GROWTH Project GRD2-2000-30112 "ARCOP"

Recommendations for VTMIS

WP 3 Integrated transportation system for Artic oil and gas

WP 3.6 VTMIS

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DELIVERABLE D 3.6.3

Recommendations for VTMIS

CONTRACT N°:	GRD2/2000/30112-S07.16174
PROJECT N°:	GRD2/2000/30112-S07.16174-ARCOP
ACRONYM:	ARCOP
TITLE:	Arctic Operational Platform
PROJECT CO-ORDINATOR:	Kvaerner Masa-Yards Inc. (KMY)

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The Fridtjof Nansen Institute	NO
Lloyds Register	UK
University of Lapland	FIN
The Norwegian College of Fishery Science	NO
Ministry of Trade and Industry	FIN

REPORTING PERIOD:	From 01.12.2002
PROJECT START DATE:	01.12.2002
DURATION:	36 Months
DATE OF ISSUE OF THIS REPORT:	04.11.2005

Project funded by the European Community under the 'Competitive and Sustainable Growth' Programme (1998-2002)

DELIVERABLE SUMMARY SHEET

Short Description
The report gives recommendations for VTMIS under ARCOP conditions and consideration of the legal, administrational and organizational framework.

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Document history					
Revision	Date	Company	Initials	Revised pages	Short description of changes

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REMARK

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

ARCOP RECOMMENDATIONS

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List of Abbreviations

AARI	Arctic and Antarctic Research Institute of Russia
AIS	Automatic Identification System
ATONs	Aids TO Navigation
CNIIMF	Central Marine Research and Design Institute
CORBA	Common Object Request Broker Architecture
COTS	Commercial-Off-The-Shelf
DSPs	Digital Signal Processors
ECDIS	Electronic Chart Display and Information System
ENC	Electronic Navigational Charts
ETA	Estimated Time of Arrival
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
GT	Gross Tonnage
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO	International Maritime Organisation
ITS	Intelligent Transport System
LAN	Local Area Network
NSR	Northern Sea Route
RIF	Radar Interface
RSC	Radar Scan Converter
SAR	Search and Rescue
SOLAS	Safety of Life at Sea
STC	Sensitivity Time Control
VHF	Very High Frequency
VTMIS	Vessel Traffic Service and Information Service
VTMIS-NET	Vessel Traffic Management and Information Service – NETwork (EU founded 4th Framework project)
VTS	Vessel Traffic Service

Executive Summary

A VTS is a service implemented by a Competent Authority designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and respond to traffic situations developing in the VTS area. There are several operating options for a VTS to be considered for the Arcop VTS as information service, navigational assistance service, traffic organisation service and co-operation with allied services and adjacent VTS. A VTMIS gathers, evaluates and distributes vessel traffic and waterborne transport data to improve the safety and efficiency of transport and to better protect the environment.

This report completes the VTMIS Work package of ARCOP. Together with the deliverable 3.6.1 User Requirements for VTMIS and deliverable 3.6.2 Assessment of Traffic Management Services on the Basis of a System Architecture a recommendation for an ARCOP VTMIS taking into account information sources and sinks, vessel support services and organizational procedures is given.

The recommendations in this deliverable are from the recommendations given by IALA in its VTS Manual – 2002, but state of the art technologies of VTS Systems have been considered in order to give more helpful recommendations. The costs of such a system was not possible to determine, but shall be part of a future work in a possible project that builds upon the ARCOP results.

1 Introduction

This deliverable provides recommendations for an Arcop VTMIS, taking into consideration the state of the art technology used for VTS. The recommended Services for an Arcop VTMIS are described briefly in chapter 2. They are structured according to the IALA Recommendations and were already described in depth in the deliverable 3.6.2. The IALA VTS Manual has been reviewed in order to show possible structures of a VTS which are briefly described in chapter 3.

Chapter 4 handles a VTS System, its technologies, elements and benefits. Chapter 5 is based on the recommendations for VTS personnel from IALA. Chapter 6 gives an overview of the costs of a VTMIS System for Arcop. And finally the chapter 7 handles the future prospect of the system.

2 Recommended VTS Services

The differences to a normal VTS are that in the NSR there is a low traffic density at the moment. The traffic in this area will increment, but will still keep being low. Furthermore the weather conditions can be considered extreme compared to other areas and at the same time the area of coverage for the VTS Service is very big. The existing rules for sailing in the NSR have to be considered when the ARCOP VTMIS is build up.

The recommended VTMIS services can be classified according to IALA in:

- Information Services
- Navigational Assistance Service
- Traffic Organisation Service
- Operating Rules and Regulations
- Co-operation with Allied Services, Port Operations, Emergency Services and adjacent VTS.

2.1 Information Services

An information service is a service to ensure that essential information is available to assist the shipboard navigational decision making process.

In the ARCOP context this is:

- **Positions, intentions and destinations of vessels; restrictions on the navigation of other vessels, potential hindrances.**
- **Boundaries, procedures, radio channels or frequencies, reporting points etc**.
- **Hydrographic support to navigation:** navigation charts, manuals, guidelines for navigation; supplying vessels; installation and operation of aids of navigation;

pilotage; information to vessels about changes in navigation conditions; forecasts; cartographic support taking into account military areas.

