

Enabling Port Efficiency by increased Collaboration and Information Sharing – Towards a Standardized Port Call Message Format

by

Mikael Lind¹, Sandra Haraldson¹, Mathias Karlsson¹,
Richard T. Watson^{1,2}, Per-Erik Holmberg¹

¹Viktorias Swedish ICT, Sustainable Transports, Gothenburg, Sweden

²University of Georgia, Athens, GA/USA

Abstract

To enable just-in-time operations, the various actors engaged in sea transport related actions need to contribute to the creation of common situational awareness. PortCDM (Port Collaborative Decision Making), as one of the concepts of Sea Traffic Management (STM), is a key enabler for reaching the full effects of STM as safe, efficient and sustainable transport from berth-to-berth. The purpose of PortCDM is to provide a basis for the collaboration between key actors within the port and towards its surroundings by enabling situational awareness. Such establishment of situational awareness and use of the information from different sources requires a standardized way of capturing the communication within the port and to port-related actors. In this paper the constituents of PortCDM are introduced followed by a proposed way to conceive Port Call Messages with its different facets.

1. Introduction

Sea transports of today are strongly affected by its legacy, such as the 1609 mare Librium, charter parties, and operations driven by “first come, first served”. This legacy has encouraged a maritime ecosystem characterized by competitive autonomous agents. Due to this current situation there is an unwillingness to share information and this creates a major challenge for collaboration. However, increased connectivity enabled by digitalization allowing different actors and objects to generate, distribute and access information about intentions and states has put pressure on the industry towards an increased degree of information transparency. This is of special concern for increasing safety, and efficiency, as well as reducing the environmental footprint.

The Sea Traffic Management (STM) concept has lately been launched as a response to these deficiencies. It relies an unused potential in sea transports to increase the efficiency by enhanced collaboration among involved actors. Enabled by digital innovations, the STM concept, as a distributed service-oriented approach to *Green Routing*, *Green Steaming*, and *Optimized Resource Utilization*, is proposed. STM enables just-in-time operations for different actors engaged in sea transport related actions and builds upon four concepts (see figure 1 below); Strategic Voyage Management (SVM), Dynamic Voyage Management (DVM), Flow Management (FM), and Port Collaborative Decision Making (PortCDM). The first one (SVM) concerns strategic decisions about the voyage, such as the route to take in which order to visit different ports dependent on diverse contextual factors. The second one (DVM) focus upon providing support for the optimized realization of the route while the third one supports the optimal coordination of multiple vessels in congested geographical areas. In the fourth one (PortCDM), the integration with the port is enabled. PortCDM is thus a key enabler for reaching the full effects of STM with safe, efficient and sustainable transports. To close the loop in STM interactions with and within ports are necessary. The purpose of PortCDM is to provide a basis for the collaboration between key actors within the port and

towards its surrounding, and to support just-in-time and green operations (see Lind et al, 2015a).

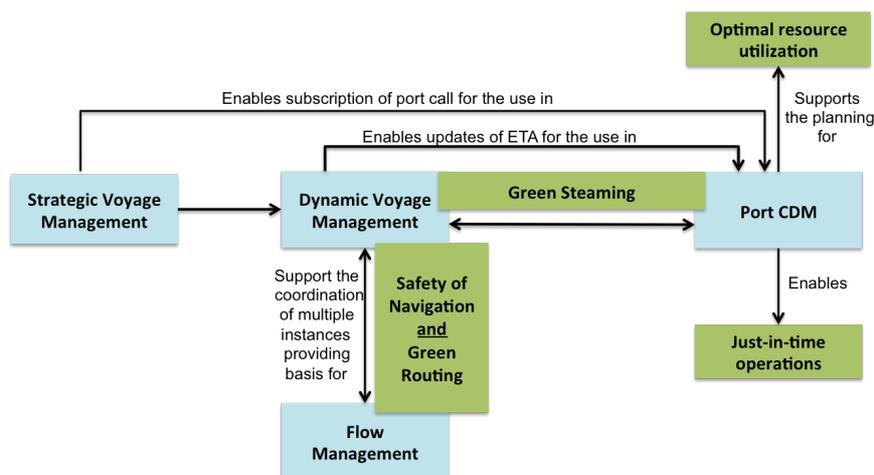


Figure 1: The four concepts of Sea Traffic Management and the expected contributions

This paper put focus upon the conception of essential interactions to take place for enabling green steaming, optimal turn-around in the port call by just-in-time operation, and optimized utilization of capacity. The purpose of this paper is to derive a *port call standard format* enabling core interactions within the port, and between the port and maritime actors acting outside the port driven by consuming as little energy as possible to steam between two ports.

In the next section the key characteristics of PortCDM, and its role in STM is explored. Deriving a standard port call message format (PCM) from core interactions follows this. The different parts of the standard are to a large extent based on standards of statement of facts as brought forward by BIMCO and FONASBA (c.f. www.bimco.org).

2. The key characteristics of PortCDM

Ports are departure and arrival hubs for different means of transportation requiring a coordinated approach, addressing the goals of the transport system as a whole, with smooth and seamless operations at sea, at port (reaching the port, performing loading and unloading operations, departing from port (and sometimes other maintenance and extraordinary administrative tasks)) as well as connections to hinterland transportation. Seamless and sustainable transports enabled by STM require an efficient and collaborative port (IMO, 2013).

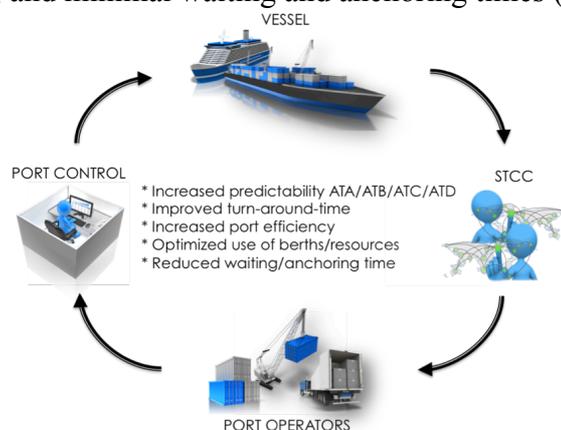
One essential need is, therefore, that the diverse actors engaged in port calls share information about different states (e.g., estimated time of arrival (ETA), desires for when a certain state is to be reached, commitments related to certain terms of condition, and the changes of the different states that has occurred). Inspired by the aviation industry (airport CDM), <http://www.euro-cdm.org>, this collaborative approach to information sharing and decision-making has been coined PortCDM. There are several similarities between airport and (sea) PortCDM, including:

- Airport and Port Collaborative Decision Making (CDM) aims at improving Traffic Flow and Capacity Management by reducing delays, improving the predictability of events and optimizing the utilization of resources.
- Airport/PortCDM allows Airport/PortCDM partners to make the right decisions in collaboration with other Airport/PortCDM partners, knowing their preferences and constraints and the actual and predicted situation.

