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“Sustainable Knowledge Platform for the European Maritime and Logistics Industry”

e-Maritime Standardisation Requirements and Strategies

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Contents

1 Introduction

1.1 Scope of this document

"e-Maritime" is still a concept under definition, but the concept is at this stage sufficiently clear to allow a discussion on its implications for standardisation. This report will try to provide some input to that discussion. Based on best current knowledge, it outlines a tentative structure for the e-Maritime concept and its definition and points to areas where standards may be an important mechanism to realise the e-Maritime concept.

This paper assumes that "e-Navigation", as currently worked on by IMO, will cater for the issues that are directly related to navigational safety as defined by the mandatory safety systems. Thus, standards that would be in the domain of IMO and related organisations are not explicitly discussed or listed.

This report will also concentrate on more or less voluntary standards and will not discuss standards that are derived from legislation related directly to, e.g., security or safety requirements.

This document will not deal with "trivial" standards such as common exchange formats (e.g., XML, UN/EDIFACT), ICT service provision standards (service oriented architectures, semantic web technology etc.) or similar basic standards that mainly will be driven by activities outside the e-Maritime domain. The focus will be on standards that are needed for e-Maritime and that cannot be relied on being developed in other places.

1.2 e-Maritime and shipping

This report will in many areas use the term "shipping" instead of e-Maritime. It is quite clear that e-Maritime is a much larger area than what is covered by shipping itself, but the movement of a ship on international routes between different ports and ports states is what sets many of the premises for developments in e-Maritime. In particular, the international aspects of shipping with UN level legislation through IMO and ILO tends to set shipping apart from other transport modes. To realise the e-Maritime concept, one of the most important set of constraints to consider is that related to international shipping.

1.3 e-Maritime and sustainability

e-Maritime and related standards need to focus on safety, security and measures to reduce the impact on environment through pollution, discharge of harmful substances and other effects of operations or emergencies. This also includes emissions of green house gases.

The IMO study on greenhouse gas emissions [IMO09] estimates that reductions in CO_2 emissions from shipping have about the equal significance on the operational as on the technical side (See Table I). As e-Maritime is about improving operations in shipping on a large scale, it is also obvious that e-Maritime is very much about greener shipping.

Table I: Assessment of potential reduction of CO_2 emissions from shipping by using known technology and practices, Table 5-2 in [IMO09]

Design (New ships)	Savings of CO_2/tonne-mile	Combined	Combined
Concept, speed and capability	2-50%⁺	10-50%⁺	25-75%⁺
Hull and superstructure	2-20%		
Power and propulsion systems	5-15%		
Low-carbon fuels	5-15%*		
Renewable energy	1-10%		
Exhaust gas CO_2 reduction	0%		
Operations (All ships)			
Fleet management, logistics and incentives	5-50%⁺	10-50%⁺	
Voyage optimization	1-10%		
Energy management	1-10%		

⁺ Reductions at this level would require reductions of speed.

* CO_2 equivalent based on the use of LNG.

1.4 Structure of this document

This section (introduction) will define some general concepts related to the scope for the report. Section 2 will define the concept of an architecture and outline a possible structure for use in e-Maritime. This architecture is in structure the same as is suggested for e-Navigation. Section 3 will create an outline definition of e-Maritime in terms of domain and areas. Section 4 will discuss e-Maritime in light of the tentative framework model and look more closely at the need for standards as seen from this perspective. Section 5 will highlight some critical issues that need to be considered when the e-Maritime concept is developed. Section 6 will look at the general strategy that could be pursued when developing the e-Maritime standards and section 7 will summarise the identified need for standards in a tabular format. Section 8 contains references.

2 Overview of e-Maritime

2.1 Preliminary definition of e-Maritime

The following two paragraphs give a very high level definition of some of the issues that are important in e-Maritime [Chr09].

Whereas "e-Maritime" stands for internet based interactions between all the different stakeholders in the maritime sector, the EU e-Maritime initiative includes a set of European capabilities, strategies and policies facilitating the development of "e-Maritime" systems and services in support of an efficient and sustainable waterborne transport system fully integrated in the European transport system.

e-Maritime capabilities will encompass legal, organisational and technical frameworks to enable maritime transport operators, shippers/ freight forwarders, and maritime administrations to seamlessly and effortlessly exchange information in order to improve the efficiency and quality of their services.

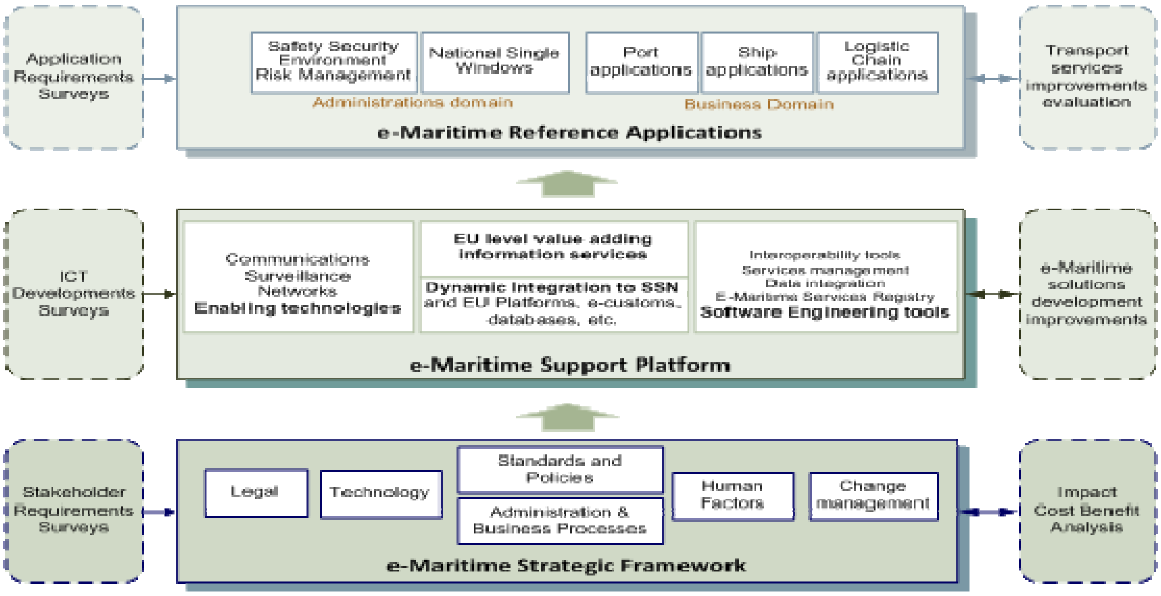

Figure 1 – e-Maritime Components [Theo09]

The components of e-Maritime as they are currently defined are shown in the above figure. This document will mostly discuss the lowest level, the strategic framework.

2.2 Special constraints for the maritime business

The maritime business is characterised by the need to support ships on international voyages. This has some important implications for the constraints that the business operates under and which in turn determines much of the written and unwritten rules that apply to the domain. Some examples are:

- One needs to support the large autonomous entities that the ships represent. A ship is a self contained "village" that is mostly under a foreign flag state jurisdiction. This also has consequences onboard as physical shore supports may be weeks away in many cases.
- Limited communication facilities require a large degree of autonomy also with respect to handling relationships to ports and port states as well as commercial parties in countries

visited. Limited communication also contributes to a problem of establishing trust or legally and commercially reliable relationships between parties.

- Shipping has a history more than 300 years old that is still reflecting on mechanisms in use today. As an example, the classification codes for ships in use today stems from Lloyd's List of 1764. Also, charter party clauses still in common use today are more than 100 years old.

- Shipping is a very international and very competitive business. This helps to keep transport costs down while creating problems for regional legislation and standards.