- **Legal information** (incl. information about location of and behaviour near to military areas).
- **Ice service/ice reconnaissance**
- **Hydrometeorological support** should include:
  - general weather outlook;
  - forecast data of wind, wave and swell conditions for the intended or recommended route in tabular form or as plotted routes and forecast charts by e-mail; route recommendations and description of possible alternative routes

2.2 Navigational Assistance Service

Navigational Assistance Service in the ARCOP context comprises:

- **Remote guidance of vessels** (a specific kind of shore based pilotage and routing for navigation in ice),
- **Ice pilotage** (comparable with those of the Canadian Ice Service), undertake ice reconnaissance services to survey and forecast ice conditions,
- **Navigational assistance, advice and operative navigation information**:
  - o Course and speed made good by a vessel,
  - o Position relative to fairways axis and way-points,
  - o Positions, identities and intentions of surrounding traffic,
  - o Warnings to individual vessels,
  - o Navigation notes to Mariners,
  - o Coastal preventions (warnings).
- **Ice breaking support:**
  - o escort ships and organize convoys to travel through ice-infested waters,
  - o free beset vessels to allow them to proceed,
  - o maintain shipping channels and tracks in shore-fast ice, and
  - o stand by in areas where requests for route assistance are likely, when requested and/or when the need is deemed to exist, and when resources are available.

2.3 Traffic Organisation Service

A Traffic Organisation Service describes a service to prevent the development of dangerous situations and to provide for the safe and efficient movement of traffic within the VTS area. For the ARCOP conditions it is anticipated that the traffic density is low. So this service should be related to:

- **Traffic organisation, e.g. convoy, escorting;**
- **Establishing routes to be followed;**
- **Sailing plans e.g. ETA.**

2.4 Operating Rules and Regulations

The Operating Rules and Guidelines are comparable to those of “normal” VTS as described in the IALA manual. The delineation of the area and the required (communication) equipment might vary:

- **Regulations within the VTS area:**
    - Aids to navigation
    - Areas to be avoided
    - Constrained vessels
    - Precautionary zones
    - Ships’ routing systems
    - Anchorage areas
    - Compulsory pilotage and pilot boarding areas
    - Patrol craft
    - Reporting points
    - Publishing and availability of local traffic movement rules and regulations
    - Delineation of the area: a segmentation of the NSR to gain wide area VTS might be desirable.
- **Communication Rules and Procedures**
    - Satcom (max 2 channels at 128 kb),
    - VHF allowing communication with airplanes, helicopters and ships in convoy (112.5 MHz),
    - NAVTEX,
    - Interport communication,
    - Email.
- **Enhancement of onboard equipment such as ECDIS** (real-time ice condition image, track recommendations, traffic & icebreaker positions image) and **data communication** (dedicated communication links and information servers).

2.5 Co-operation with Allied Services, Port Operations, Emergency Services and adjacent VTS.

Generally this is a supporting activity of the VTS intended to increase the safety and efficiency of the traffic, the protection to the environment and the effectiveness of the VTS without adding to the reporting burden of the vessel. In the ARCOP context this comprehends:

- **Ice clearance before berthing; harbour breakout**
  - breaking out approaches and clearing ice from wharf faces of port terminals and facilities,
  - assisting shipping within ports and at marine facilities, by keeping ice clear of barge; operations and the ship at anchor, and by streaming petroleum off-loading hoses.
- **Tugboat support of berthing operations**
- **Lighters**
- **Port services, repair**
- **Emergency services** e.g. search and rescue (SAR)
- **Passengers conveyance,** e.g. aircraft connection
- **Supply:** food, bunker, technical
- **Medical assistance**
- **Legal support,** e.g. provision of necessary legal documents
- **Organisation support**
- **Other services,** e.g. mail**.**

2.6 Limitation of Services

The limitations which may affect delivery of “physical” assistance (such as ice breaker support) services are:

- **Weather restrictions**: services may be reduced when current and forecast meteorological conditions will not permit successful delivery of the services;
- **Severity of ice season**: services may be reduced when current and forecast ice conditions will not permit successful delivery of the services;
- **Physical restrictions**: services will not be provided when hydrographic and/or geographic features of the area under consideration prevent safe;
- **Safety restrictions**: services will not be provided when conditions would unduly endanger service crew, ships or equipment, and/or those requesting the services; and
- **Availability of resources**: services will be provided when sufficient service units are available.

3 Structuring the ARCOP VTMIS

The overall parameters of the VTS are described in the Deliverable 3.6.2 User Requirements. The Arcop VTS Authority should organize the traffic in its area of influence. The organization of traffic should be done by:

- geographical division,
- distance separation or
- time separation/time slots.

Geographical division is a passive traffic management technique which separates traffic streams by instituting Traffic Separation Schemes, designating anchorage areas for all or special categories of ships, designating areas for cross traffic, etc. These measures should be well publicised in advance and included in navigational pilots and charts.

Distance separation is a method whereby vessels are given a minimum distance between each other in order to transit the whole or certain areas and restricted passages. The separation distances to be maintained are allocated and monitored by the VTS centre and may differ depending upon the categories of vessels or the cargo which is carried. Overtaking restrictions and/or minimum passing distances may be part of this method of traffic organisation.

IALA also recommends a time separation method, where a vessel has an exclusive use of a certain area or a restricted passage for a given time span. The time slots are then part of the VTS sailing plan, because the ice breaker service will be provided for example at fixed hours.

3.1 Infrastructure of the ARCOP VTMIS

The infrastructure recommended for the Arcop VTS can be divided in operational and technical aspects.

3.1.1 Operational aspects of the Infrastructure

For the Arcop VTS, one centralised VTS System which gathers information and disseminates is recommended. Surveillance and communication equipment at remote sites can transmit the information to the VTS centre. This has the advantage of lower operational costs especially regarding personnel, administrative support and capital costs. It must be ensured that the remote controll facilities from sensors and radio communication equipment is reliable. In case of equipment failure in one sub-area or sector, an adjacent sub-area or sector can extend temporarily until defective equipment has been repaired.

The disadvantage would be that in case of total power failure at the VTS centre the provision of a limited VTS Service would be difficult.

3.1.2 Technical aspects of the infrastructure

It is recommended to utilize Radars and AIS base stations to ensure a complete coverage of the area. The information detected by several radars can be transmitted to the VTS centre through a satellite link. Maintenance of the remote equipment and at the VTS centre should be done on contractual basis.

