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Sea traffic management – beneficial for all maritime stakeholders

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Abstract

Sea Traffic Management is the idea of sharing information and collaborating to optimise the maritime transport chain while increasing safety and sustainability. The digital information on-board and on shore is abundant; however, the interconnection today is point-to-point and proprietary and stops the industry becoming more efficient. We will discuss how Sea Traffic Management will help the industry achieve improved predictability by introducing standards for key information and supplying an infrastructure for information exchange. This enables all actors involved in the transport to plan better and utilise their resources more efficiently. Shorter routes, just-in-time arrivals, shorter port calls are factors that will strengthen the competitiveness of the maritime sector. Improved situational awareness on the bridge and knowledge of planned routes will help optimised planning as well as reducing the number of incidents and accidents. The standard route exchange format submitted by the EU-financed MONALISA 2.0 project partners in 2014 is included in the current edition of the IEC standard, which was launched in August 2015. Solutions using that standard will start realising the benefits already next year. We will describe an infrastructure, which could work in a centralised manner but also has the flexibility to be organised in a more federative manner, similar to how the maritime world works in many aspects. Some key components are: a unique identifier for each voyage; that the information publisher controls who can access the data; that updated information should be made available in real-time; and that subscription to updated data will be the main trigger for many systems and processes. We will also describe the outcomes of the test beds in the MONALISA 2.0 project – The Sound: how shore and vessel can interact better in order improve safety in dense traffic areas; Port of Gothenburg and Port of Valencia – how collaborative decision making can improve operations for all involved actors; European Maritime Simulator Network – how new solutions can be tested in complex traffic situations and areas with real people on a large number of bridges, without risk. How large of an impact will all this have on the maritime transport

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industry? Based on a study from Linköping University, we believe that the number €1 billion/year in Europe due to shorter routes is only the tip of the benefit iceberg. In the study ship operators and society split the benefit 50/50. Ship operators save on fuel and other cost, society saves on reduced emissions, and other actors associated to maritime operations benefit from a higher degree of infrastructural use. We will also present results from other business cases developed during 2015, in which the benefits of Sea Traffic Management are elaborated on main stakeholders.

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1. Introduction

Empowered by digitisation, traditional industries become reconfigured and there relies great opportunities to meet goals that stretches beyond the desires of the single organisation (Adner, 2006). As more and more devices become connected, new business opportunities arise. On the other hand this connectivity also requires that engaged co-producing actors take a joint stance for the production of value for the beneficiaries they share. This is in order to avoid sub optimisation and fragmented distribution of value to the beneficiaries they serve all together. Typically, the transport industry builds upon that multiple producers create value in a coordinated and integrated way for beneficiaries in order to meet the increasing demands in multi-modal transportation processes. Due to the legacy of the maritime industry enhanced collaboration enabled by digitisation is to be promoted (IMO, 2013).

As sea transports have become an environmentally sustainable transport mean for mid- and long-term transports, this type of transport need to be integrated in a larger transportation chain (IMO, 2013). Sea transports, and the multi-modal transport chain as a whole, do however need to meet the three pillars of sustainability (c.f. e.g. Elkington, 1988) by seamless integration and integrated performance. However, the legacy bound to today's processes in the shipping industry stretches many 100 years back in time where much of the logic is built around that "the earlier that you arrive to port the better quality of the tea will be loaded onto your vessel". Much of the contracts of today involving shipping companies build upon this logic resulting in that vessels gather outside the port and wait until possibilities to berth are given. If the vessel needs to wait, means that it, in some cases, could have been driven more slowly and thereby reducing the consumption of bunker. From a sustainability point of view this means that the environment is polluted more than necessary and that the business revenue for a particular sea transport becomes lower than necessary.

Supported by a cost benefit analysis an average reduction of 1% sailed distance per ship within the Baltic Sea Region, would save approximately € 100 million on a yearly basis for traffic sailing in the region. Approximately half of the savings are due to less emissions cost for society, and the other half are fuel and other costs for the ship owners (Andersson & Ivehammar, 2014). Baltic Sea traffic makes up approximately 10% of the European total sea traffic (Stankiewicz et al, 2010), and these finding give an indication of the potential savings within European shipping and further on for the global shipping industry.

