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GROWTH Project GRD2-2000-30112 "ARCOP"

Assessment of Traffic Management Services on the Basis of a System Architecture

WP 3	Integrated transportation system for Artic oil and gas
WP 3.6	VTMIS

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Assessment of Traffic Management Services on the Basis of a System Architecture

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DELIVERABLE SUMMARY SHEET

Short Description
The report describes the user requirements for VTMIS under ARCOP conditions und consideration of the legal, administrational and organizational framework.

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REMARK

This document will be enhanced and supplemented over the project's lifetime. Revisions and further versions might follow.

ARCOP USER REQUIREMENTS

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List of Abbreviations / Glossary

AARI	Arctic and Antarctic Research Institute of Russia
AIS	Automatic Identification System
CNIIMF	Central Marine Research and Design Institute
ETA	Expected Time of Arrival
ETD	Estimated Time of Departure
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICT	Information and Communication Technology
ID	Identification
GMDSS	Global Maritime Distress and Safety System
HELCOM	Baltic Marine Environment Protection Commission (Helsinki Commission)
IMO	International Maritime Organisation
ITS	Intelligent Transport System
KAREN	Keystone Architecture Required for European Network (EU founded 4^{th} Framework project)
NAVTEX	Navigational Warnings by Telex
NSR	Northern Sea Route
POSEIDON	European Project on Integrated VTS, Sea Environment and Interactive Data Online Network (4th Framework project)
SAR	Search and Rescue
SRS	Ship Reporting System
THEMIS	Thematic Network for the Creation of an Intermodal Framework for Freight Transport Information and Management Services
TSS	Traffic Separation Scheme
VHF	Very High Frequency
VTMIS	Vessel Traffic Service and Information Service
VTMIS-NET	Vessel Traffic Management and Information Service – NETwork (EU founded 4^{th} Framework project)
VTS	Vessel Traffic Service
WATERMAN	Thematic Network on Waterborne Transport Management and Information Services

Executive Summary

This report reflects the System Architecture approach for VTS developed within the ARCOP project.

A System Framework Architecture is a model for building ICT solutions whereas a system architecture is a specified version serving a dedicated purpose (“view”) such as functionality, information and communication, task and responsibility allocation or hardware design (physical architecture). The system framework architecture supports the development of systems by providing tools for a proper arrangement of co-operation between humans and between systems. The objective of system framework architecture is to provide a stable basis for a working and workable system: A working system is one that not only has a set of fully functioning sub-systems, but for which these sub-systems co-operate fully to provide the full functionality required by the goals of the system. A major spin off of a system architecture is to provide a common terminology to foster co-operation of experts from distinct fields.

When assessing different existing architectures, the WATERMAN-TS approach was chosen and enhanced since it also reflects the outcome of the KAREN and the THEMIS project specified for the waterborne transport. The enhanced WATERMAN-TS reference architecture correlates the role of objectives, tasks, services and functions and its relation with the other entities like service users and providers. The “entity relationship approach” allows application of software tools (e.g. UML tools).

The intended ARCOP VTS can be seen as a special case derived from a general VTS approach taking into account the requirements for navigating the NSR. Nevertheless a generic approach is needed since the intended wide area VTS comprises various local VTS´s along the NSR.

The developed Functional Architecture defines and describes what functionality needs to be included in the system that can fulfil the requirements of the ARCOP VTS User Needs. To supplement the general functions, further tasks were added, reflecting mainly the environmental conditions when navigating through ice:

- Convoy navigation,
- Ice breaker support,
- Hydrometeorological information for traffic,
- Enhanced universal information to traffic,
- Ice pilotage,
- Remote pilotage,
- Enhanced reports from vessel and
- Supply chain control.

Introduction

The objective of the VTS/VTMIS task within the ARCOP project is to assess the role of traffic management services for waterborne operations under the extreme conditions in northern Europe, taking into account the results and experiences made in other projects. The basis for recommendations for enhancements for waterborne transport and traffic management operations will be given, from the VT(MI)S point of view. This report describes the approach of an ARCOP System Architecture.

The purpose of a VTS system architecture is to design, implement and operate a vessel traffic service and related services based on a consistent and sound understanding of the whole complex system. For ARCOP it is very important to develop an adequate architecture since it is aimed to assist the waterborne traffic on a route taking up to several thousand kilometres accompanied by extreme environmental conditions. So it is necessary to specify a wide area VTS combining local traffic services. In first instance a generic approach is needed.

The best practice attempt to develop an architecture is a combined top-down bottom-up approach. This means to commence with a theoretical structure (from top) and adapt this to the individual operational requirements (according to requirements from "bottom"). Once the architecture has been established, individual system modules can be treated separately and matched later on.

An appropriate architecture must provide a common ground of understanding to avoid miscommunication of all the distinct experts co-operating within one complex system. It is important that such an architecture remains simple and understandable not challenging the users more than the system itself. When dealing only with defined aspects of a system, one needs a specific “view“ on the system not being blurred by all other aspects. Such views can aim at a physical, functional or flow of information architecture. This views together with the definition of a system architecture and its use for the architecture creation process is described in chapter 3.

Chapter 4 mirrors the assessment of the WATERMAN-TS architecture which was first created for POSEIDON and was further developed. The WATERMAN-TS approach takes into account the results of the KAREN and the THEMIS projects: KAREN describes the development of an overall system architecture for ITS whereas THEMIS lists and assesses EU founded transport projects. WATERMAN-TS is seen as the most advanced development for the waterborne transport sector.

The generic functional VTS architecture for ARCOP is given in chapter 5. The functions are listed in tables split up to the five main VTMIS tasks as given by IALA.

In chapter 6 the required functions as derived from the ARCOP user requirements deliverable (D 3.6.1.) are given: The first part lists the required functions under “normal” conditions applicable for any VTS. The functions as given in the second part are directly related to the specific ARCOP conditions.

Annex I contains a very meaningful comment by Dr. R.N. Chernyaev giving a review of the chapters 1 to 7 of deliverable D 3.6.2.