- Due to its history and international aspect, there are large volumes of international and national legislation as well as commercial contracts and understandings related to shipping. The paper work is substantially more complex than for, e.g., trucks used in international trade. There is also a host of agreements between port and flag states on what shall be done and what shall not be done when a ship visits a port and port state.

While some of the constraints still will apply in the foreseeable future, others may be changing. Although communication cannot be expected to reach shore type broadband quality in terms of reliability and capacity, satellite and other forms of communication is now fairly common on ships. Also, the general transparency that modern technology such as AIS and satellite communication provides, can also be used to increase trust between parties. This is one of the enabling factors for the introduction of e-Maritime.

2.3 Types of shipping

At the centre of e-Maritime one should probably put the ship. This is the entity that moves between ports and port states and which binds the parties in the area together. However, there are different types of shipping one may need to consider. The main groups may be:

- Cargo transport.

- Passenger transport.

- Inland waterways.

- Offshore services not directly catering for cargo or passenger transport (e.g., off-shore, surveys, cable laying etc.).

Also within cargo and passenger transport one will normally have to consider different types, typically inland, short sea and deep sea. It is suggested that the e-Maritime strategy focuses mostly on deep sea and short sea cargo transport. This will likely give benefits in other areas as the e-Maritime concept develops. However, this needs to be defined.

2.4 Domains and characteristic properties of e-Maritime

[Theo09] suggests that e-Maritime consists of five main domains, e.g., as illustrated in the figure below. This is an easy to understand and fairly straight forward way to illustrate the areas. However, as pointed out in MarNIS and other projects, the figure will need some later clarifications as different countries and different regions arrange maritime services somewhat differently.

One example is the pilot which in some countries is a private service while in others is a public service and which also may be divided into coastal fairway and port approach pilots. To avoid such ambiguities it is suggested that a more detailed definition is given for each area. A tentative outline definition is given in the following sub-sections.

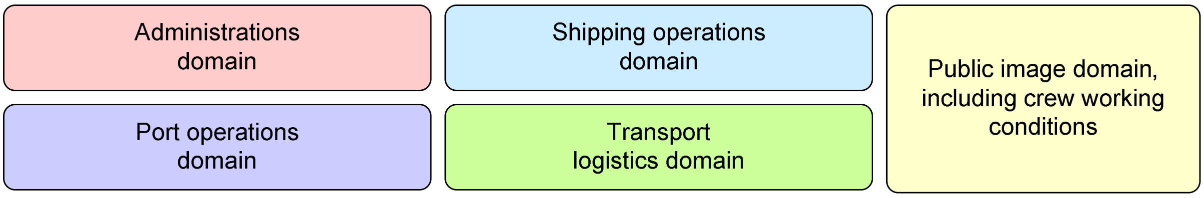

Figure 2 – e-Maritime domains

Note that the grouping of functions is also somewhat arbitrary. For some of the functions, one can easily move them between domains. Thus, the grouping only serves as a practical measure to describe under what main heading a certain function or party is expected to be found. Already the need for standards is clear. This issue will be revisited in the next main section where an e-Maritime architecture is discussed.

2.4.1 Administrations domain

It is suggested to put most legislative and control functions into this domain. This would then include, IMO, ILO and other organisations creating legislation from shipping, flag, port and coast state authorities as well as class. European level authorities, including EMSA should also be put here.

2.4.2 Ship domain

This can be defined as the commercial functions related to onboard and on shore activities. For ship board applications this can subdivided into navigational safety (mainly in the domain of e-Navigation), life support, administrative functions, cargo and ballast management, energy management, crew infotainment etc. For shore based activities the corresponding sub-domains will be related to ownership, chartering, management and other parts of ship operations.

2.4.3 Transport logistics domain

This can be defined as functions related to the integration of the maritime transport means into the logistics chain. As discussed in section 3.4, one will need to define what elements go into the e-Freight and what elements go into the e-Maritime architectures.

Large scale deep sea shipping, being it bulk, RORO or container is very efficient and one may not need to improve much on logistics there. However, for smaller scale shipping there is an increasing problem in making it competitive with in particular road traffic. This includes issues such as integration into door to door transport services and transport corridors. This is often an inter-modal issue, but may also include measures to ease the use of ships on the first or the final transport leg – also for non-bulk cargos. Short sea shipping is also strongly related to the previous issue.

An important element in this domain is also providing maritime support to the e-Freight initiative. This includes the development of new systems for providing e-Freight compatible services in the maritime sector.

2.4.4 Port and coastal domain

This can be defined as functions providing ship services in and near ports. Pilots, linesmen, stevedores, terminal operators, ports themselves, lightering, fuel and supplies, repair and yards, ship agents etc. can be defined to belong in this domain.

2.4.5 Public image and crew conditions domain

The issue of transparency in shipping is a special consideration that needs to be covered. Without increased transparency and trust, shipping cannot develop a more attractive public image.

Professional development issues and career models that make it more attractive to be a ship crew member also need to be addressed. Lack of competent crew in Europe is a problem on board ships as well as in shore based jobs.

Finally, life as a seafarer can be improved by providing better onboard facilities, being it for education, better contact with friends and family or improved infotainment facilities.

2.5 Parties and roles involved in e-Maritime

Another way to look at e-Maritime is to place the ship in the centre of activities and look at the parties that have interests in it. In the below figure, these parties have been colour coded according to (roughly) what domain they belong to.

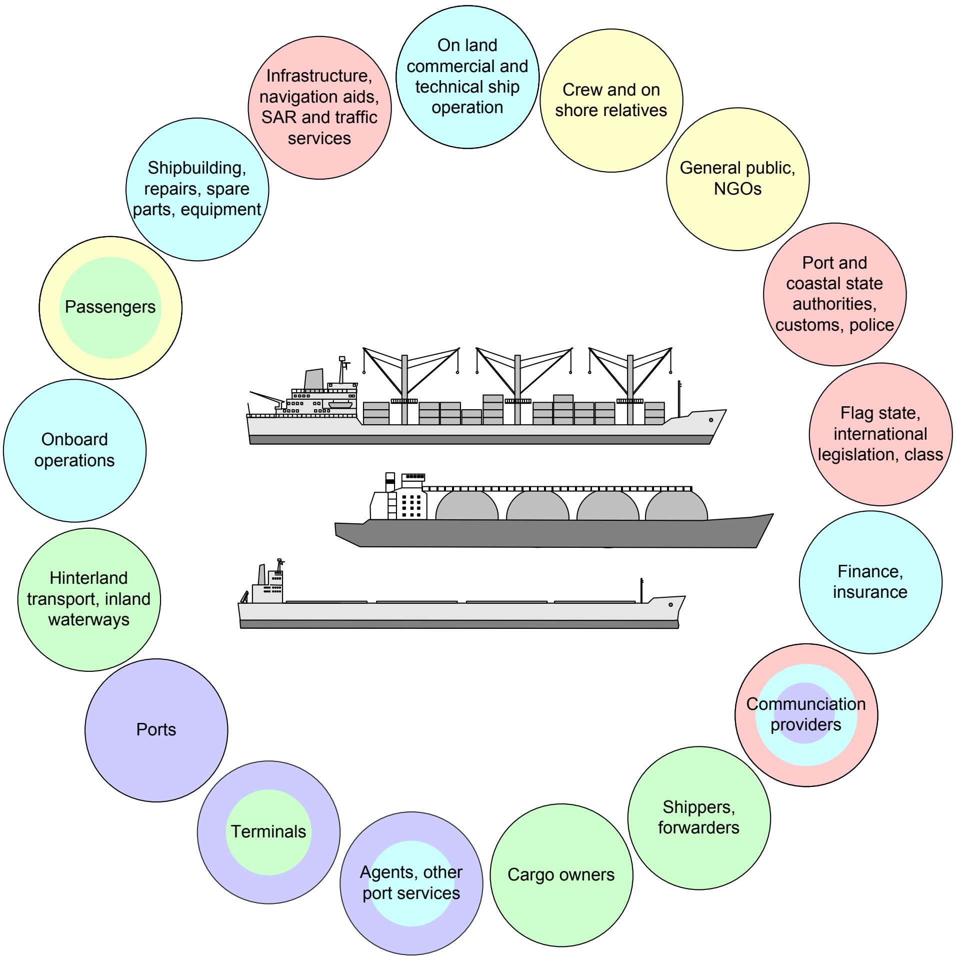

Figure 3 – Some e-Maritime parties

This is an approximation of the reality, but it still shows some of the complexity of the shipping area. The multi-colour coded circles represent parties or group of parties where several domains are mixed. One example is communication where authorities, ports and special communication system providers all operate. Similarly, ports include agents (ship operations), terminal operators (port or logistics domain) and, e.g., port workers (port domain).