Communication facilities to adjacent VTS centres, local authorities, support organisations and related services has to be provided.

4 VTS System

4.1 Open System Architecture

The VTS system should have an Open System Architecture. The application of OSE/OSI standards with the use of Ethernet or FDDI LANs on system level allows extensions to add future capabilities or updates without loss of previous investment.

4.2 Modular System

Closely connected to the Open System Architecture a modular architecture of VTS systems provide flexibility to meet specific needs and guarantees future extensions. Modularity also eases repair, maintenance and training.

4.3 Standard Interfaces

The use of standard hardware interfaces, e.g. serial and LAN interfaces, and the platform independent CORBA would allow a flexible hardware configuration enabling the selection of system components best fitted for their purpose. It would also simplify the use of existing telecommunication infrastructure. Furthermore interfacing of management and Information database systems would be possible.

4.4 Hardware and Software

The VTS system should use mainly Commercial-Off-The-Shelf (COTS). This would be an advantage for system extensions, as well as for spare parts supply. If required, these components can be replaced by local supply. Nevertheless, those components decisive for excellent VTS performance are developed and produced normally by the system provider. These are the Radar Interface (RIF) board and the Radar Scan Converter (RSC) board. In order to reduce hardware, these boards can be inserted in standard PCs. They perform high-speed radar signal processing using most up-to date Digital Signal Processors(DSPs). The RIF also performs clutter reduction, target detection and tracking.

4.5 Built-In Redundancy

The major objective of VTS is to improve the safety of navigation. Hence, VTS systems need to be highly reliable. The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) recommends an availability of 99.9%, which is equivalent with a cumulative downtime of approx. 9 hours per year, a condition that is possible to reach with a system of medium complexity. For an availability of 99,99% or a downtime of less than one hour per year, major system components must be configured with redundancy, e.g. use of duplicated radar transmitters.

4.6 Digital nautical VTS documentation

In the case of remarkable events or even accidents, it is practical to be able to repeat screen displays as well as other relevant information in order to explain and understand any sequence of events. The new system should be provided with comprehensive radar image recording which is independent of the traffic display so that events occurring outside the currently set visual range of a traffic display can also be reproduced and investigated.

4.7 Equipment

It is reccommended to use latest VTS technology regarding radar signal processing and automatic radar tracking.

AIS transponders onboard vessels can communicate directly with the system, so that the initial identification of a vessel can be performed automatically and thus reliably.

4.7.1 Automatic radar tracking

The system should be capable of signal processing for detailed, high resolution display of radar targets, and also of integrated automatic radar tracking. Similar to air traffic, any relevant target on the screen should be displayed with an attached text label so that its identity is known at any time. It should also allow the electronic computation of course, speed, arrival time at specific destinations and other evaluations supporting and making the job of the navigator easier. Thus, individual vessels should be easily identified, tracked and addressed specifically.

Automatic target tracking should also be a prerequisite for a sensible connection of a vessel data processing system with the VTS, enabling the navigator to call up information on expected vessel movement on his traffic situation display.

4.7.2 VTS display units

Vessel traffic in the NSR should be monitored by radar sensors. The monitoring range of each radar more or less corresponds to the visual range of the human eye's. Within the frame of their monitoring tasks at the traffic display units in the nautical centre, the navigators frequently need sectional views of images which cannot be completely covered by one radar station.

A combination of several radar images on one display should be possible to avoid a switching back and forth between the radar stations in order to obtain an image completely meeting the requirements of the navigators.

In addition, such a technology also allows the displays of images within images or a zoom window. In that case, also the raw radar data signals could be shown in zoom windows in order to identify the position of the monitored vessels as accurately as possible. In order to make it easier for the users to achieve different possibilities, various types of representations could be stored. These representations should be afterwards available at the touch of a button.

One of the appliances which would facilitate the interpretation of the traffic displays is the representation of an electronic sea chart as a “base” for the moving vessel targets. The system should include a chart editor so that independent updating of their electronic sea chart by the navigators is possible. It should also be possible to log, change or eliminate special information such as the “radar-guided track” or fairway limitations and also temporary impediments.

Any relevant vessel data from the vessel data processing system which are important for the navigators – such as length, width, draught etc. – should be displayed by the system.

The main task of the navigators is to ensure safety and ease of vessel traffic. One of the means which help to achieve this goal is an exchange of information and the distribution of traffic information. Therefore, modern traffic situation displays is not an end in itself, but an important tool for each navigator in a traffic centre. It should be supplemented by communication systems, data processing and other sources of information. New technologies offer a very good image quality, with ergonomic advantages for the users.

4.7.3 Functional Elements

4.7.3.1 Radar

VTS radars should provide extended performance and additional functions, such as extended dynamic range, pulse repetition frequency, power monitoring, and others. For enhanced detection capability against weak, i.e. small or distant, targets a special frequency diversity transmitter set should be provided. The VTS transceivers should be available in the radio frequency X-and S-band versions.

4.7.3.2 Video Presentation

The VTS system should be provided with two radar video processing and presentation principles:

- Raw radar video with hardware radar scan converter. This provides a loss-free video presentation, processed in parallel to target extraction and tracking. The system processes the whole radar signal dynamics including clutter and noise. It is the best solution when weak targets, such as rubber boats, have to be detected in a sea clutter environment or at long ranges. Other typical applications are coastal surveillance for security, fisheries protection, and border control. For signal and data transmission to the centre broadband links are required.

- Extracted radar video with combined video and track extraction by software. In this principle only useful targets are extracted and tracked in one process, then transmitted to the operator work station. Through this data reduction, the data rate is only in the order of 3 to 5 % of that of the other solution.