System Architecture

1.1 Basic Terms

A **System Framework Architecture** (also called Reference Architecture) is a template for construction of ICT solutions. System Framework Architectures will typically be for product family or for a set of systems belonging to a domain (e.g. the transport domain). The overall parts of the system framework architecture should preferably be valid even through changes in technology and specific issues concerning confined parts of the domain. Thus, the architecture must be generic. However, it must define functionality, information, and interfaces in such a way that integration and interoperability is enabled. It should be possible to combine and replace system components developed according to the system framework architecture.

A **System Architecture** is a customised version of the system framework architecture that is the basis for the development of a specific ICT solution. A system architecture is based on the subset of the system framework architecture that specifies issues related to the desired ICT solution. Functionality specified in the framework architecture can be omitted; new functionality can be added to fulfil local requirements, etc. However, this must be done according to the framework, and interfaces and other requirements defined by the system framework architecture must be fulfilled. In that way system components from different vendors can be combined, as long as they stick to the requirements defined in the system framework architecture, be combined, and they can operate together.

The idea behind the development of a system's framework architecture for ICT-systems for the transport domain is to have a framework that defines best practice for system design. The architecture has to be defined in such a way that systems produced according to the system framework architecture are efficient, expandable and that can interact with other systems.

By the means of the system framework architecture individual transport systems can be designed to link together and create an integrated environment in such way that the performance, usefulness, safety and efficiency of transport will be enhanced. Each individual system provides one or more functions (functions combined to meet a user need are known as *services*), and the functions can be linked and combined to create a very large multi-functional, multi-service system.

The system framework architecture supports the development of systems by providing tools for a proper arrangement of co-operation between people and between systems. The architecture provides information about what should be uniform in systems in order to make interaction and co-operation between systems possible. The objective of a system framework architecture is to provide a stable basis for a working and workable system: A working system is one that not only has a set of fully functioning sub-systems, but for which these sub-systems co-operate fully to provide the full functionality required by the goals of the system. A workable system is not only pleasant to use, but is also easy to manage and maintain for its planned lifetime.

A flexible system must be built on a stable architecture because it has to react to changing demands of the user, designers and environment and also be predictable.

1.2 Levels of Architecture and Creation Process

We can distinguish between (at least) four levels of architecture, as shown in the following figure:

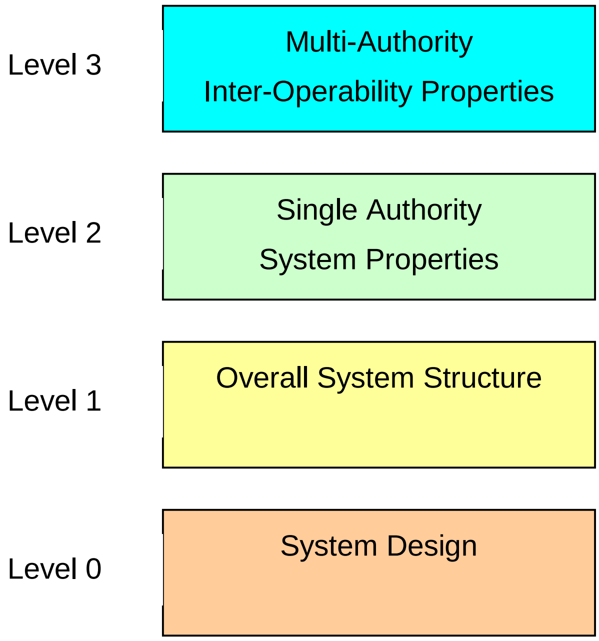

Figure 1: Model of System Architecture (reference: KAREN project)

A Level 3 architecture is necessary when the need for inter-operability between autonomous enterprises or authorities arises.

The Level 2 architecture is necessary for the integration of functions and sub-functions in a working and workable manner.

The Level 1 set of architectures defines the overall structure of the system, and how the sub-systems relate to each other. It will normally consist of at least four separate individual architectures: functional, information, physical and communication (s. next chapter). This level should be, as far as possible, technology and/or manufacturer independent.

The Level 0 architecture is not really an “architecture” at all. It is a manifestation of the Level 1 Sets of Architectures with each sub-system and component being fully described, and all the necessary standards having been chosen.

The architecture creation process is illustrated in the following figure on the next page:

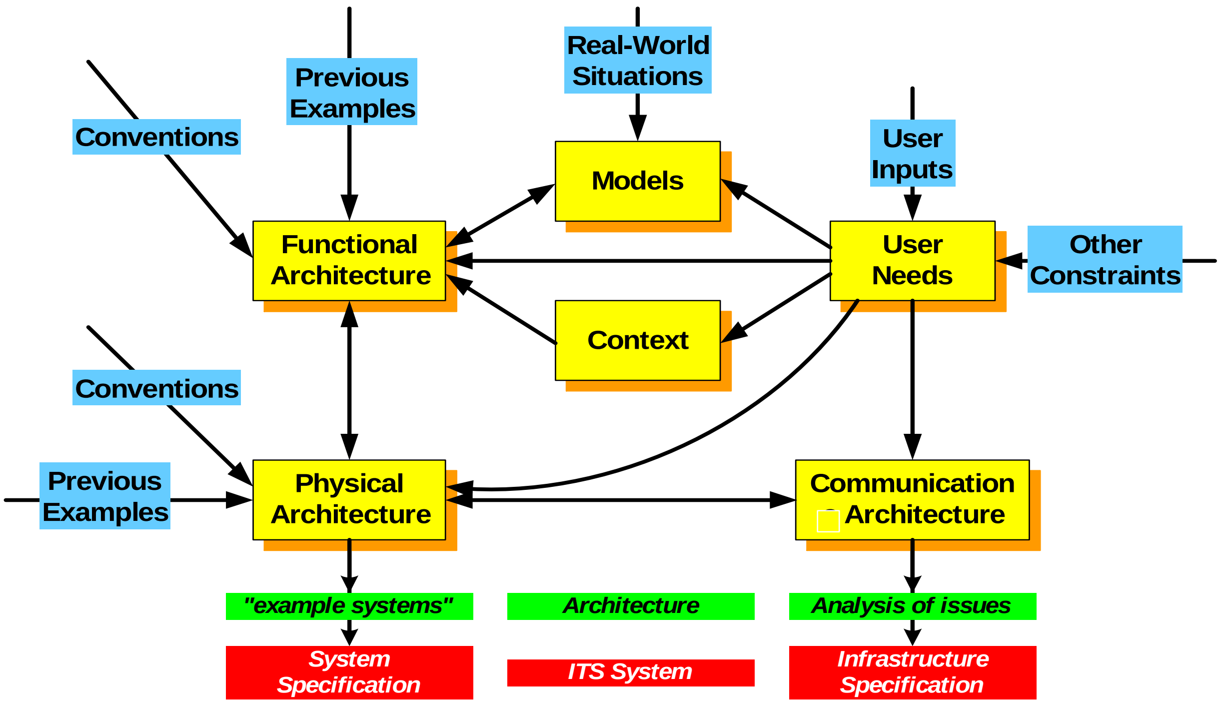

Figure 2: Architecture Creation Process (reference: KAREN project)

1.3 Definitions of different Types of Level 1 Architectures

Functional Architecture/Model - describes the structure and logical behaviour of the system in terms of what functionality is needed as well as the need for inter-relationships between the various functions. This architecture can be produced by functional decomposition or by scenario like descriptions in combination with specifications of activities and interactions that should be supported by the system.

Information Architecture/Model - describes the data needed by the system by defining the structure of the data sets and showing the relationships between them. The information architecture may be influenced by the requirements of the other architecture-types in terms of the availability of data, its accuracy, the way it is distributed around the system (i.e. ease of access), security of sensitive information and privacy of personal data.

Physical Architecture/Model - groups the functions into physical units (or components) and describes the communication lines between them. It may show the physical locations of the various elements of the system and associated links. It should normally be technology and/or manufacturer independent.

Communication Architecture/Model - describes the characteristics of the various channels identified as being needed in the Physical Architecture, i.e. the way spatially separated subsystems communicate. This can include descriptions of the type of communication medium (wire, radio, infrared, visual, etc), the physical characteristics of data flow (regularity, volume, speed, encoding techniques, etc) and the logical characteristics of data flow (such as message composition).

Note: This list of architectures/models is not exhaustive and can comprise other views to a system depending on the purpose of activity.

1.4 Levels to View a System

When dealing only with defined aspects of a system one needs a specific “view” on the system not being blurred by all other aspects. Such views can aim at a physical, functional, flow of information architecture or others. An appropriate architecture also must provide a common ground of understanding to avoid miscommunication between the distinct experts cooperating within one complex system. It is important that such an architecture remains simple and understandable not challenging the users more than the system itself.

There are three levels to view a system:

- **Policy Level** = Conceptual Level: legislative and administrative framework with reference to defined objectives (reference model).
- **Business (Service) Level**: shareholders-stakeholders relationships (organizational model) according to users needs resulting in functional model & information model.
- **Technical Level**: detailed technical systems layout to allow for required processes (physical model & communication model).

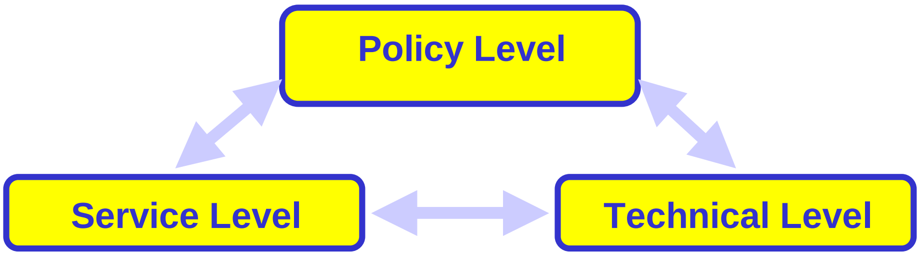

Figure 3: Relation between different “Views” [reference: Jens Froese]

There is not always a stringent hierarchy between levels:

- To satisfy public interests Policy Level is the governing level but needs to recognize feasibility (technical level), costs and risks.
- For enterprise services the Policy Level has a regulating but also a fostering function.
- For system design following a mixed top-down/bottom-up approach (common approach) the Service Level interacts with the Technical Level (services must be technically feasible).

Assessment of Existing Architectures

1.5 The WATERMAN Approach

The following architectural scheme, first invented under POSEIDON and further developed within WATERMAN elucidates the role of objectives, tasks, services and functions and its context with the other entities like service users and providers.