- The decision making by the Airport/PortCDM partners is facilitated by the sharing of accurate and timely information and by adapted procedures, mechanisms and tools.

Airport CDM concept builds upon collaboration between different airports managed by a centralized organizational body (Eurocontrol). This principle is however not readily adaptable to the maritime sector, because operations are more distributed and the presence of competing autonomous agents. PortCDM does thus needs to develop a distributed coordinating structure that recognizes and responds to market forces. It cannot apply Airport CDM's hierarchal approach. PortCDM, adopting a more distributed approach, has been identified as a key enabler for reaching the full effects of STM.

The overall goal of PortCDM is to support just-in-time operations within ports and in relation to other actors being coordinated by the efficient and coordinated port (see figure 2). PortCDM constitutes the interface between sea and port operations within the STM concept. PortCDM should enable high degree of predictability, punctuality, berth productivity, capacity utilization, and minimal waiting and anchoring times (c.f. Lind et al, 2015a).



**Figure 2: Objectives on PortCDM
- The efficient and collaborative port**

2.1 States and coordination points – the core unit of analysis of PortCDM

A common measurement system of states and coordination points constitute one of the cores of PortCDM. A state represents the condition of a social or physical fact, such as a requested tug by someone directed to someone else (social fact), or a vessel being present at a particular geographical spot (a physical fact), at a particular time. The effect of every action is a state transition (Dietz, 2001). A particular transition (e.g., requesting pilotage by the ship agent from the pilot organization) at a particular point in time is an event. Complicated states involving more than two actors are seen as coordination points in PortCDM.

In order to ensure that different actors are striving to reach a certain state (in time and place) there needs to be a common understanding of the conception of different states. Further, in PortCDM the dependencies between different states and coordination points during a port call related to different actors are founded the basis for enabling planning and realization of just-in-time operations.

This means that a port, often the port administration, needs to ensure that its port, and the actors involved in its activities, are prepared for incoming vessels and that port operations related to those vessels are executed as efficiently as possible (i.e. ensuring a fast and efficient turn-around process). The same goes for hinterland (inbound and outbound) transportation, which means that ports have dual, inter-linked, turn around processes. This requires coordination and planning of the integration of the different operational processes within a port. Important coordination mechanisms for such planning, however, have their origins with

actors operating outside the port, such as information about when the vessel is about to reach the port communicated well in advance of the physical approach.

PortCDM builds thus upon visualizing desired states to enable different operators to act in such a way that the port call (arrival, at berth and departure) can be performed as just-in-time as possible. The overall goal is that involved actors can trust the prediction of when a certain state will be reached and thereby can optimize their performance, in time (not too early, not too late) and by their optimal capacity. In PortCDM, so far, the interface to the port has been identified in relation to vessels' operations. This, among other effects, is to enable green and optimal steaming.

The design idea is built upon that, at the time of initiation of the sea voyage (by the voyage order and first tactical route planning), different planned time of arrivals (PTAs) / estimated time of arrivals (ETAs) (to waypoints and at the destination) are made available via SeaSWIM (as a representation of a common data sharing and service distribution environment) (Lind et al., 2015b). The destination port subscribes to this data and sets up an instance of a network of inter-related states to be reached for the particular port call (with status objects that need to be green, indicating available, at the time of arrival to port).

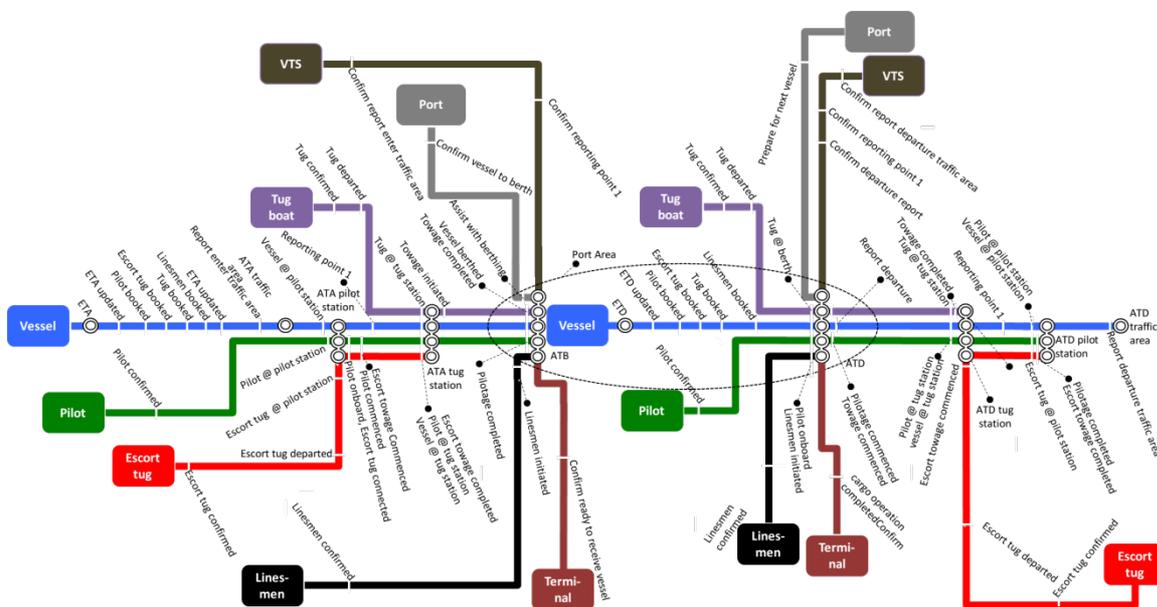


Figure 3: States and milestones for the port call process (Lind et al, 2015a)

Figure 3 indicates that the different states are dependent on each other. Thus, they should occur in parallel and in sequence for milestones to be reached smoothly. The different states depend also time-wisely on each other, such as booking a pilot should be followed by the pilot's confirmation, or that a terminal needs to confirm when it is ready to receive a vessel at berth based on the vessel's ETA.