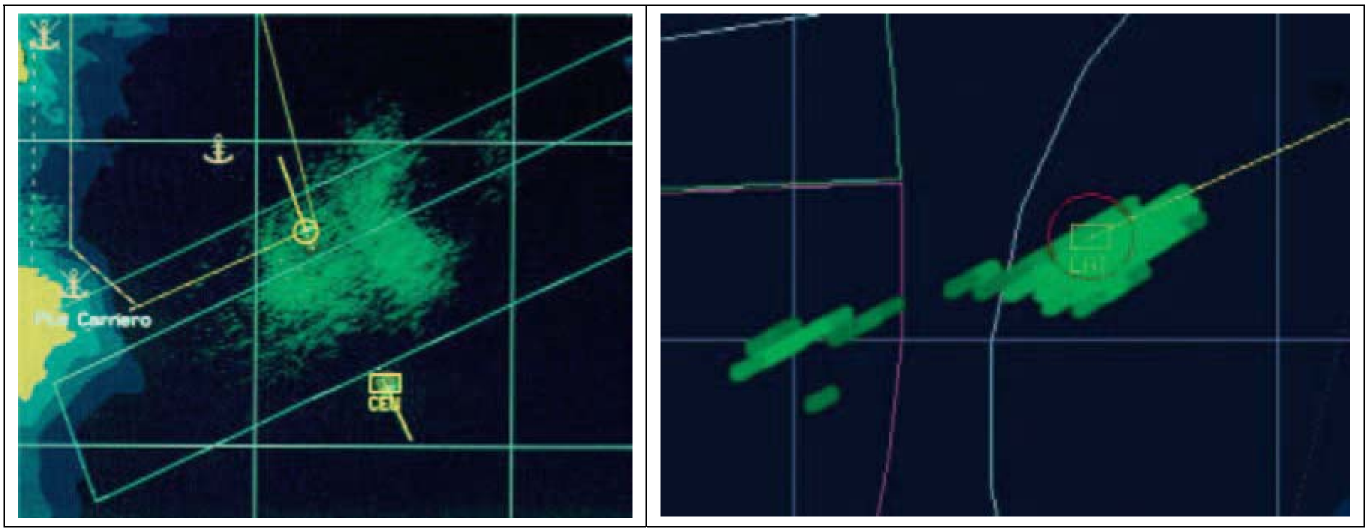

Figure 1 Raw radar video and extracted radar video

4.7.3.3 Radar Signal Processing

In a VTS, the radar signal processing capabilities define the quality of the system. Detection of small targets in a clutter environment, display precision, resolution between adjacent targets, and reliable tracking with a low target loss rate are all dependent on the capabilities of the radar signal processing.

The radar signal processing should be done with DSPs (digital signal processors chips). The processing ensures that the information content of the radar signal is preserved and evaluated and is not degraded by the transmission between radar station and the operator display. A sampling rate of 75 MHz and an amplitude resolution of 8 bit would ensure the retention of the information content of the radar signal, so that very small and short radar echoes are not lost. A two dimensional correlator reduces the noise and eliminates false echo signals.

To reduce noise resulting from clutter, an adaptive area-related Sensitivity Time Control (STC) should be provided. An automatic STC function is not globally applied to the complete range or azimuth. It is limited to noisy areas. A normalized signal-to-noise ratio across this area, ensures an improved target detection capability. To eliminate video returns from areas which are unimportant for traffic management, such as land, a receiver blanking map should be set up with a precision down to 1m. This reduces the data rate required for signal transmission to the centre considerably. For extracted video, narrow bandwidth transmission channels are sufficient.

4.7.3.4 ECDIS

Electronic Chart Display and Information System or simply ECDIS displays the vector format Electronic Navigational Charts (ENC) - an equivalent of the paper charts produced by, or on behalf of, the Hydrographic Offices of the world. It is more than a navigational and antigrounding tool of a ship, its safety features are much more sophisticated and it should be regarded as the main safety tool onboard a vessel. The application includes a an electronic updating mechanism to keep charts up to date without much operator intervention. This navigational tool can also be used inside the VTMIS for assisting the VTS operator to make a security check of the traffic situation. Even the present generation of ECDIS is already more than a paper chart on the screen, it provides more information, faster and more accurately than any previous navigational system. It can help the VTS operator to visualize the traffic situation in a two dimensional model. ECDIS is utilised today in a number of VTS stations as Flint in Sweden, Brunsbüttel and Hamburg in Germany, Harwich in U.K.. A key advantage of ECDIS is its ability to up date automatically by the a national Hydrographic Service as implemented in Warnemünde, Germany. ECDIS is also used in other VTMIS-related land-based applications, e.g. for Marine Pollution Control or Search and Rescue.

4.7.3.5 Multi-sensor fusion

This function processes sensor inputs from all available sources, as AIS, or other to establish a target‘s track. Sensor fusion is important as AIS systems aboard of ships larger 300 GT in international trade are mandatory. One particular ship might be detected by radar and AIS simultaneously. This would result in two sets of target symbols for the same target, a situation, which is unacceptable for the VTS operator. In such a situation the track fusion process would set in: the tracking software would compare the positions supplied by the two sensors, the motion data of the two targets and would decide on the basis of pre-set criteria, if the two targets could be one and the same. If this decision would be the case, the target will be related with just one track calculated from the different inputs.