However, even if the business logic would be changed where mariners were driven by contracts that prioritise just-in-time operations avoiding unnecessary waiting times other actors in different process steps need to provide solid prediction when value-adding services could be provided. This especially concerns (marine) ports that regulate when vessels are desired and expected to be at berth. A study shows that approx. 20% of vessels arriving to Gothenburg port anchor on average 18 hours before the port call can commence. If they could reduce speed by on average 2.8 knots the last 160 NM, they would save half of the bunker those miles. And they would still have a huge margin in making their port call, anchoring would go down to 15 hours on average (Watson et al, 2015). And bigger savings are possible the more accurate information is shared, and the earlier green steaming (speed reduction) can be applied.

Due to the fact that many ports of today suffer from not knowing when a vessel could depart from berth, predictions to approaching vessels become a challenge (Watson et al, 2015). Such increased knowledge by getting enabling actors to share their information to a larger degree can be enabled by digitisation. Today, a lot of digital data streams exist in the shipping domain, yet there are no standards for these streams and no central directory for locating them and the associated documentation.

As a response to these needs the concept of Sea Traffic Management (STM) has been defined. This concept adopts a holistic view to Sea Traffic Management adopting the principle that the vessel is connected and that the time horizon for communicating about the voyage is extended to its origin. The Sea Traffic Management concept has been defined in the European projects MONALISA and MONALISA 2.0 and will be validated in the newly granted project Sea Traffic Management Validation Project.

The purpose of this paper is to provide an understanding of how a holistic approach to Sea Traffic Management could meet the challenges that the shipping industry is facing and how digitisation could be used as a mean for meeting a higher degree of sustainability. The empirical basis for the paper is founded in the authors' efforts in acting as action- and design researchers in the design, realisation, and evaluation of sea traffic management within the MONALISA 2.0 (ML) project (www.monalisaproject.eu). The research is case driven guided by a theoretical lens based on a perspective, and related to the IS discourses, on multi-organisational business processes and episodic tight coupling (c.f. Haraldson, 2015). Sea traffic management has the overall goal of contributing to safer, more environmentally sustainable, and operationally efficient sea transports. Taking the possibilities from digitisation for the purpose of sharing information enables sea traffic management.

Following this introduction a holistic approach to Sea Traffic Management will be discussed and the reasons for introducing the concept for the maritime industry. This is followed by an overall description of the constituents of Sea Traffic Management covering objectives, basic principles, and operational concepts. A discussion on increased competitiveness for different maritime stakeholders due to the STM concept follows this. The paper is concluded by a discussion how the STM concept relies on an inseparable trinity of stakeholders.

2. A holistic approach to Sea Traffic Management

2.1. What is Sea Traffic Management?

Sea Traffic Management takes a holistic approach to services making the **berth-to-berth ship voyage** efficient, safe, and environmentally sustainable. Hence, STM puts the voyage in focus and uses that as a core element for enhanced safety, optimised processes for involved actors and stakeholder interaction.

In order to define STM, focus is put on user needs and a holistic view of the voyage is achieved by using legal/institutional; operational; information; and technical perspectives. STM requires enhanced interaction between ship-to-ship, ship-to-shore, shore-to-ship, shore-to-shore enabled by information sharing empowered by enhanced service interaction. In summary:

> ***STM is a concept building on services made for sharing secure, relevant and timely maritime information between authorised service providers and users, enabled by a common framework and standards for information and access management, and interoperable services***

The scope of STM includes private, mandatory, and public service opportunities along the whole voyage from berth-to-berth. Further, STM relates to existing practices and on-going initiatives within IMO's e-navigation Strategy Implementation Plan, e-maritime, and the collaborative port. STM complements and adds to existing/on-going initiatives. STM includes concepts for Strategic and Dynamic Voyage Management (DVM), Flow Management (FM), Port Collaborative Decision-Making (PortCDM), enabled by distributed and service based information management; a maritime service infrastructure.

2.2. The need for a holistic approach to Sea Traffic Management

There is a need for enhanced collaboration and information sharing among actors in the maritime transport sector in order to optimise the current processes and services, as well as providing new innovation opportunities. STM builds on continuous real-time based information sharing about intentions and actual achievements among maritime actors.