2.2 Minimized administrative burden by deriving information from diverse port systems

To ensure a minimal administrative burden in its introduction, PortCDM needs to interface with existing systems to ensure one single point for reporting/providing intentions. This could be enabled by systematized structure of related principles of data sharing between relevant systems (c.f. figure 4) enabled by implementing connectors into different systems. These connectors are then further utilized in different information services withdrawing and/or distributing information from/to connected systems. As further elaborated below, this information is to be transmitted between the different systems and the PortCDM information service system by a standardized port call format.

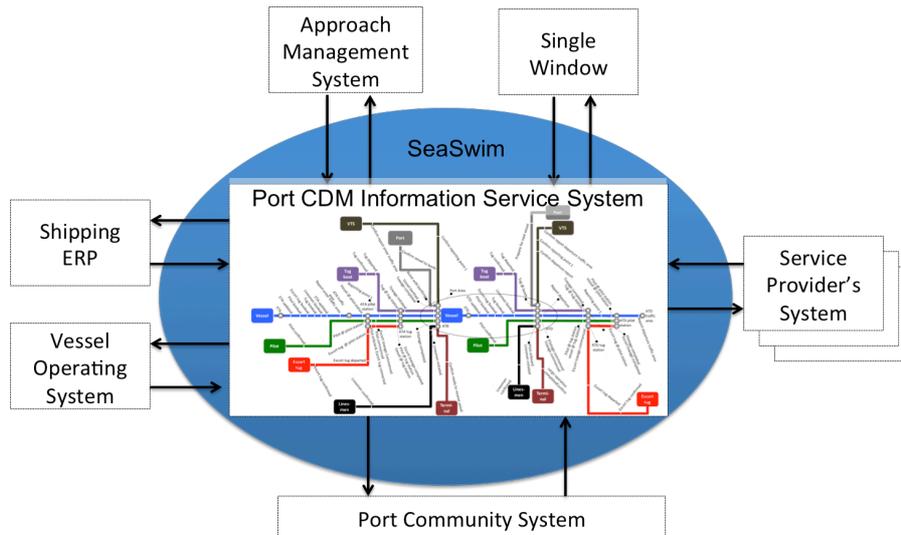


Figure 4: Integration with Port information environment

2.3 Continuous sharing of intentions and state changes

To reach the full effects of STM, and thereby enable sustainable sea transport processes, high accuracy (based on accurate estimations) related to berthing, unloading, loading, and departure, becomes necessary. Successful planning for the ultimate sea voyage can be established by enabling high accuracy on the arrival, port operations, and the departure.

PortCDM builds upon the logic that communication about upcoming port approaches is made as soon as it is known and that changes are communicated as early as possible (both from the vessel's and from the port's point of view) (Lind et al, 2015a). In order for a port to optimize its operations, it is thus essential to receive real time information of the status, together with updated estimates, of different operations/transports that are affecting the operations within the port. This means that the same measures function both as coordination mechanism for optimizing port operations (and creating readiness for managing necessary loading/ unloading operations) and as boundary objects towards other actors outside the port for their optimization. This boundary objects are relational measures for enabling collaboration/optimizing between different areas of operation. To enable optimal just-in-time operations requires that intentions and state changes are shared among involved actors.

Different planning horizons are associated with different levels of tolerance for deviation between the estimated and actually reached state (the outcome) (see figure 5). The deviation should be diminishing with time; the closer to the Execution Phase the smaller the tolerance for deviation should be, until the actual moment of occurrence is reached for a certain state. This allows for the planning process, performed by the different actors, with different time horizons (i.e., long-term, mid-term, and short-term planning) to be performed optimally, based on the information about the interval of the outcome (e.g., a time span of the reaching of a certain state). Sea transportation is a multi-organizational business with numerous actors positioning and coordinating their performance in relation to different coordination points. Related to STM, PortCDM closes the loop in the transport chain by establishing conditions for the realization of the sustainable sea voyage. STM will be realized by sharing information about status and values related to identified coordination points (e.g. states) for the particular voyage.

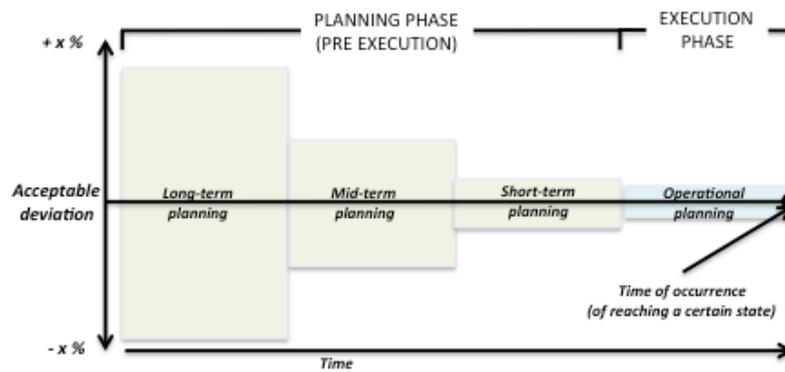


Figure 5: Acceptable deviation between estimate and actual occurrence (in different time slots)
(Haraldson & Lind, 2005)

In order to avoid multiple re-planning due to small changes by updates on estimates of when a certain state is to occur PortCDM provide a built-in inertia by using thresholds for when counter-actions (i.e., updated commitments) are needed. The thresholds to be applied have their bases in time frames of when different actors can perform their operations. Analytically, the different time frames of when a particular actor can perform its operations should overlap and as long as it is still possible to perform the operations due to changes in estimates (e.g., an earlier or delayed approach to the traffic area/port limits).

2.4 Core services in PortCDM

The PortCDM concept is defined by the PortCDM services. These are both of operational and informational characteristics (c.f. Lind et al, 2015b). These services are based on design criteria founded in an approach for service-oriented architecture, and distributed and federated service development.