One problem with this model is that the same party may have slightly or even widely different responsibilities in different areas. Thus, in ARKTRANS[1] [STF09] the "role" is suggested as a more useful concept than party. The idea is to have a fixed set of pre-defined roles that clearly describes responsibilities and processes. The processes and responsibilities are relatively similar between, e.g., different ports or shipping companies, although the actual physical entities that perform the role may differ. ARKTRANS is in this function part of an ontology for shipping (or transport, more generally). This issue is discussed further in the next main section.

The problem of party versus role is particularly visible in the maritime field as ships move around. Also, ships are large and complex, and the operation of ships require a large degree of interaction between different parties, e.g., as illustrated below. This figure is based on the previous one, but all "unchanging" parties have been removed.

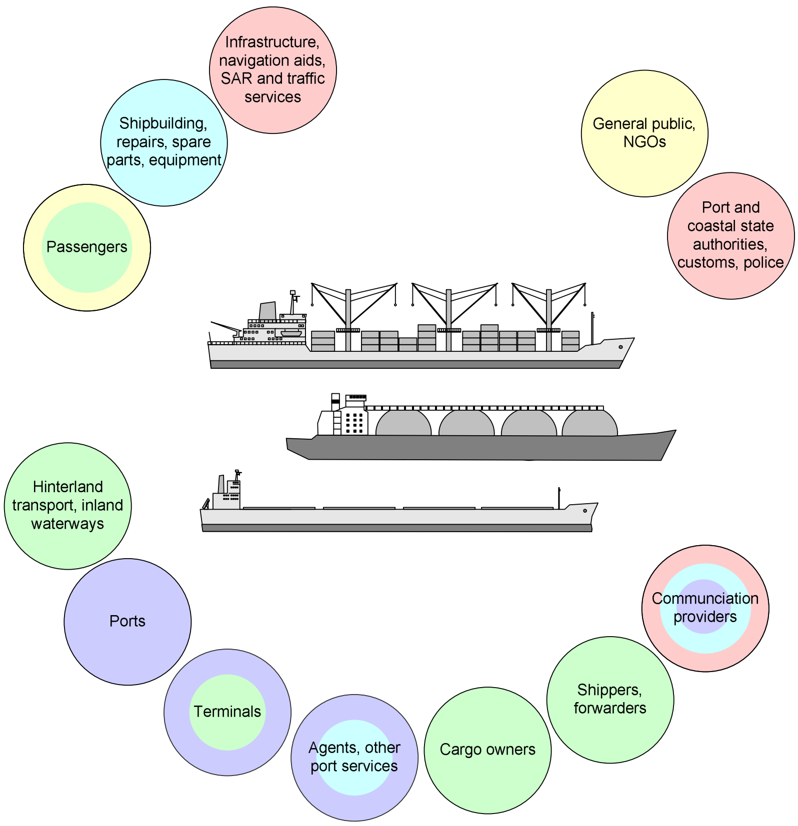

Figure 4 – Variable parties seen from the ship

Thus, the figure gives an impression of the number of relationships that have to be renewed for each port the ship calls on. This is part of the problem that e-Maritime can contribute solutions to.

[1] www.arktrans.no

3 An e-Maritime architecture

ARKTRANS as previously mentioned is an architecture for transport ICT. Architecture in this context means a conceptual framework that serves two main purposes [eNav09]:

1. The first is to ensure a common understanding and interpretation of the e-Maritime concept. This definition must be sustainable, meaning that it as far as possible must be stable over time and independent of technology, technical components and systems (which may change over time). The definition should further clarify:
    - The context of e-Maritime. That is the main aspects, scope and environment of e-Maritime and the responsibilities to be fulfilled by the stakeholders. This allows us to assign a specific role to each responsibility or set of responsibilities.
    - The logical description of e-Maritime by means of functions that enable stakeholders to meet their responsibilities and the information that has to be exchanged between these functions. Responsibilities, functions and information flows should be combined into processes related to specific situations.
2. The second purpose is to support the implementation of the e-Maritime concept. The architecture should provide implementation requirements with references to the logical specifications (see item 1), e.g., specify how to realise information flows. The current technologies, standards and solutions to be used should be defined.

Thus, the architecture should contribute to the common understanding and interpretation of the e-Maritime concept as well as the design of its components.

It may, however, take time to establish all the implementation requirements because standards and solutions may not yet be available. Therefore the implementation specifications may at the outset not be as complete as the conceptual specifications. These will have to be updated as new technologies, standards and solutions emerge.

3.1 Definition of the architecture

The general ARKTRANS architecture is in general very suitable for e-Maritime, but it does not fully cover the commercial business interests that need to be covered. It is mainly focused on satisfying authority defined constraints such as safety and security requirements by allocating corresponding authority defined responsibilities. We suggest that this architecture should be extended also to cover the business processes. This is shown in the figure below.

The figure is identical to the one suggested for e-Navigation [eNav09], but is extended to define “Other constraints” and by adding a business view on level 2.

The architecture is organised into three abstraction levels as illustrated in the figure. Levels 1 and 2 are non-technical. They are prerequisites for a common understanding of the concept. Level 3 defines the technical realization and supports the implementation of the concept.

Level 1 defines the context of e-Maritime, i.e., the main aspects, scope and environment. This also includes external constraints and the overall purpose. Level 1 further defines the generic responsibilities (the roles) of the stakeholders involved and also the roles that support or may benefit from e-Maritime. The definition of context and roles constitutes the first step towards a common and well defined understanding of the e-Maritime concept.

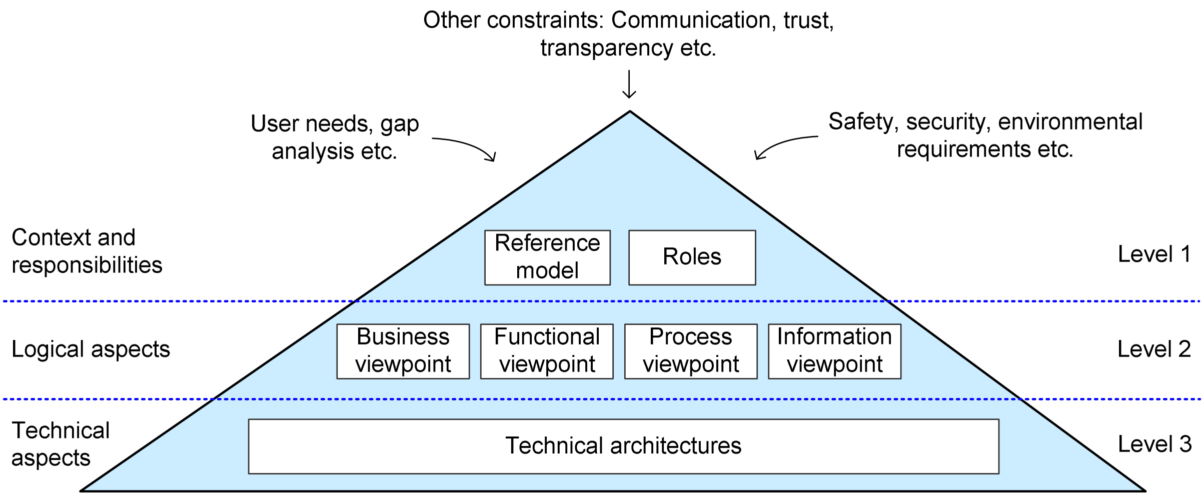

Figure 5 – Draft e-Maritime architecture

3.1.1 Concept of reference model

A reference model should support the definition of the context by being a tool for the identification of:

- The overall tasks *included* in the e-Maritime concept, e.g. vessel ownership and management, authority related tasks, port related tasks etc.
- The overall tasks *not included* in the e-Maritime concept, but which support, enable or benefit from e-Maritime, e.g., the general financial or insurance markets.

