INCARNATION

IDENTIFICATION OF ADMINISTRATIVE AND ORGANISATIONAL BARRIERS AND THE ASSESSMENT OF INFORMATIONAL AND ORGANISATIONAL REQUIREMENTS AND FUNCTIONALITIES OF AN EFFICIENT INLAND NAVIGATION INFORMATION SYSTEM WITH SPECIAL REGARD TO TRANSPORT CAPACITY AND GOODS FLOW, SAFETY OF TRAFFIC AND TRANSPORT OF DANGEROUS GOODS

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1. Project objectives

1.1. Background

Transport in Europe is increasing and is expected to grow in the next decades. Road haulage has obtained a strong position in the past years. However, this mode of transport has some serious disadvantages, notably exhaust and noise pollution. Despite research to reduce these forms of pollution, a further growth in the number of truck movements is socially no longer acceptable. In some countries, measures have already been taken, for example by limiting truck movements in cities, even banning them during weekends.

In addition to pollution, traffic congestion is increasing throughout Europe. Highways are frequently choked to the point of standstill at rush-hours, while, in some parts of Europe, the area covered by the road infrastructure has already reached an unacceptable level. This is why EU countries are developing policies to shift some transport from road to rail and water. Waterborne transport has a much lower impact on the environment than trucking.

The present research programme focuses on transport via water. Inland waterway transport is used in the Netherlands, Belgium, France, Finland, Germany and Austria and in some cases traffic is increasing. However, some characteristics of waterborne inland transport have limited its growth. Inland vessels are slower than trucks, although road traffic congestion means that the difference to some destinations is now small. Waterborne vessels also have less penetration inland.

While the slower speed of waterborne transport can be less important than may be apparent, the lack of penetration can be solved by improved inter-modal organisation

1.2. Project description

INCARNATION aims to enhance both the navigation safety and the reliability of waterborne transport. The system could also have other potential benefits:

- By offering accurate and efficient information, the capacity of the fairway can be increased with only minor consequences in terms of time for the vessels involved. Using the system it is possible to avoid queuing in congested areas. This implies that capital intensive investments to improve the infrastructure can be delayed. This aspect also strongly emphasises the introduction of a River Information Service (RIS).
- In some countries, manned VTS centres are being built alongside waterways in order to mitigate the increased risks associated with growing traffic volume. While these VTS centres certainly enhance safety, their capital and running costs are far from negligible. The RIS system as proposed could potentially either completely avoid the need for such VTS stations, or reduce running costs by improving their efficiency, while extending their role as (traffic-)information providers.

The basic concept of INCARNATION is to improve the on board information available to skippers as well as the information available to parties involved in logistics. The information flows consist of:

- Information on the tactical traffic image
- Information on the environment
- Information on logistics.

1.2.1. Information on the tactical traffic image

The safety of navigation is enhanced if all traffic in the neighbourhood of a navigating vessel is presented on the bridge along with additional information relevant for the navigation process. For co-operative vessels (i.e. those vessels which are equipped with the full INCARNATION system, see Chapter 5) vessels are also identified by the system.

1.2.2. Information on the environment

Information on the environment is of great importance when preparing a voyage, including, for example, the maximal possible draughts of vessels, information on opening times of locks, ice reports, weather conditions, obstructions of the fairway etc. In INCARNATION this type of information is referred to as the **Fairway Information Service (FIS)**.

1.2.3. Information on co-operative resource management

Logistical information is of importance for all commercial parties involved. The shippers need to know where the cargo is and the expected time of arrival, on a continuous basis. Authorities need to know the details of cargoes in case of an incident, in order to be able to carry out the proper counter measures.

Continuous knowledge of the position of all vessels results in a strategically useful traffic image. The efficiency of locks and terminals can potentially be increased by the interaction with all relevant parties in the transport process.

INCARNATION defines these information flows as the **River Information Service (RIS)**. It is emphasised that at present, hardly any RIS elements are available along the inland fairways. Consequently, it seems the right moment to introduce a standard for the EU fairways: so that vessels can obtain and provide the same information and communicate in the same way independent of the country they are passing through.

1.2.4. Tactical and strategic information

In INCARNATION a distinction is made between *tactical information* and *strategic information*. For the skipper this can be defined as:

- *Tactical traffic information*: information that affects the skipper's immediate decisions in the actual traffic situation and the geographical surrounding.
- *Strategic traffic information*: information that affects voyage preparation and voyage execution in the medium to long term.

In INCARNATION the full extent of a RIS was developed up to and including the functional specifications. The tactical traffic image was developed even further, up to the technical specifications and resulting in a demonstration of an integrated system based on the combination of radar technology and transponders.

1.3. Partners

The following organisations participated in INCARNATION:

Institut für Schiffsführung, Seeverkehr und Simulation, Germany, co-ordinator	ISSUS
Transport Research Centre, Ministry of Transport, Public Works and Water Management, the Netherlands, task leader	AVV
Marine Analytics, the Netherlands	MarAn
Kluytenaar Nautical Consultancy, the Netherlands	KNC
Holland Institute of Traffic Technology, the Netherlands	HITT
Daimler Benz Aerospace AG, Germany	DASA
Opéform, France	OPEFORM
Eraam, France	ERAAM
Maritime Simulation Centre Netherlands B.V.	MSCN
MarineSafety International Rotterdam B.V. the Netherlands	MSR
Institut Français de la Navigation, France	IFN
Transport Research Centre of Finland	VTT
University of Liege, Belgium	ANAST
Rotterdam Municipal Port Management, the Netherlands	RMPM

2. River Information Service

2.1. Safety

The safety level on inland waterways is high. However if traffic intensity increases, following greater interest in this mode of transport, it will put pressure on the present safety level. This may also influence the safety of people living and working ashore as well as the environment.

The wheel houses of inland vessels - at least in countries where this mode of transport is well-regulated - are well-equipped. However vision of the surroundings, whether by the naked eye or the vessel's radar is limited to normal lines of sight. Identification of vessels in the vicinity is often difficult, although it is easier during daytime and with good visibility. Skippers usually have to address other vessels in relative terms, which often leads to confusion.

Knowledge of the fairway is for the most part based on experience. Available charts - and this is certainly not the case for every fairway - are usually updated annually at the most and consequently give only very rough depth information. Skippers have to find out the actual available water depth by trial and error. The information that is needed for inland navigation is spread over a number of sources and is organised differently in every country.

If a River Information Service were to provide skippers with a tactical traffic image showing those vessels that he can not see with his own equipment, safety should be enhanced. If the RIS were also to provide him with identification information of these vessels and means selectively to communicate with them, vessel safety would be even further enhanced. Electronic chart information made available via a RIS could help the skipper to avoid groundings and stranding, but also to make better use of the available fairway width allowing him to maintain greater distances when meeting and overtaking.

Similarly, interactive ETA planning with terminals and locks could enable the skipper to reduce speed at times where, at present, he is trying to stay ahead of an assumed competitor. It may also help him find a safe berth for the night. Better organisation and bundling of nautical information reduces the time a skipper needs to collect such data and reduces the risk of overlooking important information.

2.2. VTS - Traffic management

The VTSs along the Rhine have updated - or are currently updating -to state-of-the-art equipment. This equipment does not, however, allow for automatic identification. Meanwhile, available manual identification is not reliable due to the very small passing distances on inland waterways.

The lack of automatic identification leads to a large amount of verbal VHF communication. There are moments where, apart from the normal VTS radio communication, the Dutch/ German reporting systems (IVS 90 and MIB), and the Dutch CBS[1] reporting system also involve significant - partly confidential - VHF communication. This communication is time-consuming and requires costly manpower. On the vessel side it may interfere with the tactical work load.

1 Central Bureau for Statistics

2.3. The efficiency of inland waterway transport

The efficiency of inland waterway transport can be significantly improved if the various parties in the logistic chain are given the information they require in time to rationalise their own planning and resources scheduling.

Much of the life time of an inland vessel is spent waiting, for various reasons:

- Waiting at terminals contributes extensively to the total waiting time, partly because terminals rarely take the arrival time of inland vessels into account in their planning. In the early days it was entirely unclear to shippers and/or terminals where the vessel was until it showed up at the destination. This situation has changed dramatically since the introduction of GSM telephony. However the standard single-voyage charter in inland shipping still allows the shipper and the receiver of the cargo several loading and discharging days (up to 4 loading days and up to 5 discharging days in Dutch law).
- In the container trade waiting time is often caused by the fact that the terminal is occupied when the vessel arrives. Once this happens it causes a domino effect on all subsequent terminals the vessel will be calling at, resulting in increasing time losses.
- Let's consider for example the calls of an inland container vessel in the port of Rotterdam. The inland vessels call at about 7 to 8 terminals in the port area on average. It takes in total 28 hours to charge and discharge while, again as an average, about 150 containers are handled.
- Given that 150 containers can currently be handled within 5 hours and that the time for sailing between terminals and manoeuvring is on average 8 hours, the waiting time is currently, on average, 15 hours. Better information on the vessels' arrival at terminals would be expected to allow these waiting times to be reduced by at least a factor of 2.
- It appears that the system is still inefficient. Decreasing waiting times leads directly to improved productivity and smaller costs, provided that the schedules of the inland trips can be adjusted in order to cope with the shorter transit times in the port.
- One means to improve the overall situation is to provide the parties involved with information that will allow them to adjust their individual planning systems (eg. stevedores, barge operators, etc) in time. This is a good reason why the arrival time of inland vessels should be included in terminal planning. The strategic part of the River Information Service can therefore be of great potential importance.
- Logistical information is part of RIS. Container identification numbers, their content, destination and transfer point are important data. The (digital) bay plan should also be available and known to the terminals to be called at. Last but not least the ETA's at the terminals involved should be made available and adjusted whenever necessary.
- If this information can be made available at the terminals and if stevedores can also interact with this part of the RIS , the schedules may be adjusted to reduce waiting times. Vessels are responsible for informing the parties further down the logistic chain of any significant changes in their schedule, while the stevedores should do the same when unexpected events force them to deviate from the original plan.
- By combining the planning efforts of vessels and stevedores electronically, significant improvements should be able to be obtained. Considering a round-trip of 3.5 days (i.e. 2 trips per week) or 84 hours, the example mentioned above would lead to an improvement of about 10%. For those vessels operating under standard charters, this improvement may be well over 20%.

2.4. Environmental sustainability and the modal split

A RIS will contribute to environmental sustainability if the modal split can be shifted towards inland waterborne transportation. This might be affected if transport costs are properly calculated by externalising the internal factors, such as the use of resources that are so far apparently free. The CEC's green paper discusses this new kind of approach in detail.

2.4.1. Atmospheric and noise pollution

Road traffic, for example, could be asked to pay for the free air it pollutes. A charge could be levied to these users, making transport more expensive. A similar procedure would also need to be applied to inland vessels, which are also equipped with diesel engines.

The differences in transport capacities for the same unit of power applied (a lorry uses 200 HP for one TEU and an inland container vessel uses 2000 HP for 200 TEUs) may drastically decrease the diesel engine emissions of container vessels if they are assumed to have the same transport capacity. Lorries will not disappear from international traffic, since some cargoes are so valuable that the time factor is overriding. But it may be expected that a proportion of international lorry traffic will shift to inland navigation if a network is available.

It is clear from the studies which have been carried out in this project that most inland waterways have a large reserve capacity and that most of these waterways can easily accommodate a 50 to 100 % increase in vessels without large delays, if no locks are needed. When locks are used the capacity will often be determined by the capacity of the locks. In some cases no extra capacity can be offered. The rivers Rhine and Seine are attractive because they are waterways with no locks.

Another important consideration in densely populated areas is noise from road traffic. In these areas extra measures have been taken or should be taken in order to decrease the noise levels in housing areas to acceptable levels. Heavy lorry traffic is the main contributor to undesired noise levels and by shifting the modal split to inland navigation a number of remedial measures may delayed or avoided altogether.

Calculations have shown that the noise production of inland vessel traffic on the main fairways does not generally require extra noise abatement measures. If inland vessel traffic is increased then some extra measures may need to be taken at bottlenecks, but the number of houses affected remains extremely low compared to road traffic.

Benefits may therefore be expected from reduction of emissions of diesel engines and reduced noise pollution, while a contribution will be made to environmental sustainability, if the results of the green paper are implemented.

The direct benefits of a RIS in terms of accident reduction, better use of the transport capacities of the fleet, improved resource management and improved calamity abatement based on reporting of dangerous goods, are barely commensurate with the expected costs of a RIS. However, a RIS can be seen as a supportive tool for environmental sustainability, since it provides a large qualitative contribution to the reliability of transport, making the choice between road and inland waterway transportation easier.

These indirect benefits are much more important in the long term than the direct benefits, since they contribute to the quality of life in most of the densely populated areas across Europe.

2.5. Reliability of transport

Inland navigation, as a mode of transport, is increasingly attracting the attention of both shippers and ministries. However, there are uncertainties when changing from one mode of transport to another. The truck is of course very flexible, fast, relatively cheap and reliable. The routes are short and well known. Changing from road to barge (or rail) means that some thresholds need to be considered.

For example, it is generally recognised that for most commodities, time is not the most important item. Vessels sail day and night and when related to the time of the whole transport chain, transport by barge takes only slightly longer.

Cost is another significant consideration. In this respect, distance is often the dominant factor. Because barge handling is more costly than truck handling, the truck comes out better on short routes and the barge on the longer ones. The costs of transport from and to the inland terminal also play an important role and should be taken into account. In the Netherlands a distance of 50 km is considered as a break-even distance for the two modes of transport.