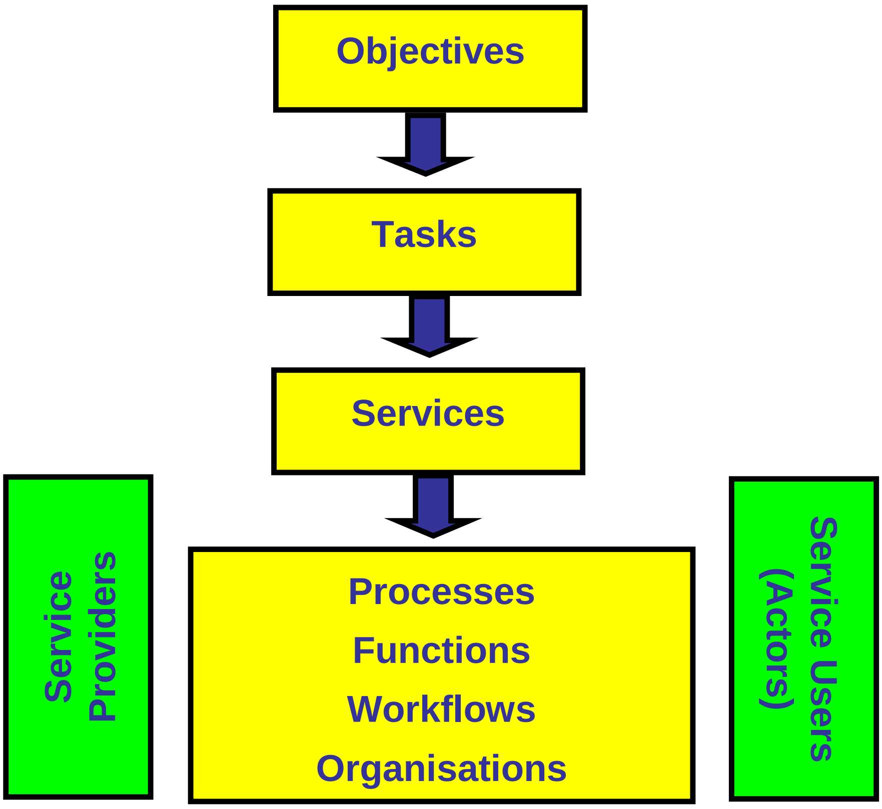

Figure 4: Modified WATERMAN Reference Architecture [reference: Jens Froese]

In theory an architecture is not to be designed commencing with the service level but in case of most applications it can be assumed that some of the services already exist. Further operational experiences from other areas can be viewed, evaluated and possibly transferred.

Under such circumstances commencing to view the system with the services already linked to functions is ideal because the practical operation can best be mirrored this way and the terminology is being well understood in practice. Thus a first design can easily be assessed with the assistance of responsible agencies and persons then become corrected and amended. Besides supporting the system design the results can also later serve for practical operation and to establish and operate a quality assurance system.

1.6 Vessel Traffic Service

Objectives:

- *Safety* (reduce potential dangers and minimise risks for persons, materials and the environment).
- *Efficiency* (optimum exploitation of waterway resources such as fairways, locks and berths and maintaining ETA/ETD).

Tasks:

- Monitor traffic and conditions
- manage traffic
- support navigation
- manage fairway and port facilities for navigation
- barrier closure planning and operation
- environmental protection
- casualty avoidance
- contingency planning and operation.

Services:

According to IALA a VTS usually offers the following services (s. Figure 5):

- *Information service* to ensure that essential information is available in time to assist the shipboard navigational decision making process.
- *Navigational assistance service* to support navigation and to monitor the effects; this also includes shore-based pilotage.
- *Traffic organisation service* to ensure a safe, smooth and efficient flow of traffic.
- *Operating rules and regulations* to regulate traffic operations and for law enforcement.
- *Co-operation with allied services, port operations, emergency services and adjacent VTS* in order to achieve defined VTS objectives and for casualty management and calamity abatement.

Furthermore in recent years security services came up, e.g. to retrace the port of origin or the nature of cargo.

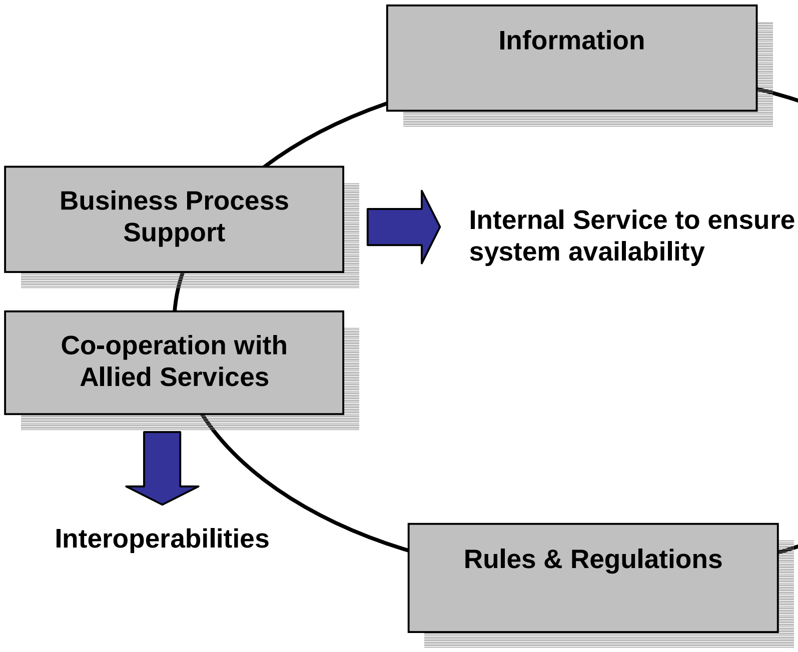

Figure 5: VTS Services [reference: Jens Froese]

From Functions to Flow of Information

The functions to be provided within a VTS area depend on

- hydrographic (morphology, tides, current etc.) conditions
- meteorological (reduced visibility, strong winds etc.) conditions
- traffic (types and sizes of vessels, density etc. conditions)
- fairway dimensions and geometry (narrows, bends etc.)
- traffic barriers (locks, bridges, flood barriers etc.)
- available support services (pilots, tugs etc.)
- ecological sensitivity
- rules and regulations
- political objectives.

Most of them depend on a given local situation others are defined according to "targets of protection" such as e.g. "protection of environment".

Once the functions are defined it is necessary to specify required information, sources and sinks (dataflow), content and frequency. Related parties need to agree on conventions covering exchange format, data storage, ownership and media.