3.1.2 Concept of roles

A role is a generic stakeholder type with well defined responsibilities. By using roles, stakeholders can be referred in a generic way independent of the local organization of responsibilities. Real stakeholders may play one or more roles, depending on the local organization.

Example: The customs authority and immigration authority roles are in some countries held by the same stakeholder (e.g. the customs). In other countries these roles are however held by different stakeholders (e.g. the customs and the police).

The roles also ensure a generic and well defined terminology for the naming of responsibilities throughout the architecture. The roles may also be used in regulations related to the implementation of the-navigation concept.

3.1.3 Concept of business viewpoint

The business viewpoint will consist of business process models showing how value is generated in the area of e-Maritime. Value may be monetary gains, increased safety and security or other objectives defined by the reference model.

3.1.4 Concept of functional viewpoint

A function is here meant to be tasks or activities that have to be carried out. A function is strictly related to a role and contributes to the fulfilment of the responsibilities of this role. One role may have to accomplish many functions and many activities in each function to fulfil its responsibilities. To cope with this, a functional breakdown structure should be defined. In that way a terminology for functions at different detailing levels are defined in a hierarchy.

3.1.5 Concept of process viewpoint

The process viewpoint specifies how the e-Maritime is working with respect to interactions between functions and roles. The roles, the functions (activities) from the functional viewpoint and the information content that is exchanged as defined in the information viewpoint are building blocks when the processes are defined.

3.1.6 The concept of information viewpoint

The information viewpoint addresses the information that is exchanged between the activities (and roles) in the process viewpoint. The information elements are defined, and they are grouped together to define the content on information flows. These specifications arrange for the establishment of technical solutions specified at Level 3 (e.g. Web-services, use of communication protocols, etc.).

Traditionally there have been many alternative information exchange formats and procedures, and the parties involved have agreed on how to do it on a local basis (e.g. different solutions in different ports). The aim is that the information exchange is harmonised and standardised, and the same solution should be used everywhere.

3.1.7 Concept of Technical architectures

Level 3 specifies the realisation of the e-Maritime concept (functions/activities, information flows and processes as defined at Level 1 and Level 2) by means of available technologies, standards, systems, etc.

Technical architectures must be established for the different solutions. The functionality is defined at Level 1 and Level 2 of the architecture. Thus, the main focus must be on the required physical system components, interoperability and communication solutions.

3.2 Need for a specific e-Maritime architecture

One should note that it is most likely necessary to develop a specific architecture for e-Maritime. ARKTRANS itself and the e-Navigation architecture (see section 3.4) have different objectives and cannot be expected to be developed in sufficient detail for the e-Maritime domains.

However, as far as possible compatibility between the architectures as discussed in section 3.4 should be ensured. Compatibility is mainly needed in the interfaces between the architectures.

3.3 Relationship between architecture and e-Maritime components

The architecture as discussed above is a tool to create the components of the e-Maritime components shown in Figure 1. Thus, level 3 of the architecture roughly corresponds to the top two layers of the components figure and parts of layer 1 and 2 to the lowest layer of the components. The mapping is not completely one to one as the two figures show the same reality in two different perspectives.

However, the architecture is the first necessary step on the road towards the realisation of e-Maritime. Note also that the architecture is a living concept. One will normally have to start with the reality (“as is”) and then find out how it can be improved (“to be”). This requires interactions between all three levels of the architecture.

The components view can be looked at as the high level structure of the final results, as developed through the work on the architecture.

3.4 Relationships to other architectures

Similar architectures are being developed in the area of e-Freight and e-Navigation. Both are likely to be in part based on the ARKTRANS principles. Thus, there should be a relatively high degree of compatibility between them.

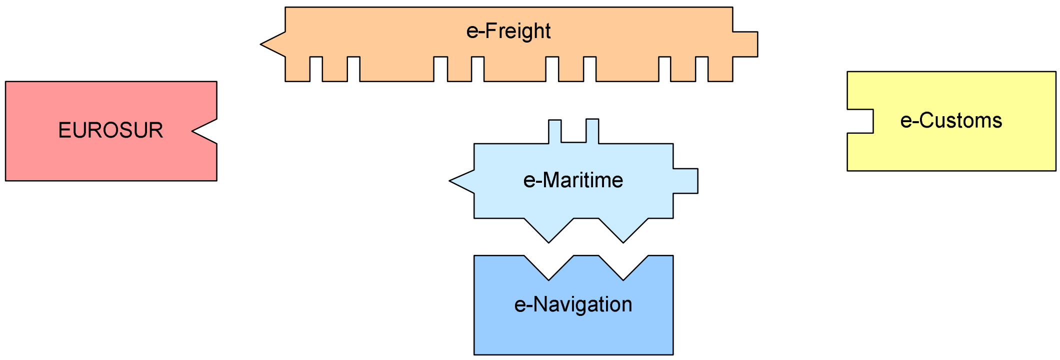

Figure 6 – e-Maritime architecture and other initiatives

The above figure tries to illustrate the relationships between some of the initiatives. e-Freight will have to cater for all transport modes and will be focused on the cargo and the movement of cargo. It is clear that e-Maritime must fit in the e-Freight framework, but there is not a significant degree of overlap if the general multi-domain freight logistics area is kept out of e-Maritime. Similarly against EUROSUR and e-Customs: These are initiatives that e-Maritime needs to fit into, just as e-Freight needs to fit.

e-Navigation is somewhat different as it is headed by IMO, a world covering organization. One can probably not expect that e-Navigation will be able to fully interface with e-Maritime, but it should be possible to develop compatibility between the two initiatives so that e-Maritime fits to e-Navigation. There are some important interface areas that need to be handled correctly.

The interfacing work will be simplified by using a common architectural principle in many of these areas. The actual architectures need not be fully compatible as well as the semantic relationship between the interfacing components are well understood.

4 Issues in e-Maritime that may require standards

This section is organised as defined by the internal blocks in the three levels of the e-Maritime components as shown in Figure 1.

4.1 Strategic framework

4.1.1 Legislation and contractual relationships

e-Maritime, through increased trust, better information availability and in general increased transparency can contribute significantly to more efficient legislation and contractual relationships.

As an example, a ship that calls on a European port today may have to submit more than 25 official papers and forms to get a clearance to berth. This represents a significant cost both for shipping operators as well as ports and port state authorities. By increasing transparency one can simplify such reporting requirements.

On the other hand, changes in legislation are also necessary to simplify many procedures that today can be implemented efficiently by electronic means. For instance, many countries' legislation still require signed paper forms to be submitted and does not allow foreign parties to submit many types of forms.

Contractual relationships suffer under the same problems as legislation. Lack of trust and transparency creates unnecessarily rigid and complex contracts.

Finally, legislation also tends to be inconsistent and difficult to fully understand. An important part of e-Maritime should be to provide mechanisms by which legislation could be semantically coded so that one can implement electronic systems to verify compliance with international, national and local laws and bylaws.