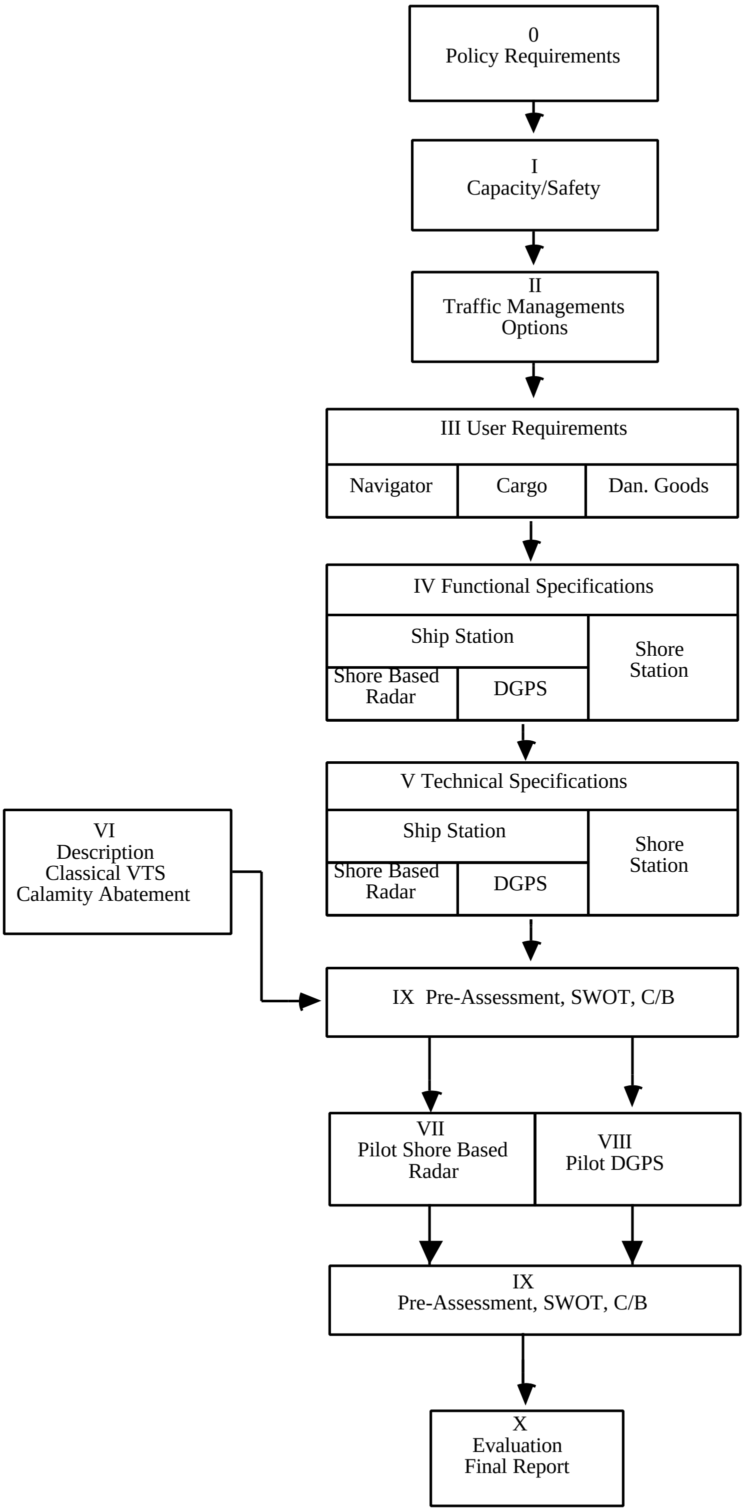
The accessibility and reliability of inland barge transport will be discussed briefly. Accessibility is of prime concern for barge operators. Reliability can be strongly enhanced by using a RIS. With the RIS, interested and authorised parties (like shippers) can follow the position of the cargo in real time and are, in principle, constantly informed about the expected time of arrival. The cargo in transit can thus be considered as floating stock, thus reducing costs related to the required stock of the company.

2.6. Lock management

Once vessel position is known, along with other relevant vessel data, such as dimensions and speed, an RIS makes it possible to predict arrival times at locks. This makes proper lock planning possible, contributing to more efficient use of the costly infrastructure. It may also lead to a reduced need for - very expensive - accommodation for waiting vessels on both sides of a lock. On the other hand, the speed of the approaching vessels can be adjusted, as a function of lock availability, leading to more efficient use of vessel engines and reducing exhaust.

3. Project description

3.1. Work packages



3.1.1. Work package 0: Policy requirements

The first task in task 15 consists of an inventory of the requirements set forth by the participating countries with respect to safety and efficiency of the fairways, especially focusing on those requirements affecting the presence of an on-board traffic image.

This inventory provided input for a number of other Work packages (see Figure 1):

WP 1: Capacity/Safety, to get insight into the infrastructure, traffic densities, safety levels and the availability of navigational aids.

WP 2: The traffic management options arising from conditions in the major countries.

WP 0 also aimed to provide input for the user requirements derived from WP 3.

In this report surveys of Policy Requirements of the member states co-operating in task 15 are presented. Then, information is presented on the following items for the Netherlands, Germany, Finland, France and Belgium, respectively:

- Traffic characteristics
- Safety aspects
- Operational aspects
- Regulatory aspects
- Political context
- State organisation with regard to inland navigation
- Telematic aspects
- Conclusions

3.1.2. Work package 1: Capacity and safety

Work package 1 addresses the safety and economy of a traffic management system for inland waterways. It studies the effects of a River Information Service on capacity and safety on inland waterways. Relationships are developed between *safety*, measured as the costs of accidents, and *capacity*, measured as costs and time delays, and the level of information and knowledge provided to the waterway users. The final aim is to deliver results concerning capacity and safety as input for the assessment Work package (WP 9) in order to make a comparison of the different traffic information services that provide information to the waterway users.

3.1.3. Work package 2: Traffic Management Options

The objective of this work package was to describe the different "Traffic Management Options" to be considered in the final assessment of task 15.

The assessment of the River Information Service (RIS) within INCARNATION requires a number of different traffic management options for the system. These options include, amongst others, Vessel Traffic Services (VTS) as well as the Regional Traffic Information Service (RTIS) and Fairway Information Service (FIS) components, which were used to configure RIS options. Clearly there is a strong relationship between the RIS and the VTMIS concept in the maritime world.

The work package states the Baseline Options and then introduces the various components of a RIS, i.e. the Tactical Traffic Image (TTI), Strategic Traffic Image and FIS, and elaborates on the functions of the shore based system. The traffic management options for a given area include the selection of the level at which these three components should be used.

3.1.4. Work package 3: User requirements

Work package 3 describes the requirements of the different users of a River Information Service (RIS). Identified users are:

- skippers of inland vessels
- authorities, including:
  - VTS authorities
  - locks and bridge operators
  - calamity abatement services
- shippers, charterers and operators of inland terminals.

The user requirements can be divided into requirements for tactical information and requirements for strategic information. For the skipper this can be defined as follows:

Tactical traffic information: the information that affects the skipper's immediate decisions in the actual traffic situation and the geographical surrounding.

Strategic traffic information; the information that affects voyage preparation and voyage execution in the medium to long term.

The pilot study mainly deals with tactical traffic information, which is primarily of interest to the skipper. The introduction of transponders on board of inland vessels, however, provides the means to draft an enhanced strategic traffic image and to optimise the planning of times of arrival. These matters are also of great value for the other parties mentioned above and will be further elaborated in subsequent projects: RINAC and INDRIS.

3.1.5. Work package 4: Functional specifications

Work package 4 - functional requirements for providing an onboard operational traffic image - contains a breakdown of information flows today as well as those within a River Information Service.

WP 4 summarises the overall structure of the kind of "River Information Service" which might be envisaged. This includes not only supplying vessel positions to skippers on the basis of shore based radar and DGPS data, but also the main contents of database information referring to the infrastructure, meteorological conditions, lock processes, etc. The database information will not be implemented in task 15 demonstrations.

Guidance is given on basic requirements for Man-Machine interfaces for these systems. Reference is also made to existing or proposed database River Information Services that could be integrated with any future implementation of the traffic image systems being developed in task 15 (e.g. the IVS 90 dangerous goods monitoring system in the Netherlands and the French Minitel-based system for cargo brokering).

3.1.6. Work package 5: Technical Specifications Shore based radar on board/ DGPS

Work packages 5 and 6 comprise the technical specifications of the Incarnation Project- the specification of the functions for the pilot system of the Incarnation project, i.e. the technical design. Different from the previous work packages, work packages 5 and 6 are limited to the tactical traffic image and do not contain strategic parts.

3.1.7. Work package 6: Classical VTS

Work package 6 - Classical VTS - describes VTS on inland waterways as it exists today. The description serves as a reference to be used in work package 9 where the different options of traffic management, as described in work package 2 will be evaluated.

3.1.8. Work package 7: Pilot Shore based radar on board and Work package 8: Pilot DGPS

The pilot demonstrates a part of the RIS; called TIRIS - *Traffic Image of the River Information Service*. TIRIS is the system for presentation of a tactical traffic image on board of a vessel, based on traffic information from a shore based radar and/ or transponders and traffic reports. TIRIS has three options:

1. A tactical traffic image based on shore based radar information alone.
2. A tactical traffic image based on transponder information alone.
3. A tactical traffic image based on shore based radar information as well as transponder information.

The pilot comprises all three options.

The system supplements and supports existing on-board traffic imaging systems on vessels, and includes the following features:

1. Display of traffic picture as seen by the shore-based radar and/ or AIMS transponders.
2. Display nautical information and traffic reports.

3.1.9. Work package 9: Assessment

The methodology used for the comparative assessment of the different systems developed within INCARNATION is based on a multi-criteria approach and introduces the concept of *"situation"*. A *Situation* means: a given geographical area + given technical means to manage the traffic inside that area + management rules and option(s) + traffic scenario(s) to be managed. Relevant groups of criteria are defined.

The determination of the "values" of the *Situation* for each group of criteria as well as the relative weights of the group criteria is performed on the basis of an expert survey using an "electronic boardroom". This expert session was attended by several experts from different disciplines involved in Inland Navigation (skippers, policy makers, VTS operators, etc.).

It is to be noted that emphasis is placed especially on the assessment of the TTI (Tactical Traffic Image). However, some core aspects related to the concept of FIS (Fairway Information System) and to the Strategic Traffic Management capabilities of the considered systems are addressed and highlighted.

3.1.10. Work package 10: Final report

After the assessment, the main results of INCARNATION are presented in the final report.

3.2. Project Execution

The work package leaders' meetings are summarised in the Annex.

Four consolidated progress reports were sent to DG VII, at the end of each semester.

Cost statements were attached to these reports.

The task leader introduced newsletters to improve internal communication and provide information about general progress to external parties. Four newsletters were produced and these have been annexed to this report.

During the execution phase no major problems were encountered. The demonstrator, originally planned for September 1997 was postponed by one month due to some problems with the Mobile Transducer Units. However, efficient interaction on the part of DASA minimised the delay and the deadlines for the final results of the project were not affected.

Some work package reports were delivered too late. Some of these problems arose from inefficient communication. The delays of the work package reports did not endanger at any moment the timely completion of the main activities in INCARNATION.

Generally speaking the completion of this task was smooth and efficient.

4. Results

4.1. Policy requirements

This Workpackage in task 15 consisted of an inventory of the requirements set forth by the participating countries with respect to safety and efficiency of the fairways, especially focusing on the requirements concerning the RIS. The countries considered were Belgium, Finland, France, Germany and the Netherlands.

All policies pay attention to the fact that inland navigation is an environmentally-friendly mode of transport. Improving rail and waterways so that there is a modal shift in their favour contributes to a reduction of the emission of CO_2 and NO_x. Furthermore, the roads are becoming congested so that the mobility of road transport threatened. This last argument does not hold for Finland, where there are no problems related to congestion.

In *Belgium* the positive elements of inland navigation are certainly recognised and various studies are being carried out to evaluate the financial, economical and sociological impacts of modal shifts in favour of waterborne transport. These studies include traffic management and infrastructure investments. Attention is paid to the principle that every traffic mode should pay its external costs correctly.

Finland is aiming to achieve a direct connection between the Kymi basin and the open sea. Because of the restricted use of the waterways and the fact that Finland has no congestion problems, no investment in inland navigation is foreseen. However, attention is paid to safe and efficient navigation.

France is strongly in favour of reinforcing the position of inland navigation. Anticipating the required liberalisation and future developments, the government recently established the *Office National de la Navigation* and the *Voies Navigables de France* (VNF). The VNF has its own budget with a mandate to maintain, operate and manage the inland fairways. The competitive position of the inland vessels has improved because road transport became more expensive with the introduction of stricter operational and safety regulations for trucks.

The government is aiming at giving the railway and fleet operators a private industry status to improve their service level and operability. Interestingly, special attention is being paid to reduce the cost of transhipment by reconsidering the legal status of dockers. If this succeeds, it will certainly help improve the competitive position of French ports and the use of inland navigation. Along the same lines are current and future efforts to establish good, efficient and therefore cheap connections with the hinterland.

In the *Netherlands* the use of waterways and railroads is strongly supported. However the use of road transport is significant, especially for shorter distances (i.e. less than 50 km). As a result, multi modal transport is encouraged. Because the inland fairways are of great importance for the Netherlands economy, due attention is paid to:

- removing bottlenecks with regard to expected developments of transport via water (with emphasis on the transport of maritime and continental containers)
- maintaining and improving the infrastructure
- the safety aspects related to transport via water and other modes.

The government encourages the development of technical and organisational innovations.

In *Germany* the government also pays due attention to improving the waterways and stimulating combined traffic. Fair competition between modes is a major topic in efforts to increase the possibilities of inland navigation. This is also true for the elimination of the fiscal and legal restrictions on co-operation, to improve the overall transport chain. For road traffic a 24 hour economy is being stimulated.

In conclusion, in almost all the countries involved in Task 15, there is a strong wish to support and strengthen transport via inland waterways (and railroads) in order to relieve road traffic and to reduce the emission of CO_2 and NO_x as far as possible, albeit minimal with respect to the level agreed upon between the member states of the EU.

The safety of inland navigation is also receiving attention, including the risk to those living near fairways. In the Netherlands risk limits have even been proposed to keep the risk of people living near the fairways to a level determined by the Ministry of Transport and the Ministry of the Environment. The existing forms of traffic management which have been introduced in the past in the main ports of the Netherlands, parts of the river Waal (near Dordrecht and Nijmegen), along the Amsterdam-Rhine Canal, Eastern and Western Scheldt and in Belgium at the port of Antwerp will play a larger role.