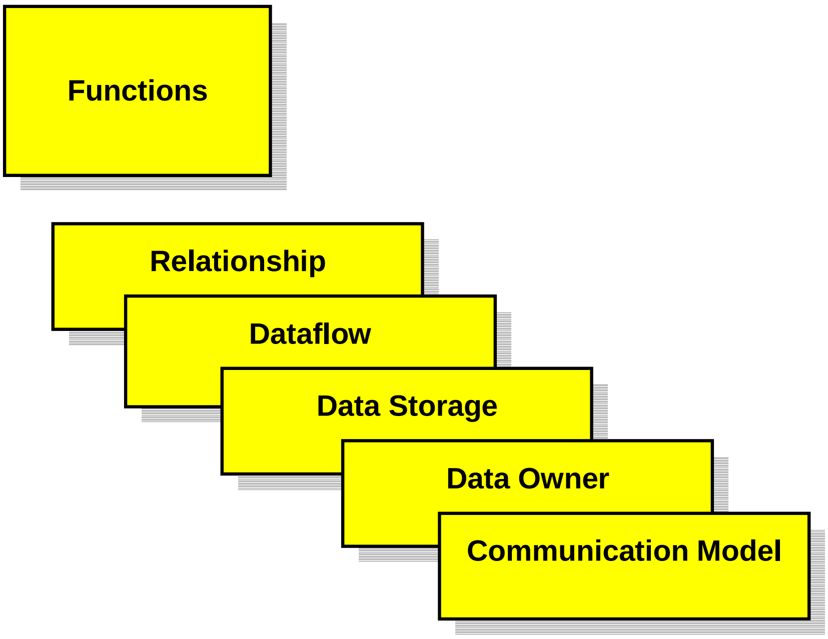

Figure 6: From Functions to Information Architecture [reference: Jens Froese]

It is helpful to include elements of an organisational architecture in order to define responsibilities. From the functions necessary information can be derived showing the links to the "actors", i.e. information providers and information users.

To achieve an appropriate Flow of Information Architecture it is necessary to

- assess the functional architecture and decide which functions are required/desired to provide defined services,
- assign responsibilities to actors,
- define sources and sinks of information and its content and frequency.

Because VTS systems require a high financial investment administrations increasingly look at opportunities to exploit information commercially. A flow of information architecture therefore does not need to be restricted to information to fulfil safety and efficiency purposes; it can become extended to information to be sold to interested parties within the transport and logistics community.

1.7 Functional Areas for improvement of Maritime Shipping

Another goal of ITS-services is to improve the maritime transport to be fostered through ARCOP such as the enhancement of supply chains. Safe, smooth and cost-efficient maritime shipping emerges from the interactions between the stakeholders in maritime shipping on at least five different ‘levels, namely:

- **Transport logistics arena**, in which cooperate parties that cause the transport (e.g. consigners, consignees, shippers) and parties that organise the transport (e.g. logistical suppliers, forwarders, shipping companies);
- **Transport arena**, in which parties co-operate that organise the transport and parties that execute the transport (e.g. shipping companies, terminal operators, customs);
- **Traffic arena**, in which parties co-operate that execute the transport, the masters and steersmen and parties that ‘manage’ the resulting vessel traffic (e.g. traffic manager, waterway authority);
- **Navigation Arena**, in which the master of the ship navigates its vessel, if necessary supported by tug masters, ice breaker masters and pilots;
- **Safety arena**, in which parties co-operate that organize and execute transport and parties that ‘guard’ the regulations related to safety (e.g. waterway authority, police, crisis team)
- **Supporting Arena**, in which parties co-operate that organize and execute transport and parties that enable transport (e.g. bunker companies, repair companies, suppliers).

Functional Vessel Traffic Service Architecture

The following tables provide the generic functional VTS architecture based on the services.

Explanation:

Table Header	**Explanation**
Ref. No.	to be able to link functions to other architectural views by a coding system
Function	the generic function or functional area to be later broken down to "atomic" functions related to relevant information
Responsible Entity	the system entity, job function or operator who is responsible for performing the function to be inserted later according to the organisational architecture, the tables show only examples
Provider	the entity or person which or who provides the results of the function to be inserted later according to the organisational architecture, the tables show only examples
User	to be inserted later according to the organisational architecture, the tables show only examples
Remark	for clarification or reference purposes

The information given in *italic letters* is specific to the ARCOP requirements.

1.8 Information Service

Ref. No.	Function	Responsible Entity	Provider	User	Remark
1	**Information Service**				
1.1	vessel data i.e. name, call sign, length, draught, cargo especially hazardous cargo, last port	VTMIS	vessel command agent	VTMIS	some of these data will be provided automatically through AIS once in place
1.2	vessel sailing plan i.e. position(s), intentions, destination	VTMIS	vessel command	VTMIS	
1.3	port and fairway information	VTMIS	VTMIS	vessel command	
1.4	traffic information	VTMIS	VTMIS	vessel command	
1.4.1	Legal information	VTMIS	VTMIS	Vessel command	
1.5	meteorological information	VTMIS	Met. Service	vessel command	
1.5.1	*Weather charts*	*VMTIS*	*Met. Service*	*Vessel command, ice pilot*	
1.5.2	*Weather forecast, wind, wave and swell conditions*	*VMTIS*	*Met. Service*	*Vessel command, ice pilot*	
1.6	hydrological information	VTMIS	Hydrographic Institute	vessel command	
1.6.1	*Ice reconnaissance, charts*	*VTMIS*	*Hydrographic Institute*	*vessel command, ice pilot*	
1.6.2	*Ice service*	*VTMIS*	*Hydrographic Institute*	*vessel command, ice pilot*	
1.7	aids to navigation	VTMIS	Waterway Authority	vessel command	
1.8	communication channels and content	VTMIS	VTMIS	vessel command	

1.9 Navigational Assistance Service

Ref. No.	Function	Responsible Entity	Provider	User	Remark
2	**Navigational Assistance Service**				
2.1	onboard navigational advice	Pilot Association	pilot(s)	vessel command	
2.1.1	*Ice pilotage*	*Pilot Association*	*pilot(s)*	*vessel command*	
2.2	shore-based pilotage	Pilot Association	pilot(s), VTMIS operator	vessel command	
2.3	vessel track data such as position(s) relative to reference objects, speed	VTMIS	VTMIS, AIS Base Station	vessel command	
2.4	navigational plan including way points and arrival/passage times	VTMIS	VTMIS	vessel command	
2.5	traffic image	VTMIS	VTMIS, AIS Base Station	vessel command	