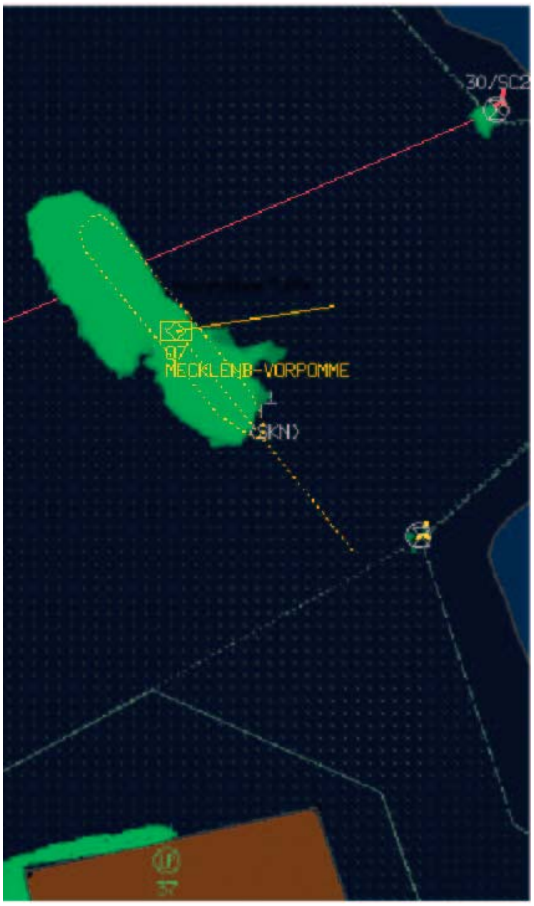

Figure 2 Combined Radar / AIS Track

4.8 Automatic Identification Systems (AIS)

Automatic Identification System (AIS) is an advanced navigation system developed and used by ships and vessel traffic systems (VTS) for collision avoidance at sea. The IMO SOLAS requires AIS to be fitted aboard all ships of gross tonnage =>300 for international voyage.

4.8.1 AIS base stations

AIS base stations incorporated in VTS offer further functionality. They are used to transmit safety-relevant messages addressed individually to one vessel or to a group of vessels. These messages replace a great amount of voice communication.

An AIS base station can also disseminate differential position corrections for GPS. They can also be used for monitoring of floating Aids TO Navigation (ATONs) equipped with an AIS set, and they can even create virtual ATONs.

4.8.2 Benefits of AIS

The benefits of AIS are:

- Automatic Vessel Identification
- VHF communications
- Improved Vessel Tracking

Automatic Vessel Identification

The automatic and immediate provision of vessel identity (MMSI, call sign etc), thereby facilitating rapid radio communication where necessary is a benefit to VTS authorities.

Achieving vessel identity relies on such vessels reporting both identity and location to the VTS centre, and the VTS operator then correlating this information with an unassigned radar track.

The process is time consuming and wholly reliant on the co-operation of participating vessels. It is not uncommon for some vessels to fail to comply with this requirement, thereby creating a potentially dangerous situation, and creating further distraction for the VTS operator.

Even where VHF direction finding equipment is fitted, the VTS traffic image is still reliant on vessels reporting identity via VHF thereby permitting the correlation of identity with the radar track identified by DF. AIS helps to overcome the safety weaknesses and time consuming procedures.

VHF communications

A major benefit of AIS is likely to be the reduction of VHF voice messages. The use of AIS reduces language problems and the chances of vessels misunderstanding messages from a VTS centre and vice versa.

Improved Vessel Tracking

Wider geographical coverage.

AIS data will be received by other AIS transponders, or by base or repeater stations. Thus where a VTS organisation is fitted with such equipment, it will be capable of receiving both identity and precise location of a vessel at the maximum reception range of the radio communications frequency in use. Often this will be VHF, and as a consequence will normally permit detection of vessel target outside of radar coverage. Even where this is not possible due to the need to screen base stations from adjacent VHF interference, extended VTS detection range may be achieved by the installation of additional base or repeater stations connected into a network at much lower cost than radar.

Positional accuracy.

AIS aims to achieve positional accuracy better than 10 metres when associated with DGNSS correction signals.

Absence of "radar shadow" areas.

In coastal and harbour waters radar tracking of vessels can be masked, or otherwise affected by the proximity of land and buildings. The resultant "shadow" areas can cause radar based VTS to lose track, thereby denying the VTS centre the ability to monitor accurately vessel movement. The loss of tracking may also result in the need to reacquire and re-identify lost tracks.

Whilst AIS tracking is expected to avoid the majority of such effects, the very close proximity of buildings and bridges can cause difficulties for AIS transponders in heavily built-up areas. This is a consequence of inhibiting either the reception of the differential GNSS signal by the AIS transponder, or the transmission of the subsequent AIS message.

Traffic image accuracy

Vessel tracking can similarly be interrupted when two vessels pass close to one another, with the result that the radar tracking of one contact may be confused by the proximity of the other. This may result in the identity of one track transferring or "swapping" to the other. The more precise tracking associated with AIS has been shown to prevent the incidence of "track swap".

Real time manoeuvring data.

Radar based VTS systems will typically provide details of a vessel's course speed over the ground. Of necessity, this information is historical in that it is calculated from track made good by a vessel. However, AIS in addition to course and speed information provide elements of real time manoeuvring data such as Ships Heading and Rate of Turn. These are derived directly from the vessel navigation systems and are included automatically in Dynamic Message broadcast by the AIS.

Weather effects on tracking performance.

Navigational radar performance is often adversely affected by precipitation as a function of the radio frequency on which it operates. In heavy rain or snow, effective radar tracking sometimes unachievable, even with the use of modern suppression techniques. However, radio transmissions are not so attenuated and consequently a VTS centre is much more likely maintain an accurate traffic image in adverse weather where that tracking is based on AIS data.

VHF radio transmissions can be affected by atmospheric ducting. In these conditions, VHF reception ranges can be greatly extended. Where AIS messages are received at such enhanced reception range, the system will automatically overcome ignore signals originating from vessels at long range.

Provision of more precise navigational advice.

Where a VTS centre is able to receive AIS information from vessels within or adjacent to its area, it is expected that the quality, accuracy and reliability of vessel tracking will improved markedly. The VTS centre would therefore be able to provide more precise navigational advice, as and when required, or when deemed necessary. In addition, availability of certain real time manoeuvring data within the VTS centre is expected to enable VTS operators to appreciate more rapidly, and in greater detail, actual vessel movement.