Moreover, in the Netherlands and Germany an information system on vessels transporting Dangerous Cargo and other, so called target vessels, has been introduced. This system plays a role in calamity abatement following an accident. The system, called IVS 90, is operational in the Netherlands and linked further upstream with the German system (MIB), as can be seen in the German contribution. The VTS stations of the Dutch ports have their own system (connected to IVS-90) to deal with the transport of dangerous cargo.

4.2. Capacity and safety

4.2.1. River Information Services

The RIS aims to contribute to safety and efficiency of navigation by providing a tactical traffic image to the wheel-houses of vessels sailing in a certain area and providing logistic information and information on the surroundings. The RIS consist of three elements, as described below.

Traffic image on board

Most vessels navigating on the European fairways are equipped with radar. The possibilities of radar systems inland are however restricted. For example it is impossible to get information beyond bridges and bends in the fairway. To overcome this limitation the authorities in some countries (notably the Netherlands) have installed VTS centres at a number of stretches with a relatively high risk. These VTS stations more or less regulate the traffic by giving information by VHF, based on the VTS radar image, which covers the entire relevant area.

In INCARNATION, the radar-based tactical traffic image, as available in the VTS centre, is transmitted to vessels (SROB[2]). By doing so it is no longer necessary to inform skippers on the presence of other vessels. Only the regulating and supervisory tasks of the VTS operator remain. The system thus contributes to a decrease in VHF communication. In less crowded areas the INCARNATION system may operate without a VTS operator.

A very important part of the INCARNATION system is the AIMS[3], i.e. the transponder. The AIMS first of all provides information on the presence of other vessels that are also equipped with AIMS in areas without radar coverage. Additionally, it provides identification information on these vessels in the tactical traffic image, both in areas with and without radar coverage. However, it can also be used to provide other relevant data on the vessels that are equipped with AIMS. The AIMS can therefore be used to shift a great deal of the present verbal VHF communication to digital communication.

ECDIS, the electronic chart display and information system, is also part of the tactical traffic image of INCARNATION,. Although only the basic elements of ECDIS are implemented during the pilot, it is expected that providing ECDIS on board of inland vessels can increase safety, by reducing the risk of grounding, and also by enabling better use of the navigable space. At the same time, ECDIS may also improve route planning and draft optimisation, thus improving the logistical aspects of transport.

[2] Shore Based Radar on Board
[3] Automatic Identification & Data Management System

Logistic information and calamity abatement

Logistic information is first of all of interest to parties dealing with the cargo. These can be the shippers who want to know if any delays are to be expected and want to know the precise time of arrival, the next transport mode in order to adjust their own planning system, the maritime agent to inform his principal, the forwarder to inform his client etc. The VTS stations mentioned earlier play a role in regulating the traffic. But these stations are also of importance with respect to calamity abatement when accidents occur in the fairways.

At present (in the Netherlands) vessels carrying dangerous goods are obliged to report details concerning their cargoes to the first VTS station that they pass during their trip, so that, if anything happens to a vessel, the authorities already have information concerning the cargo, the number of people on board, etc. and can take the appropriate measures to restrict the consequences of the accident. At present, this communication is still carried out verbally, although recently an experiment to transmit the relevant data digitally was started in the Netherlands (BICS). At present these data are not accessible for third parties like shippers and terminal operators. Furthermore, the progress of vessels is only updated - manually - at a limited number of reporting points. Progress between these reporting points is calculated by dead reckoning and only in case of an incident.

In a RIS, the AIMS technology, as introduced in INCARNATION, can provide very accurate real-time information on the whereabouts of all vessels equipped with a transponder, without the need for human activity. And where confidential or commercially sensitive data are involved, these are only communicated to those parties that have the relevant authorisation. Using the route information (e.g. water depths, currents, etc.) available in ECDIS, together with input from skippers regarding voyage particulars (e.g. delays due to bunkering or stores on a certain location, etc.), the system can calculate an accurate estimated time of arrival (ETA). This can then be communicated via the RIS to interested parties, which may use it for the planning of their resources, e.g. quays, connecting transport, cranes, personnel, etc. In turn these parties could communicate via the RIS if this ETA fits within their planning or should be changed. The onboard system could then (automatically) adjust the engine settings to attain the necessary vessel speed.

Fairway Information Service

Information on the environment is of especial importance for skippers on board. In the Fairway Information Service (FIS) information on the indicated route will be provided, incorporating information on water levels, obstructions, fairway characteristics etc. The required data and updates (e.g. ECDIS updates, water levels, etc.) can be downloaded from the FIS to the on board computer. The skipper may consult the system before loading for the next port of call and use the results to optimise, for instance the draught of the vessel. During the trip occasional consultation of the system will be carried out to see if there are new developments in the coming stretches.

The three elements together form the River Information Service.

4.2.2. Safety and efficiency

Work package 1 deals with the efficiency and safety of traffic flows. A traffic simulation programme was used, where simplified models of navigators (skippers) and manoeuvring models of inland navigation vessels were implemented. Safety considerations were based on an accident database for the river Waal and an analysis of the way elements of a RIS could have prevented accidents.

Simulation of traffic behaviour indicated that any delay due to traffic under the present traffic flows was not to be expected. Delays were less than 1 second per kilometre sailed by each vessel. This would signify that total delays over the whole stretch of river under consideration were less than 2 minutes for an average travelling time of 4-5 hours.

In scenarios where the river is used near to its maximum capacity, delays of more than 10 seconds per vessel kilometre were calculated. With an average speed of 20 km/hr this would signify traffic delays of 6-7 %.

The simulation programme also provided interesting results regarding the number of "interactions". These "interactions" are encounters where one of the vessels has to make a small manoeuvre to ensure safe overtaking and passing distances. A failure to implement the right avoiding manoeuvre would lead to a collision. These "interactions" could be calculated for each traffic scenario.

Analysis of the accident database leads to two major conclusions:

- the actual level of safety on the river Waal is satisfactory,
- there is only a small margin for improvement of the safety level.

Using the number of "interactions" and the number of failures of "interactions", called collisions, the number of expected collisions for other traffic scenarios could be calculated.

The results are summarised in the following table. Three different scenarios were considered:

- The 1995 scenario represents the present traffic and traffic composition on the river Waal.
- The Global Shift scenario is a scenario with the same number of vessels but with a larger average size.
- The European Renaissance scenario is based on assumptions regarding the rebirth of the European economy.

The elements of the total accident costs are summarised in columns 2 through 4 for the three scenarios considered. The last four columns represent the average reduction in accident costs if one of the four elements of a RIS is applied.

Total accident costs in the present situation are well over 2 MECU and this amount is expected to increase to nearly 9 MECU in the European Renaissance scenario. It should be remembered that the accuracy of these values is low and that they might deviate by a factor 2 from the real values. It should also be borne in mind that some effects are not translated into monetary terms, such as damage done to the environment by dangerous substances, in case of a collision with a vessel carrying dangerous substances.

Survey of damage costs (in ECU)	Scenario's						
	1995	Global shift	European Renaissance	Reduction percentage			
damage costs				VTS	SROB	AIMS	ECDIS/FIS
economic damage of suspension	4,276	5,817	29,069	15.75%	11.25%	22.75%	2.25%
damage costs collisions	1,750,822	2,160,381	7,224,574	15.75%	11.25%	22.75%	2.25%
economic costs of groundings	84,556	84,556	165,196	7.25%	0.75%	2.25%	42.75%
damage costs strandings	20,455	20,455	35,674	4.25%	0%	0%	11.00%
third party damage costs strandings	40,909	40,909	71,349	4.25%	0%	0%	11.00%
damage costs contacts	94,938	94,938	165,579	4.50%	1.00%	2.00%	26.25%
third party damage costs of contacts	135,543	135,543	236,398	4.50%	1.00%	2.00%	26.25%
killed people	187,500	222,031	742,500	15.75%	11.25%	22.75%	2.25%
injured people	50,000	59,208	198,000	15.75%	11.25%	22.75%	2.25%
Total	2,364,722	2,818,020	8,839,270				

Table 1 Survey of damage costs

Table 1 indicates that with regard to accident reduction AIMS is the most attractive option[4]. The reduction percentages as given in the table apply for the whole river. This is the case with AIMS and ECDIS/FIS. On the Rhine three local VTSs are in operation and one more is being considered in order to improve the safety of specific stretches. It is not comprehensible from an accident reduction point of view that the river Waal

[4] One should bear in mind however that the underlying analyses assumed that all professional inland vessels would be fitted with AIMS.

will be covered by a continuous VTS. If we study Table 1 in detail it appears that VTS will have only a small effect on the reduction of the accident costs, if the area of coverage of VTS is also taken into account.

SROB is not necessarily dependent on the availability of the VTS. The required shore installation of SROB could operate unmanned. When a radar sensor is available, the picture that is obtained can be sent to passing vessels. Nevertheless, the area of coverage of the radar sensors is restricted and a great number of sensors would be needed to cover the whole river. If SROB is based on VTS sensors, SROB will also have only a small effect on the reduction of accident costs, if the area of coverage of VTS is also taken into account.

Full coverage of the entire river by VTSs or SROB seems unlikely, given the considerable costs involved. Also from section 1 it will be clear that the benefits of a RIS are not limited to safety and reduction of traffic delays on a tactical level, the items that are addressed by VTSs and SROB. Relevant benefits are also to be expected from improving ETA's and better information on water levels. For a discussion of the elements of a RIS, two elements might apply to the entire river. In Table 2 attention has been paid to:

- lock management and reduction of delays at locks (in the case of AIMS)
- casualty reduction
- reduction of traffic delays
- increase of cargo-carrying capacity (in the case of ECDIS/FIS)

Lock management includes better adaptation of the lock process to the arrivals of vessels or informing vessels of the starting time of a new lock cycle.

Traffic delays can be reduced when the navigator is better informed about navigable space and when oncoming vessels are identified, so that he can contact them in case of any uncertainty regarding the track to be followed, which might otherwise have led to speed reduction.

Cargo carrying capacity may be increased by a better utilisation of the present water levels as well of those of the near future. These elements are addressed by AIS and ECDIS/FIS. When the expected benefits be are summarised, the following table results.

Balance of AIS (all values are ECUs)			
Benefits	1995	GS	ER
locks	2,044,453	3,652,492	3,323,447
casualty reduction	461,823	563,304	1,875,924
reduction of traffic delays	9,717	58,397	585,229
Total	2,515,993	4,274,193	5,784,600

Balance of FIS (all values are ECUs)			
Benefits	1995	GS	ER
cargo carrying capacity	1,412,338	1,698,646	2,701,126
casualty reduction	150,227	158,466	372,281
reduction of traffic delays	9,717	77,863	1,672,083
Total	1,572,282	1,934,975	4,745,490

Table 2 Survey of benefits

Table 2 indicates that interesting benefits may achieved. It also shows that in monetary terms the benefits are mainly of logistic nature.

4.3. User requirements

4.3.1. Assessment of user needs

The normal procedure to assess user needs is to derive them from interviews, checklists and questionnaires where users play the dominant role. This procedure is useful when a new system takes over the functions of a number of ageing systems and where the requirements can clearly be defined by the users themselves. The present project is somewhat different. A River Information Service (RIS) may have features which users do not know they want, because they had never thought of them. A RIS is an example of a service where, after demonstration of the system's capabilities, users may say that they are interested in the characteristics it offers. User needs have therefore been developed by experts based on knowledge of and experience with the processes and tasks involved.

4.3.2. Users

The users of a RIS are in the first place those who directly benefit from the services:

- skippers
- the competent authority
- shippers, charterers en terminal operators.

4.3.3. Skippers

The most obvious users of a RIS are the skippers and mates of inland vessels and seagoing vessels operating on inland waterways. The user requirements of skippers can be divided into those dealing with tactical information and those dealing with strategic information.

Tactical traffic information is information that affects the skipper's immediate decisions in the actual traffic situation and the geographical surrounding.

Strategic traffic information is information that affects voyage preparation and voyage execution in the medium to long term.

Tactical information - and hence the user needs - mainly deal with the navigation process. User requirements concerning strategic information however not only affect the navigation process but also contain a logistic element. The tactical requirements serve to enhance safety and to a lesser extent efficiency. On a tactical level the information available to skippers can be enhanced by providing traffic information for locations that are 'around the corner'. i.e. outside his line of sight or the line of sight of the on-board radar.

A major enhancement will be identification information provided by AIS/ transponder technology. This would complement 'old fashioned' VHF communication or - if digital communication means are included - greatly reduce presently overloaded VHF communications. Due to the relative importance of traffic handling, a head-up display and close resemblance to the on-board radar display is very important.

The strategic user requirements aim to enhance the efficiency of inland waterway transport as well as its position in the inter-modal logistic chain. These goals may be reached by, among others, centralising the information needed for voyage planning in a digital format within the RIS and thereby facilitating possibilities to link it to voyage planning software. By making position and/or estimated time of arrival (ETA) data available on-line to lock operators it will be possible to 'book' a lock operation at a time most convenient for both vessel and lock, allowing more efficient lock operations and fuel saving.

4.3.4. Competent authorities

The use of a RIS by competent authorities will have different rationales. The most important are:

- calamity abatement
- overview of traffic in the vicinity of an incident
- knowledge of cargo on vessels involved
- (digital) communication with vessels involved and/or in the vicinity
- management of locks, bridges, harbours
- statistical information

Calamity abatement

Some authorities are responsible for calamity abatement along the fairways. This responsibility encompasses the implementation of measures which should reduce the consequences of an accident with a vessel carrying dangerous substances. The Netherlands fairway authority has introduced an information service which contains all particulars of vessel and cargo when dangerous goods are transported. The skipper is obliged to report his dangerous cargo before departure. The information is attached to the vessel, minimising reporting at the next reporting points.