It is thus expected that the enhancement of the areas covered by the STM concept will lead to improvements in:

- <u>Situational awareness</u> for the purpose of facilitating:
    - reduced number of accidents and incidents
    - optimised resource utilisation
    - secured route passages
- <u>Predictability</u> of arrivals and departures (by early information sharing enabling better planning for involved actors leading to reduced idle time for resources);

- Just-in-time operations (by enabling stakeholders and service providers to be efficiently organised for handling vessel movements, port resources, and hinterland connections); and
- Innovation capability in the ecosystem (by giving rise to increased availability of unforeseen, non-vendor dependent, standardised, and interoperable services at low cost).

A common information sharing and service infrastructure, SeaSWIM, is motivated by the gains that can be reached in STM related activities, i.e. in Voyage Management, Flow Management, and in Port Collaborative Decision Making. It is expected that the introduction of SeaSWIM would enable the innovation and spreading of services that has not yet been thought of both within STM as well as within other maritime domains relying on interaction between maritime stakeholders. By joining forces with other maritime initiatives (c.f. figure 1), the goal is that these different initiatives are using the same infrastructure.

Fig. 1. Different maritime initiatives enabling a common maritime service infrastructure.

3. The constituents of Sea Traffic Management

3.1. The objectives of Sea Traffic Management

STM enables interoperable, standardised and harmonised services allowing a ship to operate in a safe and efficient manner from port to port with a minimal impact on the [marine] environment. Of high concern for STM is to minimise the use of energy fuel/bunkers to steam between two ports and to maximise the utilisation of facilities in ports. In the current definition of STM, the *voyage* is the central element of analysis and development. STM covers land as well as sea based actors and their operations from voyage planning, dynamic re-planning and departure to port arrival and evaluation, relying on the basic process logic depicted in figure 2.

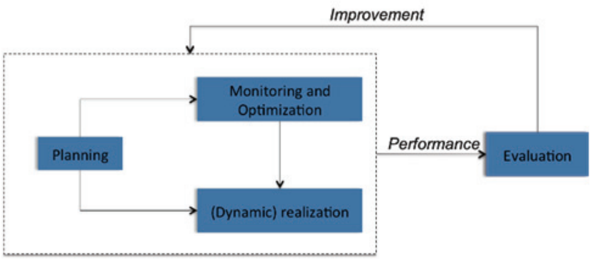

Fig. 2. Basic process logic for STM.

Essentially, the provided infrastructure enabling STM will come as a layered model (c.f. figure 3) that different service providers can use to provide and consume services. This means e.g. that access to particular information services would enable the distribution of new information services and/or allow integration in different applications. This means an essential move from vendor-specific solutions to the inclusion of diverse service providers enjoying new business opportunities.

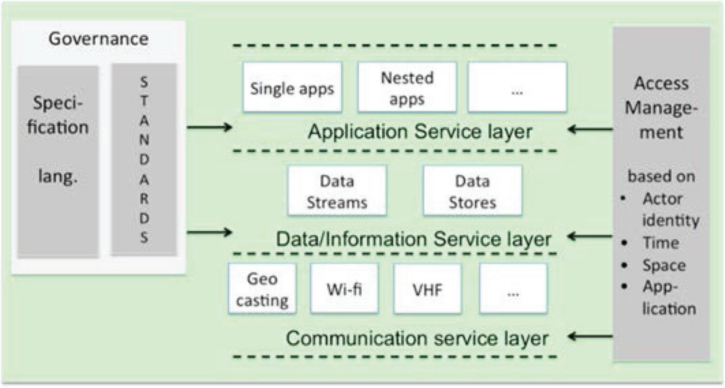

Fig. 3. A layered service model.

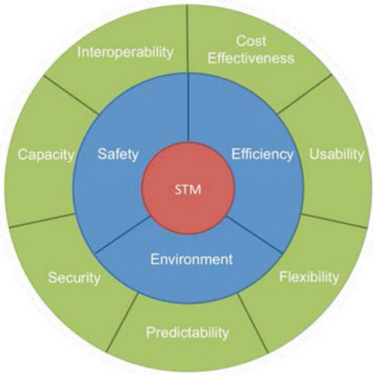

Fig. 4. Sea Traffic Management's main and subordinate objectives.

Seven sub-objectives complement the three main ones to outline the scope of STM, presented in figure 4.

Improved navigational safety, based on an increased ship-to-ship, ship-to-shore and shore-to-ship interaction, is achieved by increased situational awareness and correct information at the right time. Shore based organisations can contribute considerably by adding valuable information and advice based on:

- An enhanced traffic image which can be used to detect potential collisions, groundings and traffic congestions alerting vessels ships; and
- Updated regional information and effective way of informing ships about potential hazards.