Electronic transfer of port passage information

If AIS is integrated into a VTS system, it would become possible for suitably equipped vessels and the VTS centre to exchange passage information such as intended way points, provided the appropriate software is available.

Electronic transfer of safety messages.

The facility available within AIS for the transmission of short safety messages makes possible the electronic broadcasting from a VTS centre of local navigation warnings, and similar safety related messages to suitably equipped ships.

VTS centres could also the capability of broadcasting local chart corrections to ECDIS fitted ships via AIS.

Automatic indication of Voyage Related Information(cargoes, dangerous substances, etc)

Vessels are normally required to report to VTS authority any dangerous substances being carried. The AIS voyage related message will permit the inclusion and automatic transmission of this information.

Archiving data

The automatic availability of AIS data for suitably equipped vessels in a VTS Centre would facilitates the rapid and comprehensive recording, replay and archiving of their data.

System redundancy

By equipping VTS centres with AIS, an alternative method of tracking and monitoring the navigation of suitably equipped would be introduced, thereby improving system redundancy significantly.

Potential for interaction within regional AIS network

Increasing emphasis is being placed on networking VTS centres on a regional basis. Such an arrangement facilitates greater efficiency by making possible the rapid transfer of vessel details between different centres. This benefit may be enhanced by the provision of AIS within the relevant VTS centres.

Improved SAR management

Many marine authorities are expected to equip SAR units, including aircraft and helicopters, with AIS transponders. The AIS voyage related message permits vessels to transmit the number of persons onboard a vessel. Whilst this is not mandatory for vessels at sea, it can be made a formal requirement in a VTS area. The provision of such details, and the ready identification and location of SAR units is expected to facilitate the management and evaluation of any SAR response.

4.8.3 Installation of AIS into a VTS

The issues to be considered when installing AIS into a VTS are:

- **Number/location of base stations/repeaters**
- **Operability with adjacent VTS organisations**

- **Availability of suitable VHF Communications channels**
- **Availability of national/regional/local DGNSS corrections**

Number/location of base stations/repeaters
In deciding the size, and thus cost, of integrating AIS into a VTS system, a careful study needs to be undertaken to establish the number and location of base and repeater stations required to achieve full and reliable coverage.

Operability with adjacent VTS organisations
Where it proves necessary to use more than one base station, or where a VTS organisation involves more than one VTS centre, the method of connecting the component elements into a local network needs to be given careful consideration.

Availability of suitable VHF Communications channels.
Two maritime VHF Channels have been allocated by the ITU for the international use of AIS in its primary ship-to-ship mode. The need for additional channels will be where the VTS centre has a particular interest in deriving vessel identity at maximum range.

Availability of national/regional/local DGNSS corrections
In order to monitor vessel navigation with the 10 metre precision required for port approach and harbour navigation, a reliable DGNSS correction signal will need to available to all vessels throughout the VTS area and such services are provided nationally or regionally in many areas. However, where such a service does not exist, the VTS may consider providing this service by transmitting the relevant corrections using the AIS system.

4.8.4 AIS and Aids to Navigation

A further potential application of AIS is as an aid to navigation. When positioned at a significant geographic point or danger to navigation, an AIS transponder could provide information and data that would serve to:

- **complement or replace an existing aid to navigation**;
- **provide identity, state of "health" and other information** such as real time tidal height, tidal stream and local weather to surrounding ships or back to the shore authority;
- **provide the position of floating aids** (primarily buoys) by transmitting an accurate position (based on DGPS corrections) to monitor that they are "on station";
- **provide information for performance monitoring**, with the connecting data link serving to remotely control changes of navaid parameters or switching in back-up equipment;
- **as a supplement to radar transponder beacons (racons)**, providing longer range detection and identification in all weather conditions; and,
- **as a data gathering tool**, providing information on all AIS fitted shipping traffic passing within VHF range of the site.

4.8.5 AIS for Meteorological and Hydrological information

Another potential application is the transmission of meteorological and/or hydrological data.

Options for implementing this application include:

- **Connecting a measuring station directly to a local AIS-unit**, which then broadcasts the relevant information.
- **Several measuring stations can be connected to a base station network** via a data communication system. Information can then be broadcast from appropriate base stations.
- **A measuring station can be co-located with an Aid to Navigation equipped with AIS**. The AIS-unit can then be used to broadcast both the Aid to Navigation information and meteorological and/or hydrological information using separate messages.

Examples of information to be broadcasted:

- Wind speed, average and gust values
- Wind direction
- Water level
- Water temperature
- Air temperature
- Current speed and direction on different depths
- Tide information

The availability of such data would permit the presentation of real time information at receiving stations, including onboard ships within VHF range.

4.9 Legislative Elements

4.9.1 IALA Recommendation

By the end of 2004 most of the merchant ships have to carry AIS systems under Regulation 19 of Annex V to the SOLAS (Safety of Life at Sea) convention. IMO currently discusses to extend AIS to the open sea by adapting AIS to a satellite-based interface.

The AIS unit aboard broadcasts at defined intervals (depending on speed and rate of course change) on the two assigned VHF channels the ship‘s identity, current GPS position, course, speed, rate-of-turn and further ship and voyage related data. The transmissions are received by other ships in their AIS sets, indicated on the bridges and used by the officers for navigation and collision avoidance purposes. Particularly a ship‘s position transmissions, but also its motion data, have a great significance to VTS operations. For this reason, IALA recommends the use of the AIS ship broadcasts in VTS stations.

4.9.2 Data exchange

An important legal aspect of information networks is data protection. Technically this is, in most cases, easy to achieve. However, convincing the users is more challenging. This applies especially to any connection to / from VTS centres in regard to the kind of information to be exchanged. Here significant resistances may to be overcome. The agreements of co-operation between administrations, users and third parties are a first step in this direction.