In the event of a calamity, a special procedure starts informing all authorities involved. According to Dutch Law the regional fire brigade commander has responsibility for calamity abatement . If he wishes to obtain information about the cargo, this can be retrieved from the database[5]; and presented on a screen according to the location of the accident. The software used is called *Aquabel*.

Calamity abatement is in fact a management tool which is used in exceptional cases. However the information needs to be collected for each and every vessel that transports dangerous goods. When, as is normally the case, nothing happens during the trip of a vessel with dangerous goods, the information on the vessel, its cargo and destination are usually deleted. It should be remarked however that IVS 90 also produces lists of ETA's of vessels at locks, but this option is not very often utilised, due to the different allocation schemes in use when passing locks.

Dutch public opinion considers calamity abatement an important tool for reducing the consequences of accidents with vessels carrying dangerous goods, in relation to the preservation of the life of innocent citizens living on the waterside, as well as the preservation of a clean and healthy environment. The database and mandatory reporting system can be used as the core of a new RIS.

Management of infrastructure

The competent authorities manage a great number of locks, bridges and harbour basins including quays and terminals. In the present situation the authorities usually only know about a vessel shortly before she arrives. Advanced planning is therefore impossible. This results in inefficiency on the vessel's side, but also in the use of the infrastructure. Optimisation of the lock process cannot take into account vessels that are unknown, but which may arrive just after a schedule has been drawn up. The resulting waiting times of vessels lead to a larger than necessary need for expensive waiting places.

The same applies for bridges. Advanced knowledge of ETA's of vessels heading for a bridge will enable better balancing of the interests of shipping on the one hand and rail/road on the other.

Finally, a better knowledge of vessel ETA's allows a better use to be made of harbour basins and could simplify the collection of harbour dues.

Statistical Information

The phasing-out of the '*tour de rôle*' system in Europe, in addition to the open borders of EEC countries, results in tremendous lack of data about goods carried on inland waters. This information is however much needed for policy making. A RIS can be used to fill in this gap.

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[5] This database is called IVS 90 in the Netherlands and MIB in Germany

4.3.5. Shippers and charterers

Usually shippers (the cargo owners) make use of the services of a charterer to provide the necessary vessel(s) for the transport of their cargoes. Charterers often have long term relationships with both shippers and ship-owners.

Hence relationships can exist:

- between shippers and charterers,
- between charterers and vessel-owners,
- shippers and vessel-owners directly.

The shipper will generally need information, such as the quality of the vessel, the number of holds and the dimensions of the hold(s), tariffs, sailing schedules, special provisions (e.g. RO/RO), etc.

The charterer needs information about, among other details: fairways, authorised vessel dimensions, terminals/ stevedoring companies, the vessels available, legislation and regulations, tariffs and conditions, information on connecting transport (train, truck), ETA's and ETD's, predicted water-levels on the rivers, 'status of the holds' of the vessel.

The shipper's interest is that his products will be on time at the place of destination, in an undamaged condition and for a competitive price. He informs the charterer about the demands (quality) of the vessel with respect to the products he wants to transport. He also needs to have an idea about the possibilities of waterborne transport. The charterer is the specialist in this respect. With respect to ETA's and ETD's the shipper's direct interest is that the vessel is in time at the loading place (e.g. the shippers' company).

The charterer needs (strategic) information about the fleet composition and (tactical) information about the availability of vessels for a certain consignment. He needs information about the 'status' of the hold(s) of the vessel: what was the previous cargo, have the hold(s) to be cleaned or is it possible to load the (new) cargo directly into the vessel without cleaning? He needs information about water-levels in order to plan the number of vessels needed for the assignment. He has to know whether there are obstructions or draft restrictions in the fairways to be used.

The more accurate and reliable the above mentioned information is, the higher the quality of the services of both shipper and in particular the charterer. High quality, punctual service is nowadays an important selling point. The quality of the information involved in the process plays a paramount role. Certain information derived from a River Information Service may contribute to the improvement of the process of shipping and chartering.

Part of the relevant information in the shipping and chartering business is commercial and hence confidential. Shippers and charterers will require a River Information Service to respect their commercial interests and want crucial information to be protected.

4.3.6. Terminal operator

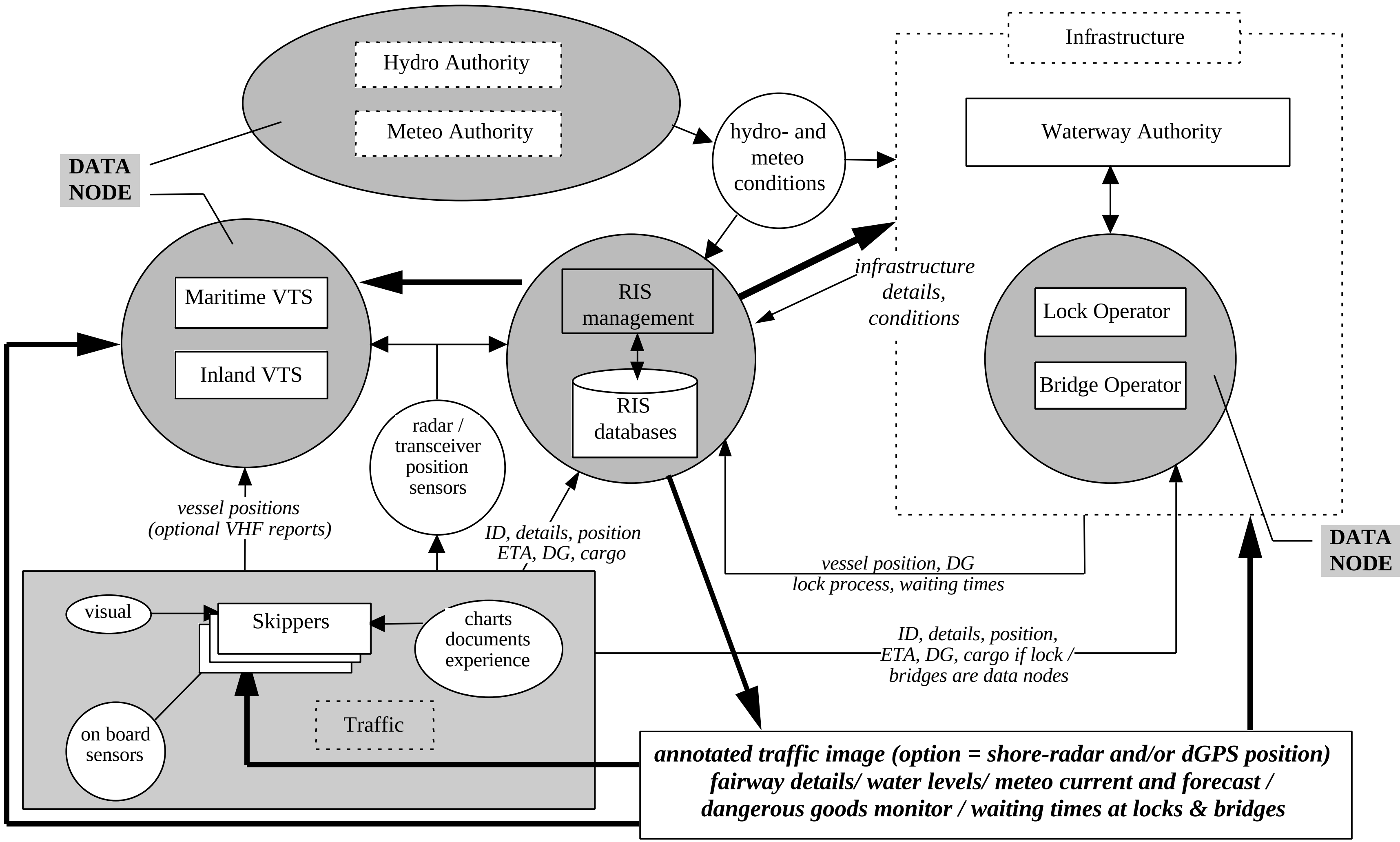
A terminal operator is mostly interested in reliable and accurate ETA's to plan his terminal operations efficiently. He needs to have information about the dimensions of the vessel and information about the weight and particulars of the cargo. At present the charterer informs the terminal operator about the ETA of the vessel at an early stage. Shortly before arrival, skippers will inform the terminal operator either by VHF or by mobile telephone. With access to a River Information Service the terminal operator does not need to contact the individual vessels. With an overall picture of the vessels' ETA's, status of the cargo, etc., that are relevant for his terminal, operators may greatly improve berth planning, connecting transport modes, scheduling personnel, etc.

4.4. Functional Specifications

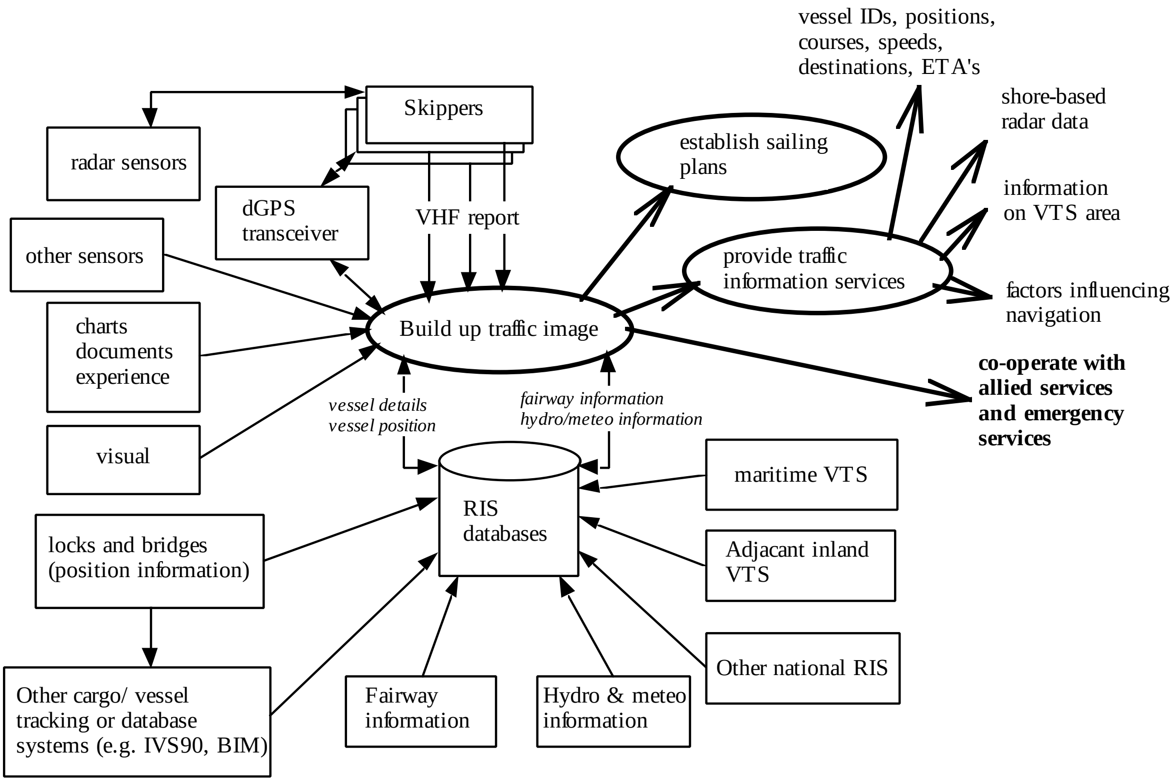
Work package 4 contains a breakdown of information flows today and as they would be in future within a proposed River Information Service. The work package summarises the overall structure of the kind of River Information Service which might be envisaged. This includes not only supplying vessel positions to skippers on the basis of shore-based radar and DGPS data, but also the main contents of database information referring to the infrastructure, meteorological conditions, lock processes, etc.

The functional specifications of INCARNATION form a necessary intermediate step between the user requirements and the technical specifications. The functional specifications organise the user needs in logical relationships and information flows. These are illustrated by the following flow charts and tables.

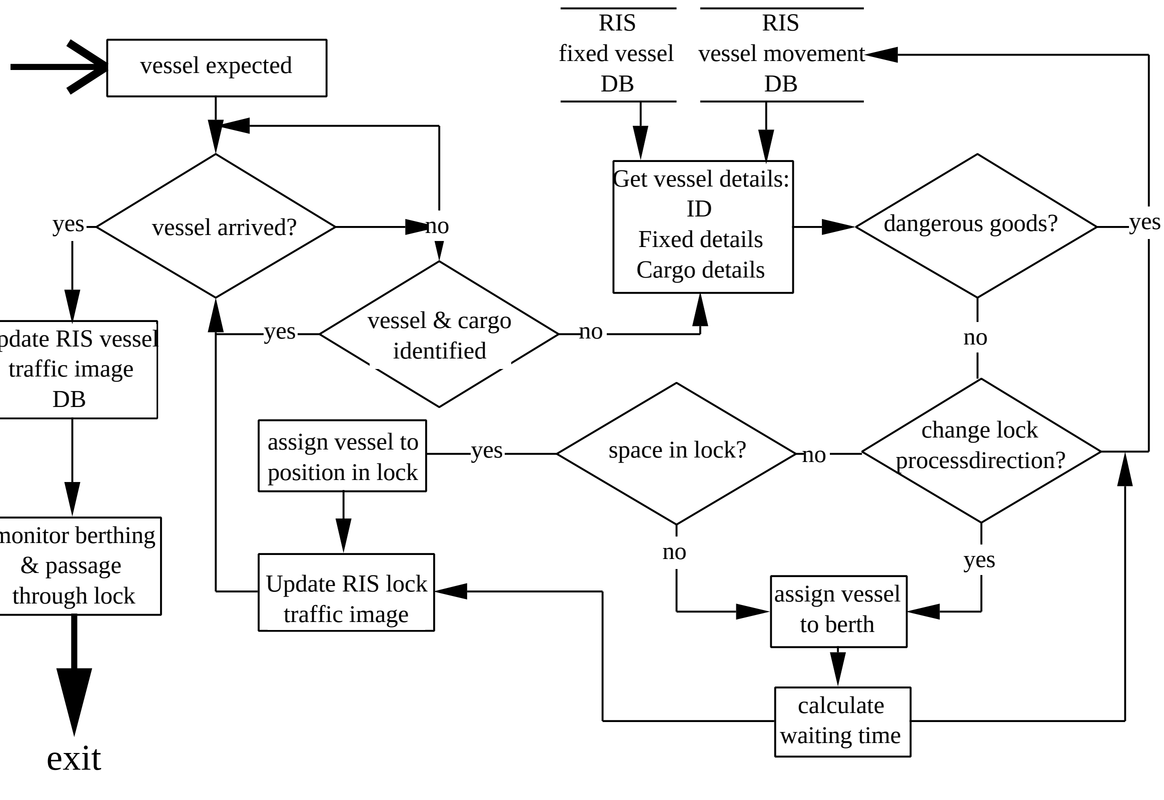
4.4.1. Navigation and voyage planning with RIS