A Formal Safety Assessment (FSA) study of the STM concept, based on IMO guidelines showed that the cost-benefit for *"introduction of STM and its expected risk reduction in terms of averted fatalities caused by collisions and groundings justifies its introduction."* (Target Concept, 2015).

Further, two test beds in MONALISA 2.0 have been looking at these aspects. In the Sound a common Danish-Swedish ship reporting system SOUNDREP exists. Two vessels frequently passing the area have transmitted their routes through the area to SOUNDREP and gotten verifications or suggestions back. The experience shows that best value is added if static information is returned to the vessels as early as possible, e.g. local information on military exercises, whereas the dynamic information to the vessels, based on the current traffic flow, is returned about 30 minutes before they enter the area. The other test bed is the European Maritime Simulator Network (EMSN). The first civil simulator network in the maritime area, it was conceived in order to test new STM services in complex and dense traffic situations, with real mariners on many bridges. Instead of building a huge test centre, the project has made efficient use of existing resources by building a vendor independent solution, tying seven European centres with more than fifteen bridges together. Test runs during three week-long exercises have given results valid for Voyage and Flow Management and the inter-cultural aspect has been an automatically added bonus.

Improved sea traffic efficiency is achieved by enhanced sharing among involved actors (ship-to-ship, ship-to-shore, and shore-to-shore) in which intentions and actual performances are shared in real-time. The information owner determines access rights. Information related to the voyage is shared to amongst nominated recipients via subscription services for the purpose of optimising the voyage (to steam between two ports), optimising the flow of vessels ships in condensed restricted zones, and optimising the port call. Such optimisation builds upon a high ability to predict state changes and thus upcoming needs of resources. This means that a basis is created for enabling a maximised utilisation of existing resources.

The first step in order to achieve port efficiency is to increase information transparency between the actors. This will automatically unnecessary idle times and thereby contribute to efficient realization of business processes related to the port call. To demonstrate the potential of the collaborative decision making process, MONALISA 2.0 has conducted a small-scale validation of the concept through real-life tests in Port of Gothenburg and Port of Valencia. On a generic level, the two ports have similar port call processes, but the details of the processes differ quite a bit as well as the interaction patterns between the different actors. And different states carry more weight in one port than in the other. This means that the Port CDM demonstrator has a configurable core in order to handle the important states of any port in the world for enhanced port call efficiency. The benefits seen so far: actors with capital investments has seen an improved utilization giving rise to that e.g. the tug operator can plan maintenance in daytime, actors with little or no capital investment has seen possibilities to reduce unnecessary non-value adding activities and could focus on better planning (e.g. linesmen has stopped calling pilots to ask about the status every ten minutes). Further, by sharing information about intentions and actual states different actors have increased their ability to perform integrated operations.

Reduced environmental impact is achieved by enabling decision support for minimising the use of energy fuel/bunkers to steam between two ports, to enable just-in-time approaches to ports, and to minimise shipping traffic in environmentally sensitive areas. Just-in-time approaches matched with a synchronised readiness for berthing in the port which both would enable green approaches as well as green steaming optimising arrivals avoiding late departures going to the next port. Fast turn-around processes do also provide possibilities for increased utilisation of the vessel as transportation mean. A reduced number of accidents due to STM will also reduce the number of fuel and cargo spills and their impact on the environment.

The cost-benefit analysis shows that the break-even reduction in distance for making route optimisation profitable is 0.2 percent. For STM concept as a whole, the net benefits are positive with a benefit/cost ratio between 4.8. to 9.8 for the three analyzed sub-concepts; DVM, FM and PortCDM. For STM, benefits and costs are distributed on different actors, with the ship owners identified as the major stakeholder. (Andersson & Ivehammar, 2014).

3.2. Basic principles of Sea Traffic Management

To achieve these benefits, a service-based and regulated information sharing framework is required. The basic logic behind STM builds upon the following principles:

1) A voyage is defined and all its attributes are connected through a unique voyage identifier;
2) Information related to the voyage, and thus basis for sharing, is connected via the voyage identifier;
3) Operational intentions of sea- and land based actors are provided to others well in advance and kept up to date;
4) ICT services supporting personal contacts;
5) A collaborative attitude is empowered in information sharing and decision making;
6) One single point of reporting;
7) Situational awareness is derived from multiple informational sources;
8) Secure and authorised service realisation; and
9) Discovery and distribution of services are realised through an infrastructure governed by a [federation][Organisation].