1.10 Traffic Organisation Service

Ref. No.	Function	Responsible Entity	Provider	User	Remark
3	**Traffic Organisation Service**				
3.1	Estimated time of, arrival at …, …. hours prior	VTMIS	vessel command	VTMIS, Port Community System	to be distributed also to other users
3.2	traffic scheme such as sequence of entrance, allocation of space, route	VTMIS	VTMIS	vessel command	objective oriented advise or instruction; execution is up to the vessel
3.3	movement data such as speed and arrival/passage time (movement reports)	VTMIS	VTMIS	vessel command	reporting scheme to be provided by VTMIS
3.3.1	*Convoy composition*	*VTMIS*	*VTMIS*	*Vessel command, ice breaker service, ice pilots*	
3.3.2	*Escort monitoring*	*VTMIS*	*VTMIS*	*Vessel command, ice breaker service, ice pilots*	

1.11 Operating Rules and Regulations Service

Ref. No.	Function	Responsible Entity	Provider	User	Remark
4	**Operating rules and regulations**				
4.1	establish, publish and maintain aids to navigation	Waterway Authority	Waterway Authority	vessel command, VTMIS	
4.2	monitor aids to navigation	Waterway Authority	Waterway Authority, VTMIS	vessel command	
4.3	establish, publish and maintain traffic precautionary zones, traffic separation schemes, anchorage areas, pilot boarding areas	Waterway Authority	Waterway Authority	vessel command, VTMIS	
4.4	define speed limits, traffic situations (overtaking, encounters) and areas to be avoided	Waterway Authority	Waterway Authority	vessel command, VTMIS	
4.5	monitor traffic and react to violations of rules and regulations	VTMIS	VTMIS	Waterway Authority	
4.5.1	*Monitor convoy navigation*	*VTMIS*	*VTMIS*	*Vessel command*	
4.5.2	*Monitor escorting*	*VTMIS*	*VTMIS*	*Vessel command*	

1.12 Co-operation with Allied Services, Port Operations, Emergency Services and Adjacent VTMIS Service

Ref. No.	Function	Responsible Entity	Provider	User	Remark
5	**Co-operation with allied services, port operations, emergency services and adjacent VTMIS**				
5.1	vessel data, ETA and traffic information exchange	VTMIS, pilots, tug services, berth services, port and terminal operators, *ice breaker service*	VTMIS, pilots, tug services, berth services, port and terminal operators, *ice breaker service*	VTMIS, pilots, tug services, berth services, port and terminal operators, *ice breaker service*	all stated parties can be providers and users; VTMIS includes adjacent VTMIS
5.2	casualty reports	Water Police, Coast Guard	VTMIS, vessels, Water Police, Coast Guard,	vessel command, VTMIS, Coast Guard, Water Police, Emergency services (SAR, fire brigate etc.), pollution control	
5.3	contingency plan(s)	Governmental Agencies, Waterway Authority, Coast Guard, Water Police, Environmental Agencies	to be named by authority or in co-operation between responsible entities	Governmental Agencies, Waterway Authority, Coast Guard Water Police, Environmental Agencies	

Required VT(MI)S functions

1.13 Required Functions under normal conditions

1.13.1 Approach and Waterway Status

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
VTS	Ministry of Transport, Port and Waterway Administration, Meteorological Office, Hydrographic Office	navigable Areas, Waterways, Aids to Navigation, Tidal Status, Weather Status		Waterway Status	Vessels	VHF, Navtex

1.13.2 Vessel Announcement

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
Port Administration, other VTS, reporting Service, Agent, Master	Agent Vessel	Name, Call Sign, ETA at …., Length, Draft, Cargo, Haz. Cargo, Port of Departure	Traffic Data Base	predictive Traffic Image	other Parties on Request	VHF, Fax, digital Messages, Data Storage Display

1.13.3 Vessel Data

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
Port Administration, other VTS, reporting Service, Agent, Master	Agent, Vessel, Data Base (e.g. Lloyds), National/local Data Base	Vessel Static Data	Traffic Data Base, Vessel Data Base	Vessel Information	other Parties on Request	Data Storage Display

1.13.4 Arrival/Departure Notification

Source	Originator	Content	Data Processing	Results	Forward to	Media
Port Community System	Port Administration Agent	Vessel ID, Gross Tonnage, Draught, Length, Persons aboard, Cargo Status, Berth Status, ETA/ETD Berth, Pilotage Requirements, Tug Requirements, Linesmen Requirements, Berthing Place	Amendments and Integration	Traffic Image	other Parties on Request	Data Storage Display

1.13.5 Availability of Pilot

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	Port Pilots	Vessel ID, Boarding Time, Boarding Position, Pilot ID	Vessel Information		Vessels Agents	VHF, Phone, Fax, digital Messages

1.13.6 Port Entrance Passage Planning

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	Port Administration	Vessel ID, Entering/Departing, Pilot ID, Port Entrance, ETA	Integration	predicted Traffic Image	to other Parties on Request	VHF, Phone, Fax, digital Messages

1.13.7 Entry/Departure Clearance

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	Port Administration	Vessel ID, Port Entrance, Estimated Time of Passing Port Entrance	Vessel and Traffic Data Base	Traffic Image	Vessels, Terminal, other Parties on request	VHF, digital Message

1.13.8 Position and Identity

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
VTS	AIS Base Station, VTS Radar Surveillance & Communication, Pilots	Vessel ID, Position, Heading, Speed, Port Entrance, Estimated Time of Passing Port Entrance	Vessel & Traffic Data	Traffic Image	other Parties on Request	VHF, digital Messages

1.13.9 Report from Vessel

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
Vessel, VTS	Vessel	Vessel ID, Heading, Speed, Passage Plan, Intentions	Vessel & Traffic Data Base	Traffic Image	other Parties on request	VHF, digital Message