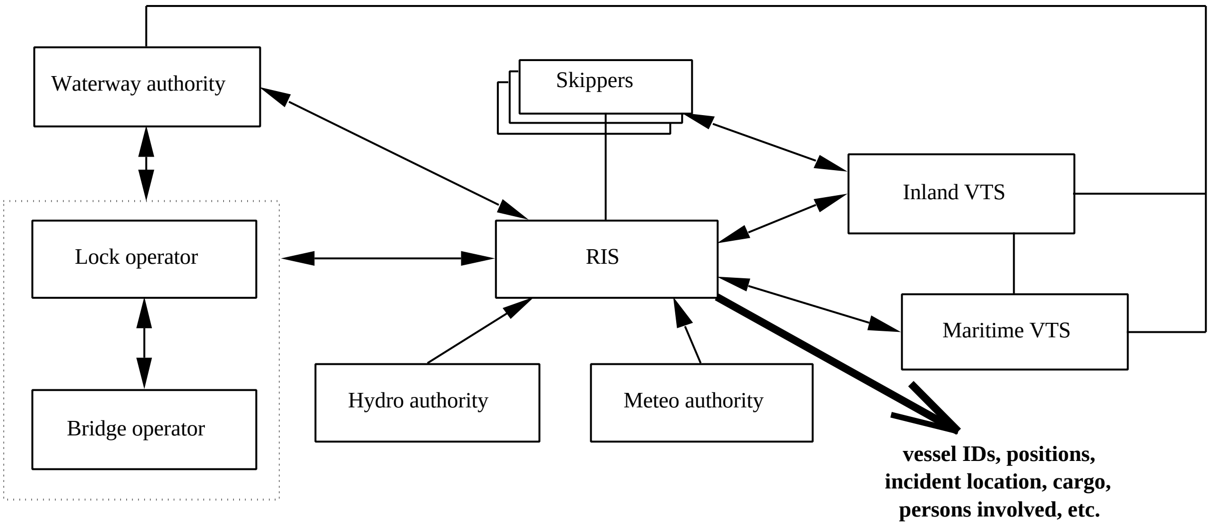
4.4.2. Inland VTS with RIS (VTS as data node)



4.4.3. Lock process with RIS (lock as node)

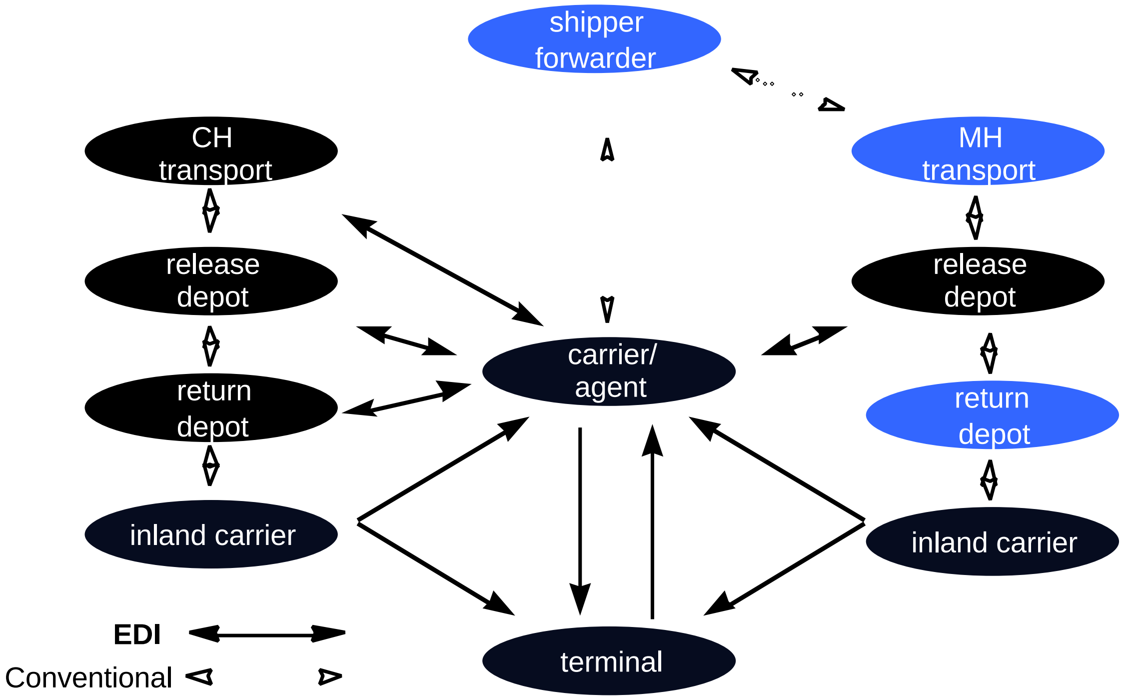


4.4.4. Calamity abatement

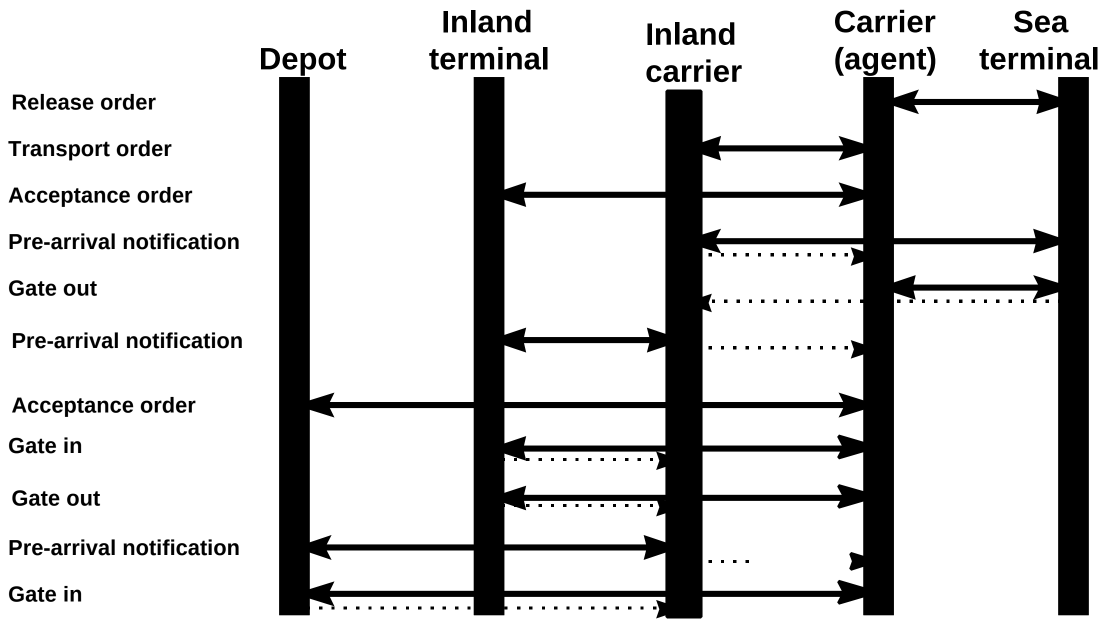


4.4.5. Cargo handling: within the Dutch EDI-Land system

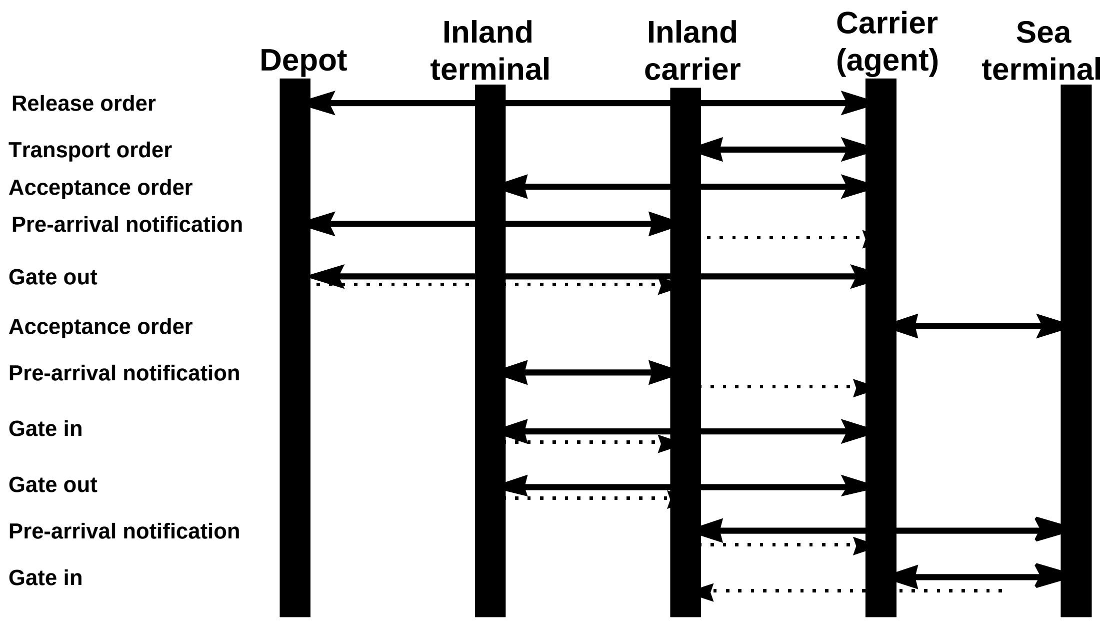
Process/data flow:



4.4.6. EDI-land Import scenario (Netherlands)



4.4.7. EDI-Land Export scenario (Netherlands)



4.4.8. Database contents and data flow

Recipient / Sender	Shipper	Consig-nee	Broker	Vessel Co.	Vessel owner	Skipper	Termi-nal Opera-tor	Lock opera-tor	Bridge opera-tor	Water-way authori-ty	Hydrolo-gical authority	Meteo autho-rity	Inland VTS	Maritime VTS	Police	Customs
Shipper			Cargo availability + Cargo details	_If no broker_ Cargo availability + Cargo details	_If no broker_ Cargo availability + Cargo details		Cargo details ETA ETD			*_Dutch IVS 90 & BICS systems_ I(1) (see notes below)						
Consignee			Cargo availability + Cargo details	_If no broker_ Cargo availability + Cargo details			Cargo details ETA ETD									
Broker	Time of availability for a new consignment; Last cargo; State of holds; Vessel fixed details Agreement on terms of transport	Time of availability for a new consignment; Last cargo; State of holds; Vessel fixed details Agreement on terms of transport		Cargo availa-bility + Cargo details	Cargo availa-bility + Cargo details	Loading place and time										
Shipping Company	_If no broker_ Agreement on terms of transport	_If no broker_ Agreement on terms of transport	Agreement on terms of transport			_If no broker_ Loading place and time										

Recipient / Sender	Shipper	Consig-nee	Broker	Vessel Co.	Vessel owner	Skipper	Terminal Operator	Lock operator	Bridge operator	Waterway authority	Hydrological authority	Meteo authority	Inland VTS	Maritime VTS	Police	Customs
Ship owner (may also be skipper)		*If no broker* Availability for new consignment; Last cargo; State of holds; Fixed vessel details	Time of availability for a new consignment; Last cargo; State of holds; Vessel fixed details Agreement on terms of transport													
Skipper (own ship)				Time of availability for a new consignment		*Other skippers* Passing arrangements	ETA for loading or discharging; Resource requirements	ETA at lock Fixed vessel details Variable vessel details (esp draft) Cargo DG.		**Dutch IVS 90 & BICS systems* I	Request for details of water depths, currents	Request for short term and long term weather forecast;	Vessel fixed details; DG on board;); ETA in VTS area		Any anomalies spotted (hazards, calamities, etc	Import or export documents, taxes, etc;
Terminal operator	Availability of resources Tariffs, etc.					Berth availability Resource availability				**Dutch IVS 90 & BICS systems* I						

Recipient / Sender	Shipper	Consig-nee	Broker	Vessel Co.	Vessel owner	Skipper	Termi-nal Opera-tor	Lock opera-tor	Bridge opera-tor	Water-way authori-ty	Hydrolo-gical authority	Meteo autho-rity	Inland VTS	Maritim e VTS	Police	Customs
Lock operator						Lock opening times; Lock availa-bility; Lock process direction; Waiting times; Anoma-lies or restric-tions		*Adjacent lock operator* Vessel ATD, Vessel fixed details; Vessel variable details; DG		Vessel ATD, ETA. Vessel fixed details; Vessel variable details; DG	Local hydrolo-gical conditions	Local meteoro logical condi-tions (eg: fog, ice, visibilit y)	Vessel ATD, ETA. Vessel fixed details; Vessel variable details; DG		Anomali es	Vessel ETAÕs? vessel details? Anomali es
Bridge operator						Bridge opening times; Bridge availa-bility; Waiting times; Anoma-lies or restric-tions		*Adjacent bridge operator* Vessel ATD, Vessel fixed details; Vessel variable details; DG		Vessel ATD, ETA. Vessel fixed details; Vessel variable details; DG	Local hydrolo-gical conditions	Local meteorolo gical conditions (eg: fog, ice, visibility)	Bridge opening times; Bridge availability; Waiting times; Anomalies or restrictions Vessel ATD, ETA. Vessel fixed details; Vessel variable details; DG		Anomali es	Vessel ETAÕs? vessel details? Anomali es