Further, the following prerequisites are used in the STM definition:

- The Master is in command;
- United Nations Convention on the Law of the Sea (UNCLOS) and the Convention on the International Regulations for Preventing Collisions at Sea (COLREG) are complied with;
- Existing systems and on-going initiatives are considered; and
- Information ownership is managed by a secure system of access control and authentication.

STM is a framework, harmonisation of data formats and standards for information management and operational services. Some of the standards enabling STM are:

- route exchange format;
- port call message format;
- other text message format;
- time stamp definitions;
- service specification language;
- geospatial and location data standards;
- processes for approval, distribution, and discovery of services;
- processes for federated governance of service portfolio; and
- access management.

3.3. Operational services

The STM concept, as outlined above, is defined by its operational services. The introduction of a standardized way of route exchange will give rise to:

- enhancements of existing services;
- interoperability between services; and
- proposals and validations of new innovative services including on-going initiatives like e-navigation, e-maritime and the collaborative port.

On a general level, the navigation process is divided into appraisal, planning, execution/monitoring and evaluation services (c.f. figure 2). However, since the execution phase contains the majority of the defined service portfolio, this is further sub-divided into services for dynamic navigation, traffic coordination, and port call synchronisation and optimisation. This division also relates more directly to the STM sub-concepts of:

<u>Strategic Voyage Management (SVM):</u>

- To optimise the voyage plan of a sea voyage before sailing; and
- To nominate collaborators and govern access rights to services and information (publish and subscribe) related to the voyage.

<u>Dynamic Voyage Management (DVM):</u>

- To continuously monitor and adjust the voyage plan in order to run the ship in the most operationally optimised, cost efficient, safe and environmentally sustainable way; and
- To enable information services giving a complete real-time picture for optimisation.

<u>Flow Management (FM):</u>

- To optimise throughput and increase safety of the sea traffic flow in congested areas;
- To provide situational awareness services for specific geographical areas;
- To increase safety in specific areas through enhanced monitoring of traffic; and
- To provide updated geolocated area information for specific geographical area

<u>Port Collaborative Decision Making (PortCDM):</u>

- To provide a basis for collaboration between key actors within the port and towards its surroundings based on shared situational awareness enabling increased predictability;
- To enable just-in-time arrivals of ships, just-in-time operations and further on just-in-time integration with hinterland transportation leading to optimised turn-around processes; and
- To enable improved resource utilisation for all involved port actors' entities and optimised operations.

<u>Distributed Information Management – SeaSWIM:</u>

- To provide trustworthy and secure information sharing and service framework including common standards, infrastructures, processes and governance.
- To enable [federations][Organisations} taking responsibility for parts of the ecosystem such as:
    - IALA – Recommendations and Guidelines for international standards for the implementation and operation of aids to navigation including Vessel Traffic Services navigational data, infrastructure
    - IHMA/ESPO/IPCSA/Port CDM Council – port (reporting) data
    - IMO –International Conventions, guidelines and criteria for maritime matters, performance standards for ship borne navigational and radio communications equipment including e-navigation
    - Transport associations/BIMCO – cargo/goods information including relevant Charter party clauses
- To enable automation of information exchange and reporting related to e.g.:
    - Single Window interaction concept
    - Traffic area reports
    - Noon reports
    - Port reports

3.4. STM enables increased information transparency

When validating the STM concept, it is shown that substantial savings of fuel/bunker costs could be realised, navigational safety can be enhanced, and that high utilisation of resources of the facilities in ports can be reached still with a high degree of safety. Enhanced sharing of information ship-to-ship, ship-to-shore, shore-to-ship, and shore-to-shore, is also an important enabler for increased safety during sea transports. This is achieved by allowing information owners to share real-time information to preferred recipients as well as allowing information users to access necessary (real-time based) data streams for their purpose. Realising that the maritime sector is constituted by autonomous organisations acting in competition, peer-to-peer information exchange will be dominating. A service based approach, to distribution and discovery of information is therefore preferred avoiding centralised storage of data, but relying on a unified communication channel.