4.10 VTS Benefits

Benefits gained from a VTS can be in issues regarding navigational assistance, sequencing of vessel traffic, reduction of accidents, increased traffic efficiency, well distributed information, efficient resource planning and port development among others.

4.10.1 Navigational Assistance

In confined waterways and under adverse weather conditions, vessel navigation is a complex task. With an ever growing vessel size and increased transport of hazardous goods, the ships‘ masters cannot rely on the traffic information that can be obtained on board the vessel alone, but draw on the support from shore-based Vessel Traffic Services. By means of electronic systems such as radar, AIS, direction finders, meteorological and hydrological sensors, the VTS are able to compile a traffic image with all relevant information within the area concerned.

With this information, hazardous situations can be identified before critical situations develop, and appropriate advice can be given to the masters of the vessels.

4.10.2 Sequencing of Vessel Traffic

Vessel navigation in waterways having limitations must be planned in advance in order to avoid dangerous situations, such as groundings. Vessels navigating in the NSR must properly take into account the meteorological and hydrographic information. This is best supported by a VTS having an overall traffic view. The VTS, however, can not only support the ship, but can also ensure the best possible use of the waterway‘s transport capacity.

4.10.3 Reduction of Accidents

Similar to road traffic, several accidents happen every day at sea. Most of these are of minor nature with only little damage. However, each year a number of serious marine casualties occur, often with loss of life and material and sometimes with dramatic consequences to the environment. To a large extent, such accidents result from the lack of knowledge of the waterways, bad communication between the involved vessels, human error to recognise the developing situation.

The COST 301 study (a joint research project on shore-based marine navigation aid systems) of the European Union has established that at least 50% of such accidents can be avoided if a VTS system is used. This figure is well supported by practical experience with numerous VTS systems world-wide.

4.10.4 Information Distribution

The VTS authority is normally the origin of up-to-date shipping information. It has become customary that this information is offered and distributed to third parties, such as agents and ship owners. In this way, VTS will also contribute to the attractiveness of a shipping area or port, as the shipping world appreciates the land-based support from such a source. This helps attracting further shipping and shipping business.

4.10.5 Resources Planning

Improvement of efficiency requires best use of existing resources such as pilots, tugs, lines-men, berths and cargo handling facilities. The VTS system supports the just-in-time allocation of these resources by provision of comprehensive and up-to-date information on a vessel‘s particulars and its estimated time of arrival (ETA), and thus helps in the planning of capacities.

5 Personnel

A major factor in the efficient operation of a VTS Centre is the standard of competence of its personnel. Recognising that VTS personnel are members of a profession whose principal interaction is with mariners and maritime pilots in the safe management of maritime traffic, their competence needs to reflect that professional responsibility.

VTS personnel should be capable of providing VTS information, rendering navigational assistance when required and establishing a traffic organisation service in a VTS area as specified by the relevant VTS Authority. For the ARCOP VTS, the Centre may comprise VTS Operators, VTS Supervisors and a VTS Manager.

The purpose of standards for training VTS personnel is twofold. First, to ensure the competence of personnel that occupy key positions in VTS in which critical situations can occur and, secondly, to provide uniform consistency of procedural communications with ships throughout the world. A series of publications has therefore been prepared by IALA that provide recommended standards and guidelines on all major aspects of the training of VTS personnel.

The publications are:

- Recommendation V-103 on Standards for the Training and Certification of VTS Personnel;
- Model Course V-103/1 - VTS Operator Basic Training;
- Model Course V-103/2 – VTS Supervisor Advancement Training;
- Model Course V-103/3 – VTS On-the-Job Training, VTS Operator, VTS Supervisor;
- Model Course V-103/4 – VTS On-the-Job Training Instructor;
- Guidelines for the Accreditation of VTS Training Institutes;
- Guidelines on the Assessment of training requirements for existing VTS Personnel, Candidate VTS Operators and the Revalidation of VTS Operator Certificates

5.1 Recommendation V-103 on Standards for training and certification of VTS Personnel

The Recommendation describes the principles and objectives of VTS training, it outlines possibilities for career enhancement, proposes entry standards and aptitude testing and describes the basis for the conduct and award of qualifications, certification, annual assessment and revalidation. Advice on the training of VTS personnel follows the format used by IMO for the training of shipboard personnel and sets out the requirements for competency-based training for VTS Operators and Supervisors.

The main topics of the Recommendation include job descriptions, selection and recruiting, training, qualification and certification and competence charts.

The purpose of Recommendation V-103 is to ensure that VTS Operators are professionally qualified personnel capable of contributing to safe and efficient marine operations.

However, many existing VTS Operators have already reached the required level of competence, and therefore a way to evaluate and assess their knowledge, understanding and skills has been devised as a process to certificate them.

The basis of the process is that an individual assessment is made of existing VTS Operators by using the following tools:

- Portfolio review
- Demonstration
- Standardised tests
- Programme review

The assessment should be carried out in steps (see Figure 3). Where the assessment indicates that the candidate has the required competence, no training needs to be given and the competent Authority should award a VTSO Certificate and VTS Certification Log.

When the assessment indicates that the candidate does not have the required competence, appropriate training should be given.

