanship also apply to container loading.

The main requirements for ship-to-ship operations are:

- An approved STS operations plan in place
- A suitably qualified person in overall advisory control
- Properly briefed and trained crew on deck
- All STS equipment properly rigged and maintained [1]

As the nature of ship-to-ship loading is uncertain and dangerous, it must be understood that even with high standards of skill and care, STS operations are potentially hazardous and can involve accidents.

STS transfer operations are occurring more frequently and in more locations than before. This is because cargo owners have been able to increase their flexibility with low financial outlay. It should also be noted that ship size has increased at a greater rate than port development – resulting in transportation bottlenecks. This has given rise to an increase in the number of ship-to-ship operations and locations, as well as an increase in the number of specialist firms offering STS expertise and equipment [1].

For economic reasons, shipowners are reluctant to perform STS operations, even at sea. It is easy to understand that while two ships are at sea, ship-to-ship transfer poses a greater risk than when one ship is at anchor [2]. Thus, even greater focus needs to be placed on pre-process operations and checks.

In the context of logistics chains, this document focuses on the cargo handling envelope of ship operations, which is part of the execution phase, see Figure 1. In the cargo handling envelope, traditional operations include unloading and loading of cargo and interaction between terminal and ship. Crane operations are the main activities in this context. During such operations, the transport user needs to receive tracking information about the cargo. This information is often given to the user by agents based on information from the ship and terminal.

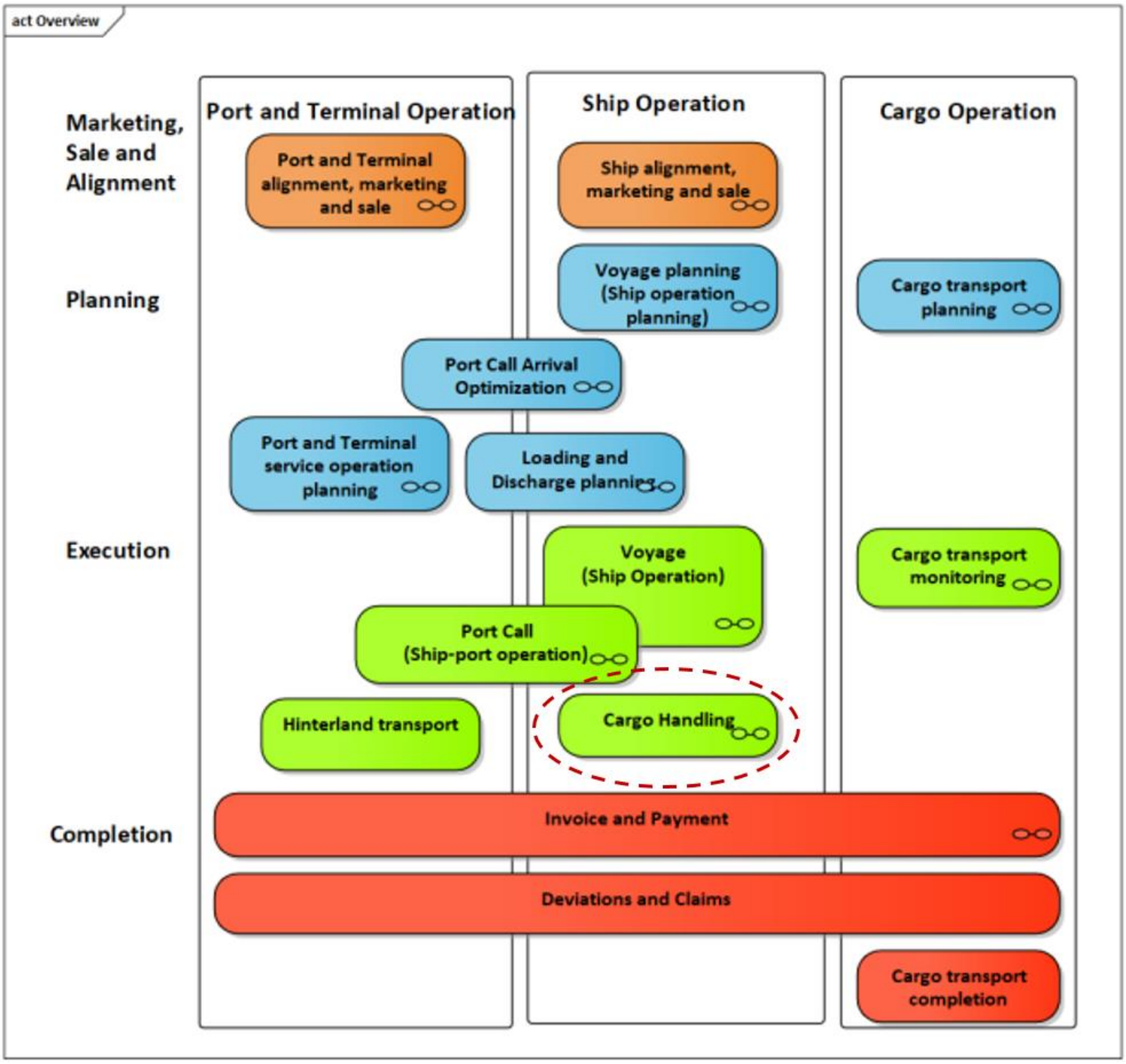


*Figure 1 - Overview of Port, Terminal and Cargo operations according to D5.1: System Design specification [3]*

For cargo handling that involves automated functionalities, such operations will result in extended information exchange between ships, terminal systems, and cranes, see Figure 2. Also, the positioning of ships, cargo and cranes is of crucial importance, as well as their operational status. In addition, automated cranes will need information about the weight and volume of the cargo, where it is stored, and where it is to be moved [3]. Such information exchange plays a key role in the automation of operations.