2.4.1 Operational services in PortCDM

At its core, four operational services define the PortCDM concept (c.f. table 1):

Table 1: Operational services in PortCDM (c.f. Lind et al, 2015a)

<i>Port Call Synchronization Service</i>	
Objective:	Coordinate the vessels approach with a port's readiness. Enable the vessel to set an accurate speed for a just-in-time approach to the "service meeting point," such as traffic area/ pilot station. Enable each involved Port Call Service Provider to plan in advance enabling optimized turn-around times and resource utilization.
Description:	Synchronization is enabled by coordinating service planning and realization (requested needs and available capacity) for involved actors, using information about service realization (time, spatial and infrastructure) as the basis.
Service provider:	Port Authority or Company/ Private Service Provider
Area of operation:	Berth to Berth
<i>Port Call Optimization Service</i>	
Objective:	To coordinate and adjust actions related to other actors shared intentions and performances, based on the set of states for a particular port call
Description:	An optimization service for planning and on-going activities for actors involved in a port call, based on an instantiated generic port call process
Service provider:	Port authority or company/private service provider
Area of operation:	The turn-around from arriving to the traffic area / pilot station, to departure from the traffic area / pilot station.
<i>Port Call Monitoring Service</i>	
Objective:	To provide situational awareness for upcoming and on-going port calls and actors performance, to enable involved actors to monitor particular (and/or parts of) port calls (based on each actors accessibility to provided information).
Description:	This service provides real-time images of the status (desired, committed, fulfilled actions by different actors) of upcoming and on-going Port Calls. Provide basis for monitoring, coordination, and optimization.

Service provider:	Port authority or company/private service provider
Area of operation:	The turn-around from arriving to the traffic area / pilot station to leaving from the traffic area / pilot station after loading/unloading
<i>Port Call Improvement Service</i>	
Objective:	To evaluate and propose means for optimizing future port calls.
Description:	This service uses conducted port calls as a basis for evaluation to establish means for optimizing future port calls. Generic process definitions of a port call are up-dated and then used as the basis for future port call instances.
Service provider:	Port authority or company/private service provider
Area of operation:	The turn-around from arriving to traffic area / pilot station, to leaving from traffic area / pilot station after loading/unloading and information exchanges related to port call.

2.4.2 Information services in PortCDM

Three types of information sharing services are distinguished; Commitment/expectation management services, Capacity planning services, and Port Approach Optimization services.

Table 2: Informational services in PortCDM (c.f. Lind et al, 2015a)

<i>Planning services</i>	
ETA_Planning service	Based on the vessel's desired ETA to the traffic area/port limits, a response is given of when the port operators have the capacity of taking the vessel to berth.
PortCall_Managing service	To establish/update a network/tree of related desires/intentions/ outcomes/ capacities for a certain port approach, where involved actors inform each other about their status.
Capacity_Planning service	To provide operators with plans for how available capacity could be utilized optimally in respect to upcoming port approaches (short-term, and long-term) expected efforts
State_Indicator service	To provide service consumers with the current state, and planned state changes, of a certain object
PortCall_Status service	To provide service consumers with a status report of how the port approach is planned for/is being realized
Noon_Reports_Sniffer service	To provide service consumer with noon reports (of updates about states and forthcoming ETAs) by searching multiple entry points
Port_Service_Planning service	To match the vessel operator's needs of services and service providers' capability (and/or capacity) to provide needed services and expected realization.
<i>Execution services</i>	
State_Updates service	To provide information about changed states related to the ETx-Manager and ETA_Planner for one voyage or several voyages)
Commitment_Mgmt service	To provide real-time information about changed states, and patterns of behaviour related to commitments as a basis to manage actor relations and real-time evaluation in relation to commitments and established SLAs.
<i>Evaluation services</i>	
ETAT_Evaluator service	To provide an evaluation of the capability to predict the actual time for a particular state change.
Root_Cause_Analyser	To provide root causes for, and solutions to, why a certain port approach (arrival, berth, departure) did not fully correspond to the expectations.
Waiting_Time_Statistics service	To provide information about waiting time per operator for a particular port approach and/or accumulated waiting time for a certain operator and/or sum of waiting time per voyage.
Commitment_Monitoring service	To provide information of broken commitments during planning and/or realization. This information (sometimes combined with the Root_Cause_Analyser) can function as a basis to manage commitments per actor and/or per voyage to improve future estimates and realization patterns.
<i>Other services</i>	
Port_Maturity service	To provide a judgement of a port's maturity level and what requirements there are for moving to the next level based on the result from several port approaches
Berth_Productivity service	To provide a measure ofn the berth productivity for a certain time period for a certain terminal
Port_Approach_Analyse service	A Port_Approach_Analyser provides the possibility to simulate and re-plan approaches based on a range of estimated and real time based input parameters (e.g., number of voyages, type of vessels, port operators capacity) for optimal realization and capacity utilization for a specific approach.

3. Towards a Port Call Message Format

3.1 Continuous interactions leading to optimal port calls

Port CDM relies on continuous interactions between the maritime actors involved in a port call. As claimed in section 2 above, intentions about actions to perform as well as achieved states and coordination points constitute the interactions. In order to enable port calls by fast turn-around, continuous interactions between port actors as well as with shipping companies / shipping operators are essential. Key enablers are green steaming and high degree of predictability resulting in just-in-time operations, minimal waiting times, and optimal resource utilization (see figure 6).