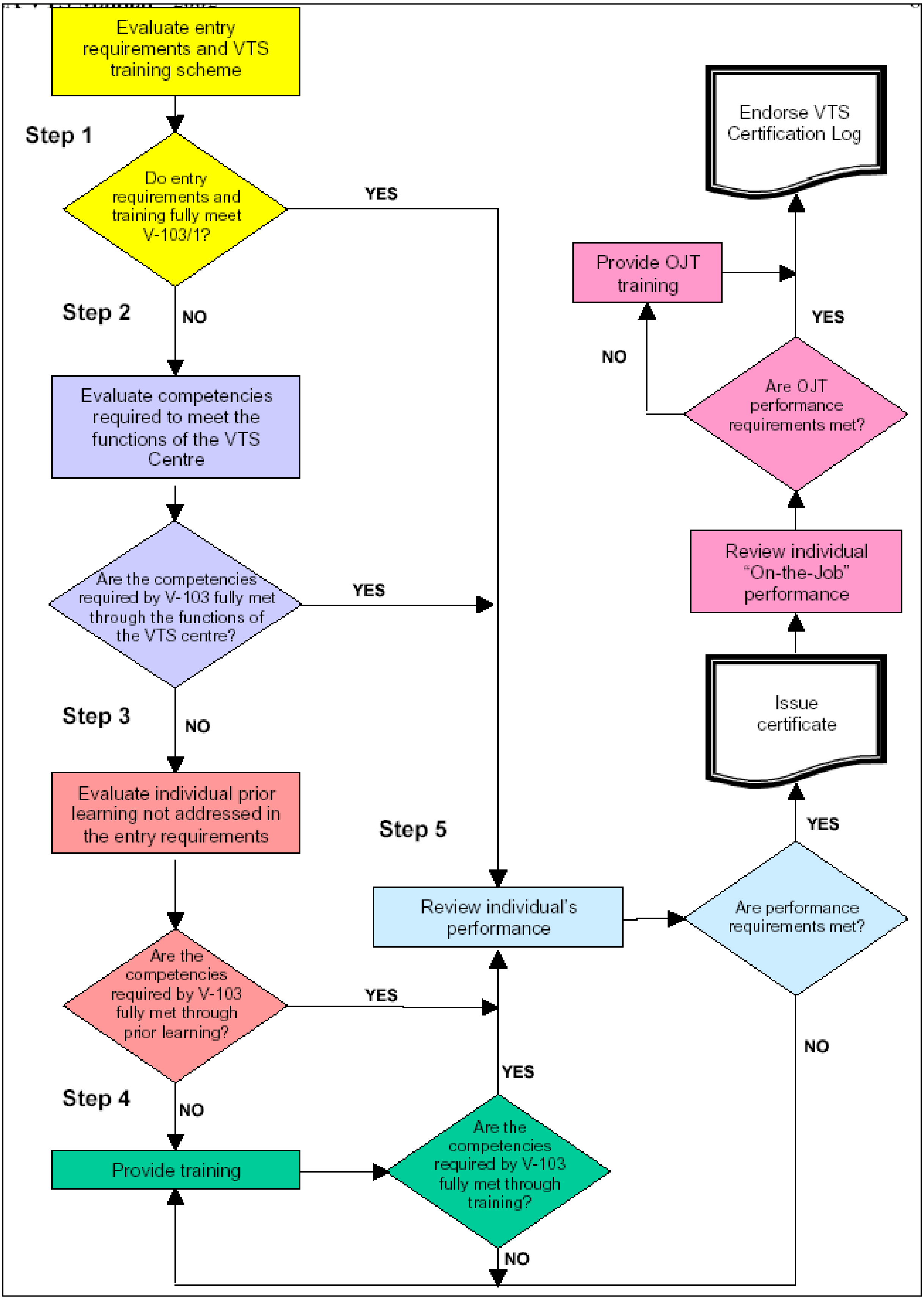

Figure 3 IALA Flow diagram for Recommendation V-103 VTS Operator Certificate to existing VTS Operators

6 Costs

The cost components of a new VTS consist of two distinctive groups, investment costs and operation costs.

The investment costs are:

- planning (e.g. feasibility studies, tendering, procurement, legislation)
- building works (e.g. VTS stations, radar posts, VHF masts, power/water/telephone connections)
- equipment purchase and installation (e.g. radar, VHF and other communication, computers, software, VTS work consoles, vessels/vehicles)
- organisation set-up (e.g. recruitment and training of staff, developing procedures)
- project management and administration (including intermediate measures)

The operation costs:

- maintenance and repairs of the building works (including spare parts)
- maintenance and repairs of the equipment (including spare parts)
- personnel (including replacement and additional/refreshment training)
- consumables (e.g. power, water, telephone, in/outgoing documents)
- insurance cover (if appropriate)

It is not possible to give figures of exact costs for an ARCOP VTMIS. The system providers are not willing to give list prices and the costs depend on the technical features of the system required. The price of the system must be negotiated and maintenance contracts for example will have an influence on the VTS purchase cost. If the system provider gets the maintenance contract for the VTS system, the purchase costs of equipment can be lower.

It was not possible to find out the existing VTS centres in the NSR. A VTS centre in Murmansk and one in Varandey provided by a Russian system provider. It has to be further investigated which VTS functionalities these centres offer in order to upgrade the VTS System to the functionalities recommended in the former chapters. The desired area of coverage must be delineated and afterwards a Cost Benefit Analysis can be realized. With the information gathered till now it is not possible.

7 Future Prospects

The progress of technical development is such that it is increasingly difficult for all persons involved to prepare for any eventuality. Therefore, great importance should be attached to a modular system design of the technology which makes it possible – as far as foreseeable today – to maintain the system's relevant required state of the art in future by stepwise and scheduled partial modernisation. This should include an extensive use of standardised interfaces between main components, up to and including broadband signal processing, without the previously required signal switches.

In order to ensure an extensive availability of the system, care should be taken that a possible failure of one subsystem does not affect other intact system parts as far as possible, and that the remaining system is capable of taking over any essential functions of the failed part. Furthermore, there should be the possibility to support the technical and engineering service personnel by remote diagnostics of the manufacturer directly via a telephone data line. A reliable, continuous 24-hour operation could be ensured over many years.

For future investigations of VTMIS systems in the NSR it should be stressed to delineate the VTS coverage area. The recommended functionalities in this report should be part of the VTS System. As VTS Systems are cost intensive it should be found out which VTS centres and its functionalities already exist to upgrade the system. In the context of this Workpackage it was not possible, but it can be included in a future research project that builds upon the results of ARCOP.

8 Bibliography

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