4.1.2 Technology

Most critical to the realisation of e-Maritime is probably ship to shore communication. Implicit in e-Maritime is more information exchange and ship to shore communication is a bottleneck today. In principle, one should look at communication facilities for:

- Arctic areas (very limited today, only Iridium)
- Deep sea (mainly Inmarsat today)
- Coastal water (no special systems today)
- Ports (some deployment of WiFi and WiMax today).

Otherwise, there do not seem to be any particular technological obstacles to e-Maritime. Better collision detection systems (better radars) and better electronic chart coverage are desirable, but this is in the e-Navigation domain.

There are also large challenges in the area of integrated information management, but these challenges are in the domain of standards and linked to various developments and applications that will be discussed elsewhere in this document.

4.1.3 Standards and policies

This is perhaps one of the most critical areas to realising the ambitions in the e-Maritime concept.

There is in general no lack of information in the maritime domain today. The problem is the quality and systematic retrieval of the data. This is more or less the same case in ports, in shipping companies and in administrations. The situation is improving, but standard information models will be critical.

Policies, particularly as basis for legislation or incentives, are also a very important component. The maritime business is very much segmented and driven by relatively old constraints and to change this situation one need a strong emphasis on policy.

4.1.4 Administration and business processes

Four large EU projects have or are investigating the four domains of e-Maritime. These projects are Flagship[2] (ship operations), Freightwise[3] (logistics), Efforts[4] (ports) and MarNIS[5] (administrative). What is particularly significant is that all these projects have to varying degrees developed process models for their respective domains. MarNIS and Efforts have been particularly detailed in their work.

The process models are important because they provide a description of how the different activities in each domain is undertaken and, in particular, shows necessary interfaces between activity (and roles) internally in a domain and externally to the domain.

This information in turn has many applications, both when looked at as higher level standard references and more detailed actual process specifications:

- Critical to identification of interfaces between parties and related information needs. Thus, process modelling is a necessary component of the UN/CEFACT Modelling Methodology (UMM).
- Critical to establish process improvement mechanisms as, e.g., in quality management (ISO 9000), environmental management (ISO 14000), port security management (ISO 28000) etc.
- Critical to establish key performance indicators (KPI) for use in process improvements.
- Critical to establish benchmark criteria for comparisons between organizations.
- Critical to in general understand how things work.

The process models will be an important component of the e-Maritime strategic framework and may also be part of the standards developed.

However, it is important to look at the underlying business processes as discussed in section 3.1.3. This will help to understand the value adding functions, also for non-governmental processes. There should also be large gains to be had in efficiency if the value adding activities is better integrated. A realisation of these gains will require a thorough business understanding as it more or less has to be done on voluntary basis.

[2] www.flagship.be
[3] www.freightwise.info
[4] www.efforts-project.org
[5] www.marnis.org

4.1.5 Human factors

One area where human factors clearly will be an issue is in more integrated shipping operations where shore and ship personnel cooperate more closely. This will require streamlining of work processes where the human factor will become central. This issue will appear both in Administration-Ship, Port-Ship and Logistics-Ship links. The link between the shore based parties, e.g., administration-port-logistics should also be considered.

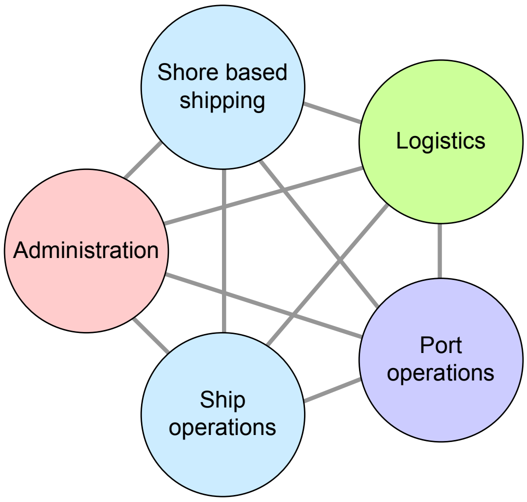

Figure 7 – Human factors in integrated operations

One could consider creating standard work practices for this type of integrated operations. It would then most likely be a best practice type standard, except perhaps for interactions between administration. In the latter case one may aim for directives type standards.

The human factor issue is obviously important also in other areas, but currently it is too early to identify specific needs for standards. It is known that the human factor needs more attention both on ship bridges and in vessel traffic service centres, but this is mainly an issue for e-Navigation.

4.1.6 Change management

Change management is a critical component to the eventual realisation of e-Maritime. Change management is basically a process that needs to be maintained by the different entities responsible for implementation of the various components of e-Maritime. Thus, at this stage it is not clear what standards may be needed in this area, if any.

However, change management will depend on good business and process models. Thus, these standards and specifications will be critical to the implementation of e-Maritime.

4.2 Support platform - EU level value adding information services

Adding value through information based services will depend on information models that ensure interoperability and common semantics in the information that is the basis for the services. The main problem today, in most areas of maritime, is not lack of information, but lack of compatible and quality controlled information. Thus, the general information models are critical.

4.2.1 Enabling technologies

Communication technology, in terms of wireless ship/shore communication, new network infrastructures and information models have already been mentioned as critical issues. Standards will play an important role as the maritime business is a world encompassing activity and both plain interfacing and common understanding of information elements are necessary.

Surveillance and administrations' communication networks should also use standards. On the information exchange level, between regions or states, information models that can serve as common frameworks are needed. Also, standard data models and possibly messaging standards for exchange of information are needed in order to increase public-private cooperation.

Standards are also needed in the domain of e-Customs and e-Freight, but these standards should preferably be developed in those domains. Already, the WCO (World Customs Organisation) has developed a common data model for much of the customs clearance requirements world wide.

4.2.2 Dynamic integration into SSN and other systems

SSN, e-Customs and other database systems basically represent information management and value adding services. So far, these systems have been based on a closed network between certain types of authorities so interoperability issues have been dealt with through design features in the respective systems and/or legislation. Thus, the syntax and semantics of information elements and services is fully defined by the context the service and/or information is used.

However, if the ambitions are to improve integration between systems and/or include other parties than authorities, one will need to consider at least information exchange standards. This may include information models, message formats and other features.

Information exchange between other administration parties should be included, such as flag state registries, port state control registers, conditions of class, certificate related information and so on.

4.2.3 Software engineering tools

This category includes interoperability tools, service management, data integration, service registries and various other systems that can be implemented by commercial parties or authorities. It should be noted that the systems may be implemented as distributed or centralised services. A very careful analysis of requirements and available technology is required to ensure than a viable and flexible solution is found. Central systems are in a sense easier to implement and can be created incrementally, but they tend to create some resistance in the market and it may prove difficult to implement sufficient flexibility in such systems to ensure compatibility with future requirements.

However, the same issues apply here as has been mentioned already: Information models and exchange standards will be critical. In addition, one will also need a very good understanding of the processes one wants to support with these systems. Thus, standard process models will also be an important component here.

The EU-project Efforts has analysed the requirements for ICT related services in ports and suggest the use of a service oriented architecture (SOA). This approach should be considered on a wider scale and a standardised approach to using ICT services should be developed. This will simplify the implementation of large scale information exchange as discussed in section 4.1.5. Such a technical architecture should include service registries, the actual services and all related functionality.