Recipient / Sender	Shipper	Consignee	Broker	Vessel Co.	Vessel owner	Skipper	Terminal Operator	Lock operator	Bridge operator	Waterway authority	Hydrological authority	Meteo authority	Inland VTS	Maritime VTS	Police	Customs
Waterway authority	**Dutch RIZA system see note I(2) below*			**Dutch RIZA system*	Regulations and restrictions; Fairway dimensions; Water depths; obstacles; notices to traffic; works; procedures	Regulations and restrictions; Fairway dimensions; **Dutch RIZA system see note I(2) below* Water depths; obstacles; notices to traffic; works; VHF frequencies; procedures; berthing places; fresh-water, supplies, resources;	Regulations and restrictions; Fairway dimensions; Water depths; obstacles; notices to traffic; works; VHF frequencies; procedures	Regulations and restrictions; works	Regulations and restrictions; works	**Dutch RIZA system see note I(2) below*	Changes in fairway details;	Results of local sensors?	Regulations and restric-tions; chan-ges to fairway; works; notices to mari-ners;		Regulations; anoma-lies; ;	
Hydrological authority					Water depths; condition of water; currents; sluice opening							ice	Water depths; condition of water; currents; sluice opening			
Meteo authority				Local and long-range weather forecast / conditions									Local and long-range weather forecast / conditions			

Recipient / Sender	Shipper	Consignee	Broker	Vessel Co.	Vessel owner	Skipper	Terminal Operator	Lock operator	Bridge operator	Waterway authority	Hydrological authority	Meteo authority	Inland VTS	Maritime VTS	Police	Customs
Inland VTS						Traffic image; rules and regulations; restrictions; hazards; warnings, advice; meteo and hydrological information;		Vessel position; Vessel ID (fixed details) vessel variable details, DG onboard; ATD VTS area; Local hydro and meteo conditions; anomalies	Local and long-range weather forecast / conditions	Local conditions and anomalies; vessel statistics; DG	Anomalies (pollution, spills) local conditions (water depths, water condition, ice, etc)	local conditions (wind, temperature, precipitation, ice, pressure ...)	*Adjacent VTS* Vessel position; Vessel ID (fixed details) vessel variable details, DG onboard; ATD VTS area; Local hydro and meteo conditions; anomalies		Anomalies	
Maritime VTS						Traffic image; rules and regulations; restrictions; hazards; warnings, advice; meteo and hydrological information;		Vessel position; Vessel ID (fixed details) vessel variable details, DG onboard; ATD VTS area; Local hydro and meteo conditions; anomalies	Local and long-range weather forecast / conditions	Local conditions and anomalies; vessel statistics; DG	Anomalies (pollution, spills) local conditions (water depths, water condition, ice, etc)	local conditions (wind, temperature, precipitation, ice, pressure ...)	*Adjacent VTS* Vessel position; Vessel ID (fixed details) vessel variable details, DG onboard; ATD VTS area; Local hydro and meteo conditions; anomalies		Anomalies	
Police																
Customs																

5. Tactical Traffic Image

5.1. Technical Specifications

5.1.1. Introduction

The System/Segment Specification contains - as the first part of the technical specifications of the INCARNATION Project- the specification of the functions for the pilot system of the INCARNATION project and - as the second part of the technical specifications - the technical design of the pilot system.

The specified system is a part of the River Information System; called TIRIS - Traffic Image of the River Information Service. TIRIS is the system for presentation of a tactical traffic image on board of a vessel, based on traffic information from a shore-based radar, transponders and traffic reports.

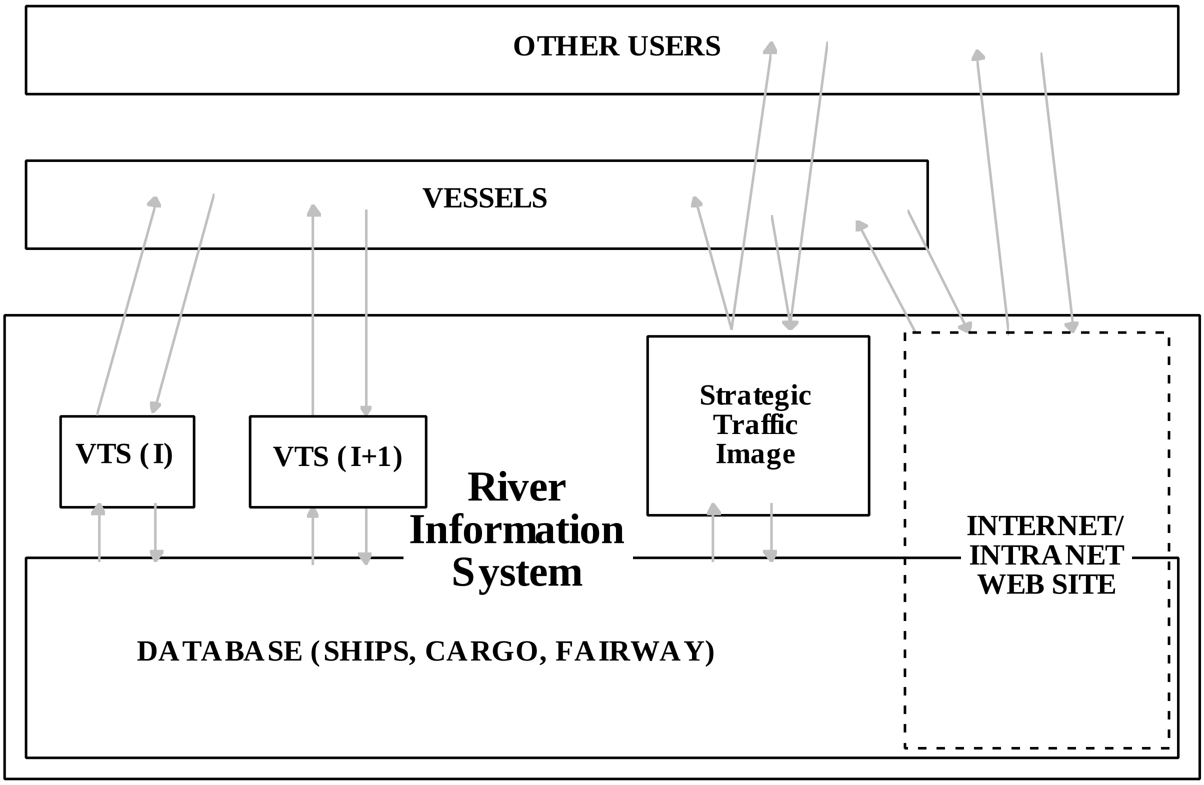


Figure 1 Schematic view of a River Information System and its components.

The system supplements and supports existing on-board traffic imaging systems on vessels, and includes the following features:

1. Display of traffic picture as seen by the shore-based radar and AIS transponders.
2. Display nautical information and traffic reports.

5.1.2. TIRIS - The tactical traffic image of the RIS-concept

The TIRIS -system is designed to enhance the on-board traffic picture by providing vessels with information generated by shore-based radar stations and with additional information such as traffic information.

The TIRIS system comprises the following subsystems:

Radar

Target Detection, Target Tracking

Shore

Radar Picture Generation, Information Management, System Control

Vessel

Presentation

Communications

Communications

The following block diagram provides a functional overview of the TIRIS system:

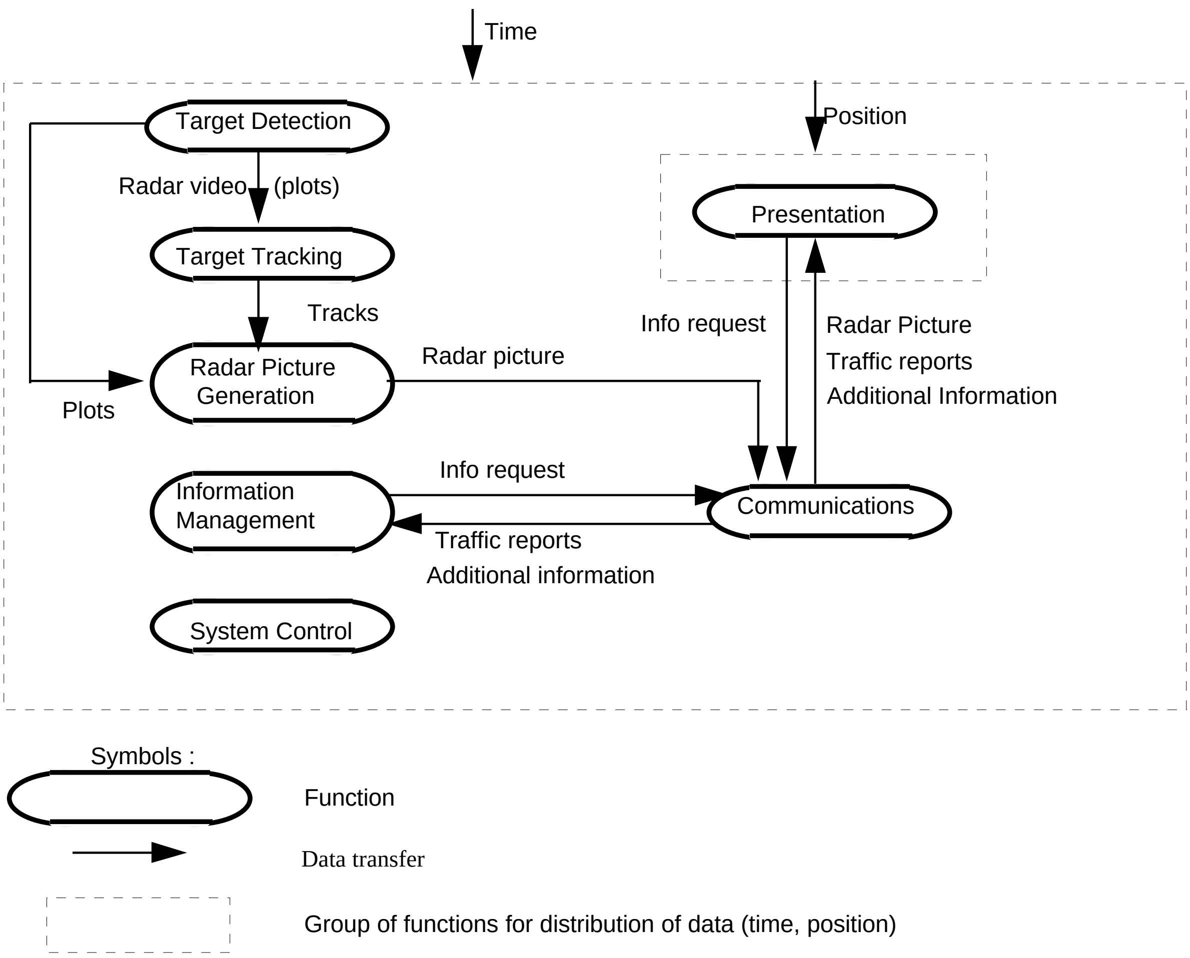


Figure 2: Functional overview of the TIRIS system

The data produced by a radar station, after filtering and digitalisation (video extraction), are sent to a target tracker which combines and selects the data, and constructs and maintains tracks for targets detected.

The shore-based system constructs a radar picture based on the detected tracks and plots which encompasses the entire area covered by the radar; the radar targets are sent to the vessel. In addition, traffic information is also sent to the vessel. Finally, additional information requested by an individual vessel by means of an information request is sent to that vessel. Additional information includes both information which is managed locally by the shore subsystem and urgent traffic information obtained from external sources.

The on-board system superimposes the radar picture received onto the charts kept on board and displays the resultant traffic picture on a dedicated monitor. Traffic reports are presented to the skipper.

The "System Control" function relates to the shore subsystem. All the necessary control actions are performed within this component. Details of these actions will be given in the description of the shore subsystem; individual data flows are therefore not shown in Figure 2.

Radio transmission will be used for communications between shore and vessel.

Users

The TIRIS distinguishes the following users:

- The *skipper*, who is the operational user of the traffic image of the TIRIS system. The skipper interacts operationally with the system and chooses the actions and settings which affect the manner in which the traffic picture is presented.
- The *system manager*, who is responsible for controlling the TIRIS system. These activities include both monitoring the technical status of the system and off-line management and maintenance of system information such as charts, data files, etc. The system manager can modify system information which is then activated for the operating system.
- The *information manager* - e.g. a VTS operator - responsible for managing the traffic/data reports.

Traffic picture of the TIRIS system

The traffic picture consists of the radar picture, maps/charts and traffic reports. The radar picture consists of radar video (plots), buoys and tracks. Radar video consists of the displayed results of radar detection (plots).

The position, length, width, heading and echo strength are calculated for each object detected by the radar; these calculations result in target reports (plots).

5.1.3. Radar subsystem

The radar subsystem includes the following components:

- Radar Sensor
- Extractor
- Single Radar Tracker (one for each Radar Sensor)
- Multiple Radar Tracker, needed where there is more than one Radar Sensor.

Target detection

Vessel detection is performed by means of advanced radar data analysis techniques. During this process, objects in non-relevant areas are blanked out, and clutter (e.g. background echoes) is attenuated. The radar data are aggregated together to form targets with a given length and breadth.

Target detection is a dynamic process that is carried out in the extractor. In the extractor, objects are determined by a group of resolution cells which can all have different echo strengths. The position, length, breadth, heading and echo strength are calculated for each object detected. The plots are passed to the target tracker and to the shore subsystem.

The target tracker processes the filtered radar video on a scan by scan basis for each radar station to form tracks. These tracks are combined for those areas scanned by more than one radar station to give central tracks, which provide a more accurate traffic picture than simply aggregating together the presentations of each separate radar station. Tracks are constructed in the coverage area of the radar.