In the maritime industry of today there are many competing autonomous actors putting a lot of emphasis on developing their own systems and solutions, most of which are vendor specific. This causes a non-harmonised situation with unnecessary lack of interoperability. The entry barriers for new service providers are high, jeopardising the innovative capability of the industry. There is a need for more [performance] standards for information sharing and service interaction connecting key actors of the maritime ecosystem to enable safe, efficient and sustainable sea transportation. STM proposes a common secure service distribution and information sharing framework enabling trusted, non-proprietary, and federated collaboration. Such a framework would enable third-party developers to provide new innovative services to the industry. The introduction of the framework is motivated by the gains to be reached within the key concepts of STM; strategic and dynamic voyage management, flow management, and port collaborative decision making.

Even though that the global economy is mostly propelled by maritime transports, the transport sector is really concerned with transporting goods and people from door-to-door. Today, the accuracy of predicting when a certain cargo will be at a particular location is too low. By the introduction of STM, it would be possible to share essential information amongst the key actors in the inter-modal transport chain. This means that STM brings sea transportation into the light with relative accurate information on departures and arrivals. Services providing information about arrival and departures of vessels ships to/from ports have a key role for the success of inter-modal integration and synchronisation (c.f. figure 5). At the end of the day, different traffic means modes, including hinterland transports and sea transports need to exchange information in order to make each transport mean mode as efficient as possible. The total performance of a chain is never stronger than the weakest link. With STM, a basis for an efficient inter-modal transportation is can be established.

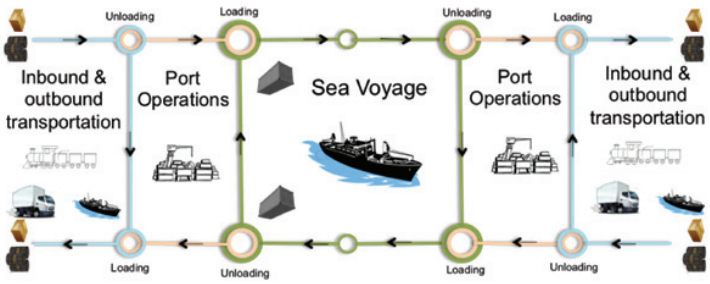

Fig. 5. The sea voyage as an integrated part in a larger inter-modal transportation chain.

4. Discussion: Towards increased competitiveness for sea transports enabled by STM

STM requires the engagement of many actors. Important enablers are an increased degree of connectivity, increased possibilities of digital collaboration, seamless interoperability between systems, and highly distributed coordination (i.e. each actor taking responsibility for its actions) in sea transportation. This is enabled by episodic tight couplings. This presents an opportunity to move away from a traditional approach to traffic management with a central governance unit. STM will involve and engage multiple actors on multiple levels and will require new procedures for information sharing in a distributed manner within each stakeholder's action scope. Adopting such a modern approach to traffic management, as proposed by STM in ML, enables and requires that each involved actor is engaged as a *traffic management co-producer*. This does however require that each stakeholder do have good enough incentives for such engagement.

According to Andersen & Schellhorn (2015) it has been identified that STM would contribute to 1) improvement in planning and conducting the voyage for reducing bunker consumption and increase the utilisation of fixed assets, such as vessel and crew, and 2) improvement in port operations from the very first estimation of ETA/ETD to the actual arrival/departure of vessel at/from the port.

By using the Business Model Canvas (Osterwalder and Pigneur, 2011) the analysis made by Andersen & Schellhorn (2015) showed that the introduction and implementation of an 'ideal' STM would make it possible to save 10 – 15% of planning and operational costs both for voyage optimisation and for port operation optimisation. These figures are estimates based on data from the Scandinavian countries, and it is evident that there are huge differences between highly automated/sophisticated ports like Singapore and ports in many developing countries. It is presumed that the benefits potentially achievable in ports in the Nordic countries would be even larger in most other ports in the world, where current systems are less optimised. The authors also comment that the introduction of an 'ideal' STM is likely to make a significant re-engineering process of the overall ecosystem very beneficial. Accordingly, one could say that the biggest advantage of the STM system is exactly this – a reinvention of the maritime shipping industry. However, in such a process there are bound to be both losers and winners.

Consequently sea traffic management will be performed on different actor levels contributing to the overall performance of the transportation system. The co-production of sea traffic management will be designed to enable the involved actors to optimise their operations. Such optimisation, both for the performance of individual actors and for the integrated performance of the transportation system as such, requires stakeholders to share relevant information related to a *shared common object* of interest (Adner, 2006).