4.3 Reference applications

4.3.1 Safety, security and environmental risk management

Three types of standards are required to implement such applications:

- Information models to ensure accurate capture of compliant data into the applications so that reliable results can be provided. This applies to assessment, forecasts, statistical analysis and other features of such systems. Reliable input to the systems is necessary to provide useful results. This issue has already been discussed in 4.2.2.
- Well defined rules for how indicators for safety, security and environmental risk are calculated. Some of this may be part of the e-Navigation domain, but standards should also be considered also on EU level. This work could be based on the Shipping KPI concept[6].
- Standard process definitions for where the safety, security and environmental risks are to be assessed. This is most acutely needed if the ambition is that the management applications are going to be used in a “continuous improvement” feedback loop. In this case, the results of the assessments or forecasts will be used to influence existing processes and without a reference for how these processes look, different parties will reach very different to the stimuli. It may be that it is sufficient to cover this aspect in the general architecture discussed in section 3.

In this context it should be noted that legislation and various authorities’ regulations make references to entities in the maritime domain without a properly defined vocabulary. This means that it is very difficult to create electronic rule compliance systems as they have to be based on more or less heuristic approaches to find out what rules and regulations apply in a given situation. A dictionary of terms (ontology) would make it possible to provide semantically coded legislation in electronic format. This was also discussed in section 4.1.1.

4.3.2 National single windows

National single windows are already being established in Europe, but unfortunately not in any standardised fashion. IMO FAL[7] has created an inter-sessional correspondence group to create draft guidelines for such single windows, but the work seems to be lacking support from IMO member states. Thus, standards in this area are urgently needed. The standard need to cover the following components:

- A general data model. Currently being developed as ISO 28005-2 (based on MarNIS results and being supported by Efforts and in part Flagship). This model will also be aligned with the forthcoming WCO[8] data model.
- Message standards for ship to port state and port for clearance of ships. UN/CEFACT standards exist for most FAL forms, but these are not suitable for all ports and types of ships. New messages may also have to be developed to fit into new work processes in e-Maritime.

[6] www.shipping-kpi.com
[7] IMO Facilitation Committee
[8] World Customs Organisation

- Process standards for clearance. Currently, the implicit process standard is based on the FAL forms, but no clear semantics for exchange of clearance requests and acknowledgements are defined. This should be part of the e-Maritime architecture discussed in section 3.

As mentioned above, these standards are urgently needed and this issue could be addressed independently of the e-Maritime strategy.

4.3.3 Port applications

Many ports in Europe also do not generate the majority of their income from port activities. Traditionally, ports are located on prime property and many can therefore draw significant income from property or office lease.

More efficient port operations will again depend on process standards as discussed above and in other contexts. In addition to this, a port single window as discussed in MarNIS would be a beneficial addition to in particular smaller ports. The port single window should also be interfaced to the national or European level single windows. For this one needs standards for information format and content. The following standards should be considered:

- Interface between national single window and port single window. The main issue here is the information content. This standard may be national, but a European level standard is probably more appropriate.

- Interface between ship/logistics and port single window. This should also cover the mechanisms by which the interface is made, e.g., through XML messages over electronic mail.

Standardisation of processes and information would make it much easier to provide small ports with efficiency-enhancing tools at reasonable prices. Standards would allow larger customer groups for (a smaller number of) manufacturers and more functionality for lower cost.

4.3.4 Ship applications

This section discusses applications onboard the ship. Shore based applications are discussed under the heading of logistics applications. For both areas one should also refer to the IMO GHG study [IMO09] as discussed in section 1.3. As was pointed out in there, shipping operations has as large a potential for reducing CO_2 emissions as has new technology in shipbuilding. The applications that were highlighted there were:

- Fleet management, logistics and incentives.

- Voyage optimisation.

- Energy management.

For improvements in all these areas, improved information management is a key issue as well as a more holistic approach to shipping, involving improved cooperation between port states, flags states and ports. This issue will be elaborated on in the next section.

Onboard control and monitoring applications is provided by a relatively small group of manufacturers that dominate this business. Also, this area will to a large degree fall under the umbrella of e-Navigation. Significant improvements can be made also there, but these improvements must be coordinated by general regulations provided by IMO. Thus, it is not clear that the e-Maritime strategy and standards can provide as much value in this area as on the operational side.

Higher level decision support applications may include tools to improve energy management and various forms of shorter term voyage optimisation. Also here is access to information of critical importance. Current approaches usually have to rely on costly new installation of sensors and cables as it is difficult to access and reuse existing monitoring equipment. This is in part due to relatively closed monitoring and control systems onboard and in part to lack of proper semantically coding of information elements so that they can be reused outside the context in which they are collected. Standards for how ships should be instrumented would be very useful in this area. By taking the proper steps during building, later addition of decision support systems will be relatively easy and low cost. To realize this one should aim for the following standard:

- A standard specification for onboard data acquisition systems, including minimum sensor requirements, data models for sensor information, message standards where applicable and so on.

It is also clear that administrative tasks onboard take up much of the time of senior crew. New regulations and demands form authority usually result in adding reporting and log keeping chores without removing any old requirements. Thus, the master is swamped with a variety of reporting requirements in a large number of different formats. It is necessary to look at the current reporting burden and see what means can be used to make it more efficient. Integrated electronic systems are an obvious solution to parts of this problem. However, also support from authorities in making available or accepting information electronically as well as proving more standardised reporting requirements is important. Possible standards in this area are:

- Process models to define interaction between authorities and ship. Should be part of e-Maritime architecture.
- Standard formats for electronic log books, certificates and other information that can be exchanged electronically between ship and shore.

On the operational side, process and information standards would be very valuable in getting a more structured market for manufacturers of such systems and also to streamline the shipping process itself. This is also a prerequisite for new ways of performing shipping operations in a closer cooperation with all parties. Possible standards in this area are:

- Process models for inter-domain exchange of information, e.g., between charter and owner. Should be part of e-Maritime architecture.
- Message and information models for exchange of data. A general data model should cover as much of shipping operations as possible, more specific message models should focus on inter-domain exchanges. Within the domain there are also potential benefits in standards,

but these are less critical here. However, standards will simplify interfaces between different types of ship and shore systems, e.g., fro maintenance, stores and supplies.

Better working conditions for the crew are also a consideration. Many of the above systems may indirectly provide this by reducing many trivial tasks and by creating new responsibilities for monitoring and control of the ship's performance. However, it is also important to address the provision of better ways for the crew to stay in touch with their homes and relatives as well as meaningful ways to spend free time . Many such applications are already available, but key to making them work onboard is to provide a minimum of on-line "high bandwidth" communications and also to modify applications to make more efficient use of the communication bandwidth. There will in the foreseeable future be limitations to how much bandwidth a ship can get access to at a reasonable price. Many modern infotainment applications assume several mega-bit per second bandwidth and that is probably not realistic for ships. New performance standards could help to provide seafarers with more suitable systems.

For issues that are related to the shore based parties, several possibilities were mentioned in the IMO GHG study. Key to all suggestions is optimization of resources, both to reduce emissions and inherently, cost. Optimization works by removing "slack" from processes or by creating new ways to execute a set of processes. Removal of lack will often reduce robustness against unexpected events and needs back up by more accurate monitoring of processes and the process environment. This is in its basis about information management and the issue of standards for information retrieval and storage is central here.

Creating new and improved processes also needs accurate measurements of process performance and access to high quality and sufficient information to implement new and leaner processes. Concepts such as process modelling, Key Performance Indicators, Benchmarking etc. are central tools in doing this. On a larger scale this will also require standards for both high level processes and information. The Shipping-KPI has already been mentioned as a very interesting starting point in this area.

4.3.5 Logistic chain applications

General logistic chain applications are many and varied. E-Maritime can obviously contribute in this area, but here there should be a consideration of the wider co-modal transportation scope. One interesting possibility is to put more emphasis on door to door transport services. However, the approach here needs to be determined by who one thinks is more likely to manage this: Either third party transport service providers or the ship owners themselves.

Standards are in any case required to make higher degrees of integration possible. As a minimum interface standards between ship and port and from port onto other transport modes should be examined. Also there should be proper consideration of work going on in other areas. It is not clear that e-Maritime alone should develop standards or policies here.