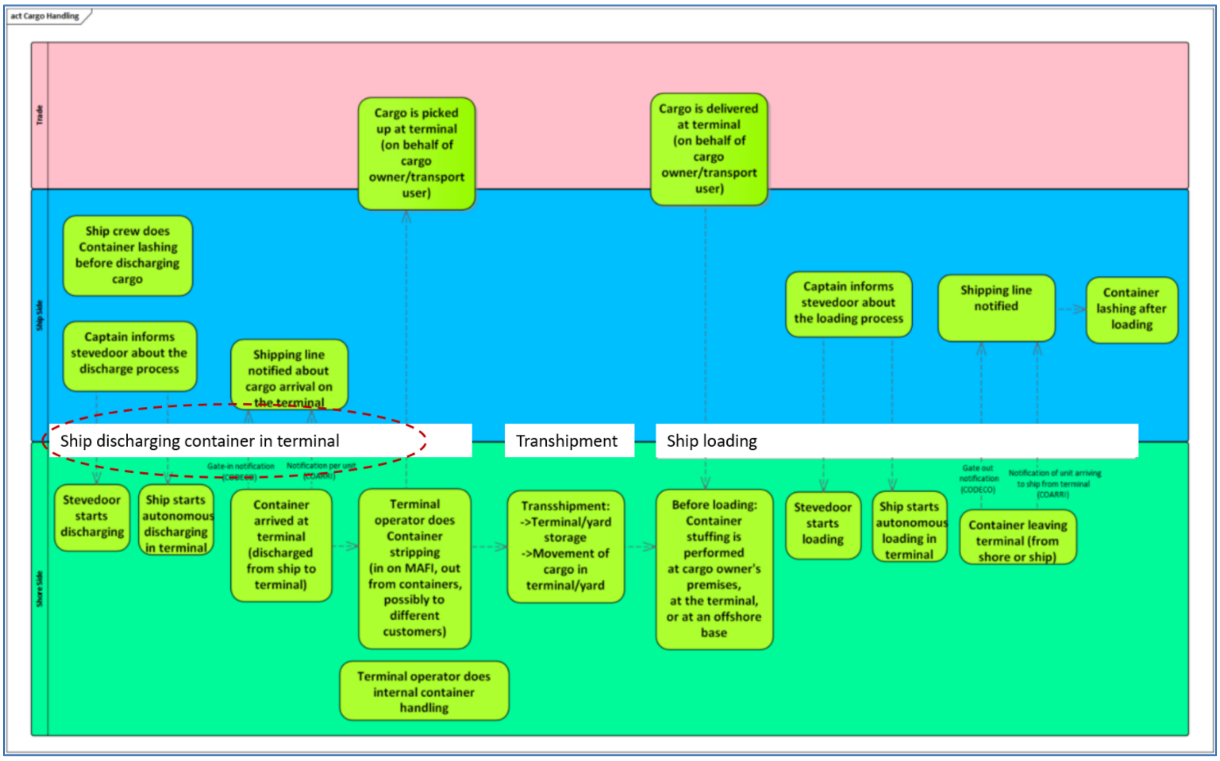


*Figure 2 - Cargo handling process according to D5.1*

The ship-to-ship loading blueprint presented in this document includes unloading containers from a mother vessel to a daughter vessel in the context of use case A of the AEGIS project. The loading of the mother vessel is regarded as happening from the quayside, as is the practice today, see Figure 3.

*Figure 3 - Ship-to-ship loading of a daughter vessel whilst moored to mother vessel.*

In order to ensure that ship-to-ship loading is a viable option there must be acceptance on the part of various stakeholders associated with the operations. In order to meet the requirements of such stakeholders, we aim to answer more generic questions in the following context:

- What state-of-the-art solutions are available?
- What are the requirements for developing an automated container handling solution to support the short-sea supply chain?

The stakeholders for this subcase are vessel operator NCL and the Port of Trondheim. The Port of Trondheim took partial control of Hitra Kysthavn (Port of Sandstad) from the beginning of 2023. In general stakeholder attitudes to the idea of ship-to-ship loading can be regarded as traditional, even though some innovative elements have been highlighted. Overall, the current way of operating containers is deemed to be the most suitable solution. This means that mother vessels and daughter vessels would load and unload containers on the quayside. The transhipment of cargo would then be carried out using reachstackers at the port. It is expected that unloading containers directly from a mother vessel to a daughter vessel will be too demanding from both a scheduling and a technological perspective. Positively thinking, the increased level of the necessary automation of onboard cranes is regarded as an option and also as the next step in order to be integrated with industry operations.

In order for ship-to-ship container loading, as described above, to be viable, the industry will soon need to start partially incorporating automated operations into its processes. This is a necessary part of the process as there is still a certain amount of hesitancy regarding automation. Also, technical solutions are imagined in the process of automated ship-to-ship loading. These non-existing technologies must be brought up to the required industry standard.

Furthermore, as the technical solutions are complex we should be able to test the solutions by virtual means. Within the task we have created a virtual environment that is reflecting the Hitra Kysthavn port with the mother and daughter vessels. So far, the development of the control system and required sensor technology does not allow us to test the complete operational system in the virtual environment. In order to do the simulation in the related context, there needs to be technological development on various operational issues. The issues to be developed is including a daughter vessel mooring operation alongside the mother vessel. This would need a decision on used technology for connecting the two vessels and the design of how to autonomously reposition daughter vessel to complete the loading activities. In addition, the loading from the mother vessel to the daughter vessel is more complex than originally anticipated, as the accuracy of the onboard crane system is not yet at the sufficient level.