Transportation systems are ecosystems involving different actors performing different tasks based on episodic shared common objects and actions of interest. The common object of interest in Sea Traffic Management is efficient, safe and sustainable sea transport. While the various stakeholders share this common interest, they interact episodically. The shipping industry operates as a series of episodically tightly coupled events when parties tightly coordinate their resources and then return to operating independently or tightly couple with another party. The involved actors have to arrive at a consensus regarding the performance targets that govern the performance of the different focus *areas*. As mentioned previously, three areas of focus are *safety*, *environmental sustainability*, and *operational efficiency*. Furthermore, performance targets within one area affect performance targets of other areas.

Consequently Sea Traffic Management, as conceptualised in ML, explores alternatives to a centralised solution. Even though STM has been inspired by Air Traffic Management the structure of the maritime industry makes it more suitable to establish an approach to distributed traffic management rather than the central solution used in aviation. Such a distributed approach recognises that the culture and history of shipping has lead to that the various parties have a high degree of autonomy, which is anathema to centralised control and command. A distributed data sharing design also gives room for new actors to enter the domain by providing new services building on data made available from the various stakeholders. Hence, STM favours a federative, regulated, cooperative and coordinating model of data sharing which fits the historical modus operandi and culture of shipping.

As inspired by Svallvåg 2013 (Södahl et al, 2013), information sharing for STM in Intermodal Sea Transport could be expanded to include other transport means and thereby cover multimodal transport processes. Hence, Sea Traffic Management needs to become an integral part of the (distributed) management of the total chain of operations in multimodal transportation processes. The proposed distributed data sharing design can readily accommodate the inclusion of more stakeholders as higher levels of integration are sought.

5. Concluding remarks: The inseparable trinity and the continued containerisation of the industry

In the distributed world of Maritime transportation, different actors have taken up digitisation in the way that it serves them best. Typically, big actors have created systems for coordinating their transport operations. They do however rely on other actors' ability to become efficient. To overcome this situation, Sea Traffic Management has been proposed in which intentions of upcoming, and the accomplishment of, actions are communicated prior to and during a sea voyage. STM puts an emphasis on interoperable and harmonised systems allowing a ship to operate in a safe and efficient manner while also lowering its carbon footprint.

Maritime operations build upon the interplay between three types of core actors; shipping companies, ports, and cargo owners. This is an inseparable trinity (see figure 6) meaning that neither of them exists without the other. Connected to this trinity there are numerous coordinators (such as the shipping agent) and service providers (such as tug operators) enabling efficient operations.

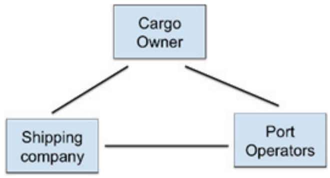

Fig. 6. The inseparable trinity in sea transports.

In this paper we have discussed the key constructs of STM enabling increased collaboration among core maritime actors. Potentially, there are great savings in energy and bunker consumption, if waiting times in pre-cargo operations and anchoring could be eliminated (coined as green steaming), and if shorter routes could be taken (coined as right routing). This, of course requires changes in business contracts and industry practices (such as virtual ETA, Virtual Laycan). This would mean that a port with good predictability would enable a shipping company to earn more by green-steaming, than going to another port, all other things being equal it would become a competitive parameter for the port and all its actors. A reliable and collaborative port is a profitable port for the shipping company enabling the cargo owner to higher precision in its delivery.

Maritime transport adds value by shipping cargo that can be produced at an economic advantage near the port of origin. In order to make the transfer as efficient as possible the container has proven its value. It is standardised, it protects the cargo from damages, and it can handle a wide variety of goods: from fresh fruits in reefer containers to liquids in large “bag-in-boxes”, from high value consumer electronics to cars. And the price advantage and competition coming from standardisation has made the container attract new kinds of goods.

However, there is actually one more important “cargo” that maritime transport carries that add value – the information about the cargo and the voyage associated with transporting the cargo. That information is not even close to being harmonised and standardised today. The means of communicating varies from EDI to fax machines, personal phone calls and even telex. The game changer to the industry will be the digitisation of the data and the containerisation of maritime information. Information containers will standardised and protect the information “cargo” from damages. Early drivers and adopters will gain business advantages, and the industry might be able to establish these standards without regulatory framework.

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