Currently, it is assumed that these standards should primarily be developed through the e-Freight initiative. However, some issues should be covered in e-Maritime, in particular those directly involving only maritime parties. This could include:

- Improved information flows in the logistics chain. Some of the standards here needs to be developed in the context of e-Freight, but more specific variants of the standards must come from the maritime area.
- Process models for inter-domain activities as part of e-Maritime architecture. Particularly the business models are important here.
- New contract forms based on improved business models. The charter party contract is one example where current contract forms may not give optimal performance neither for owner nor charterer. More advanced contract forms based on more voyage and ship data may improve technical performance, economy and environmental impact of shipping.
- Data and messaging standards for improved cooperation between parties. One example is daily reports from ship to manager, charterer and possibly owner.

5 Critical issues

This section will discuss a few cross-cutting issues that are of particular importance with regards to e-Maritime, in the domain of standards and possibly also in other domains.

5.1 Transparency and trust

As has been mentioned before, the maritime business is in many respects rather old fashioned. One of the reasons for this is a traditional lack of trust and a requirement for robustness in legal and contractual relationships due to problems with identification of proper owners, communication to ship at high sea and the need for establishing robust relationships between ships from one flag state operating in the port of another state.

An important change that seems to be coming in the maritime business is an increase of transparency. This change can be seen in many manifestations such as:

- Monitoring systems such as AIS is a very important component of this, but also the introduction of LRIT[9] contributes.
- Voluntary reporting regimes such as Shipping KPI[10], Environmental impact reports or Tanker Management Self Assessment (TMSA).
- Documentation requirements from IMO and flags states make it easier to find out who owns and operates ships. This is still not completely solved, but improvements are made.
- Increased port state control through Paris MoU and other similar agreements.
- Increased national and trans-national cooperation through, e.g., SafeSeaNet, port to port information exchanges, Equasis and other systems.
- Trade partnerships such as AEO (Authorized Economic Operators).

Transparency will in most cases lead to higher degrees of trust. It becomes more difficult to hide intentions and it is easier to expose violation of rules etc. This in turns opens up completely new ways in which maritime business and legislative relationships can be constructed and managed. New contract forms that allow more optimisation of fuel and/or travel times, more self assessment instead of authorities control and a more binding relationship between port and ship to implement port slot times.

5.2 Processes and process understanding

As the objective of e-Maritime is to improve the maritime processes, an accurate description and understanding of these processes is a vital component in the strategy. Incentives, standards and legislation may easily have unexpected side effects if they are not accurately targeted on specific and well understood processes.

Process descriptions and understanding is also critical for internal improvement in the industry itself. This is not normally a problem internally in companies or organisations, but it rapidly becomes a

[9] Long Range Identification and Tracking
[10] www.shipping-kpi.com

problem when dealing with the interactions between organisations. In these cases, all involved parties need to have the same understanding of the main processes in each of the cooperating parties' organisations.

Standard processes can also be used to develop common KPIs and benchmarking practises. This in turn will increase transparency and best practice developments in the maritime area.

It should also be noted that processes discussed here need to include the business processes. This was discussed in section 3.1.3.

5.3 Information management

Improved information management is at the heart of e-Maritime. Standards are critical to achieve this.

5.4 Ship-shore communication

An improvement in information management depends on better ship to shore communication. This has made some advances in recent years with the introduction of global satellite coverage through Inmarsat and other service providers, but ship to shore communication is still limited in bandwidth and is very costly.

Examining communication needs, it is fairly obvious that this is much greater near shore and in port [Rød09]. Thus, systems which are complementary to satellite communication for ships should be considered. Commercially viable developments of satellite communication at high sea will always be limited by the number of subscribers and even communication near shore is a relatively limited market segments for the providers. Thus, low cost and high bandwidth communication solutions based on terrestrial base stations should be investigated.

5.5 Level playing ground – international aspect

As has been pointed out several times, shipping is and needs to be an international business. This means that one should be careful about using negative incentives as a component in e-Maritime if it creates problems for European operators only. Negative incentives should, as a rule, be channelled through IMO so that it gets international scope.

Positive incentives, including making voluntary efficiency enhancing standards available, are much less problematic. There are some interesting possibilities here, e.g., by increasing the role of flag states in port clearance and port state control that can give significant benefits for ships with flags that implement such services. Likewise, new directives and new standards making more efficient port-ship interfaces possible will also have a great potential in realizing the e-Maritime objectives.

It is also clear that most standards will provide a neutral possibility for parties to provide more efficient services and as such, help to level the playing ground.

It should be noted that the WTO agreement on technical barriers to trade [WTO95] oblige signatories to make use of international standards rather than regional or national.

6 Strategies for standards

6.1 Scope of standards

While most of the e-Maritime concept can be implemented in Europe alone, promotion on an international level is clearly desirable. Applying for international standards will make details available for all, but it does not necessarily ensure buy-in. If one wants more active participation from other countries or regions, there must be some consultation and relationship with international partners. This would be useful both in the development and implementation stages.

Possible standards, their scope and codes are as follows:

- International: Primary aim should be an international standard through ISO, IEC or ITU. If not possible, one should consider an EU level standard.
- EU: Primary aim should be a European standard, e.g., through CEN, CENELEC or ETSI. It is normally better to go for an international standard if this is possible.
- EU legislation: Standards should be established through European legislation.
- De Facto: No official standard is necessary. It may be more convenient to publish specification and let market adopt it. This is mostly appropriate for rapidly evolving specifications.

Since shipping is international, the aim should be for international standards where possible such as ISO or IEC (ITU may be relevant for some radio communication standards, although e-Maritime can be expected to deal more with how communication is used than the radio-technical details). However, it may be more practical to first implement legislation on a European level. In Europe, CEN, CENELEC and ETSI correspond to ISO, IEC and ITU. One should also note that the World Trade Organisation has developed treaties that favour international standards over regional [WTO95]. These treaties are relatively weak, but they may cause problems if regional standards are perceived to distort free trade.

Standards could also be developed independently of the standards organisations. Such standards are commonly referred to as “de facto” standards. These may be just as useful as “real” standards, but do not give the same benefits with regards to various international treaties, e.g., the WTO agreement.

6.2 Types of standards

Standards have several uses in the modern world. Some of the most important are described below:

- *Performance standards*: Technical standards to specify a certain level of performance. These standards may be compared to performance requirements in the form of legislation such as, e.g., IMO standards for critical safety equipment.
- *Process standard*: A standard way to perform a process, e.g., a test procedure, so that the result is guaranteed to be comparable to other results from the same process.
- *Interoperability standards*: Specifications that describe an interface so that users that need to connect to each other is guaranteed a certain level of compatibility.
- *Reference standards*: Standards that define a framework for reference. In its simplest form, this may be a form of, e.g., a coordinate system, in more complex variants it can be a taxonomy or ontology.

The different types of standards have different applicability, also in e-Maritime. For information technology, the focus is normally on interoperability standards (e.g., message formats) and reference standards (e.g., data model or ontology).

6.3 User buy-in and marked driven development

Standards can be used to define "ownership" of a domain without necessarily requiring that users have a positive attitude to them. However, e-Maritime is to a large degree about process improvements and standards alone are not sufficient to make the necessary changes. Legislation and directives may help, but active user buy-in is essential.

Buy-in one requires involvement of relevant user groups at an early stage in terms of dissemination and demonstration of viability. One problem in the maritime domain is fragmentation such that there is no small group of organisations which encapsulates the majority of stakeholders. One option may be to try to develop a new organisation for this purpose. A possibility could be to use the ITS network and make a variant for the maritime field.