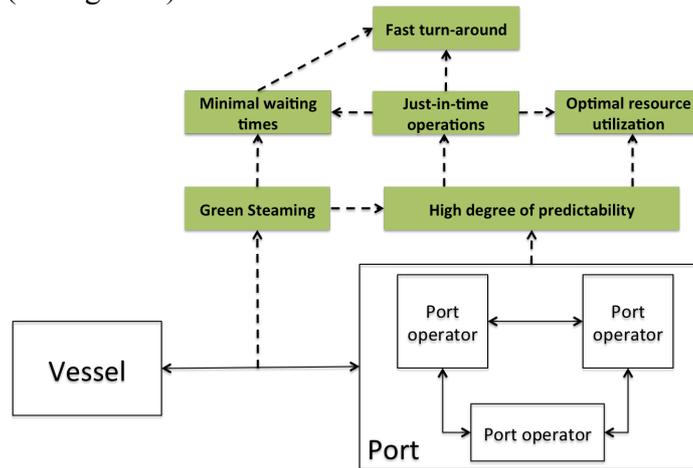


Figure 6: Enablers for fast turn-around port calls

Interactions are constituted by inter-related actions that come in pairs of initiatives and responses (c.f. Linell, 1998). A message is constituted by a *message part* (the propositional content) with a *communicative intent* (illocutionary force) issued by a *communicator* directed to one or several *addressees* resulting in a *communicative state* (Austin, 1962; Searle, 1969). An example would be a vessel operator (*the communicator*) issuing a planned time of arrival to a certain geographical location (e.g., the pilot station) (*the message part*) with the intent to request (*communicative intent*) cargo operations addressed to the agent (*the addressee*). The communicative state established is that a plan for a port call has been agreed upon among several actors. Communicative acts are multi-functional, meaning that a communicative intent might well be an expression for another intent; the plan for a port call also means that the vessel operator *intends* a location at a particular time. Further a first message serves as a trigger for a response becoming a new initiative. The logic of inter-related initiatives and responses constitute interactions (see figure 7 below).

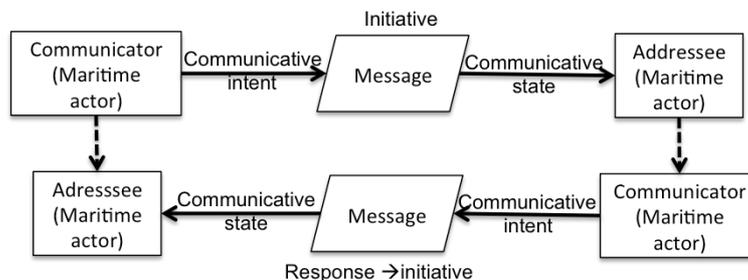


Figure 7: Messages constituting interaction patterns as initiatives and responses

3.2 The constituents of the Port Call Message

3.2.1 The message part

In the standards of different time stamps, as e.g. set by BIMCO, FONASBA, the estimated time of arrival (ETA) is a typical one. ETA is constituted by a Time_Type (ET), a Time_Sequence (A), and a Location (e.g., the pilot station). Naturally ETA is also referring to a certain time of occurrence and refers to a particular reference object (as e.g. the vessel) (c.f. Lind et al, 2015a). The message incorporates the communicative intent/communicative state by the time communicative intent. The ETA is often referred to the vessels estimated time of arrival. Due to the fact that the ETA is what the onboard systems aim towards due to diverse contextual factors, such as other traffic and weather conditions, the planned time of arrival is used as the timestamp for the strive that the vessel is trying to match its ETA. The following time types has been identified as important for enabling efficient coordination of the port call incorporated in the interactions:

- PT – Planned Time: The time that a particular actor have committed to be at a certain location / perform certain operations.
- ET - Estimated Time: The times for when a particular actor is aiming to be at a certain location / perform operations
- RT – Recommended Time: The time recommended for another actor to be at a certain location / perform operations.
- AT – Actual Time: The time when an actor is at a certain location / performs operations. The actual time is used for evaluation based on the actual occurrence related to planned and/or estimated times. Actual times can also be used for billing, logbooks and/or statements of facts.

In the message then the communicative intent / state is captured by the following types:

- RQ – Requested time: The time requested for another actor to perform operations
- CO – Confirmed/committed time: The time confirmed/committed by another actor to be at a certain place / perform operations
- AG – agreed time: The agreed between one and one or several actors to be at a certain place / perform operations
- SH – Shared time: A status indicating whether the time has been shared among others.

Two sets of time sequences have been identified due to if the subsequent category is a certain location, or a service/process. The first set of time sequence is used to define the events for a certain location, using Arrival or Departure. The latter set defines services and/or administrative processes as started and/or completed.

In the table 3 below we summarize different variances of the categories used for expressing a certain state based on the timestamp. Timestamps are thus combinations of the instances of the different categories expressed in the proposed nomenclature (building on Lind et al 2015a). This nomenclature includes categories necessary for a port call message. In the table 3 below the variances for the different categories are summarized.

Table 3: Instances of categories constituting the timestamp (based upon Lind et al, 2015a)

Time_type	Time sequence	State	Location	Service	Adm Proc.	Reference object	Information provider
ET [Estimated]	A [Arrival Time]	RQ [Requested]	TA [Traffic Area]	CO [Cargo Operations]	RE [Reporting]	VE [Vessel]	VE [Vessel operator]
AT [Actual]	D [Departure]	CO [Confirmed/	PS [Pilot Station]	BS [Bunkering]	CL [Clearance]	PL [Pilot]	SA [Ship Agent]

	time]	committed]					
PT [Planned]	S [Start Time]	AG [Agreed]	TU [Tug Area]	PR [Provision]	NO [Notification]	Tug [TU]	PL [Pilot]
RT [Recommended]	C [Complete Time]	SH [Shared]	BE [Berth]	MA [Maintenance]		LM [Linemen]	TE [Terminal]
			PA [Port Area]			SD [Stevedore]	PA [Port Authority]
			AA (Anchoring area)			TE [Terminal]	PC [Port Control]
						SP [Service Provider]	TO [Tug Operator]
						QU [Quay]	MA [Maritime Administration]
							GB [Governmental body]

3.2.2 Bringing the communicative act and digital data streams to a Port Call Message standard

To establish a standard format for messages the following format is being used

- **Who** (information provider) *has said what for which purpose* (message) *to whom* (Addressee/information consumer) *at what time* (Time reported) *being at what location* (reported location)

To adopt this to STM and PortCDM it is further essential to include the source of the information and associate the call with the unique voyage identifier, as proposed in MONALISA 2.0. For the purpose of tracking the different port call messages to each other a unique port call identification and a voyage identifier is used. In the port call message the time that the message concerns as well as the time_reported is included. The information consumer is built upon the same instances as the information provider.