Target tracking

Target tracking is a process by which the filtered radar video is processed on a scan by scan basis for each radar station to create tracks. For areas scanned by more than one radar station, these tracks are combined to give central tracks which provide a more accurate traffic picture than simply aggregating together the presentations of each separate radar station. Each central track identified by the target tracking process is unique to the entire system, and this makes it possible to link information to these central tracks, which is maintained for as long as the target is detected by any sensor in the system.

5.1.4. Shore subsystem

The shore subsystem has the task of constructing the radar picture on the basis of the target data being received. Blanking areas and buoyage data used in this process can be modified by the system manager. The radar picture is sent to the vessel system.

The data traffic between the shore and vessel subsystems consists of the radar picture (i.e. track and plot updates), traffic reports.

Maps

The system will be able simultaneously to construct a composite radar picture from the video from different radar stations. The **mosaic map** contains the mosaic boundaries needed for this. The system manager will be able to edit this map.

An **area blanking map** is used to suppress areas of no interest (mostly land), in order to reduce the number of targets requiring processing by the video extractor. There will be a separate area blanking map for each extractor.

This water blanking map is used to indicate the sections of the waterway which are to be blanked out.

The **buoyage chart** is used to detect buoyage. The map may be edited by the system manager. The buoyage detected is used to generate buoyage tracks, which are sent to the vessel.

Information management

Nautical information of importance for the traffic situation is managed by the shore subsystem and sent regularly to the vessel. Nautical information will be maintained by the information administrator.

5.1.5. Vessel subsystem

The vessel subsystem constitutes the link between the skipper and the shore subsystem. An overview, adjustable by the skipper, of the traffic in the radar coverage area is displayed on a dedicated monitor, with charts, track history.

Screen output will be presented in windows. Windows will be used to display the following information categories (one window per category):

- Traffic picture with maps, tracks, plots and labels.
- Traffic information.
- Information generated by local screen functions.
- Function menus.

The screen is controlled using a pointing device and the keyboard.

The following objects are pointer-sensitive:

- Tracks and the associated labels (plots are not pointer-sensitive).
- Displayed chart objects.

Charts

The chart consists of lines, filled or unfilled areas and symbols. This chart is based on a GIS file, constructed from the Digital Topographical Database for Rivers - *in RIS-future adapting the Inland ECDIS-standard*.

The GIS database contains definitions of object types (for example: bridges, locks, etc.). Each object type can be displayed either always, never, or at the request of the skipper.

The form and size of the symbols used in the various objects can be freely specified by the principal or will correspond to the symbols specified by IALA or SIGNI. Chart objects can be set to be displayed always or conditionally (i.e. at the request of the skipper). The skipper can define a predetermined number of chart types of his own choice.

Orientation

The skipper will be permitted to select a relative or an absolute picture orientation. Relative picture orientation means that his vessel will be displayed at the "centre" of the screen, with the surroundings moving. The "centre" means here that use is made of a margin around the selected position. This margin is equal to 25% of the range set. With absolute orientation the surroundings are fixed and dynamic objects (vessels) move. If there is no position-finding equipment on board the vessel then absolute orientation will be selected by default until the skipper has marked the position of his own vessel, when the display will switch to relative orientation.

5.1.6. Communications subsystem

A communication link is necessary for suppliers of TIRIS and the transponder system produced under the AIS recommendations of IMO / IALA.

A (VHF)duplex communication link with a minimum bandwidth of 2 * 25 kHz is needed to fulfil the requirements for communicating 2 * 9600 bit/s. Because of the limited bandwidth the modulation scheme should be Gaussian Minimum Shift Keying (GMSK). GMSK is also very robust to phase errors.

The operating area of the communication system - and the TIRIS system - depends - because of the amount of data to be transmitted - primarily on traffic intensity in the area. The area can be enlarged by using two or more VHF duplex-channels

The communication system must be used for transmitting transponder data - from vessel to shore - as well as the radar and or the transponder traffic image -from shore to vessel.

5.1.7. AIMS

The Automatic Identification & Data Management System (AIMS) is a VHF broadcast system in the marine band. Each vessel equipped with a Mobile Transceiver Unit (MTU) is broadcasting its navigational, static and voyage related data automatically, using an adequate update-rate. A GNSS receiver with differential error correction capability provides accurate navigational data. Differential error correcting (e.g. for DGPS) is provided by a base station.

AIMS 7100 provides an autonomous mode and a controlled mode. The autonomous mode is dedicated to the open-sea. Vessels approaching coastal areas or inland waterways will be switched into the controlled mode by a base station. This means that mixed traffic (seagoing vessels using inland waterways) can use the same equipment for all areas.

In both modes the actual traffic image of all system users within the coverage area is available on the vessel.

The controlled mode provides a variety of services to skippers and VTS-operators. These include weather information, waiting times at locks, data fusion with existing radar sensors or reduction of voice communication by automated correlation of call-signs and radar tracks.

By using the optional telemetry module traffic lights, lighthouses, etc. can be controlled or monitored through several analogue and digital I/O channels.

Data exchange between systems users is possible due to the built-in Short Message Service (SMS). Vessel owners etc. can be connected via LAN/WAN. Privacy can be guaranteed by using cryptographic techniques.

The system design refers to the OSI standard and is therefore open for special applications or stand-alone solutions without the need for a change of hardware. One special application is the transmission of synthetic radar, based on plot information, onboard of a vessel, as demonstrated in the project together with HITT.

This technique enables the skipper to use the tactical traffic image of a VTS-Centre, which allows him "to look around the corner".

5.2. The INCARNATION demonstrator

In preparation for the demonstrator the "radar tracking" part was simulated by means of a radar recorder that replayed the radar data from the VTS at Drechtsteden. The "transponder part" of DASA was simulated by a traffic simulator, that injects the GPS data for the test of "multi sensor fusion".

The HITT equipment was installed on site (VTS Drechtsteden) in the last week of August 1997 and integrated with the equipment of DASA to build the integrated pilot system of the INCARNATION project. In this week the mobile unit was installed and tested on shore. In the following weeks the mobile units were installed and run on the vessels that were used during the demonstrations. Scenarios were developed to best demonstrate the functionality of the pilot system. The demonstrations started October 13th, 1997.

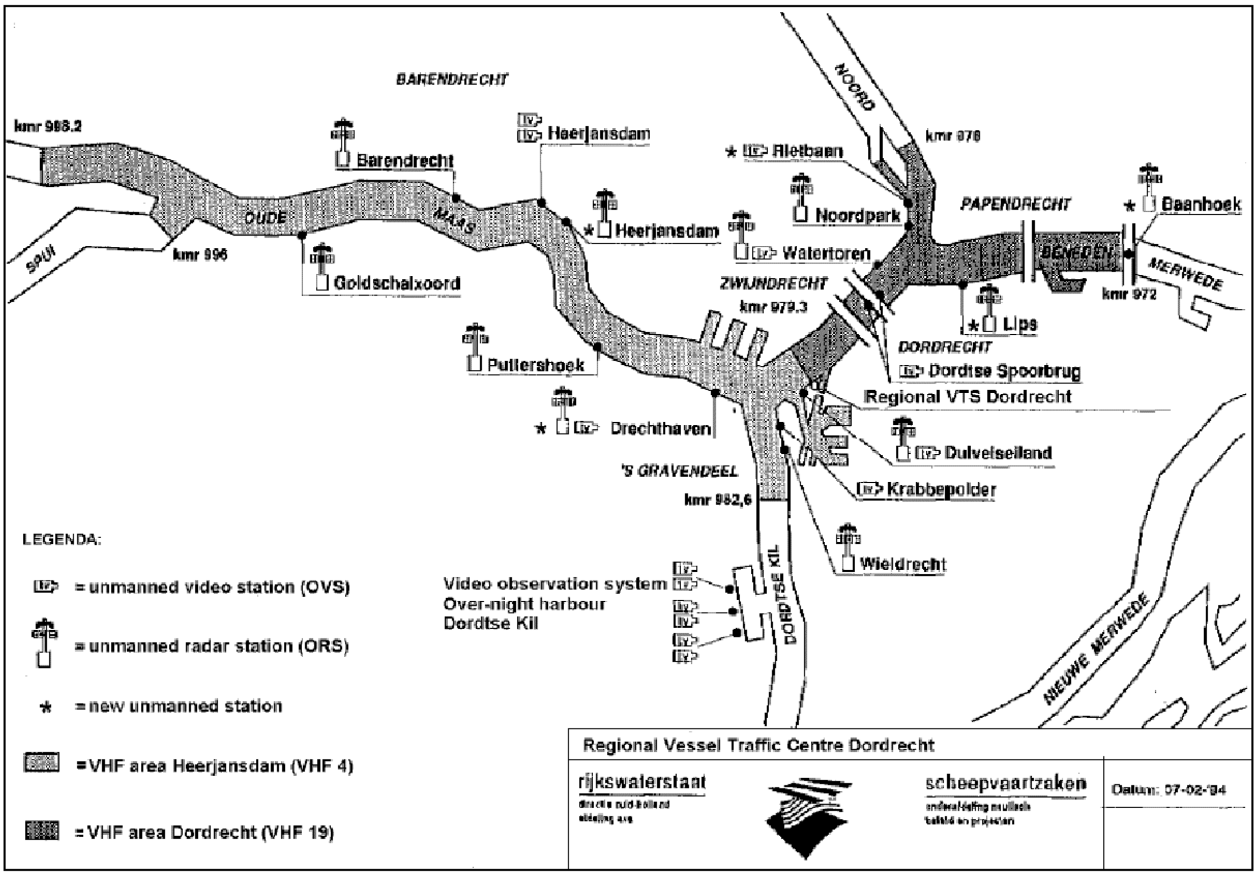
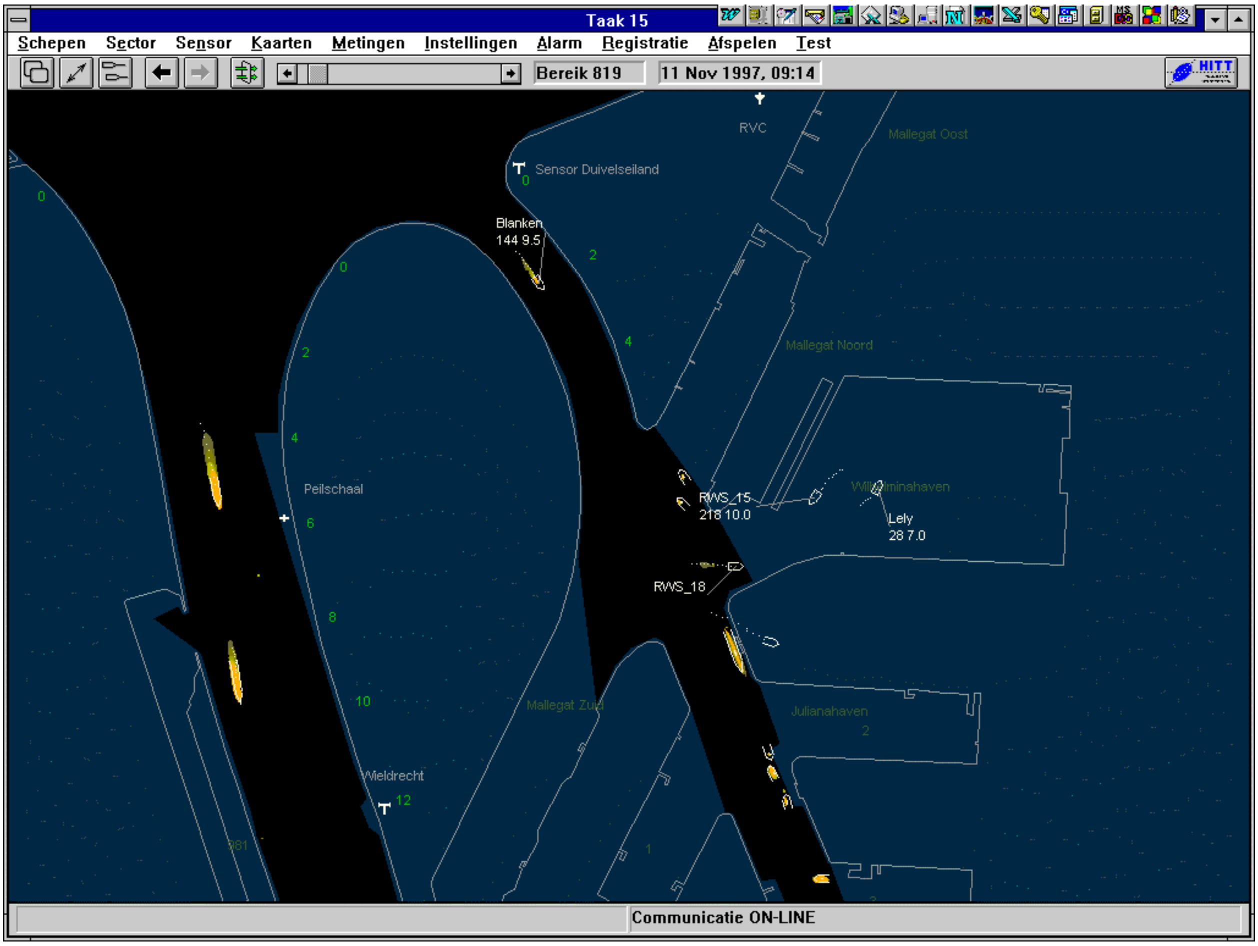


Figure 3: Demonstration area INCARNATION

The functionality of the demonstrated system can be described briefly as follows:

- VTS Drechtsteden contains a complete multi radar tracking system with a radar coverage area that covers the demonstration area. The demonstration area covers the crossing of three fairways near the traffic centre of VTS Drechtsteden (see Figure 3).The radar data of VTS Drechtsteden is combined with GPS data that is received from the vessels' transponders. This function is called "multi sensor fusion". The combined information is broadcast to radar displays on the vessels. VHF transceivers are used to transmit GPS data from vessel to shore and to broadcast the combined radar/GPS data from shore to vessels that carry a transponder. These will. be presented as an identified target on the vessels' radar display.
- The identifier (e.g. vessel's name or call-sign) is derived from the unique code received from the vessels' transponder. Vessels that do not carry a transponder will be displayed as an unidentified target, provided that the vessel is detected by radar. If the target is detected by radar, then the position, speed and course data of the displayed target is based on radar data, otherwise it is based on GPS data. The vessels' display enables "relative motion" display with the own vessel's position in the centre of the screen and "head-up" or "course-up" as the orientation of the picture.
- The radar data processing part of the pilot system is provided by HITT and the GPS/transponder (AIMS) is provided by DASA. The vessels were provided by RWS - Directie Zuid-Holland, RWS - Directie Oost-Nederland and KNC.
- Originally Work package 8 was to provide differential GPS data and vessel identification on-board. This aim was enlarged so that the system is now able to transmit synthetic radar based on plot information, also. The communication system is compatible with the upcoming IMO recommendation for an AIS system. By guaranteeing this compatibility, mixed traffic can use the same equipment for all areas. Because of the different regulations for inland navigation (especially the maximum power) some changes had to be introduced to the system.