Active user buy-in will, if it succeeds, ensure rapid adoption of the e-Maritime concept at a much lower cost than if it has to be done through administrations and authorities alone. However, buy-in also requires that the benefits are clear and sufficiently large to defend necessary changes in organisations. Note also that the international aspect may play a role here. It may be easier to get the concept adopted if it has an international approach that is at least supported by the major export and import nations and regions.

7 Summary of identified standards

7.1 Summary of identified standards

The table below lists the most central standards that have been identified in this report. The columns are from left to right:

- A reference to the main section where this standard is discussed.
- A brief description of contents.
- Type of standards as defined in section 6.2 and scope as defined in 6.1.
- The domain of the standard in terms of e-Maritime areas as discussed in 2.4.

The next sub-section will outline a possible structure for these standards. In the below table, each row is in principle intended as a separate standard.

Table II: List of possible standards.

Ref.	Contents	Type and scope	Domain
2, 3, 4.3.1 4.3.2 4.3.3 4.3.4 4.3.5	A general reference model or architecture for e-Maritime, defining roles, functions, processes, domains etc. Should be based on ARKRANS and MarNIS work. This should be a relatively high level model on which more detailed standards can be built. However, process models need to contain sufficient detail to ensure interoperability between the domains in e-Maritime.	Reference, de facto	All
4.1.1 4.3.1	Legal dictionary/Ontology for legal documents and commercial contracts	Reference, International	Administration
4.1.1 4.3.5	New standard contracts to make use of improvements in realisation e-Maritime.	Interoperability, EU/International	Transport and logistics
4.1.2 4.3.3	Standardised radio-communication facilities near shore and in port. Both frequencies and protocols must be agreed on.	Interoperability / Performance, EU/International	All
4.1.5	New work processes for integrated operations between maritime parties: Commercial part.	Process, de facto	All
4.1.5	New work processes for integrated operations between maritime parties: Administration part.	Process, EU legislation	All
4.2.1 4.2.2	Information model for interoperability between administrations' information networks and databases (SSN, SSN++, other surveillance and information	Interoperability, International/EU	Administration, All

4.3.1	networks). Can also be used for private-public data exchanges (see also single window standards).		
4.2.3	Service oriented architecture or similar standards for access to distributed services in the e-Maritime domain (see work done in Efforts).	Interoperability, EU/International	All
4.3.1	Standard assessment criteria for safety, security and environmental risk, based e.g., on Shipping KPI.	Performance, EU/International	Administration All
4.3.2	National single window implementation standard, implementation guideline or similar. Should also consider port to port or similar exchanges.	Performance Interoperability International/EU	Administration, Ship, Port
4.3.2	Information and message models to fit the standard SW implementation guideline. Can be based on ISO 28005-2	Interoperability International	Administration, Ship, Port
4.3.3	Information and message models for interface between national/European single window and port single window.	Interoperability, EU	Administration Port
4.3.3	Information and message models for interface between ship and port single window.	Interoperability, EU/International	Ship, Port
4.3.4	Reference technical architecture for shipboard monitoring and control systems with corresponding information models (navigation, automation, safety etc.)	Interoperability International/EU	Ship
4.3.4	Information models and message standards for electronic reporting and logging on board ships.	Interoperability International/EU	Ship Administration
4.3.4	Information and message models for inter-domain ship to shore communication (ship, owner, technical, administrative etc.)	Interoperability, International/EU	Ship, Logistics
4.3.4 4.3.5	Information and possibly message models for other intra-domain communication. Scope needs to be considered. e-Freight must be part of the framework.	Interoperability, International/EU	Ship, Logistics
4.3.4	Performance standards for crew communication.	Performance, EU/International	Ship
4.3.5	Information and message models for inter-domain ship to shore communication (ship, charter, owner, technical, administrative etc.)	Interoperability, International/EU	Ship, Logistics

7.2 Proposed structure of e-Maritime standards

The table presented in the previous section lists the currently identified standards. Most of the standards are general interoperability standards that map into a system of standards as shown below.

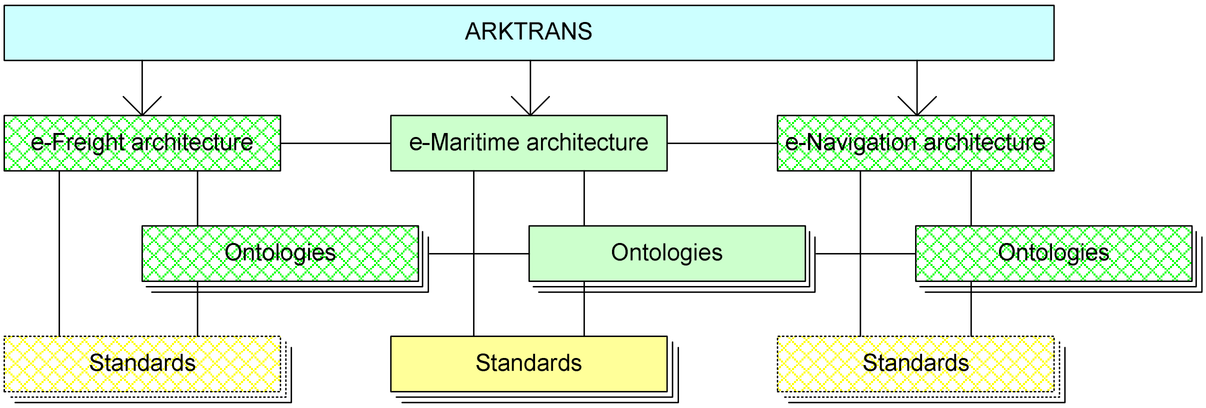

Figure 8 – Human factors in integrated operations

The proposal is to build the basic architectures on the ARKTRANS model and it is expected that e-navigation as well as e-Freight will do likewise. This helps to provide a certain level of interoperability between the different initiatives from the start.

The three architectures must be harmonised and this is indicated by the relationship lines. There are also links to other initiatives for customs and security, but these are not shown in the figure.

From the e-Maritime standard it is proposed to develop one or more ontologies. The ontology should in principle be part of the architecture, but as the architecture may not be suitable for standardisation due to its dynamic nature, it may make sense to make the ontologies separate and proper standards.

One ontology has been identified regarding legal concepts, but this should probably be extended to also include commercial and other areas. The main idea here is to provide standardised terms in the context of e-Maritime that can be used in an unambiguous way to develop standards and cooperation processes.

Note that one ontology could be a complete and integrated information model for all of e-Maritime. It is not clear if this is practically feasible, but it would help to provide interoperability between different application specific standards. As one can see from the table, a number of suggested standards will require individual data models and it is a danger that information elements that could be the same in different models get different definitions.

Note also that ontologies in the different architectures need to be similarly harmonized, in areas where domains overlap.

The actual standards as listed in the previous section will then be developed as separate documents for each application area. The table in itself a proposition for how these standards can be structured. The architecture and the ontologies will provide the common ground for interoperability between standards.

8 References

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Connecting maritime professionals and marine companies since 2007. Log in / Register Newsletter. Your E-Mail Password Remember me.Â 3. Standardization of Assessment Techniques. Even with the same curriculum being taught, one would get very different outcomes if the assessment methodologies are different. A lot of work is needed in defining appropriate methodologies for carrying out the assessment of students to ensure similar outcomes after teaching the same curriculum in different countries.Â The industry has been reducing the onboard training requirements over the last three decades. This, combined with the faster turnaround of ships and reduced manning, has led to the situation that learning from mentors on board has gotten severely restricted. The SKEMA e-Maritime Standardisation - Requirements and Strategies study has revealed 19 standards that may be needed; mostly in information management and interfacing between maritime transports stakeholders. e-Maritime-standardisation-requirements-and-strategies. Transport and Logistics Development. Dominant trends in Logistics. Review of Logistics Concepts Adopted in the Last Decade. Guidelines for Selecting Logistic Concepts. Supply Chain Integration and Intelligent Logistics.