Building on the elements of digital data stream segments (c.f. Watson, 2014) and stressing the communicative intent / state (Austin, 1962; Searle, 1969) in the interactions (Linell, 1998) a port call message is thus constituted as follows;

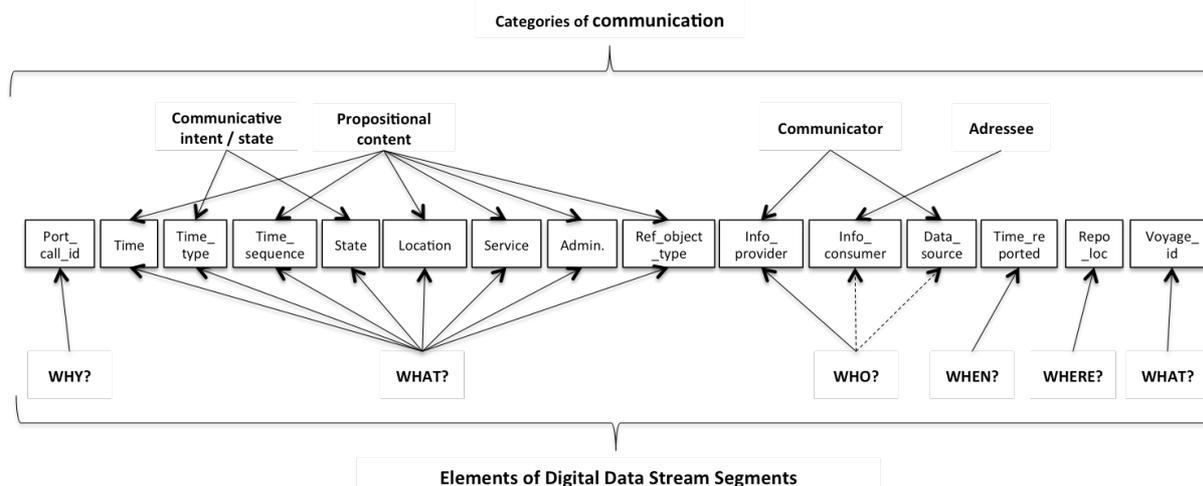


Figure 8: Proposed categories in the port call format

4. Putting the Port Call Message to practice

4.1 Deriving messages from existing systems

The main purpose of PortCDM is to go *from* a situation which is rather unstructured and that to a large extent build upon dyadic interactions *to* where the communication is standardized and that sharing of updated information in one dyadic interaction instantly is spread to other actors (see figure 9).

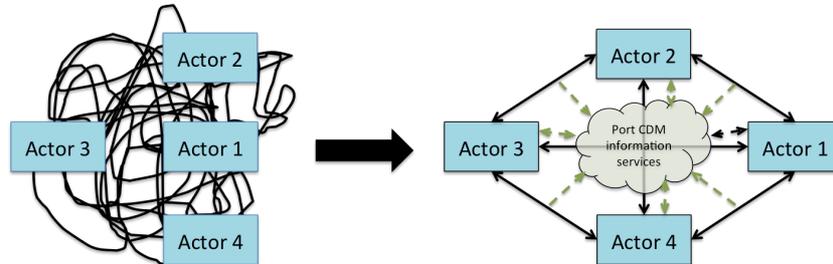


Figure 9: From dyadic and unstructured interactions to establishment of common situational awareness

This also has the benefit of enabling more efficient information distribution avoiding multiple dyadic interactions as well as making possible for one single point of registration. Dyadic interactions are however acknowledged.

PortCDM does not manage different assignments between different actors, but rather derive information from existing systems and uses that as a basis for providing information services for planning, efficient realization, and evaluation. At the core is the goal for to enable situational awareness derived from multiple information sources.

Figure 10 below depicts how the on going interactions between different actors are captured in diverse systems, such as vessel management systems, Single Window, SafeSeaNet, Port Management Systems, Planning systems for different actors, and then withdrawn for the provision of PortCDM information services. These information services are then further used in different PortCDM application services supporting operational services.

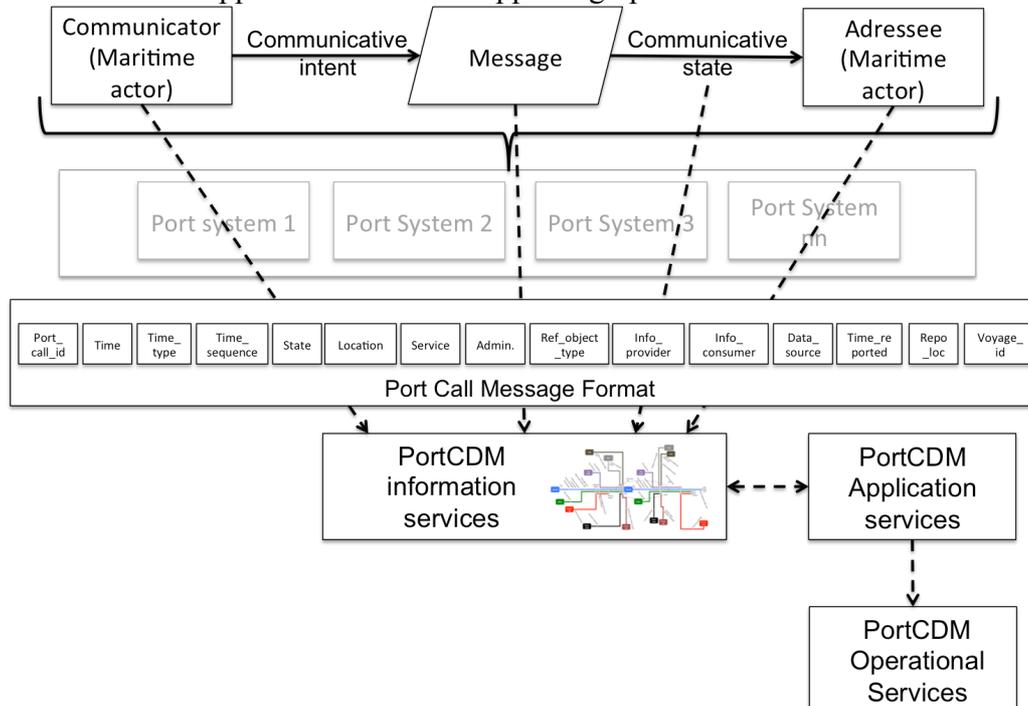


Figure 10: Deriving data from existing systems using the Port Call Message Format for PortCDM information services used in application services

4.2 Positioning interactions for the optimal port call and green steaming

It has been noted in Holm (2015) that green steaming is an appropriate way forward to save bunker fuel. The analysis shows that, for approaching vessels during August 2014, 17 % of them anchored outside the port waiting to get access to port services. By enabling communication between the vessel and the port prior the arrival of when berth can take place, the vessel can slow down in the latter part of the voyage, i.e. perform green steaming. This figure will be higher for congested ports. The same analysis also shows that by taking the average anchoring time of these vessels, 18 hours, they could have slowed down by 2.8 knots (in average) the last 227 NM by taking the speed profiles into consideration of the particular anchoring vessels.