The shore to vessel link provides a communications link to transmit radar information onboard. Therefore two interfaces have been defined and realised. One interface for the VTS centre and one for the equipped vessels. The interfaces are based on predefined international standards set by IEEE etc. This means that the whole communication system including the external interfaces, the modulation technique etc., is based on existing or upcoming open standards. As a result, this system can be set up by any competent supplier.

The demonstration in Dordrecht included only - part of - the tactical implementation of AIMS. For tactical use AIMS offers the potential to take over the larger part of present day VHF communication. Not only does AIMS offer vessel identification, it may also be used for selective digital communication with regard to passing manoeuvre agreements and so on. Its selectivity is an important safety enhancement. However the most important advantage of the implementation of AIMS may well be on a strategic level: providing all relevant parties in the logistic process with up-to-date position information of vessels and cargo.

6. Assessment

6.1. Introduction

Assessment is a primary issue in INCARNATION. Originally, assessment in INCARNATION aimed to seek and find opinions of people interested in the results of INCARNATION, such as decision makers and users. The mandate for the assessment was to evaluate two traffic images on board: one based on transponder technology and the other based on shore based radar images transmitted to a terminal on board a vessel. The assessment should then encompass different aspects of the use of an enhanced traffic image by the navigator on board. In a later stage the producers of both technologies were able to construct a combined traffic image, which was a major and welcomed breakthrough in the project.

INCARNATION was not a project only aiming at the demonstrator. It also focused on the definition and functional specifications of an information service along rivers and canals in a large region in order to enhance safety, efficiency and the protection of the environment, but also to promote inland waterway traffic.

The design of the project was based on a consideration of safety and efficiency of the present river system, estimation of user requirements, derivation of functional specifications of the system and transformation of the relevant part into technical specifications of the Tactical Traffic Image. The feasibility of the Tactical Traffic Image was to be demonstrated by a small demonstration of the capabilities of the combined traffic image.

The project was to conclude with an assessment.

During the development of the assessment the ever returning question appeared to be whether or not the assessment should be a preliminary assessment of the total RIS in order to have sufficient information for the continuation of much more elaborate demonstrators in a successive project (INDRIS) or to concentrate on the results of the demonstrator of the Tactical Traffic Image.

The second important question was what method should be used for assessment. Basically one has the choice between two fundamentally different methods. The first is a more formal assessment method where those carrying out the assessment make calculations using formal criteria. Decision-makers could then use the results for their own assessment. The role of the project participants is then to collect objective data based on reputable models and methods.

Another type of assessment is assessment by experts, where questions are asked. Although the answers to the questions are subjective, there are many methods available to transform these subjective replies into a consistent result. The method used should be able to provide measures of consistency so that the final user is certain about the impact of the criteria.

The assessment of work package 9 mainly focused on the assessment of the demonstrator and related subjects by experts. A new-technology "Boardroom of the Future" was selected to support the assessment process. This technology is based on the availability of a large number of software decision tools and procedures. The methodology was implemented and checked and subsequently was found ready for use.

Experts were invited to give their opinions. The results could be visualised immediately. However, when the situation regarding the availability of experts was discussed at the end of the day, two major issues became apparent:

- not all experts had seen the demonstrator
- the number of experts was smaller than was desired in order to have confidence in the results of the formal assessment.

6.2. Assessment by experts

The design of the formal assessment was to take the Tactical Traffic Image as a basis and then add some new options, among them the traffic image enhanced by VTS radar signals as well as by AIS. Also the option of fusion of the two signals was being assessed. While the methodology used was scientifically appropriate, there were still some doubts about the reliability and validity of some of the results.

Six situations were presented to the experts, as follows:

1. Own vessel radar + VHF
2. VTS (including VHF communication with operator)
3. SROB tactical traffic image
4. AIMS tactical traffic image
5. SROB and AIMS tactical traffic image
6. VTS and SROB and AIMS tactical traffic image.

The global results indicate that for all expert groups (Skippers, VTS-operators and Policy-makers), situation 6 was regarded to be the best situation. This situation was followed by situation 2. Between situations 3 and 5 only small differences could be discerned. This also applies for situations 1 and 4. These situations were evaluated as being, relatively, the least favourable.

The results were based on a consideration of safety, efficiency and "Quality and contents of the information provided".

Some questions were addressed to the other elements of a RIS, in particular an appreciation of the Strategic Traffic Image and ECDIS/FIS with regard to safety, efficiency and the "Quality and contents of the information provided" by these two elements. Regarding safety, the experts felt that STI and ECDIS/FIS would provide small improvements in safety, whilst larger improvements could be achieved in efficiency. Assessment of the quality and contents of the information provided was somewhat better for ECDIS/FIS than for STI.

6.3. Analysis of the assessments

The results of the assessment (WP 9) and the results of considerations regarding safety and efficiency (WP 1) appear to be contradictory. In WP 9 the assessment indicated that more safety was desired, since the last situation (# 6) was seen as the best solution for a Tactical Traffic Image. The conclusion was based on all factors concerned. From WP 1 it follows that if the important effects were translated into monetary terms, VTS and SROB do not appear to be a cost effective solution. They might be applied under special conditions. On the other hand AIMS and ECDIS/FIS seem to be attractive solutions, certainly from a logistic point of view.

The differences are partly due to the fact that the experts were not sufficiently familiar with the investments and running costs of VTSs and the new intended systems. Furthermore, for different reasons, cost appears to play only a limited role in their evaluations. More importantly, there seems to be a difference in the definition of the various situations. While work package 1 assumed all commercial inland vessels to be fitted with AIMS, apparently during the expert session of work package 9, it was assumed that only a part of the inland vessels would have AIMS. At the same time - contradictory to practical radar performance - the expert session apparently assumed a 100% coverage of SROB.

This explains why the results of WP 9 are different from the results of WP 1.

6.4. General assessment of the RIS

When the numerical results of the expected benefits of a RIS are considered, the immediate benefits are not very large. System costs have not been determined in this project, but if costs of present equipment are used as a guide, despite continually falling prices, a large immediate benefit/ cost ratio may not be expected, even when direct effects such as accident reduction and time delays are taken into account. The effects with regard to resource management, and optimisation of cargo carrying capacity may be better.

When one looks at the individual vessel, the annual benefits depend very much on whether the RIS concept is adopted by shippers, brokers and terminals. The logical effect of enhanced ETA information would be a change of the present contracts which allow for a number of loading and discharging days without extra pay, to contracts with less allowance for such waiting days. If there is no corresponding reduction in the freight rate this would provide a substantial benefit for the individual vessel. These effects were not accounted for in the assessment.

However, if these gains are not reached, the benefits may still compensate the costs of the required equipment, especially if transponders (AIS) can be provided at low cost. ECDIS software would not be very expensive and most vessels already have a computer on board. Problems are expected in the fusion of vessel borne radar with ECDIS and AIS. The reason is that the integration of components of river radar has advanced so much over the years that it is difficult to send the PPI to a computer display. Investment will be needed to design river radar with modular components so that they can easily be integrated with the ECDIS navigational display.

Further costs will be incurred by the new communication systems which are required to communicate not only with the shore elements of RIS but also with other parties in the logistic chain.

It is nevertheless believed that for most vessels new equipment can be installed on the bridge that is beneficial for the skipper, with recuperation of the investment costs within 4 to 7 years.

Requests from skippers and other players in the logistic chain will not be sufficient to drive introduction of RIS. However, European policy requirements demand a sustainable environment and careful use of the transport infrastructure. Both can be achieved by a modal split which is based on transport prices that include and reflect the use of environmental resources. In these cases air pollution and noise production may be reduced substantially if there is shift from road transport towards inland navigation transport. Some studies have suggested reductions of a factor 15 in air pollution and it is generally assumed that noise production of vessels on the river will not disturb the people living along the banks of the rivers and fairways.

Nearly all European inland waterways, especially the lower Rhine, will be able to take many more vessels than at present. If this infrastructure is better utilised by taking appropriate measures, the need for new road infrastructure could be delayed. This in turn will contribute to environmental sustainability.

RIS will enhance the use of the inland navigation infrastructure by providing the same quality of services as is available in other transport modes: a large degree of reliability, adequate traffic services such as planning of locks, accurate water level reports and other facilities required for non continuous sailing practices. At the same time RIS would also provide a communication infrastructure for logistic purposes so that both the public and the private aspects are in balance.

7. Conclusions and recommendations

7.1. Conclusions

The following conclusions appear to be important:

1. The policy work package report shows that the development of a coherent European Policy to better utilise the European inland waterway infrastructure in the member states is overdue. Initiatives, such as research projects like EUDET, INCARNATION, RINAC and INDRIS may help to develop a common European policy.
2. RIS comprises a number of services which aim to improve the quality of inland water transport so that it becomes a full fledged competitor of road and railway transport, with the same level of reliability, service, cost-effectiveness and sufficient speed of delivery.
3. The infrastructure of a RIS is also designed to encompass logistic and commercial messages. Tracking and tracing of cargo seems to be a first logical step. The intended infrastructure may also be used to create a smooth interface between inland vessels and stevedores in ports and terminals.
4. From the point of view of noise production and the adverse effects of noise on health of people living in the neighbourhood, river transport emerges in a favourable light. Noise levels on inland waterways are not nearly as high as those on the roads. Each enhancement of river transport helps reduce noise levels.
5. A better utilisation of the inland waterway infrastructure may postpone or even obviate the need for expensive new investments in road or railway infrastructure.
6. The capacity of the present main shipping axes is ample and no major queuing problems may be expected even if traffic density is increased by 50% (European Renaissance Scenario used on the lower Rhine). This may not be expected before 2015.
7. Inland navigation is an extremely safe mode of transport in terms of risk to life. However inland navigation also ranks first in other aspects of safety,.
8. Effects of a RIS are:
   - The safety level on inland waters is already fairly high. The effect of a Tactical Traffic Image on safety will therefore be limited.
   - An AIMS, implemented on a large proportion of inland vessels across Europe will contribute to the efficiency of the use of the fleet, to the efficiency of the use of the inland resources/ infrastructure and to the safety of navigation.
   - Interesting reductions in sailing time and/ or fuel consumption may be achieved using information of the strategic traffic image by locks and a new regime of lock use (This new regime includes advanced planning and an early allocation of space without the necessity of racing to a lock in order to obtain first priority).
   - The use of Fairway Information and ECDIS charts for inland navigation for improved water level predictions may help better utilise the vessel's cargo carrying capacity. The used draft of the vessels may therefore increase whilst the number of groundings due to overloading will be reduced.
9. The role of the RIS with respect to logistics can be extended towards tracking and tracing of cargo.
10. The demonstrator of a Tactical Traffic Image was extremely successful. About two hundred observers attended the demonstrations on the test site and their general impressions were favourable.

11. DASA and HITT were able to fuse their technologies in providing radar based and AIMS based tactical traffic images in an impressively short time. The transmitter and receiver part of the DASA equipment were able to handle the HITT radar targets.
12. The conclusions of the trial weeks were that, in subsequent experiments, better coincidence of the radar targets and AIS targets should be achieved.
13. It was concluded that the demonstrator of the TTI is a firm basis for the larger scale RIS demonstrators across Europe (Task 17: INDRIS).
14. The assessment of the TTI shows that observers are positive about both safety and efficiency aspects. The assessment also showed that, in the opinion of the experts, even after the introduction of an enhanced tactical traffic image on board there will still be an important role for the existing VTSs.
15. The assessment regarding FIS shows that the experts expect the greatest benefits to be increased efficiency.

7.2. Recommendations

1. All the elements of the RIS should be demonstrated in full at different regions of the European inland waterway network.
2. At the same time it is of great importance to start discussions within the EEC member states to have the INCARNATION results included in their respective policies.
3. It is equally important to consider the legal aspects of INCARNATION and the need for reserved radio frequencies.
4. In order to implement RISs across Europe, it is recommended that preparations are made with respect to:
   - the organisation of each RIS,
   - rules and regulations for satisfactory performance of a RIS within legislation (such as reporting and communication).
5. The EC and other responsible bodies, such as the Rhine and Danube Commissions should be informed at an early stage, in order to improve prospects for implementation.
6. There is a need to harmonise reporting and communication procedures as a part of European-wide RISs. The same is true for ECDIS standards.

Annexes

Glossary

AIMS	Automatic Identification and Data Management System
AIS	Automatic Identification System
CBS	Centraal Bureau voor de Statistiek (Central Bureau for Statistics)
ECU	European Unit of Account
ETA	Expected Time of Arrival
ETD	Expected Time of Departure
FIS	Fairway Information System
GIS	Geographic Information System
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organisation
Inland ECDIS	Inland Electronic Chart and Display System
IVS	Informatie Verwerkend Systeem (Information Processing System)
MIB	German Information Processing System
MTU	Mobile Transducer Unit
RIS	River Information Service
SROB	Shore based RADAR on board
STI	Strategical Traffic Image
TIRIS	Traffic Image of the River Information Service
TTI	Tactical Traffic Image
VHF	Very High Frequency
VTS	Vessel Traffic Service