1.13.10 Traffic Image

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
VTS	VTS	Identified Targets, Unidenfied Targets, Tracks, ECDIS Information, Aids to Navigation	Integration into Vessel & Traffic Data Base	Traffic Image	Vessels other Parties on Request	Data Base Display

1.13.11 Assistance to Vessel

Source	**Originator**	**Content**	**Data Processing**	**Results**	**Forward to**	**Media**
VTS	Vessel(s), Water Police, Waterway & Port Administration	Vessel ID, Navigational Assistance, Collision Avoidance Assistance		Assistance Request	Vessels Assistance Providers	VHF, Phone, Fax, digital Message

1.13.12 Information to Traffic

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	Waterway & Port Administration, Meteorlogical Service, Hydrographic Service, Pilots, Tug Service, Terminals	Inbound/outbound Traffic, Port and Fairway Information, Entrance Information, Berth Information, Support Service Information, Meteorological Information, Hydrological Information, Aids to Navigation Status, Communication Channels		Safety & Efficiency of Traffic	Vessels, other Parties on Request	VHF, Phone, Fax, digital Message

1.13.13 Infringement Detection

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	VTS, Vessel(s), Pilots, Water Police	Area Infringement, Traffic Infringement, Clearance Infringement, Vessel ID	Risk Assessment Reporting	Precautionary Measures Report	Vessels Administration	Paper, Report, digital Message

1.13.14 Warning to Vessel

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	VTS, Vessel(s), Pilots, Water Police, Waterway Administration	Vessel ID, Violation of Regulation, Dangerous Action	Risk Assessment Reporting	Traffic Information, Traffic Advice, Traffic Instruction	Vessels Administration	VHF

1.13.15 Traffic Incident Management

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTS	VTS, Vessel(s), Pilots, Water Police, Waterway Administration	Vessel ID, Position, Type of Incident	Risk Assessment Reporting	Support Actions, Traffic Information, Traffic Advice, Traffic Instruction	Vessels Administration, Allied & Emergency Services according to Contingency Plan	VHF, Phone, Fax, digital Message

1.13.16 Debriefing and Assessment (after special situations)

Source	Originator	Content	Data Processing	Results	Forward to	Media
Administration	VTS (Recordings Expericences Observations)	Traffic Images, Communications Monitoring and Support Actions	Evaluation Assessment	Validation of Operations, Deficiencies Shortcomings, Improvement Potential	Quality Assurance, Recruitment and Training Section	Data, Audio and Video, Recordings, Prints

1.14 Functions required under ARCOP conditions

1.14.1 Convoy Navigation

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTMIS	Ice Pilot	Vessel IDs, Position, Estimated Time of Meeting Ice Breaker/Convoy, Speed, Heading, Intentions, Aids to Navigation, Ice Information	Vessel Information	Convoy Image, Assistance Request	Vessels	VHF, Phone, Fax, Digital Message

1.14.2 Ice Breaker Support

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTMIS	Ice Breaker Service	Vessel IDs, Position, Estimated Time of Meeting Ice Breaker, Speed, Heading Intentions, Aids to Navigation, Berth Information, Ice Information, Ice Breaker Position	Vessel Information	Assistance Request for Support Actions in Harbour and Open Water: Assistance, Harbour Breakout, Berthing, Free Beset Vessel	Vessels	VHF, Phone, Fax, Digital Message

1.14.3 Hydrometeorological Information for Traffic

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTMIS	Ice Information Services, Meteorological Services, Hydrographic Services	Ice Charts, Ice Information, Ice Reconnaissance, Navigation Charts, Manuals, Guidelines for Navigation, Hydrometeorological Forecasts: Wind, Wave, Swell Conditions, Information Bulletins		Safety & Efficiency of Traffic	Vessels	VHF, Phone, Fax, Digital Messages, Digital File

1.14.4 Information to Traffic

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTMIS	Waterway & Port Administration, Pilots, Tug Service, Terminals, Port Services, Repair, Divers, Ice Clearance Service, Goods Supply, Bunker	Port and Fairway Information, Entrance Information, Berth Information, Support Service Information, Aids to Navigation Status, Communication Channels, Reporting Points, Legal Information, Sailing Plans		Safety & Efficiency of Traffic	Vessels, Other Parties on request	VHF, Phone, Fax, Digital Messages, Digital File

1.14.5 Availability of Ice Pilot

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTMIS	Pilots	Vessel ID, Boarding Time, Boarding Position, Boarding Vehicle (e.g. helicopter) Pilot ID	Vessel Information		Vessels Agents	VHF, Phone, Fax, Digital Messages

1.14.6 Remote Pilotage

Source	Originator	Content	Data Processing	Results	Forward to	Media
VTMIS	Shore Based Ice Pilot	Vessel IDs, Position, Speed, Heading, Intentions, Aids to Navigation, Tactical Advice, Ice Information	Vessel Information	Safety & Efficiency of Traffic	Vessels	VHF, Phone, Fax, Digital Message

1.14.7 Report from Vessel

Source	Originator	Content	Data Processing	Results	Forward to	Media
Vessel, VTMIS	Vessel	Vessel IDs, Position, Speed, Heading, Intentions, Passage Plans, Ice and Sailing Conditions	Vessel & Traffic Data Base	Traffic Image	Other Parties on request	VHF, Digital Message

1.14.8 Supply Chain Control

Source	Originator	Content	Data Processing	Results	Forward to	Media
Vessel, VTMIS	Vessel	Revised sailing plan because of ice constrains	Supply chain	Availability of cargo status	Cargo owners and receivers	Digital Message

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Annex I: Comments by Dr. R.N. Chernyaev

1. We share author’s position that a System Framework Architecture is a model for building VTMIS in a specific sea region. The system framework architecture indeed supports the development of systems by providing tools for a proper arrangement of co-operation between humans and between systems.

It is understand that waterman-ts approach was chosen and enhanced since it also reflects the outcome of the karen and the themis projects specified for the waterborne transport. The enhanced waterman-ts reference architecture correlates the role of objectives, tasks, services and functions.