Using PortCDM for enabling just-in-time operations is highly possible for two reasons; PortCDM enable port actors to set up a readiness to handling the incoming vessel efficiently, and interaction between the vessel and the port is enabled via PortCDM information services (See figure 11 below). In the figure below Planned time of arrival (PTA) (as the goal value in the Electronic Chart Display & Information System (ECDIS)) becomes established in the beginning of the voyage, and then changed in the latter part of the voyage due to recommendations made by the port (RTA). Estimate Time of Arrival (ETA) is used to show the deviation related to planned time of arrival (at the vessel), but also used for providing diverse actors with information about when the vessel is estimated to be at a particular location. This information, together with information about actual occurrences (ATA), is derived from ECDIS. Whether PTA or ETA is distributed to the ship agent, potentially via the shipping company, is ensured by the access management and collaborator nomination services enabled by SeaSWIM, as a concept of Sea Traffic Management.

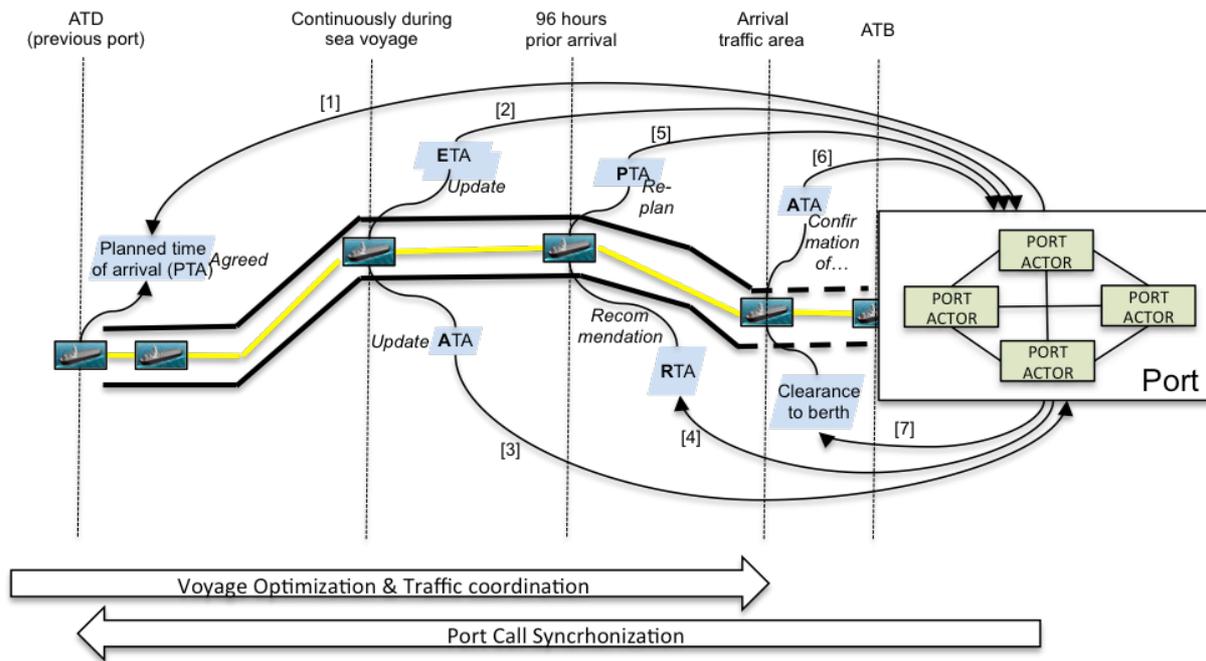


Figure 11: Interaction vessel and port for optimized just-in-time approach

4.3 PortCDM for providing situational awareness for involved actors in the Port Call

The coordinated port call builds upon a series of inter-related requests and commitments made by different actors (c.f. the CFA-schedule according to Winograd & Flores, 1984). The port is to be conceived as a multi-organisational business network (c.f. Haraldson & Lind, 2010) where each actor needs to coordinate its efforts. In the left part of figure 12 below a typical assignment logic for a port, i.e. inter-related communicative acts, between core actors is

depicted. The ship agent constitutes the interface to the shipping company and the vessel (c.f. section 4.3 below). These interactions are a differ depending on how far away in time the port call is expected to occur, as e.g. port operators such as pilots, tugs, and linesmen commit to their task rather soon before the physical port approach, the ship agent need to confirm with the terminal that there is room for the port call. To establish a readiness for an upcoming port call is based on communicative acts of **requests**, **commitments**, based on **shared** information reaching **agreements**. During the port call the state of actual is an expression for that a certain state has been reached (ATx); a **report of completion**. A request could be based on a recommendation derived by the main actor (or the co-ordinating actor) of the multi-organizational business network (c.f. Haraldson & Lind, 2010) constituting the port.