The intended arcop vtmis may be seen as a special case derived from a general VTS approach improved by additional information sources taking into account the requirements for sailing the NSR. Nevertheless the system would be supplemented by some additional tasks derived from necessity to integrate it with VTMIS planned for northern coast of Norway with active information exchange between Vardo and Murmansk VTMIS Centres .

Executive summary of ARCOP D 3.6.2 (ISSUS) contains the list of tasks, reflecting mainly the environmental conditions when navigating through ice, convoy navigation, ice breaker support, hydrometeorological information for traffic and universal information to traffic, ice pilotage, remote pilotage, enhanced reports from vessels and supply chain control.

These tasks indicate the technical aids and complexes, needed for development of ARCOP VTMIS.

We consider that except the listed tasks it would be reasonable to add satellite systems for communication, surveillance and meteorological purposes. We think that technical infrastructure of safe navigation on Arctic and North Norway routes should be substantiated in the next reports of the project.

2. Report ARCOP D 3.6.2 (ISSUS) contains thorough investigation of System Architecture, developed in different projects: simnav, converge, waterman, karen, themis etc.

The waterman approach was chosen as the most suitable for ARCOP-VTMIS. It includes the circuit of main tasks: information, navigation assistance, traffic organization, rules and regulations, cooperation with allied services and business process support (see Fig.5, page 15/32 of ISSUS report D 3.6.2.).

The functions to be provided within a VTMIS area depend on

- hydrographic conditions,
- meteorological conditions,
- traffic conditions,
- fairway dimensions and geometry,
- traffic barriers,
- available support services,
- ecological sensitivity,
- rules and regulations,

- political objectives.

Of course related parties need to agree on conventions, covering exchange format, dates storage etc.

3. The authors of D 3.6.2 logically substantiated Functional Vessel Traffic Service Architecture based on the information services. They are enumerated in the following tables:

- Information Services (page 20/32),
- Navigational Assistance Service (page 21/32),
- Traffic Organization Service (page 22/32),
- Operating rules and Regulation Service (page 23/32),
- Co-operation with Allied Service, Port Operations, Emergency Services and Adjacent VTMS Services (page 24/32).

In the tables besides the functions of VTMIS the Responsible Entity, Provider and User are designated. The tables have a great significance for future project works on study of realization of the system. This system could be adapted not only for oil and gas transportation in Arctic but for any other VTMIS. In this mode the authors of report D 3.6.2 developed the theory of Traffic Management Services and specifically theory and practice of VTMIS. The same mode of expounding the text is used in chapter 6 «Required VT(MI)S functions». For each function in tables 6.1.1 to 6.1.16 all the VTMIS data and actions are listed in detail. Functions required under ARCOP conditions (convoy navigation, ice breaker support, hydrometeorological information for traffic, information to traffic, availability of ice pilot, remote pilotage from vessel and supply chain control) are collected separately in the tables 6.2.1 to 6.2.8.

4. It is reasonable to stress special attention on item 2.3 of table 5.2 (page 21/32) which touches the «vessel track data» in VTMIS using the shore-based radars and AIS Base Stations. Uninterrupted Ship autotracking being carried out by shore-based VTMIS plays the crucial role in shore-based pilotage and assures rigorous supervision of ship movements excluding the violation of rules of passage. The radar and AIS ranges have to be sufficient to track all the SOLAS ships sailing on Traffic Separation Schemes (TSS).

In Russian projects of VTMIS for Cola Gulf and Russian part of Barents sea this problem is being resolved in project in course. This conceptual requirement was realised in integrated VTMIS in the Gulf of Finland.

In table 5.5 (p.24/32) it would be essential to include in Ref .5.2 the Global Maritime Distress and Safety System (GMDSS). Its infrastructure relay on ship- and shore-based equipment.

Besides listed communication aids Ship Reporting System (SRS) servicing marine areas A1, A2 and A3 (see Regulation 11 «Ship reporting system») deserves to be perfectly credible (SOLAS CONVENTION-74). These questions are the subjects of IMO. For the Arctic region the special application has to be developed and sent to IMO for approval.

The sea way for tankers in Northern part of Norway stretches from Rost (western border) to Vardo (eastern border close to Russia). There are some Traffic Separation Schemes (TSS) for the route. From East part TSS joins the Russian TSS.

To support safety on the ship routes except equipment installed on board the ship (in accordance with new Chapter V SOLAS Convention 74) shore-based infrastructure is provided.

First of all VHF and MF network have good coverage (up to 70 miles) along the coastline. The Norwegian Coastal Administration installed AIS base stations for reception of AIS messages along the entire coast of Norway. From our point of view it is reasonable to consider the monitoring system for all ships based on AIS-shipborne signals as analogue of system realised for Baltic sea by HELCOM. A central server may be placed in national Centre in Fedje.

AIS integrated with shore based radars will create a reliable autotracking system. Using uninterrupted operator surveillance for ships sailing on TSS, it is possible to develop analog air traffic control systems. The aim of the project is to assure the safe transportation of oil and gas.

One important advantage of north Norwegian TSS is the short distance from baseline in territorial waters of Norway. The administration of new VTMIS will get the possibility to develop the special rules for ship sailing.

These problems should be developed in nearest future but together with Norwegian experts. It will simplify the integration of Russian and Norwegian components of entire VTMIS.

5. Conclusions

The public report D.3.6.2 carried out by Maritime Logistics ISSUS (Authors: Prof. Jens Froese, Karsten Bruns-Schueler) is related to the shared-cost RTD project (ARCOP), Workpackage 3.6, Task 3.6.2 (System Architecture).

The authors have chosen the WATERMAN-TS approach, which reference architecture correlates with the role of objectives, task, services and functions of future Arcop-vtmis.

The report mentioned includes the circuit of main task: information, navigation assistance, traffic organization, rules and regulations etc.

The authors logically substantiated Functional Vessel Traffic Service Architecture based on information services.

Some additional proposals and remarks are considered as useful supplements, not deteriorating the high quality of the report.

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