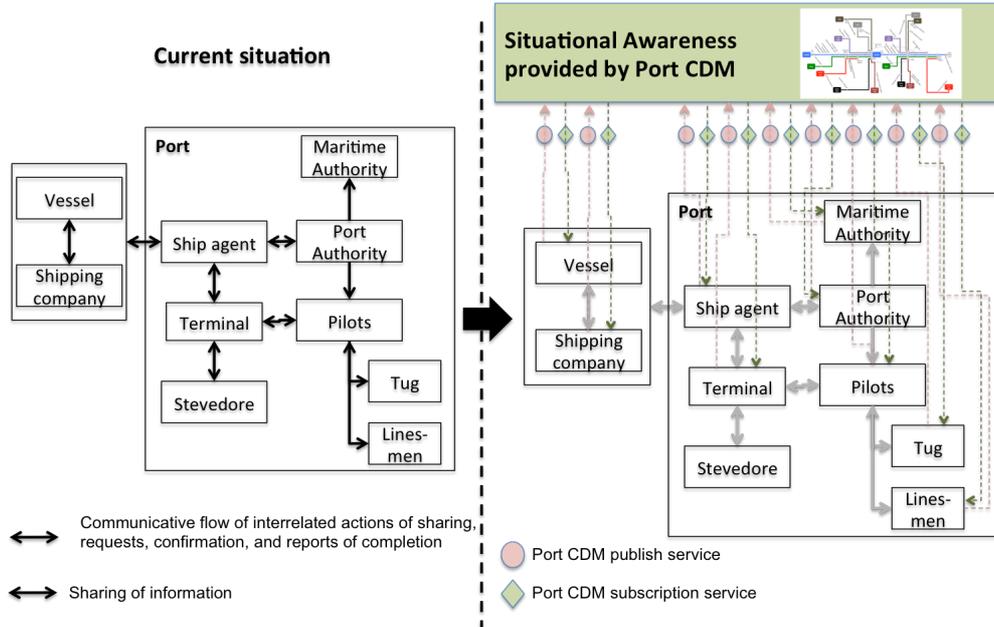


Figure 12: Typical assignment logic during port call (from current situation to PortCDM enabled situation)

Introducing PortCDM (see right part of figure 12 above) still means that there need to be an assignment logic established for the planning and realization of the efficient port call. It is however essential to see that there will be a shift from dyadic interactions in the sense that agreements between two actors instantly could be shared by PortCDM publishing services where other involved actors could get information instantly when there is a change that is of interest to that actor.

This means that PortCDM builds upon capturing and visualizing different communicative states of a particular states and/or coordination point. Derived from the discussion above this means that a certain time type, i.e. estimated, planned, actual, and recommended, could be requested, committed, shared, and agreed. Messages relating these communicative intentions to each other resolve in patterns that most often are unique for each port due to contextual factors, the port characteristics, and the role that different actors undertake.

5. Conclusions and final remarks

PortCDM utilizes digital data sharing and collaboration between key actors engaged in the port call process to reach desired efficiency. Taking a distributed approach to service development, dissemination, and discovery enables this. To encourage such distributed development, incentives for third-party developers need to be ensured. Two essential components becomes apparent; that beneficiaries acknowledge that the services that are brought into to the ecosystem are credible and that there exists standards enabling wide spread distribution and consumption of services. The credibility is to be reached by a federated

approach to govern service distribution, i.e. issuing criteria for which services that are qualified as STM and PortCDM compliant, and service realization by processes for monitoring and quality assurance. Governance of such service ecosystem enabling a high degree of integrity for involved participants must ensure that the information provider stay as the information owner regulating who that is allowed to access the information provided by the owner.

Standards are necessary for ensuring that the services being developed are applicable using diverse applications and equipment to wide variety of users. For the purpose of reaching the effects of STM two standard formats are essential; the route exchange protocol and the port call message standard, as discussed in this paper. Standards come in different versions, and to establish conformity between different ports, standards development needs to be facilitated. This also concerns the exposure of template services to be adapted to different ports and to serve as a driver for a proactive development of port call processes. Inspired by the European Airport CDM council a European PortCDM council has been proposed to be established for the continuous development of standards, approval of new/refined services, and to share (templates) of service innovations.

At present PortCDM information services and PortCDM application services (front end services) are being developed for demonstration in Port of Gothenburg and Port of Valencia. The purposes of these demonstrators, which gather key stakeholders for port calls in living labs, (Liedtke et al, 2011) are to:

- Validate the Port CDM concept, to get experiences from realization of the concept, and to get informed about areas to clarify / deepen in the concept
- Identify and verify effects of the use of Port CDM
- Create a demonstrator used to encourage others to engage in the development of a new generation of ports that build upon enhanced collaboration
- Get experiences from applying the port call message standard

In forthcoming reports quantitative and qualitative results from these demonstrations will be provided.

References

- AUSTIN, J. L. (1962) *How to do Things with Words*, Oxford University Press
- DIETZ J.L.G. (2001) DEMO: Towards a discipline of organisation engineering, *European Journal of Operational Research* 128 (2001) 351-363
- HARALDSON S.; LIND M.(2005) *Broken patterns*, 10th Int. Working Conf. The Language Action Perspective on Communication Modelling, Linköping
- HOLM H. (2015) Estimating potential fuel savings from relevant back propagation of anchor times, SSPA, RR102592-01-00-A
- IMO (2013) A concept of a sustainable maritime transportation system, International Maritime organization (IMO)
- LIEDTKE C., WELFENS M. J., ROHN H., NORDMANN J. (2011) LIVING LAB: user-driven innovation for sustainability, *International Journal of Sustainability in Higher Education*, Emerald Insight
- LIND, M., HARALDSON, S., KARLSSON, M., & WATSON, R. T. (2015a). *Port collaborative decision making – closing the loop in sea traffic management*. Paper presented at the 14th International Conference on Computer Applications and Information Technology in the Maritime Industries, Ulrichshusen, Germany.
- LIND M., JENSEN J.K., HARALDSON S., WATSON R. T., SETTBERG P., HOLMBERG P-E. (2015b), *Service and Communication Infrastructure for Sea Traffic Management*,

*Accepted to WCTRS-SIG2, The Port and Maritime Sector: Key Developments and Changes,
University of Antwerp, 11-12 May, 2015*

14th Conf. Computer Applications and IT in the Maritime Industries (COMPIT),
Ulrichshusen, pp.290-305

LINELL P. (1998) "*Approaching dialogue. Talk, interaction and contexts in dialogical perspectives*", John Benjamins Publ, Amsterdam

SEARLE J.R. (1969), *Speech acts - An essay in the philosophy of language*, Cambridge Univ. Press

WATSON, R. (2014). *Are You Ready to Profit from Real-Time Digital Data Streams?* MIS Department. University of Georgia.